SYMMETRIC FLOW PAST ORTHOTROPIC BODIES: SINGLE AND CLUSTERS

by

JACOB HESKEL MASLIYAH

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M.Sc., University of New Brunswick, 1966

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Department of Chemical Engineering

The University of British Columbia
Vancouver 8, Canada

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ABSTRACT

Numerical solution of the Navier-Stokes equation was successfully accomplished, using an adaptation of the relaxation technique of Jenson, for axisymmetric flow past single oblate and prolate spheroids at particle Reynolds numbers up to 100. The aspect ratio of the spheroids varied between 0.999 (nearly perfect sphere) and 0.2.

For low aspect ratios the surface pressure and vorticity distributions showed a marked difference from those of a sphere. The appearance of the wake bubble behind a spheroid was found to be a strong function of the particle shape.

Numerical solutions were also obtained for two-dimensional symmetric flow past elliptical cylinders, with the flow parallel to the major axis for aspect ratios of 0.995 to 0.2 at Reynolds numbers up to 90, and with the flow parallel to the minor axis for an aspect ratio of 0.2 at Reynolds numbers up to 40. The numerical solution was found to be less stable than the corresponding three-dimensional axisymmetric case.

The variation of the total drag coefficient with Reynolds number for the spheroids and the elliptical cylinders of various aspect ratios was not much different from that of a sphere and a circular cylinder, respectively. The results for both the spheroids and the elliptical cylinders showed a steady trend with Reynolds number from

Stokes and/or Oseen flow to boundary layer flow.

Happel's free surface cell model and Kuwabara's zero vorticity cell model were employed for the study of creeping flow past swarms of aligned spheroids and clusters of aligned elliptical cylinders. Large deviations of the Kozeny constant from its commonly assumed value of 5 for packed beds were found by both models for particles which deviate significantly in shape from a sphere or a circular cylinder.

In general, Happel's free surface model predicted lower total drag coefficients than did Kuwabara's zero vorticity model for both the swarms of spheroids and the clusters of elliptical cylinders.

Contours of the streamlines, equi-vorticity lines and equi-velocity lines are presented.

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CHAPTER I

Introduction

The wide range of applications in chemical and process engineering of systems in which motion takes place between a fluid and suspended solid particles has led to the need for a greater understanding of their underlying characteristics.

The most straightforward applications of particle dynamics occur in situations where mutual interaction of particles can be taken as negligible. Dust and mist collection from dilute suspensions of fine solid particles and from liquid drops in gases are simple practical examples of such idealization. One common application is in the elimination of atmospheric pollution, as in the cleaning of ventilating air. The recovery of valuable by-products from dusts leaving dryers and smelters represents another important application. Seepage of underground water, flow of oil in wells and sedimentation are a few more common examples of solid-fluid interactions.

Fluidization has become an important unit operation in the chemical industries, where fluidized bed reactors are designed in which not only chemical reaction, but also heat transfer and mass transfer, can take place in the bed. Rates at which these transfer processes occur are strongly influenced by the mechanics of the fluid flow, knowledge of which is basic

in the fundamental study of the transport phenomena and the relationship between them (1, 2, 4, 8).

Gravitational and centrifugal separation processes are also widely employed in the chemical industry and have received the attention of chemical and mining engineers over a long period. However, sedimentation and thickening devices and the classification of particles by hindered settling are usually still designed on a fairly empirical basis.

More theoretical work will give a better understanding of particle-fluid interactions, and it seems reasonable to suppose that the design of any device which involves such interactions could be made more rational as one acquires more knowledge of the laws governing them.

CHAPTER II

Review of Prior Work

The study of the steady isothermal laminar flow of an incompressible viscous Newtonian fluid about an impermeable rigid body immersed therein requires the simultaneous solution of the Navier-Stokes and the continuity equations, subject to the prevailing boundary conditions. The non-linearity of the Navier-Stokes equations renders their solution very difficult, and only a relatively small number of exact solutions of rather specialized character are known: Lamb (5), Dryden (6), and Payne and Pell (7). In many cases, however, the flow is such that reasonable simplifying assumptions regarding its character can be made which result in a less complicated mathematical problem. Indeed, a large part of the theory of viscous flows consists of problems obtained in this manner, c.f. Happel and Brenner (8) and Brenner (9).

1. Review of Analytical Work

A. Single Bodies

The mathematical analysis of the flow past isolated bodies is the first stage in the understanding of particle-fluid interactions. In the present study of symmetric flow past orthotropic bodies, two classes of bodies were considered, namely, spheroids and elliptical cylinders. A sphere and a circular cylinder are each a special case of a spheroid and an

elliptical cylinder, respectively. An orthotropic particle is defined as a body which possesses three mutually perpendicular symmetry planes. It includes ellipsoids (spheroids being a special case of an ellipsoid), right elliptical cylinders and rectangular parallelepipeds (8).

The Navier-Stokes equation for steady state axisymmetric or two-dimensional flow, expressed in orthogonal curvilinear coordinates in terms of the dimensional stream function ψ', is

$$\nu E'^4 \psi' = h_1 h_2 h_3 \frac{\partial(\psi', E'^2\psi')}{\partial(\xi,\eta)} - 2E'^2\psi' h_1 h_2 h_3^2 \frac{\partial(\psi', h_3^{-1})}{\partial(\xi,\eta)} \quad (1)$$

where h_1, h_2 and h_3 are the dimensional metric coefficients, ν is the kinematic viscosity and

$$E'^2 = \frac{h_1 h_2}{h_3}\left[\frac{\partial}{\partial\xi}\left(\frac{h_3 h_1}{h_2}\frac{\partial}{\partial\xi}\right) + \frac{\partial}{\partial\eta}\left(\frac{h_3 h_2}{h_1}\frac{\partial}{\partial\eta}\right)\right] \quad (2)$$

(ξ,η) being the curvilinear coordinates. The elliptical, spherical and spheroidal coordinate systems are discussed with excellent clarity by Happel and Brenner (8) and by Goldstein (10). Equation 1 is of the fourth order in ψ' and it is not linear because of the presence of the terms on the right-hand side, contributed by the inertial effects. Another form of the Navier-Stokes equation is given by

$$\rho\, \bar{v}'.\bar{\nabla}\, \bar{v}' - \mu\, \bar{\nabla}^2 \bar{v}' = -\bar{\nabla} P' \quad (3)$$

where ρ is the density, μ is the viscosity, P' is the dimensional dynamic pressure and $\bar{v}'$ is the dimensional velocity vector. The operators $\bar{\nabla}$ and $\bar{\nabla}^2$ are given by

$$\bar{\nabla} = i_1 h_1 \frac{\partial}{\partial q_1} + i_2 h_2 \frac{\partial}{\partial q_2} + i_3 h_3 \frac{\partial}{\partial q_3} \qquad (4)$$

and

$$\bar{\nabla}^2 = h_1 h_2 h_3 \left[\frac{\partial}{\partial q_1} \left(\frac{h_1}{h_2 h_3} \frac{\partial}{\partial q_1} \right) + \frac{\partial}{\partial q_2} \left(\frac{h_2}{h_3 h_1} \frac{\partial}{\partial q_2} \right) + \frac{\partial}{\partial q_3} \left(\frac{h_3}{h_1 h_2} \frac{\partial}{\partial q_3} \right) \right] \qquad (5)$$

respectively, (q_1, q_2, q_3) being the curvilinear coordinates and (i_1, i_2, i_3) the unit vectors.

A.1 Spheroids

The oldest formulation of flow past an obstacle is the so-called "Stokes flow". It is defined by the assumption that the inertial effects are negligible in comparison with those of viscosity, or more precisely, that the Reynolds number of the flow is very small. This situation is obtained when the characteristic flow velocity and/or the body dimension appearing in the Reynolds number are sufficiently small, and/or the kinematic viscosity is large (8).

Stokes (3), in 1851, while considering the motion of a sphere in a viscous fluid, seems to have been the first to omit the inertial terms of the Navier-Stokes equation, which then reduces to

$$E^{4} \psi = 0 \qquad (6)$$

Such a simplification of the equation of motion is very substantial, for the equation of motion thus becomes linear.

This means, for example, that if ψ'_1 and ψ'_2 each separately satisfy the aforementioned equation, then so does $\psi'_1 + \psi'_2$. Exact solutions are then feasible even for relatively complex geometries, via classical superposition techniques applicable to linear partial differential equations. A general solution in spherical coordinates has been developed by Sampson (11) using the separation of variables technique. It has also been given independently by Savic (12) and by Haberman and Sayre (13), and has been reviewed by Happel and Brenner (8).

The complete solution of equation 6 for the stream functions is given by

$$\psi'(r,\theta) = \sum_{0}^{\infty} (A_n r^n + B_n r^{-n+1} + C_n r^{n+2} + D_n r^{-n+3}) I_n(\zeta) + \sum_{2}^{\infty} (A'_n r^n + B'_n r^{-n+1} + C'_n r^{n+2} + D'_n r^{-n+3}) H_n(\zeta) \quad (7)$$

where (r,θ) are the spherical coordinates, while A_n, B_n, C_n and D_n and the corresponding primed terms are constants. The term ζ is defined by $\zeta = \cos\theta$. $I_n(\zeta)$ and $H_n(\zeta)$ are Gegenbauer functions of order n anddegree -1/2 of the first and second type, respectively.The constants are evaluated from the applicable boundary conditions.For the no-slip condition at the sphere and the uniform streaming condition at infinity , the Stokes stream function as given by equation 7 becomes

$$\psi' = \frac{1}{4} U a^2 \left(\frac{a}{r} - \frac{3r}{a} + 2 \frac{r^2}{a^2}\right) \sin^2\theta \qquad (8)$$

where a is the radius of the sphere and U is the velocity of the undisturbed stream, the line $\theta = 0$ being in the direction of the undisturbed stream.

The dimensional surface pressure is then given by

$$P' = \frac{1}{2} \rho U^2 \left(1 + \frac{6}{Re} \cos\theta\right) \qquad (9)$$

where Re is the Reynolds number defined as

$$Re = \frac{2\rho U a}{\mu} \qquad (10)$$

The drag force experienced by the sphere is given by

$$F = 4\pi\mu D_2 \qquad (11)$$

where D_2 is a constant from equation 7 which is equal to $\frac{3}{2} a U$. Hence

$$F = 6\pi\mu aU \qquad (12)$$

This is the well known Stokes' law of resistance.

The general solution of the creeping flow equation 6 for spheroidal coordinates is given by Sampson (11):

$$\begin{aligned}\psi' = {} & C_0 + D_1\tau + I_2(\zeta)\{B_2\tau + C_2 I_2(\tau) + D_2 H_2(\tau) + B_4^* H_4(\tau)\} \\ & + I_3(\zeta)\{B_3 + D_3 H_3(\tau) + B_5^* H_5(\tau)\} \\ & + I_4(\zeta)\{B_4^* H_2(\tau) + D_4 H_4(\tau) + B_6^* H_6(\tau)\}\end{aligned} \qquad (13)$$

where

$$\tau = \cosh\xi \qquad (14)$$

and

$$\zeta = \cos \eta \tag{15}$$

For a prolate spheroid one obtains

$$\psi' = I_2(\zeta) \{ B_2\tau + C_2 I_2(\tau) + D_2 H_2(\tau) \} \tag{16}$$

For an oblate spheroid the stream function ψ' is given by simply replacing τ in equation 16 by $i\lambda$, where λ is $\sinh \xi$.

For the no-slip condition at the spheroid surface and a uniform stream condition at infinity, the Stokes stream functions given by equation 16 for a prolate spheroid and by its transformed form for an oblate spheroid become respectively

$$\psi' = 1/2\ U\ c^2(\tau^2-1)(1-\zeta^2) \left(1 - \frac{\{(\tau_a^2+1)/(\tau_a^2-1)\} \coth^{-1}\tau - \{\tau/(\tau^2-1)\}}{\{(\tau_a^2+1)/(\tau_a^2-1)\} \coth^{-1}\tau_a - \{\tau_a/(\tau_a^2-1)\}} \right) \tag{17}$$

and

$$\psi' = 1/2\ U\ c^2(\lambda^2+1)(1-\zeta^2) \left(1 - \frac{\{\lambda/(\lambda^2+1)\} - \{(\lambda_a^2-1)/(\lambda_a^2+1)\} \cot^{-1}\lambda}{\{\lambda_a/(\lambda_a^2+1)\} - \{(\lambda_a^2-1)/(\lambda_a^2+1)\} \cot^{-1}\lambda_a} \right) \tag{18}$$

where subscript a denotes the surface and c the focal length of the spheroid. Payne and Pell (7) arrived at the same expressions by using Weinstein's generalized axially symmetric potential theory.

The drag force (7,8) experienced by the spheroid is then given by

$$F = 6\pi\mu\, U a_e K \tag{19}$$

where a_e is the equatorial radius of the spheroid and

$$K_{oblate} = \frac{1}{\frac{3}{4}\sqrt{\lambda_a^2+1}\ \{\ \lambda_a - (\lambda_a^2+1)\ \cot^{-1}\lambda_a\ \}} \qquad (20)$$

while

$$K_{prolate} = \frac{1}{\frac{3}{4}\sqrt{\tau_a^2-1}\ \{(\tau_a^2+1)\ \coth^{-1}\tau_a - \tau_a\}} \qquad (21)$$

A comparison of the drag force experienced by a spheroid as given by equation 19 with that for a sphere, equation 12, shows that the ratio of the two drag forces is given by the factor K. Despite a misprint in their expression for K_{oblate}, Happel and Brenner (8) provide an accurate tabulation of K as a function of aspect ratio A.R. for both oblate and prolate spheroids, A.R. being defined as the ratio of minor axis to major axis of the spheroid. For a thin circular disc (A.R. = 0), the tabulated value of K is 0.84883. A circular disc is, of course, the limiting case of an oblate spheroid whose minor axis is zero. The drag force experienced by a disc can be obtained from equations 19 and 20 as $\lambda_a \to 0$, giving

$$F = 16\ \mu\ a_e\ U \qquad (22)$$

Similar expressions for the drag force are given by Sampson (11), Ray (14), Roscoe (15) and Gupta (16).

The dimensionless surface pressure distribution for Stokes flow past an oblate spheroid is

$$P = 1 + \frac{6K_{oblate}}{Re}\left(\frac{\lambda_a^2+1}{\lambda_a^2+\cos^2\eta}\right)\cos\eta \qquad (22a)$$

and for a prolate spheroid,

$$P = 1 + \frac{6K_{prolate}}{Re}\left(\frac{\lambda_a^2}{\lambda_a^2 + \sin^2\eta}\right)\cos\eta \qquad (22b)$$

Once again the unity term of equations 22a and 22b comes from consideration of the inertial terms in the Navier-Stokes equations, since for strictly creeping flow it is absent.

It should also be mentioned that Oberbeck (17) in 1876 solved the problem of the steady translation of an ellipsoid in a viscous liquid without the use of the stream function (due to lack of symmetry), using instead the velocity components expressed in terms of the gravitational potential of the ellipsoid. For the ellipsoids of revolution one obtains the same results as given by equations 17 and 18. Lamb (5) discusses Oberbeck's technique in detail.

The case when the inertial effects of the flow are small but not negligible was first unsuccessfully treated by Whitehead (18), who attempted to extend Stokes' original solution for a translating sphere to higher Reynolds numbers using a simple perturbation technique. This technique starts with the Stokes' solution of the creeping flow equation,

$$\mu\,\bar{\nabla}^2\bar{v}_0' - \bar{\nabla}\,P_0' = 0 \qquad (23)$$

and the continuity equation,

$$\bar{\nabla}\cdot\bar{v}_0' = 0 \qquad (24)$$

for the boundary conditions of no slip at the surface and an undisturbed parallel flow at infinity. This solution, given

by $(\bar{v}_0', P_0')$, is then used for the inertial term of the Navier-Stokes equation as follows:

$$\mu \bar{\nabla}^2 \bar{v}_1' - \bar{\nabla} P_1' = \rho \bar{v}_0' \cdot \bar{\nabla} \bar{v}_0' \tag{25}$$

$$\bar{\nabla} \cdot \bar{v}_1' = 0 \tag{26}$$

$\bar{v}_1'$ being the improved velocity vector of the flow field. Even though equation 25 is now linear and hence easier to solve than the complete Navier-Stokes equation, there exists unfortunately no exponentially decaying solution that can satisfy the boundary conditions, $\bar{v}_1' = \bar{0}$ at the surface and $\bar{v}_1' = \bar{U}$ far away from the surface. Moreover, as Happel and Brenner (8) point out, the next approximation for velocity, $\bar{v}_2'$, becomes infinite at infinity. The results given by such perturbation are referred to as Whitehead's paradox.

Oseen (19, 20) showed that Stokes' solution of the linearized Navier-Stokes equation is of the form $\bar{v}' = \bar{U} + Ua\ 0(1/r)$. Hence at large distances from the surface of the sphere the inertial term $\rho \bar{v}_0' \cdot \bar{\nabla} \bar{v}_0'$ becomes $\rho U^2 a 0(1/r2)$ and the viscous term $\mu \bar{\nabla}^2 \bar{v}_0'$ becomes $\mu Ua\ 0(1/r3)$. The ratio of the inertial to the viscous term then becomes of the order $\frac{\rho Ur}{\mu}$. This ratio increases indefinitely with r however small U/ν may be. For this reason Stokes' creeping flow equation cannot be considered as valid at points far away from the sphere unless $Re \to 0$. At points near the sphere the inertial forces tend to vanish while the viscous forces are of the order $\frac{Ua\mu}{r^3}$. This means that Stokes' approximation for the flow field is not uniformly valid throughout but breaks down at a large distance from the

sphere, and hence $\bar{v}_0'$ does not give an accurate estimate of the inertial term at such large distances. Consequently it cannot be used for the first approximation of the inertial terms as proposed by Whitehead.

Oseen suggested that the inertial term $\rho\, \bar{v}' . \bar{\nabla}\, \bar{v}'$ be replaced by $\rho \bar{U} . \bar{\nabla}\, \bar{v}'$, giving

$$\mu \bar{\nabla}^2 \bar{v}' - \bar{\nabla} P' = \rho\, \bar{U} . \bar{\nabla} \bar{v}' \tag{27}$$

$$\bar{\nabla} . \bar{v}' = \bar{0} \tag{28}$$

The inertial terms are thus to some extent taken into account, the previous approximation being much improved at infinity but somewhat impaired near the surface. The drag force experienced by a sphere is then given by

$$F = 6\pi\mu\, a\, U\, (1 + (3/16)\, Re) \tag{29}$$

where a is the radius of the sphere and Re is the Reynolds number based on the sphere diameter.

Oseen's original solution of equations 27 and 28, also developed independently by Burgers et al. (21) in 1916, is only an approximate solution. The complete analytical solution of Oseen's equations was first derived by Goldstein (22, 23), giving the drag force as a series in Reynolds number:

$$F = 6\,\pi\mu U \left[1 + \frac{3}{16} Re - \frac{19\, Re^2}{1280} + \frac{71\, Re^3}{20480} - \frac{30179\, Re^4}{34406400} + \frac{122519\, Re^5}{560742400} - \cdots \right] \tag{30}$$

The first term of the above equation is the value given by

Stokes, while the second term is that given by Oseen and by Burgers et al. For values of Re up to and including 2, the drag can be calculated from the series as given by equation 30. For Re up to 20, Goldstein presented a tabulation of F against Re obtained by solving one of the intermediate steps of Oseen's equations numerically.

Tomotika and Aoi (24) considered Oseen's equations and obtained the dimensional stream function as

$$\psi' = - U a^2 \{ \frac{3}{4} \cdot (\frac{r}{a} - \frac{a}{r}) - \frac{16 + 3 Re}{32} (\frac{r^2}{a^2} - \frac{a}{r}) + \frac{3 Re}{32} (\frac{r^2}{a^2} - \frac{a^2}{r^2}) \cos \theta \} \sin^2\theta \qquad (31)$$

In the limit when $Re \to 0$ the above equation degenerates into the well known Stokes stream function as given by equation 8. Based on the above expression for ψ', Tomotika and Aoi claimed that a small vortex is formed behind a sphere even for Re as low as 1.0. Pearcey and McHugh (25a), however, in their detailed computation of Oseen's equations, pointed out that no vortex is attached to the rear of the sphere even at Re = 10, and that equation 31 is only very approximate as it was obtained by an early truncation of the series for one of the constants in the solution. The dimensionless surface pressure distribution, P, given by Pearcey and McHugh (25a) could be put in the form

$$P = \frac{P'}{1/2\rho U^2} = 2 \sum_0^\infty A_n P_{n+1} \cos\theta \qquad (32)$$

where P_{n+1} is a Legendre polynomial of the first kind. A

tabulation of the coefficient A_n is given in Table 1.

Table 1. Values of the coefficient A_n

Re n	1 Ref (25a)	4 Ref (25a)	10 Ref (25a)	$\to \infty$ Ref (25b)
0	3.52627	1.21748	0.7169	0.13225
1	0.45078	0.38926	0.32761	0.23725
2	0.2216×10^{-2}	0.15192×10^{-1}	0.3363×10^{-3}	0.1600
3	-0.7004×10^{-4}	-0.1323×10^{-1}	-0.402×10^{-2}	-0.0055
4	0.1726×10^{-5}	0.861×10^{-4}	0.22×10^{-3}	-0.05
5	-0.3496×10^{-7}	-0.421×10^{-5}	-0.1×10^{-4}	0.003
6	0.6×10^{-9}	0.14×10^{-6}		0.0270
7				-0.002
8				-0.0165
9				0.002
10				0.012

It is interesting to note that Tomotika and Aoi (24) observed Oseen's solution to give a constant ratio of the form (pressure) to friction (skin) drag coefficient whatever the value of the Reynolds number.

The solution of Oseen's equations for the case of a spheroid was effected by an approximate method by Oseen himself (26). Aoi (27), using an exact analytical technique as outlined by Goldstein (22, 23), obtained identical expressions to Oseen's for both the form and the skin drag forces. In order to maintain conformity with the corresponding creeping flow solutions, the expression for the total drag force becomes

$$F = 6 \pi \mu U a_e K \{ 1 + \frac{3 K Re}{16} \} \qquad (33)$$

where K is given by equation 20 for an oblate spheroid and by equation 21 for a prolate spheroid, while Re is based on the equatorial diameter of the spheroid. The ratio of the form drag to the skin drag for a prolate and an oblate spheroid as developed by Aoi (27) is given by

$$F_F/F_S = \frac{(\tau_a^2 - 1)(\tau_a \coth^{-1} \tau_a - 1)}{1 - (\tau_a^2 - 1)(\tau_a \coth^{-1} \tau_a - 1)} \qquad (34)$$

and

$$F_F/F_S = \frac{(\lambda_a^2 + 1)(1 - \lambda_a \cot^{-1} \lambda_a)}{1 - (\lambda_a^2 + 1)(1 - \lambda_a \cot^{-1} \lambda_a)} \qquad (35)$$

for a prolate and an oblate spheroid, respectively. According to the above expressions, the ratio of the drag forces are independent of Re.

While Oseen's linearized inertial term seems a satisfactory approximation to the true inertial term in the Navier-Stokes equation at great distances from the body, controversy has been aroused by the fact that it appears to be a poor approximation in the neighbourhood of the body. The unsatisfactory status of the Oseen equations persisted until the work of Lagerstrom and Cole (28), Kaplun (29), Proudman and Pearson (30) and Kaplun and Lagerstrom (32), who suggested that one should abandon the attempt to obtain perturbation fields which are uniformly valid throughout the flow field and seek instead to find separate asymptotic solutions which are locally valid in the separate regions near to, and far from, the body. These "inner" and "outer" solutions are each deter-

mined by asymptotically matching them in their common domain of validity.

The expression of Proudman and Pearson (30) for the drag force experienced by a sphere placed in a uniform streaming flow is given by

$$F = 6 \pi \mu U a \left(1 + \frac{3}{16} Re + \frac{9}{160} Re^2 \ln (Re/2)\right) \qquad (36)$$

The first two terms are identical to Oseen's expression, equation 29. The above expression gives better agreement with experimental data than Oseen's expression, up to Re of 2. Unfortunately, for Re > 2, the logarithmic term of equation 36 becomes large and thus the equation diverges and can no longer be used to evaluate the drag force. Breach (31b) extended the technique of Proudman and Pearson to include some other terms, giving

$$F = 6 \pi \mu U a \left(1 + \frac{3}{16} Re + \frac{9}{160} Re^2 \ln (Re/2) + \frac{Re^2}{4}\left(\frac{9\gamma}{40} + \frac{3}{8} \ln 2 - \frac{323}{1600}\right) + \frac{27}{640} Re^3 \ln \frac{Re}{2}\right) + \cdots \qquad (37)$$

where $\gamma = 0.5772...$ is Euler's constant. The terms in Re^2 and $Re^3 \ln \frac{Re}{2}$ are new. The new drag equation does not provide any improvement on the previous results by Pearson and Proudman and cannot be used for Re > 0.7. Breach (31a) generalized the above results to render them applicable to spheroids. These solutions are again limited by the nature of the approximations and prove to be inadequate for Re > 2. The expression for the drag force on spheroids can be rewritten in the form

$$F = 6 \pi \mu U a_e K \{1 + \frac{3}{16} Re K + \frac{9 K^2}{160} Re^2 \ln \frac{Re}{2} \} \quad (38)$$

Once again the first term in the above equation is for creeping flow, the second being Oseen's extension while the third is new. For a sphere, K = 1 and equation 38 becomes identical to that of Proudman and Pearson.

A.2 Elliptical Cylinders

For the two-dimensional problem of streaming flow past a circular cylinder in an infinite medium, the creeping flow equation 6 has no valid solution that can satisfy both the no-slip condition at the surface of the cylinder and uniform streaming flow at infinity. This situation was discovered by Stokes (65) and is usually referred to as "Stokes Paradox". Krakowski and Charnes (66) generalized Stokes' Paradox to include any two-dimensional body placed in a medium which is infinite in all directions. Invalid solutions which defy Stokes' paradox for the streaming motion perpendicular to the axis of a circular cylinder are given by Berry and Swain (67), Wilton (68) and Harrison (69).

Lamb (5) applied Oseen's equations to the case of flow past a circular cylinder, and the difficulty of satisfying all the boundary conditions disappeared. His approximate solution to Oseen's equations gives the drag force per unit length of the cylinder as

$$F = \frac{4 \pi \mu U}{\frac{1}{2} - \gamma - \ln(Re/8)} \quad (39)$$

The validity of Lamb's equation is well established by the experimental results of Wieselsberger (147), Finn (146), and Jayaweera and Mason (145). The exact solution of Oseen's equations was obtained by Tomotika and Aoi (24). Their expression for the dimensional stream function is

$$\psi' = a\,U\,\{A\,(\frac{r}{a} - \frac{a}{r}) - B\,\frac{r}{a}\ln(r/a)\}\sin\theta + \{C\,(\frac{r^2}{a^2} - \frac{a^2}{r^2}) + D\,\frac{r^2}{a^2}\ln(r/a)\}\sin 2\theta \qquad (40)$$

where $A = \frac{1}{2}\,B = \frac{1}{2(\ln Re - 2.0022)}$,

$C = -\frac{Re}{16}$, $D = -B\,C$,

and a is the cylinder radius. As for the case of sphere, the authors (24) claim that the above expression predicts a vortex at the rear of the cylinder. It is very likely that this expression is too approximate in its derivation to put any weight on the streamlines given by it. The force per unit length is given by

$$F = 2\pi\mu U \sum_0^\infty B_m \quad , \qquad (41)$$

and the evaluation of the constants B_0, B_1 and B_2 were done numerically. In a further paper Tomotika and Aoi (70) expressed the drag force per unit length in series terms of S and Re:

$$F = \frac{4\pi U\mu}{S}\left[1 - \frac{1}{S}\left(S^2 - \frac{S}{2} + \frac{5}{16}\right) \frac{Re^2}{32} - \right.$$

$$\left. \frac{1}{S^2}\left(S^4 - \frac{1}{3}S^3 + \frac{7}{72}S - \frac{25}{256} \right) \frac{Re^4}{1024} \right] \qquad (42)$$

where

$$S = 0.5 - \gamma - \ln (Re/8) \ , \qquad (43)$$

γ being Euler's constant. The first term in equation 42 is that obtained by Lamb (5). For Re < 0.5, Lamb's expression is quite adequate. The drag force per unit length obtained by equation 42 agrees quite well with the numerical solution of equation 41 up to Re = 2.0. Using Oseen's equation, Tomotika and Aoi found that the relative contributions of the form drag and the skin drag to the total drag were the same and independent of Reynolds number. Kaplun (29) applied the inner and outer expansions for the flow past a circular cylinder and obtained the force per unit length as

$$F = \frac{4\pi\mu\ U}{S}\left(1 - \frac{0.87}{S^2} \right) \qquad (44)$$

where S is given by equation 43.

The flow past an elliptical cylinder in an unbounded fluid falls in the realm of two-dimensional flow and thus no valid solution could be obtained for the creeping flow equation. Invalid solutions which contravene Stokes paradox are discussed by Berry and Swain (67).

Oseen's equations were solved approximately by Harrison (69) and by Bairstow et al. (71). The drag force per unit length on the elliptical cylinder whose major axis, a, is parallel to the stream is given by

$$F = \frac{4\pi\mu U}{\frac{1}{2}(1+\sigma) - \gamma - \ln Re/8\,(1+\sigma)} \qquad (45)$$

where $\sigma = \frac{1 - b/a}{1 + b/a}$ and $Re = \frac{2\rho U a}{\mu}$.

The drag force per unit length experienced by an elliptical cylinder whose minor axis, b, is parallel to the stream is given by

$$F = \frac{4\pi\mu U}{\frac{1}{2}(1-\sigma) - \gamma - \ln \frac{Re}{8(1+\sigma)}} \qquad (46)$$

For a circular cylinder a=b and equations 45 and 46 collapse into equation 39, given by Lamb. When $\sigma = 1$ equations 45 and 46 give the drag force per unit length on a flat plate for flow parallel and perpendicular to the plate, respectively. Tomotika and Aoi (73), using an exact solution of Oseen's equation, obtained the drag force per unit length for the flow along and perpendicular to the major axis of an elliptical cylinder as

$$F = \frac{4\pi\mu}{L}\left(1 - \frac{Re^2}{32[1+\sigma]^2 L}\ x\right.$$

$$\{L^2 - \tfrac{1}{2}[1+2\sigma-\sigma^2\ ]L + \tfrac{1}{48}[15-4\sigma-18\sigma^2\ -12\sigma^3\ -\sigma^4\ ]\}\ -$$

$$\frac{Re^4}{32^2[1+\sigma]^4\ L^2}\{L^4 - \tfrac{1}{48}\ [31\sigma+10\sigma^2-6\sigma^3+10\sigma^4+\sigma^5]L^2 - \tfrac{1}{12}[4-3\sigma^2-2\sigma^3]L^3 +$$

$$\tfrac{1}{2880}\ [280+1185\sigma-987\sigma^2-2065\sigma^3-90\sigma^4+525\sigma^5+85\sigma^6+3\sigma^7]\ L\ -$$

$$\left.\tfrac{1}{2304}\ [225-120\sigma-524\sigma^2-216\sigma^3+390\sigma^4+440\sigma^5+180\sigma^6+24\sigma^7+\sigma^8]\}\right) \quad (47)$$

where $L = \frac{1}{2}\ (1 + \sigma) - \gamma - \ln Re/8(1 + \sigma)$
and

$$F = \frac{4\pi\mu}{L}\left(1 - \frac{Re^2}{32[1+\sigma]^2\ L}\ x\right.$$

$$\{L^2 - \tfrac{1}{2}[1-2\sigma-\sigma^2]\ L + \tfrac{1}{48}[15+4\sigma-18\sigma^2+12\sigma^3-\sigma^4]\}\ -$$

$$\frac{Re^4}{32^2[1+\sigma]^4\ L^2}\{L^4 - \tfrac{1}{12}[4-3\sigma^2+2\sigma^3]L^3 - \tfrac{1}{48}[31\sigma+10\sigma^2-6\sigma^3+10\sigma^4+\sigma^5]L^2 +$$

$$\tfrac{1}{2880}[280-1185\sigma-987\sigma^2+2065\sigma^3-90\sigma^4-525\sigma^5+85\sigma^6-3\sigma^7]L\ -$$

$$\left.\tfrac{1}{2304}[225-120\sigma-524\sigma^2-216\sigma^3+390\sigma^4+440\sigma^5+180\sigma^6+24\sigma^7+\sigma^8]\}\right)$$

(48)

where $L = \frac{1}{2}\ (1 - \sigma) - \gamma - \ln Re/8(1 + \sigma)$, respectively.

Clearly the first term of equation 47 and 48 is equivalent to equations 45 and 46 respectively.

Tomotika and Aoi (73) have indicated that the solutions obtained by Sidrak (75) for the drag force on an elliptical cylinder, and that by Davies (74) for a flat plate, are in error. Piercy and Winny (72) obtained an expression for the drag force on a flat plate up to terms in Re^2 which is in agreement with the corresponding expression of Tomotika and Aoi. The drag force as given by equation 47 and 48 can be assumed to be valid up to $Re \sim 2$. Imai (76) considered the uniform flow past an elliptical cylinder at an arbitrary angle of incidence, his results for the special cases of flow parallel to the major and flow parallel to the minor axis being in agreement with equation 47 and 48.

For high Reynolds numbers, Oseen's asymptotic theory for $Re \to \infty$ can reproduce the patterns of real flow to a rather surprising extent, according to Müller (77). Oseen (26) applied the asymptotic theory to the case of a circular cylinder and a flat plate. Stewartson (25b) applied the theory for flow past a sphere, while Hocking (78, 79) studied the flow past a circular disc set perpendicular to the flow. Tamada and Miyagi (80) studied the flow past a flat plate set perpendicular to the stream and obtained an approximate formula for the drag force per unit length of the plate at finite Re:

$$F = \frac{1}{2} \rho U^2 L \left[\pi + 8 \Gamma\left(\frac{3}{4}\right) Re^{-3/4}\right] \qquad (49)$$

where L is the plate width, $Re = U L/\nu$ and Γ is the Gamma function. The first term of equation 49 is the asymptotic value of F for $Re \to \infty$. An improvement on equation 49 was also made by Miyagi (81a, 81b) for Re of 4, 8, 12, 24 and 96. Kuo (2) improved Blasius' solution (83) for the drag force experienced by a flat plate set along the streaming flow at intermediate Reynolds numbers, using boundary layer theory.

B. Swarms

It is natural to suppose that the disturbance due to a body immersed in a flowing fluid spreads in the flow field and that the presence of more than one body in an otherwise uniform flow gives rise to a mutual interaction between the immersed bodies. Many attempts have been made to develop a reliable theoretical relationship between the concentration of such a "swarm" and the force exerted on a given body within the swarm, in order to predict, for example, the settling rate in the case of sedimentation, or the pressure drop across a packed bed of particles.

The basic equation for creeping flow through a granular bed is given by Darcy's (94) empirical equation of permeability, which is now commonly written as

$$U = \frac{K}{\mu}\left[\frac{\Delta P'}{L'}\right] \qquad (50)$$

where U is the superficial velocity (empty tube velocity), K is the permeability of the bed and $\Delta P'$ is the pressure drop across the bed depth L'. Emersleben (95) and Slichter (96) tried, with not much success, to justify Darcy's equation on theoretical grounds.

Blake (98) accepted Dupuit's (97) assumption that the interstitial velocity through a granular bed equals U/ε, where ε is the porosity of the bed (volume of pore space per unit volume of bed) and by dimensional analysis extended equation 50 to

$$U = \frac{\varepsilon^3}{k\,\mu\,S^2}\,\frac{\Delta P'}{L'} \qquad (51)$$

where k has become known as Kozeny's constant and S is the particle surface area per unit volume of the bed. Kozeny (99) subsequently derived the above equation by assuming that a packed bed consists of a group of similar parallel channels (capillaries) such that the total internal surface and the total internal volume are equal to the particle surface and the pore volume, respectively (100). Introducing the hydraulic radius, m, defined as the ratio of the volume occupied by the flowing fluid to the wetted surface, gives

$$S = \varepsilon / m \qquad (52)$$

combining equations 50, 51 and 52 yields

$$K = m^2 \varepsilon / k \qquad (53)$$

Letting S_v be the specific surface of the particles then

$$S = S_v (1 - \varepsilon) \qquad (54)$$

and substituting equation 54 into equation 51,

$$U = \left[\frac{\Delta P'}{L'} \right] \frac{\varepsilon^3}{\mu k (1 - \varepsilon)^2 S_v^2} \qquad (55)$$

Equation 55 is known as the Carman-Kozeny equation. Kozeny realized that, owing to the tortuous character of the flow through packed beds, the length of the equivalent channel should be L_e' , where $L_e' > L'$. Hence $k = k_o (L_e' / L')^2$, where k_o is the capillary constant; $k_o = 2$ for a circular channel. Davies (101), Piercy et al. (102), Fair and Hatch (103) and Ratkowsky and Epstein (104) showed that k_o for various non-circular channel shapes considered lies in general, between 1.7 and 3.0. The ratio L_e' / L' is termed the tortuousity. The Kozeny constant k is a function of the porosity of the bed, as well as of the particle shape and orientation. The principal shortcomings of the Carman-Kozeny equation are that it overcorrects for $\Delta\varepsilon$ due to changes in particle properties as opposed to $\Delta\varepsilon$ due to changes in degree of packing (105) and that it is invalid for high Reynolds numbers and for high porosities (105). A review on the Carman-Kozeny equation and some twenty other empirical correlations is given by Epstein (105).

For low Reynolds numbers flow, the technique of reflections can be used for dilute assemblages or swarms of particles. This method, in simple terms, involves a piece-wise matching of boundary conditions on the boundary surfaces, including the container walls, using a set of partial solutions. A general discussion on this technique is given by Happel and Brenner (8). Smoluchowski (84, 85, 86) considered an assemblage of n falling spheres having a cubic arrangement both in an infinite stagnant medium and in a container. For the latter case, the drag force experienced by a given sphere in the assemblage is given by

$$F = 6\pi \mu a U (1 + 2.6 a/h) \qquad (56)$$

where h is the distance between the centres of two spheres in the assemblage. Burgers (87), McNown and Lin (88) and Lin (89) obtained approximately the same expression as above for a dilute cubic assemblage ($a/h >> 1$) . The concentration of the spherical bodies in a cubic assemblage is given by

$$c = \frac{4\pi}{3} (a / h)^3 \qquad (57)$$

and equation 56 therefore becomes

$$F = 6\pi \mu U a (1 + 1.61 c^{1/3}) \qquad (58)$$

Famularo (92) extended the technique of reflections and obtained the drag force experienced by a sphere in a dilute assemblage of cubic, rhombohedral and random suspensions as

$$F = 6\pi \mu U a (1 + 1.91 c^{1/3}) \quad (59)$$

$$F = 6\pi \mu U a (1 + 1.79 c^{1/3}) \quad (60)$$

and

$$F = 6\pi \mu U a (1 + 1.3 c^{1/3}) \quad (61)$$

respectively. The reflection technique becomes extremely tedious for concentrated suspensions and is therefore not commonly used for such suspensions, its applicability being confined to dilute systems.

Another important technique used to evaluate the drag force on a particle in a swarm of other particles is the "cell method". This method is based on the concept that an assemblage of particles can be divided into a number of identical cells, one particle occupying each cell. This method is more applicable than the method of reflections to concentrated suspensions, especially where the wall effect due to the vessel containing the suspension is negligible.

Cunningham (118) used the cell model to predict the drag force F for a swarm of spheres. He considered that the swarm could be represented by a rigid sphere surrounded by a rigid outer envelope. This model presents the difficulty that the position of the outer envelope is empirically determined.

Uchida (90) investigated a cubic assemblage using a cubic model, and obtained for a dilute swarm of spheres

$$F = 6\pi \mu U a (1 + 2.1 c^{1/3}) \quad (62)$$

Kawaguchi (91) used another cell model for spheres by considering a sphere within a frictionless cylinder, and obtained

$$F = 6\pi \mu U a (1 - \frac{1.649}{M} c^{1/3} + 0.7968 c)^{-1} \quad (63)$$

where M = 0.9095 for a cubic assemblage and M = 1.1458 for a body-centred lattice. For high dilution, i.e. $c \to 0$, equation 63 becomes

$$F = 6\pi \mu U a (1 + \frac{1.649}{M} c^{1/3}) \quad (64)$$

Happel and Ast (125) obtained a similar expression.

Hasimoto (93) constructed a periodic array by repeating a basic cell. He replaced each sphere by a point force retarding the flow and obtained expressions for F using Fourier series for simple, body-centred and face-centred cubic arrangements. His respective expressions for the creeping flow régime are:

$$F = 6\pi \mu U a (1 - 1.76 c^{1/3} + c - 1.5593 c^2)^{-1} \quad (65)$$

$$F = 6\pi \mu U a (1 - 1.791 c^{1/3} + c - 0.329 c^2)^{-1} \quad (66)$$

$$F = 6\pi \mu U a (1 - 1.791 c^{1/3} + c - 0.302 c^2)^{-1} \quad (67)$$

When $c \to 0$, equation 65 becomes

$$F = 6\pi \mu U a (1 + 1.76 c^{1/3}) \qquad (68a)$$

and equation 66 and 67 becomes

$$F = 6\pi \mu U a (1 + 1.79 c^{1/3}) \qquad (68b)$$

It seems clear that the general expression for the drag force in dilute suspensions has the form

$$F = 6\pi \mu U a (1 + q c^{1/3}) \qquad (69)$$

The value of q does not vary much between authors and geometric arrangements, indicating that the particle arrangement is not very important in uniform dilute suspensions.

Hasimoto (93), using the same technique as for spheres, obtained an expression for the force per unit length on a square array of circular cylinders:

$$F = \frac{4\pi \mu U}{-\frac{1}{2} \ln(c/\pi) - 1.3105 + c^2/\pi} \qquad (70)$$

When $c \to 0$, the above expression becomes

$$F = \frac{4\pi \mu U}{-\frac{1}{2} \ln(c/\pi) - 1.31} \qquad (71)$$

Brinkman (106) obtained a relationship between the porosity ε and the relative settling velocity applicable to both dilute and concentrated systems. The drag force acting on a sphere in the swarm is given by

$$F = 6\pi \mu U a [1 + \frac{3}{4} (1 - \varepsilon) \{ 1 - (8/((1-\varepsilon)-\varepsilon)^{1/2} \}]^{-1} \qquad (72)$$

When $\varepsilon \leq 1/3$, Brinkman's model fails. This cell model considered the flow past a sphere embedded in a packed bed. The pressure drop is summed from two sources, namely, that given by Darcy's equation and that given by the creeping flow equation, so that

$$\bar{\nabla}P' = -\frac{\mu\bar{v}'}{K} + \mu\bar{\nabla}^2\bar{v}' \qquad (73)$$

Brinkman reasoned that when the porosity $\varepsilon \to 1.0$ the second term of equation 73 becomes the dominant one, and when ε is $O\left|\frac{1}{2}\right|$ the first term is the dominant one. In terms of the dimensional stream function, equation 73 could be reduced to the form

$$E^4\psi' = (\text{constant})\ E^2\psi' \qquad (74)$$

Since Darcy's equation is empirical, it follows that Brinkman's results are not theoretically rigorous.

An extension of Brinkman's model was made by Spielman and Goren (107) for cylinders in four different arrangements: a) All cylinders normal to flow, b) All cylinders parallel to flow, c) two-dimensional random distribution in planes parallel to flow and d) three-dimensional random distribution. The range of ε given was $0.7 < \varepsilon < 0.997$.

Richardson and Zaki (108) employed a cell model for sedimenting spheres. Particles were assumed to be settling in such a way that they are aligned one above the other in hexagonal-type tubes. They considered two patterns:

configuration I assumed that the spheres in adjacent horizontal layers are the same distance apart vertically as horizontally; configuration II assumed that the spheres in adjacent horizontal layers touch each other. The results of configuration II are in good agreement with Brinkman's model for $0.6<\varepsilon<0.95$.

For the case of cylinders the method of reflections cannot be used directly due to Stokes' paradox. The cell models of Hasimoto (93) and of Spielman and Goren (107) for circular cylinders have been noted earlier. Emersleben (95) obtained an approximate solution for laminar flow parallel to circular cylinders in square array using a second order Epstein Zeta function (120,8). Sparrow and Loeffer (119) subsequently obtained an exact analytical series solution for longtitudinal laminar flow along circular cylinders in equilateral triangle and square arrays.

For an isolated row of parallel circular cylinders Miyagi (121), using Stokes' approximation, and Tamada and Fujikawa (122), using Oseen's approximation, obtained for flow perpendicular to the cylinders at low Reynolds number

$$F = \frac{4\pi \mu U}{-\ln(a/h) - 1.33 + (\pi^2/3)(a/h)^2} \qquad (75)$$

where h is the distance between the centres of neighbouring cylinders. For $a/h<<1$, equation 75 becomes very close to

that given by Hasimoto, equation 71, where for a square array $c = \pi a^2 / h^2$. This shows that for dilute arrays the pressure drop across several rows of cylinders is equal to the sum of pressure drops across isolated rows. For high values of Re, Tamada and Fujikawa employed numerical analysis to obtain F. For a dense arrangement of cylinders in an isolated row, Keller (123) gives

$$F = \frac{9\pi \mu U}{2\sqrt{2}} \left[1 - 2a/h \right]^{-5/2} \qquad (76)$$

Kuwabara (124), using Oseen's approximations, treated the case of flow past an isolated row of parallel elliptical cylinders for the following situations:

a) major axis parallel to flow

$$F = 4\pi \mu U \left[S + \frac{1}{2}(1 + \sigma^2) - \frac{4\pi}{d\ Re} + 2\ T_o \right]^{-1} \qquad (77)$$

b) minor axis parallel to flow

$$F = 4\pi \mu U \left[S + \frac{1}{2}(1 - \sigma^2) - \frac{4\pi}{d\ Re} + 2\ T_o \right]^{-1} \qquad (78)$$

c) circular cylinders

$$F = 4\pi \mu U \left[S + \frac{1}{2} - \frac{4\pi}{d\ Re} + 2\ T_o \right]^{-1} \qquad (79)$$

d) flat plates set perpendicular to flow

$$F = 4\pi\,\mu\,U\,[\,S - \frac{4\,\pi}{d\,Re} + 2\,T_o\,]^{-1}$$

$$\simeq 4\pi\,\mu\,U\,[\,\ln(\,d/\pi\,) - 2\,\zeta(3)\,(Re\,d/16\pi)^2 + \ldots]^{-1} \quad (80)$$

e) flat plates set parallel to flow

$$F = 4\pi\,\mu\,U\,[\,S + 1 - \frac{4\,\pi}{d\,Re} + 2\,T_o\,]^{-1}$$

$$\simeq 4\pi\,\mu\,U\,[\,1 - \ln(\pi/d) - 2\,\zeta(3)\,(d\,Re/16\pi)^2 + \ldots]^{-1} \quad (81)$$

where $S = \ln[\,8(1+\sigma^2)/Re\,] - \gamma$, $Re = 2(1+\sigma^2)\,U\rho/\mu$

γ is Euler's constant, $(1+\sigma^2)$ is the major semi-axis, $(1+\sigma^2)$ is the minor semi-axis, $\zeta(x)$ is Riemann's zeta function, $d = h/(1+\sigma^2)$ and

$$T_o = 2\pi/(d\,Re) + \frac{1}{2}\ln(d\,Re/16\pi) + \frac{\gamma}{2} - \zeta(3)\,(d\,Re/16\pi)^2 +$$

$$+ \frac{3}{8}\,\zeta(5)\,(d\,Re/16\pi)^4 - \ldots\ldots \quad (82)$$

$\zeta(3)$ and $\zeta(5)$ are both of $O|1|$.

Equations 77 - 81 are applicable when d is large. Numerical calculations are given by Kuwabara for d = 10.

Another cell model was developed by Happel (126) to predict the drag force exerted on a sphere for a sedimenting swarm. A random assemblage is considered to consist of a number of cells, each of which contains a spherical envelope, such that the relative volume of fluid to solid in a cell is the same as in the entire assemblage. Such an envelope is assumed to be frictionless. The solution of the creeping flow equation (equation 6) in spherical coordinates, as given by equation 7, yields

$$\psi' = \frac{1}{2} U \sin^2\theta \left(A_2 r^2 + B_2 r + C_2 r^4 + D_2 r^{-1} \right) \qquad (83)$$

The constants A_2, B_2, C_2 and D_2 are determined from the no-slip conditions at the surface of the inner sphere, the zero shear stress condition at the outer envelope and zero radial flux across it. The drag force is then given by

$$F = 4\pi \mu U a \frac{2\gamma^5 + 3}{-2\gamma^6 + 3\gamma^5 - 3\gamma + 2} \qquad (84)$$

where γ is the ratio of the inner sphere radius to that of the outer sphere, and the volumetric concentration c, is therefore given by γ^3. Equation 84 reduces to Stokes' law for $\gamma = 0$, and has no singularity for all the values of γ between 0 and 1. For small values of γ, i.e. dilute systems, it reduces to

$$F = 6\pi \mu U a (1 + 1.5 c^{1/3}) \qquad (85)$$

It is clear that the above expression has the same form as that given by equation 69. Happel's free surface model gave excellent agreement in the dilute range with the experimental data of McNown and Lin (88) and the theoretical expressions of Smoluchowski (84, 85, 86) and Kawaguchi (91) For the intermediate range of concentration, less favorable agreement was observed with the experimental data or empirical equations of Hanratty and Bundukwale (111), Hawksley (modified) (109), Richardson and Zaki (108), Adler (127), Steinour (114), Mertes and Rhodes (128), Wilson (117), Verchoor (129) and Happel and Epstein (130),and the theoretical derivation of Brinkman (106). But it should be mentioned that the experimental data of the various workers in this range are not in agreement either, as it appears that a unique relationship between relative velocity and concentration does not exist in the intermediate range of concentration, due possibly to agglomeration and circulation. For high concentrations good agreement was again obtained with the empirical equations of Richardson and Zaki (108), Hawksley (modified) (109), Carman-Kozeny (100) and Fair and Hatch (103). Subsequently Smith (131, 132)

used Happel's free surface model for the analysis of the differential settling of spheres of different sizes.

Happel (133) also used his free surface model for analyzing flow perpendicular and parallel to arrays of circular cylinders. His solution of the fully developed laminar flow equation in cylindrical coordinates for these two cases are, respectively,

$$F = \frac{4\pi\mu U}{-\ln\gamma - 0.5 + [\,\gamma^4 / (1+\gamma^4)\,]} \qquad (86)$$

and

$$F = \frac{8\pi\mu U}{4\gamma^2 - \gamma^4 - 3 - 4\ln\gamma} \qquad (87)$$

where γ^{-1} is the ratio of the radius of the outer frictionless cylinder to the inner solid cylinder. The concentration c is then given by γ^2. It is interesting to note that both equations 86 and 87 show zero drag force per unit length as $\gamma \to 0$, thus giving rise to Stokes' paradox for the translation of a two-dimensional body in an infinite medium. Happel and Brenner (8) made a comparison of the Kozeny constant as obtained from equations 86 and 87 with that obtained by Emersleben (95) for square arrays and by Sparrow and Loeffer (119) for square and trianglar arrays. Good agreement was obtained for the dilute range, indicating that geometrical arrangement does not effect the permeability significantly in the dilute range according to the various models.

The expressions for laminar flow parallel to clusters of circular cylinders are also in general agreement with the experimental data of Galloway (143) and Epstein (142) and of Gunn and Darling (144). The numerical values for k by Sparrow and Loeffler (119) at lower fractional void volumes show substantial deviations between equilateral-triangle and square arrangements, and also from Happel's free surface model.

At the same time as Happel developed the free surface model, Kuwabara (134) suggested that instead of imposing zero shear stress at the outer envelope, one can impose the condition of zero vorticity at this outer envelope. For the case of creeping flow past spheres,he obtained for the drag force

$$F = 6\pi\,\mu\,U\,a\,[\,1 + \frac{51}{50}\gamma + \frac{3}{50}\gamma^2 - \frac{7}{25}\gamma^3 + \frac{2}{5}\gamma^4 + \frac{12}{25}\gamma^5$$

$$+ \frac{6}{25}\gamma^7 + \frac{2}{25}\gamma^8][\,1-\gamma]^{-3}\,[\,1 + \frac{6}{5}\gamma + \frac{3}{5}\gamma^2 + \frac{1}{5}\gamma^3\,]^{-2} \qquad (88)$$

and for creeping flow perpendicular to circular cylinders, he obtained for the drag force per unit length

$$F = \frac{4\pi\,U\,\mu}{-\ln\gamma - 0.75 + \gamma^2 - \gamma^4/4} \qquad (89)$$

Kuwabara (134) obtained the drag force for the case of spheres using the energy dissipation method. However, different results are obtained when one uses the pressure

and shear stress distribution at the sphere surface to calculate F. The drag force using the latter method gives

$$F = \frac{30\pi \mu U a}{5 - 9\gamma + 5\gamma^3 - \gamma^6} \qquad (90)^*$$

Equation 90 gives a slightly higher value for F than equation 88. The experimental work on flow perpendicular to aligned circular cylindrical fibres by Kirsch and Fuchs (135) indicates that Kuwabara's model represents their experimental data very well, while Happel's free surface model for flow perpendicular to an assemblage of cylinders is at variance with their data. On the other hand, Happel's model for spheres gives better agreement with the available experimental data on flow past clusters of spheres (126) than Kuwabara's model. It is very difficult from theoretical considerations alone to decide which of the two models is the more realistic, although it has been pointed out that Kuwabara's model, unlike Happel's, suffers from an energy imbalance (8). LeClair and Hamielec(58) extended Kuwabara's model to higher Reynolds numbers.

Galerkin's method was used by Snyder and Stewart (141) to solve the creeping flow equation for both a simple and a denser (orthorhombic) arrangement of spheres, and obtained friction factors within 5% of those obtained ex-

* The reason for this discrepancy in F is that the energy dissipated within the cell is not due to the drag-producing stresses at the surface of the sphere alone, as assumed by Kuwabara, but also to the stresses on the outer envelope.

perimentally by Martin et al.(116) for stacked spheres, and 9.1 % , lower than those predicted by Happel (126).

There are several other formulae, many empirical, for predicting the drag force, or more simply the deviation from Stokes flow of a particle with concentration. Oliver (140) gives a review of the various formulae.

2. Review of Numerical Work

It is evident that the solution of the Navier-Stokes equation via Stokes, Oseen and Proudman and Pearson expansions fails to describe the flow for higher Reynolds numbers. Approximate solutions using the Galerkin method have been tried. This method first assumes trial functions, and an approximate solution is then obtained by determining the trial function parameters such as to satisfy the Navier-Stokes equation and the boundary conditions as closely as possible. Increased accuracy can be obtained by having a large number of terms in the trial functions, as indicated by Snyder (33) and by Flumerfelt and Slattery (34). The optimum trial functions may be determined by variational calculus or by error distribution methods. Kawaguti (35) used the Galerkin method to evaluate unknown parameters in his assumed stream functions for flow past a sphere in an unbounded fluid. His recommendations are that one should use the results from one stream function at $0 < Re < 10$ and the results from another stream function at $10 < Re < 70$. Without prior knowledge of the answer, however, this slicing could not be accomplished. Hamielec and

Johnson (37), Hamielec et al. (38) and Nakano and Tien (40) used this technique to evaluate the viscous flow around fluid spheres at intermediate Reynolds numbers. A fluid sphere with a viscosity approaching infinity is, of course, a rigid sphere. Flumerfelt and Slattery (34) presented an improvement on the Galerkin method using an auxiliary variational technique given by Slattery (39). Such methods are not completely reliable, however, as they depend largely on the choice of the trial function.

Bourot (137, 138) employed the method of least squares fitting of the biharmonic function to known boundary conditions for creeping flow of a sphere in a cylindrical envelope. Bourot (136) developed the method for a spheroid, but did not perform the numerical work. This technique requires the general solution of $E^4\psi = 0$ and has the distinct virtue that the outer boundary can take any shape. The technique has found a wide application for flow in ducts and for flow in cavities (45, 139).

A finite difference method was used by Thom (42, 43, 44) to solve the Navier-Stokes equation for flow past cylinders at Re = 10, and his method has been used by Kawaguti (35) for flow past spheres at Re = 20 and cylinders (46) at Re = 40. This method is very tedious and it was converted into a relaxation method by Fox (47, 48, 49), by Allen and Dennis (53) and by Southwell et al. (50). The flow past cylinders was solved by Allen and Southwell (54)

for Re up to 1000, while Lister (51) applied a modification of their method to spheres for Re up to 20. Kawaguti (52) indicated that the work of Allen and Southwell was in error. The principle of the relaxation method is the approximation of the differential equations by their equivalent difference equations, which relate the values of the function and the derivatives involved at a point to those of neighbouring lattice points.

Jenson (55), in his work on spheres, solved the Navier-Stokes equation by splitting it into two simultaneous second order equations, using the stream function and the vorticity. Jenson approximated the vorticity near the surface by a third order polynomial which could also be derived by using Taylor's expansion correct to Re third order, and he used an exponential transformation for radial distance from the surface. He obtained the stream function, vorticity, pressure variation at the surface and drag coefficient for Re up to 80 (56) Rhodes (57), LeClair and Hamielec (58) and Hamielec et al (59, 60) extended Jenson's technique with the aid of digital computers to include higher Re. But their results for an isolated sphere are not conclusive inasmuch as their porosities are insufficiently high to accurately represent an infinite medium. Hamielec and Raal (61) adopted Jenson's technique for circular cylinders for Re up to 500, assuming that the steady state form of the Navier-Stokes equation still holds at this Reynolds number. They were careful to consider

the parameters that affect the accuracy of the numerical solution and they have obtained the most accurate numerical values of the drag force to date.

Several other workers (62, 63, 64) have obtained solutions of the unsteady state form of the Navier-Stokes equation for a circular cylinder. A numerical solution for flow along a flat plate has been obtained by Dennis and Dunwoody (41).**

** A recent paper by Rimon and Lugt (164), published after the present manuscript was completed, deals with the particular case of an oblate spheroid, performing similar calculations to the present work using a time-dependent numerical technique. Their results, which were limited to Re = 10 and Re = 100, agreed well with the corresponding results in this thesis.

CHAPTER III

Formulation of Finite Difference Equations and Boundary Conditions

The choice of spheroidal and elliptical coordinates in this study facilitates the formulation of the boundary conditions. In addition, the exponential properties of these coordinates give a fine lattice near the surface of the particle in general and near the tips in particular, and a coarse lattice far away from the surface. As the influence of the particle on the flows is mainly manifested near the surface, especially around the tips, and as this influence decreases with distance from the surface, the lattice thus produced served the purpose of giving a desired lattice gradation.

A. Spheroids

A.1 Formulation of the Finite Difference Equations

The Navier-Stokes equation for steady state flow as expressed in orthogonal curvilinear coordinates, equation 1, reduces to

$$\nu E'^4\psi' = \frac{(\cosh\xi \sin\eta)^{-1}}{c^3 (\sinh^2\xi+\cos^2\eta)} \cdot \frac{\partial(\psi', E'^2\psi')}{\partial(\xi,\eta)}$$

$$- \frac{2 E'^2\psi'(\cosh\xi \sin\eta)^{-2}}{c^4 (\sinh^2\xi+\cos^2\eta)} \cdot \frac{\partial(\psi', c \cosh\xi \sin\eta)}{\partial(\xi,\eta)} \qquad (91)$$

and

$$E'^2 = \frac{1}{c^2\,(\sinh^2\xi+\cos^2\eta)}\left\{\frac{\partial^2}{\partial\xi^2} - \tanh\xi\,\frac{\partial}{\partial\xi} + \frac{\partial^2}{\partial\eta^2} - \cot\eta\,\frac{\partial}{\partial\eta}\right\} \tag{92}$$

for oblate spheroidal coordinates, the metric coefficients for these coordinates being given by

$$h_1 = h_2 = \frac{1}{c\,\{\sinh^2\xi+\cos^2\eta\}^{1/2}} \tag{93}$$

and

$$h_3 = \frac{1}{c\,\cosh\xi\,\sin\eta} \tag{94}$$

where c is a characteristic length of the coordinate system. The minor semi-axis, b, and the major semi-axis, a, of the spheroid are given by

$$a = c\,\cosh\xi_a \tag{95}$$

$$b = c\,\sinh\xi_a \tag{96}$$

ξ_a being the value of ξ at the surface of the spheroid. The following dimensionless quantities are now defined:

$\psi = \psi'/U\,a^2$, $Re = 2a\,U/\nu$ and $E^2 = c^2\,E'^2$,

where Re is the Reynolds number and U is the velocity of the undisturbed stream. The Navier-Stokes equation then becomes

$$\operatorname{sech}\xi_a\,E^2(E^2\psi) = \frac{Re}{2}\left[\frac{\cosh\xi\,\sin\eta}{\sinh^2\xi+\cos^2\eta}\right]\left[\frac{\partial\psi}{\partial\xi}\,\frac{\partial}{\partial\eta}\left\{\frac{E^2\psi}{\cosh^2\xi\,\sin^2\eta}\right\} - \frac{\partial\psi}{\partial\eta}\,\frac{\partial}{\partial\xi}\left\{\frac{E^2\psi}{\cosh^2\xi\,\sin^2\eta}\right\}\right] \tag{97}$$

with

$$E^2 = \frac{1}{\sinh^2\xi+\cos^2\eta}\{\frac{\partial^2}{\partial\xi^2} - \tanh\xi\frac{\partial}{\partial\xi} + \frac{\partial^2}{\partial\eta^2} - \cot\eta\frac{\partial}{\partial\eta}\} \quad (98)$$

It is useful to split equation 97 into two equations, one in terms of ψ, ξ and η and the other in terms of $E^2\psi$, ξ and η to give

$$\operatorname{sech}\xi_a E^2(\zeta\cosh\xi\sin\eta) = \frac{Re}{2}[\frac{\cosh\xi\sin\eta}{\sinh^2\xi+\cos^2\eta}]\cdot$$

$$\cdot[\frac{\partial\psi}{\partial\xi}\frac{\partial}{\partial\eta}\{\frac{\zeta}{\cosh\xi\sin\eta}\} - \frac{\partial\psi}{\partial\eta}\frac{\partial}{\partial\xi}\{\frac{\zeta}{\cosh\xi\sin\eta}\}] \quad (99)$$

and

$$E^2\psi = \zeta\cosh\xi\sin\eta\operatorname{sech}^3\xi_a \quad (100)$$

where ζ is the dimensionless vorticity defined as $\zeta = \zeta' a/U$, the dimensional vorticity being

$$\zeta' = h_3 E'^2\psi' \quad (101)$$

For a spheroid which is almost spherical, $\cosh\xi$ becomes very large and difficulty will be encountered in the numerical analysis. For this reason the following functions are introduced:

$$G = \zeta\cosh\xi\sin\eta/\cosh\xi_a \quad (102)$$

$$F = \zeta\cosh\xi_a/\cosh\xi\sin\eta \quad (103)$$

Equations 99 and 100 then become

$$E^2 G = \frac{Re \text{ sech } \xi_a}{2} \left[\frac{\cosh \xi \sin \eta}{\sinh^2 \xi + \cos^2 \eta} \right] \left[\frac{\partial \psi}{\partial \xi} \frac{\partial F}{\partial \eta} - \frac{\partial \psi}{\partial \eta} \frac{\partial F}{\partial \xi} \right] \tag{104}$$

and

$$E^2 \psi = G \text{ sech}^2 \xi_a \tag{105}$$

respectively. The solution of the above two simultaneous differential equations in the stream function and in the modified vorticity G could be achieved by using Jenson's relaxation technique (55). This technique involves approximating the differential equations by finite difference equations which relate the values of neighbouring points on a flow grid. The solution of these equations is followed by the interpolation between the grid points over the whole field of influence.

Considering lattice spacing A in the ξ-direction and B in the η-direction, as shown in figure 1, and using Taylor's series expansion correct to the second order, one obtains for a field function Q :

$$\frac{\partial^2 Q}{\partial \xi^2} = \frac{Q(I,J+1) + Q(I,J-1)}{A^2} - \frac{2Q(I,J)}{A^2} \tag{106}$$

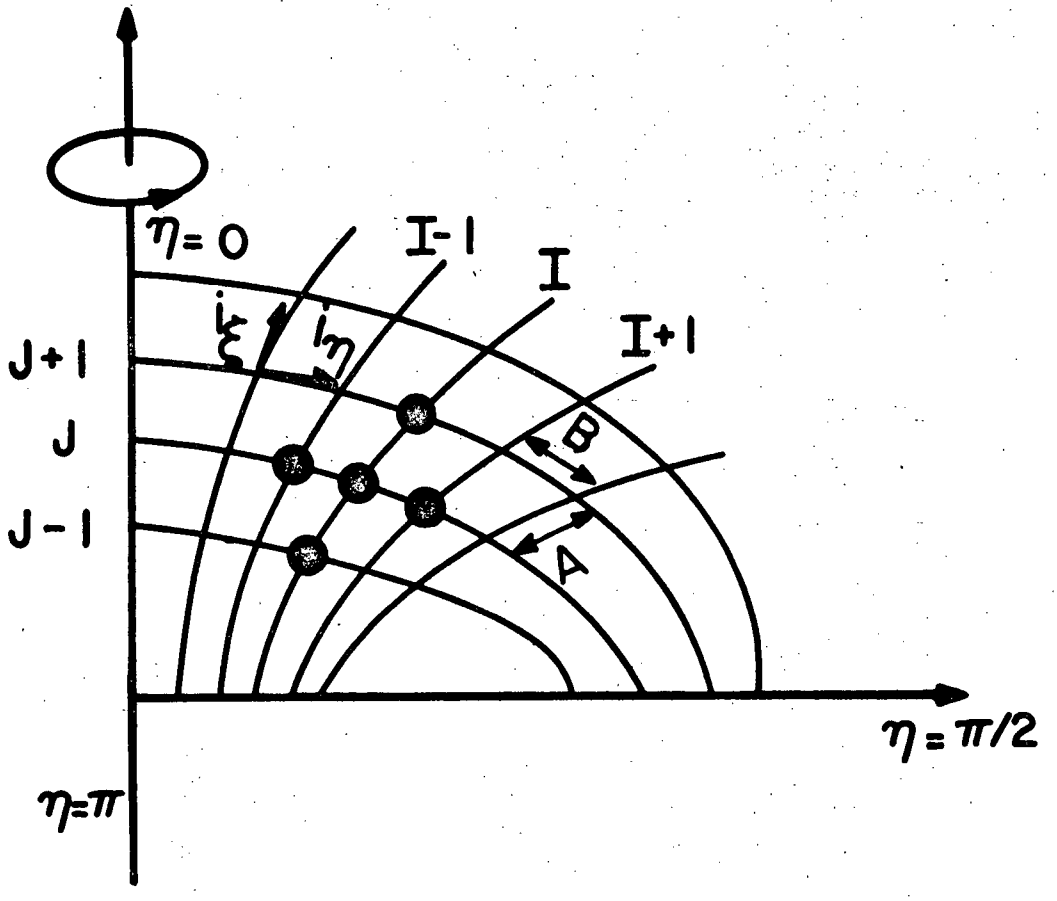

Figure 1. Oblate spheroidal mesh system.

$$\frac{\partial^2 Q}{\partial \eta^2} = \frac{Q(I+1,J) + Q(I-1,J)}{B^2} - \frac{2Q(I,J)}{B^2} \qquad (107)$$

$$\frac{\partial Q}{\partial \xi} = \frac{Q(I,J+1) - Q(I,J-1)}{2\ A} \qquad (108)$$

$$\frac{\partial Q}{\partial \eta} = \frac{Q(I+1,J) - Q(I-1,J)}{2\ B} \qquad (109)$$

Using equations 106 - 109, the differential equation 104 and 105 take the following finite difference forms:

$$G(I,J)\ (2/A^2 + 2/B^2) = G(I,J+1)\left[\ (2 - A \tanh \xi(J))/2A^2\right]$$

$$+ G(I,J-1)\left\{\frac{2 + A \tanh \xi(J)}{2\ A^2}\right\} + G(I+1,J)\left\{\frac{2 - B \cot \eta(I)}{2\ B^2}\right\}$$

$$+ G(I-1,J)\left\{\frac{2 + B \cot \eta(I)}{2\ B^2}\right\} - \frac{Re}{8} \operatorname{sech} \xi_a \cosh \xi(J) \sin\eta(I) \cdot$$

$$\cdot\left\{\frac{[\psi(I,J+1) - \psi(I,J-1)][F(I+1,J) - F(I-1,J)]}{A.B}\right.$$

$$\left. - \frac{[\psi(I+1,J) - \psi(I-1,J)][F(I,J+1) - F(I,J-1)\ ]}{A.B}\ \right\} \qquad (110)$$

and

$$\psi(I,J)\ (2/A^2+2/B^2) = \psi(I,J+1)\ \frac{2 - A \tanh \xi(J)}{2\ A^2}$$

$$+ \psi(I,J-1)\ \frac{2 + A \tanh \xi(J)}{2\ A^2} + \psi(I+1,J)\ \frac{2 - B \cot \eta(I)}{2\ B^2}$$

$$+ \psi(I-1,J)\ \frac{2 + B \cot \eta(I)}{2\ B^2}$$

$$- \operatorname{sech}^2\xi_a[\ \sinh^2\xi(J) + \cos^2\eta(I)\ ]\ G(I,J) \qquad (111)$$

The above finite difference equations for an oblate spheroid, and their solution for given boundary conditions would furnish values of the stream function and the vorticity at each point of the grid in the flow field. Equations 110 and 111 reduce to those obtained by Jenson (55) for a perfect sphere when $\xi \to \infty$.

For a prolate spheroid, the finite difference equations could be obtained from those of an oblate spheroid by replacing each $\sinh \xi$ by $i \cosh\xi$ and each $\cosh \xi$ by $i \sinh \xi$, or more generally each c by i c, in the language of Happel and Brenner (8). From the computational point of view this is exactly equivalent to changing each $\sinh\xi$ to $\cosh\xi$, $\cosh\xi$ to $\sinh\xi$ and $\cos^2\eta$ to $-\cos^2\eta$. By this procedure the term a will then represent the length of the minor semi-axis and the Reynolds number will be based on the minor axis. For both prolate and oblate spheroids

the Reynolds number is thus based on the equatorial diameter.

A.2 Boundary Conditions

The numerical analysis is confined between an inner surface represented by the spheroid itself and by an outer envelope which, like the spheroidal surface, coincides with one of the spheroidal coordinate grid lines as shown in figure 2.

As the two flow equations are of second order, four boundary conditions are to be satisfied. For an oblate spheroid the boundary conditions for ψ are:

for $\eta = 0$ along BA , $\psi = 0$ | axis of symmetry

$\eta = \pi$ along NO , $\psi = 0$ | axis of symmetry

$\xi = \xi_a$ along AMN, $\psi = 0$ | surface of spheroid

At the outer boundary, $\xi = \xi_b$ the flow is assumed to be a streaming parallel flow, giving $\psi = \frac{1}{2} \sin^2\eta \cosh^2\xi_b \operatorname{sech}^2\xi_a$.

The boundary conditions for ζ are :

for

$\eta = 0$ along BA , $\zeta = 0$ | axis of symmetry

$\eta = \pi$ along NO , $\zeta = 0$ | axis of symmetry

$\xi = \xi_a$ along AMN , $\zeta = \dfrac{E^2\psi \cosh^2\xi_a}{\sin\eta}$

$\xi = \xi_b$ along BRO , $\zeta = 0$ case I

$\xi = \xi_b$ along BRO , $\zeta = \zeta_{\tau_{\xi\eta}=0}$ case II

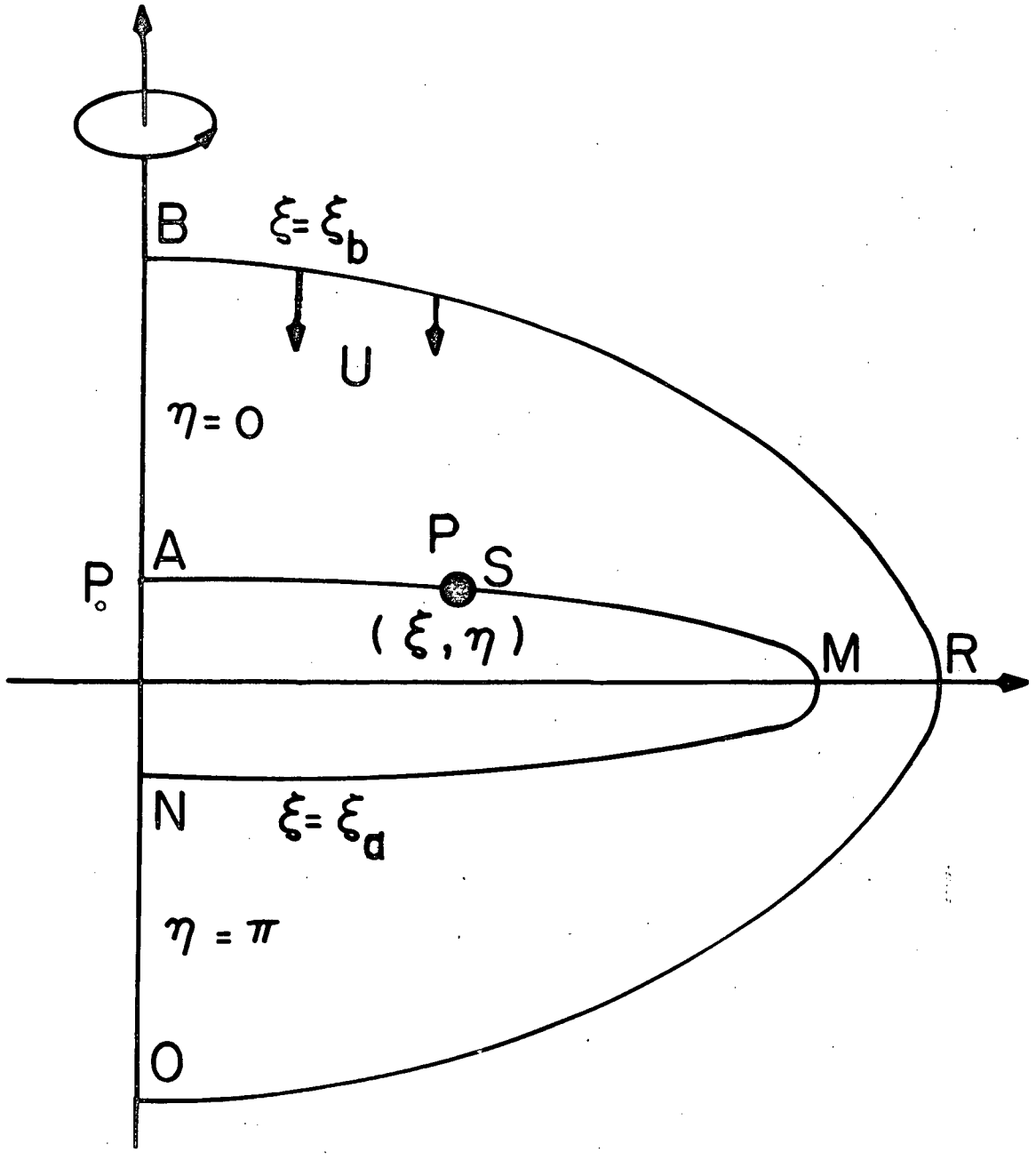

Figure 2. Oblate spheroid with its outer envelope.

The boundary condition for ζ at $\xi = \xi_a$, which originates from equation 100, can be as follows: Near the surface of the spheroid it is assumed that the stream function can be fitted by a cubic equation having the form

$$\psi = \alpha (\xi - \xi_a)^2 + \beta(\xi - \xi_a)^3 \qquad (112)$$

The above equation satisfies the no-slip boundary conditions assuming that the constant value of ψ at the surface is zero for any value of the constants α and β . Equations 98 and 105 combined give

$$G = \frac{\cosh^2\xi_a}{\sinh^2\xi+\cos^2\eta}\{\frac{\partial^2\psi}{\partial\xi^2} - \tanh\xi\frac{\partial\psi}{\partial\xi} + \frac{\partial^2\psi}{\partial\eta^2} - \cot\eta\,\frac{\partial\psi}{\partial\eta}\} \qquad (113)$$

At the surface, the no-slip conditions noted above require that

$$\psi = \frac{\partial\psi}{\partial\eta} = \frac{\partial^2\psi}{\partial\eta^2} = \frac{\partial\psi}{\partial\xi} = 0$$

and equation 113 therefore reduces to

$$G(I,1) = \frac{\cosh^2\xi_a}{\sinh^2\xi_a + \cos^2\eta} \left|\frac{\partial^2\psi}{\partial\xi^2}\right|_{\xi=\xi_a} \qquad (114)$$

Where J = 1 is the value of J at the surface of the spheroid. Differentiating equation 112 twice with respect to ξ yields

$$\frac{\partial^2\psi}{\partial\xi^2} = 2\alpha + 6\beta\,(\,\xi - \xi_a\,) \qquad (115)$$

Hence at $\xi = \xi_a$,

$$\left.\frac{\partial^2 \psi}{\partial \xi^2}\right|_{\xi=\xi_a} = 2\alpha \qquad (116)$$

Introducing equation 116 into 114 yields

$$G(I,1) = \frac{\cosh^2 \xi_a}{\sinh^2 \xi_a + \cos^2 \eta} \; 2\alpha \qquad (117)$$

Using the values of ψ at J = 2 and J = 3 in equation 116, written in finite difference form according to Taylor's series to the third order, gives

$$\alpha = \frac{8\,\psi(I,2) - \psi(I,3)}{4\,A^2} \qquad (118)$$

and equation 117 becomes

$$G(I,1) = \frac{\cosh^2 \xi_a \; [\; 8\,\psi(I,2) - \psi(I,3)\;]}{2\,A^2\;(\sinh^2 \xi_a + \cos^2 \eta\;)} \qquad (119)$$

which is equivalent to

$$\zeta(I,1) = \frac{\cosh^2 \xi_a \; [\; 8\,\psi(I,2) - \psi(I,3)\;]}{2\,A^2 (\sinh^2 \xi_a + \cos^2 \eta)\,\sin \eta} \qquad (120)$$

This equation gives the value of ζ at the surface of the spheroid ($\xi = \xi_a$) and could also be arrived at by expanding ψ directly as a Taylor series expansion correct to the third order, as subsequently shown for elliptical

cylinders.

The boundary condition for ζ at $\xi = \xi_b$ for Case II which corresponds to Happel's boundary conditions, can be derived as follows:

The dimensional vorticity, obtained by expanding equation 101, is given by

$$\zeta' = h_1 h_2 \{ \frac{\partial}{\partial \xi} [\frac{h_1 h_3}{h_2} \frac{\partial \psi'}{\partial \xi}] + \frac{\partial}{\partial \eta} [\frac{h_2 h_3}{h_1} \frac{\partial \psi'}{\partial \eta}] \} \qquad (121)$$

For the oblate spheroids $h_1 = h_2$ and equation 121 becomes

$$\zeta' = h_1^2 \{ \frac{\partial}{\partial \xi} [h_3 \frac{\partial \psi'}{\partial \xi}] + \frac{\partial}{\partial \eta} [h_3 \frac{\partial \psi'}{\partial \eta}] \} \qquad (122)$$

or

$$\zeta' = h_1^2 \frac{\partial h_3}{\partial \xi} \frac{\partial \psi'}{\partial \xi} + h_1^2 h_3 \frac{\partial^2 \psi'}{\partial \xi^2} + h_1^2 h_3 \frac{\partial^2 \psi'}{\partial \eta^2} + h_1^2 \frac{\partial h_3}{\partial \eta} \frac{\partial \psi'}{\partial \eta} \qquad (123)$$

The dimensional shear stress is given (10) by

$$\tau'_{\xi\eta} = - \frac{h_1}{h_2} \frac{\partial}{\partial \xi} \{ h_1 h_2 h_3 \frac{\partial \psi'}{\partial \xi} \} + \frac{h_2}{h_1} \frac{\partial}{\partial \eta} \{ h_1 h_2 h_3 \frac{\partial \psi'}{\partial \eta} \} \qquad (124)$$

For the oblate spheroids, $h_1 = h_2$ and equation 124 becomes

$$\tau'_{\xi\eta} = -2\, h_1 h_3 \frac{\partial h_1}{\partial \xi} \frac{\partial \psi'}{\partial \xi} - h_1^2 \frac{\partial h_3}{\partial \xi} \frac{\partial \psi'}{\partial \xi} - h_1^2\, h_3 \frac{\partial^2 \psi'}{\partial \xi^2}$$

$$+2\, h_1 h_3 \frac{\partial h_1}{\partial \eta} \frac{\partial \psi'}{\partial \eta} + h_1^2 \frac{\partial h_3}{\partial \eta} \frac{\partial \psi'}{\partial \eta} + h_1^2\, h_3 \frac{\partial^2 \psi'}{\partial \eta^2} \qquad (125)$$

Setting $\tau'_{\xi\eta} = 0$ and adding equation 125 to equation 123 yields

$$\zeta' \Big|_{\tau'_{\xi\eta} = 0} = 2\, h_1^2 h_3 \frac{\partial^2 \psi'}{\partial \eta^2} + 2\, h_1^2 \frac{\partial h_3}{\partial \eta} \frac{\partial \psi'}{\partial \eta} + 2\, h_1 h_3 \frac{\partial h_1}{\partial \eta} \frac{\partial \psi'}{\partial \eta}$$

$$-2 h_1 h_3 \frac{\partial h_1}{\partial \xi} \frac{\partial \psi'}{\partial \xi}$$

Substituting for the metric coefficients according to equations 93 and 94,

$$\zeta' \Big|_{\tau'_{\xi\eta} = 0} = \frac{2}{c^3 \cosh \xi \sin \eta \,(\sinh^2 \xi + \cos^2 \eta)} \left(\frac{\partial^2 \psi'}{\partial \eta^2} \right.$$

$$- \cot \eta \frac{\partial \psi'}{\partial \eta} + \frac{\cos \eta \sin \eta}{\sinh^2 \xi + \cos^2 \eta} \frac{\partial \psi'}{\partial \eta}$$

$$\left. + \frac{\sinh \xi \cosh \xi}{\sinh^2 \xi_b + \cos^2 \eta} \frac{\partial \psi'}{\partial \xi} \right) \qquad (126)$$

At $\xi = \xi_b$, the stream function is

$$\psi' = \frac{1}{2} U c^2 \cosh^2\xi_b \sin^2\eta \tag{127}$$

Differentiating with respect to η yields

$$\frac{\partial \psi'}{\partial \eta} = U c^2 \cosh^2\xi_b \sin\eta \cos\eta \tag{128}$$

and

$$\frac{\partial^2 \psi'}{\partial \eta^2} = U c^2 \cosh^2\xi_b \left(\cos^2\eta - \sin^2\eta \right) \tag{129}$$

Substituting equations 128 and 129 into equation 126 and rendering all quantities dimensionless yields

$$\zeta_{\tau_{\xi\eta}=0}\Big|_{\xi=\xi_b} = \frac{2 \cosh \xi_a}{\sin\eta \,(\sinh^2\xi_b + \cos^2\eta)} \left(- \cosh \xi_b \sin^2\eta + \frac{\cosh \xi_b \cos^2\eta \sin^2\eta}{\sinh^2\xi_b + \cos^2\eta} + \frac{\sinh \xi_b \cosh^2\xi_b}{\sinh^2\xi_b + \cos^2\eta} \cdot \frac{\partial \psi}{\partial \xi}\Big|_{\xi=\xi_b} \right) \tag{130}$$

and by equation 102,

$$G_{\tau_{\xi\eta}=0}\Big|_{\xi=\xi_b} = \frac{2 \cosh \xi_b}{(\sinh^2\xi_b + \cos^2\eta)} \left(- \cosh \xi_b \sin^2\eta + \frac{\cosh \xi_b \cos^2\eta \sin^2\eta}{\sinh^2\xi_b + \cos^2\eta} + \frac{\sinh \xi_b \cosh^2\xi_a}{\sinh^2\xi_b + \cos^2\eta} \frac{\partial \psi}{\partial \xi}\Big|_{\xi=\xi_b} \right) \tag{131}$$

Equation 131 gives the modified vorticity G at the outer boundary when the shear stress at this boundary is equal to zero, i.e. the envelope is frictionless. The value of $\frac{\partial \psi}{\partial \xi}\Big|_{\xi=\xi_b}$ can be found by using Newton's differentiation formula. Again the boundary conditions for a prolate spheroid could be obtained by replacing $\sinh \xi$ with $i \cosh \xi$ and $\cosh \xi$ with $i \sinh \xi$.

The boundary condition for $\zeta = 0$ at $\xi = \xi_b$, as given by case I, was used for the study of flow past isolated spheroids. For the cell models used to represent swarms of spheroids, case I refers to Kuwabara's zero vorticity model, while case II refers to Happel's free surface model. Both were used for the study of flow through swarms of spheroids.

B. Elliptical Cylinders

B.1 Formulation of the Finite Difference Equations

The Navier-Stokes equation for steady state flow as expressed in orthogonal curvilinear coordinates, equation 1 , reduces to

$$\nu E'^4 \psi' = \frac{1}{c^2 (\sinh^2 \xi + \sin^2 \eta)} \{ \frac{\partial(\psi', E'^2 \psi')}{\partial(\xi, \eta)} \} \qquad (132)$$

and

$$E'^2 = \frac{1}{c^2 (\sinh^2 \xi + \sin^2 \eta)} \{ \frac{\partial^2}{\partial \xi^2} + \frac{\partial^2}{\partial \eta^2} \} \qquad (133)$$

for elliptical cylindrical coordinates, with the undisturbed flow being parallel to the x- or major axis. The metric coefficients for this coordinate system are given by Happel and Brenner (8) as

$$h_1 = h_2 = \frac{1}{c\,[\,\sinh^2\xi + \cos^2\eta\,]^{1/2}} \tag{134}$$

$$h_3 = 1$$

where c is the characteristic length of the coordinate system. The minor semi-axis, b, and the major semi-axis, a, of the elliptical cylinder are given by

$$a = c \cosh \xi_a \tag{135}$$

$$b = c \sinh \xi_a \tag{136}$$

ξ_a being the value of ξ at the surface of the cylinder. The following dimensionless quantities are now defined:

$$\psi = \psi / Ub \;,\quad E^2 = c^2 E'^2 \quad \text{and} \quad Re = 2bU / \nu \;,$$

where Re is the Reynolds number and U is the velocity of the undisturbed stream along the major axis. The two-dimensional flow is then governed by

$$\frac{2}{Re} E^4\psi = \frac{1}{\sinh^2\xi+\sin^2\eta}\left\{\frac{\partial\psi}{\partial\xi}\,\frac{\partial E^2\psi}{\partial\eta} - \frac{\partial\psi}{\partial\eta}\,\frac{\partial E^2\psi}{\partial\xi}\right\} \tag{137}$$

and

$$E^2 = \frac{1}{\sinh^2\xi+\sin^2\eta}\left\{\frac{\partial^2}{\partial\xi^2}+\frac{\partial^2}{\partial\eta^2}\right\} \tag{138}$$

Equation 137 can be split into two equations, one in terms of ψ, ξ and η and the other in terms of ζ, ξ and η, to give

$$E^2\zeta = \frac{Re}{2} \cdot \frac{1}{\sinh^2\xi+\sin^2\eta} \left\{ \frac{\partial\psi}{\partial\xi} \frac{\partial\zeta}{\partial\eta} - \frac{\partial\psi}{\partial\eta} \frac{\partial\zeta}{\partial\xi} \right\} \tag{139}$$

and

$$E^2\psi = \zeta / \sinh^2\xi_a \tag{140}$$

where ζ is the dimensionless vorticity defined as $\zeta = \zeta' b/U$, the dimensional vorticity being

$$\zeta' = h_3 E'^2\psi' = E'^2\psi' \tag{141}$$

The solution of the two simultaneous equations, 139 and 140, in the stream function ψ and in the vorticity ζ could be achieved by using Jenson's relaxation technique (55) as for the case of spheroids. Considering lattice spacing A in the η-direction and B in ξ-direction, as shown in figure 3, and using Taylor's series expansion correct to the second order as given by equation 106 - 109, the differential equations 139 and 140 take the following difference forms:

$$G(I,J)(2/A^2+2/B^2) = \frac{G(I,J+1)+G(I,J-1)}{A^2} + \frac{G(I+1,J)+G(I-1,J)}{B^2}$$

$$- \frac{Re}{2} \left[\left[\frac{\psi(I,J+1)-\psi(I,J-1)}{2\ A}\right]\left[\frac{G(I+1,J)-G(I-1,J)}{2\ B}\right] \right.$$

$$\left. - \left[\frac{\psi(I+1,J)-\psi(I-1,J)}{2\ B}\right]\left[\frac{G(I,J+1)-G(I,J-1)}{2\ A}\right] \right] \tag{142}$$

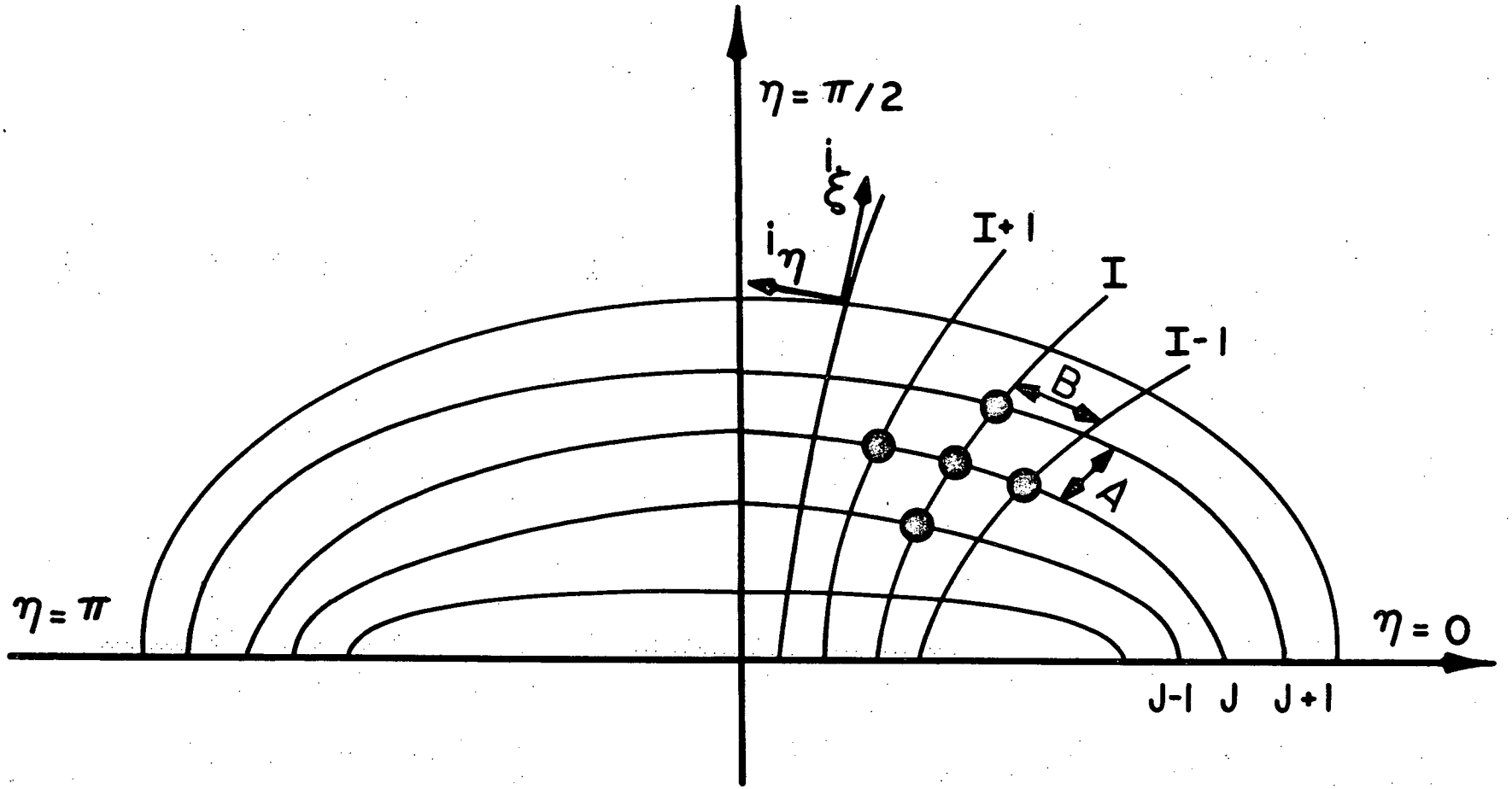

Figure 3. Elliptical cylindrical mesh system.

and

$$\psi(I,J)(2/A^2+2/B^2) = \frac{\psi(I,J+1)+\psi(I,J-1)}{A^2}$$

$$+ \frac{\psi(I+1,J)+\psi(I-1,J)}{B^2} - \frac{G(I,J)(\sinh^2\xi(J)+\sin^2\eta(I)}{\sinh^2\xi_a} \tag{143}$$

respectively, where for elliptical cylinders $G = \zeta$.

For flow parallel to the minor axis, the finite difference equations could be obtained from equations 142 and 143 by replacing each $\sinh \xi$ by $i \cosh \xi$ and each $\cosh \xi$ with $i \sinh \xi$. By this procedure the term b will now represent the major semi-axis and a the minor semi-axis, but the Reynolds number is again based on the projected length perpendicular to the flow direction. The solution of the above finite difference equations for given boundary conditions results in the knowledge of the flow details. When $\xi \to \infty$, equations 142 and 143 become identical to those obtained by Hamielec and Raal (61) for a circular cylinder with the exponential transformation $r = e^{\xi - \xi_a} = e^z$, where r is the radial distance for the cylindrical coordinates and z the radial distance in their transformed coordinates.

B.2 Boundary Conditions

The computational field is confined between an inner surface (the elliptical cylinder) and an outer envelope which coincide with the inner and outer elliptical coordinate grid lines, respectively, as shown in figure 4.

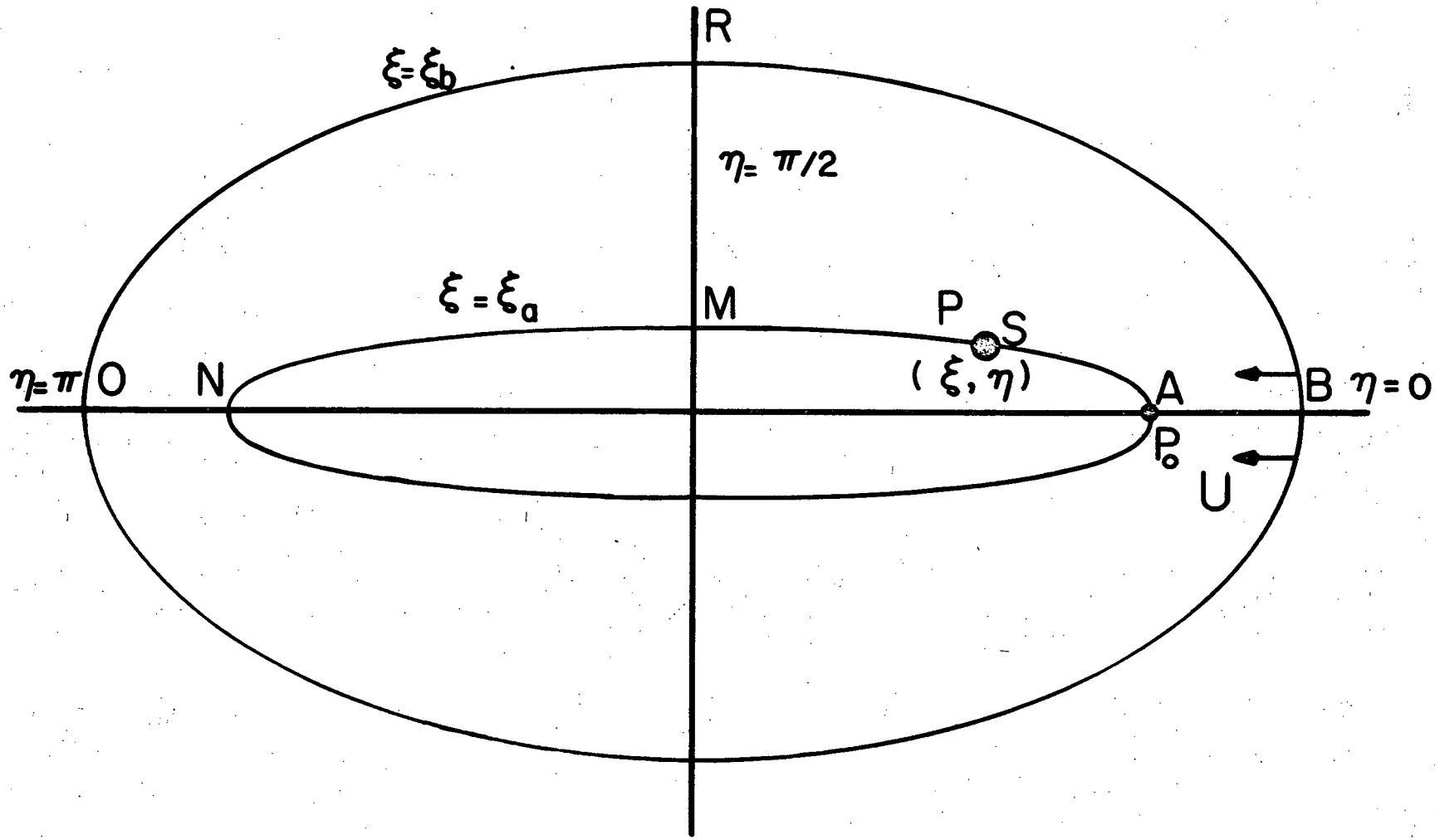

Figure 4. Elliptical cylinder with its outer envelope.

The four boundary conditions defining the flow are given by having two boundary conditions for each of ψ and ζ. For flow along the major axis the boundary conditions for ψ are:

for $\eta = 0$ along BA , $\psi = 0$ | axis of symmetry

$\eta = \pi$ along NO , $\psi = 0$ |

$\xi = \xi_a$ along AMN, $\psi = 0$ | surface of cylinder

At the outer boundary, $\xi = \xi_b$, the flow is assumed to be streaming parallel flow, giving $\psi = \sin \eta \ \sinh \xi_b \ \text{cosech} \ \xi_a$. The boundary conditions for ζ are:

for $\eta = 0$ along BA , $\zeta = 0$ | axis of symmetry

$\eta = \pi$ along N , $\zeta = 0$ |

$\xi = \xi_a$ along AMN, $\zeta = E^2\psi \ \sinh^2\xi_a$

$\xi = \xi_b$ along BRO, $\zeta = 0$ case I

$\xi = \xi_b$ along BRO, $\zeta = \zeta_{\tau_{\xi\eta}} = 0$ case II

The boundary condition for ζ at $\xi = \xi_a$ can be expanded as follows:

The vorticity ζ is given by equation 140, which when combined with equation 138 leads to

$$\zeta = \frac{\sinh^2\xi_a}{\sinh^2\xi+\sin^2\eta} \left\{ \frac{\partial^2\psi}{\partial\xi^2} + \frac{\partial^2\psi}{\partial\eta^2} \right\} \qquad (144)$$

At the surface of the cylinder, ψ is a constant for all values of η , leading to $\frac{\partial^2\psi}{\partial\eta^2} = 0$, so that equation 144 becomes

$$\zeta_{\xi=\xi_a} = \frac{\sinh^2\xi_a}{\sinh^2\xi_a+\sin^2\eta} \left.\frac{\partial^2\psi}{\partial\xi^2}\right|_{\xi=\xi_a} \tag{145}$$

The stream function near the surface can be expressed as Taylor's series expansions to the third order:

$$\psi(\xi_a+A) = \psi(\xi_a) + A \left.\frac{d\psi}{d\xi}\right|_{\xi=\xi_a} + \frac{A^2}{2} \left.\frac{d^2\psi}{d\xi^2}\right|_{\xi=\xi_a} + \frac{A^3}{6} \left.\frac{d^3\psi}{d\xi^3}\right|_{\xi=\xi_a} \tag{146}$$

$$\psi(\xi_a+2A) = \psi(\xi_a) + 2A \left.\frac{d\psi}{d\xi}\right|_{\xi=\xi_a} + 2A^2 \left.\frac{d^2\psi}{d\xi^2}\right|_{\xi=\xi_a} + \frac{8}{6} A^3 \left.\frac{d^3\psi}{d\xi^3}\right|_{\xi=\xi_a} \tag{147}$$

At the surface of the cylinder, $\psi = \frac{d\psi}{d\xi} = 0$, which satisfies the no-slip condition at this surface. Combining equations 146 and 147 to eliminate $\left.\frac{d^3\psi}{d\xi^3}\right|_{\xi=\xi_a}$ yields

$$8\,\psi(\xi_a+A) - \psi(\xi_a+2A) = 2\,A^2 \left.\frac{d^2\psi}{d\xi^2}\right|_{\xi=\xi_a} \tag{148}$$

Eliminating $\left.\frac{d^2\psi}{d\xi^2}\right|_{\xi=\xi_a}$ from equation 145 by using the above equation yields

$$\zeta(I,1) = \frac{\sinh^2\xi_a}{2\,A^2\,[\,\sinh^2\xi_a + \sin^2\eta(I)]} [\,8\,\psi(I,2)-\psi(I,3)] \tag{149}$$

The same result could be obtained by using the method outlined previously for the spheroid.

The boundary condition for ζ at $\xi = \xi_b$ for case II

which corresponds to Happel's free surface model, can be derived as follows:

Equating the shear stress given by equation 124 to zero yields

$$0 = h_1^2 \frac{\partial^2\psi}{\partial\xi^2} - h_1^2 \frac{\partial^2\psi}{\partial\eta^2} + 2h_1 \frac{\partial\psi}{\partial\xi} \frac{\partial h_1}{\partial\xi} - 2h_1 \frac{\partial\psi}{\partial\eta} \frac{\partial h_1}{\partial\eta} \tag{150}$$

where $h_3 = 1$ and $h_1 = h_2$. Introducing the values of h_1, $\frac{\partial h_1}{\partial\eta}$ and $\frac{\partial h_1}{\partial\xi}$ obtained from equation 134 into the above equation gives

$$\frac{\partial^2\psi}{\partial\xi^2} = \frac{\partial^2\psi}{\partial\eta^2} - \frac{2 \sinh\xi \cosh\xi}{\sinh^2\xi+\sin^2\eta} \frac{\partial\psi}{\partial\xi} + \frac{2 \cos\eta \sin\eta}{\sinh^2\xi+\sin^2\eta} \frac{\partial\psi}{\partial\eta} \tag{151}$$

At the envelope surface, $\xi = \xi_a$, the dimensionless stream function is given by

$$\psi = \sin\eta \sinh\xi_b \operatorname{cosech}\xi_a \tag{152}$$

Using equation 152 to obtain $\frac{\partial\psi}{\partial\eta}$ and $\frac{\partial^2\psi}{\partial\eta^2}$, then

$$\left.\frac{\partial^2\psi}{\partial\xi^2}\right|_{\xi=\xi_b} = -\frac{\sin\eta \sinh\xi_b}{\sinh\xi_a} - \frac{2 \sinh\xi_b \cosh\xi_b}{\sinh^2\xi_b+\sin^2\eta} \left.\frac{\partial\psi}{\partial\xi}\right|_{\xi=\xi_b} + \frac{2 \cos^2\eta \sin\eta \sinh\xi_b}{\sinh^2\xi_b+\sin^2\eta} \tag{153}$$

The vorticity at $\xi = \xi_b$ as obtained from equation 144 is

$$\zeta_{\xi=\xi_b} = \frac{\sinh^2\xi_a}{\sinh^2\xi_b+\sin^2\eta} \left[\frac{\partial^2\psi}{\partial\eta^2} + \frac{\partial^2\psi}{\partial\xi^2}\right]_{\xi=\xi_b} \tag{154}$$

Combination of equations 153 and 154 leads to

$$\zeta_{\tau_{\xi\eta}} = 0\Big|_{\xi=\xi_b} = \frac{2 \sinh \xi_a \sinh \xi_b}{\sinh^2\xi_b+\sin^2\eta}\left(- 2 \sin\eta \right.$$

$$\left. + \frac{\cos^2\eta \sin\eta}{\sinh^2\xi_b+\sin^2\eta} - \frac{\cosh \xi_b \sinh \xi_b}{\sinh^2\xi_b+\sin^2\eta} \frac{\partial\psi}{\partial\xi}\Big|_{\xi=\xi_b} \right) \qquad (155)$$

The value of $\frac{\partial\psi}{\partial\xi}\Big|_{\xi=\xi_b}$ is found by using Newton's formula for differentiation. The above expression, equation 155, gives explicitly the vorticity at the outer boundary when the shear stress at this boundary is zero. Once again the boundary conditions for flow along the minor axis could be obtained by replacing each $\sinh \xi$ with $i \cosh \xi$ and $\cosh \xi$ with $i \sinh \xi$.

Since the two simultaneous differential equations to be solved are of second order, four independent boundary conditions were sufficient to provide a unique solution in each case.

CHAPTER IV

Formulation of Drag Coefficient Equations and the Pressure Distribution

The derivation of the drag coefficient equations for an oblate spheroid will be given in detail as it will serve as an example of the general method.

A. Spheroids

Goldstein (10) gives the dimensional shear stress in general curvilinear coordinates as

$$\tau'_{\xi\eta}=\tau'_{\eta\xi} = \mu\left(\frac{h_1}{h_2}\frac{\partial}{\partial\xi}(h_2 v'_\eta) + \frac{h_2}{h_1}\frac{\partial}{\partial\eta}(h_1 v'_\xi)\right) \qquad (156)$$

where v'_η and v'_ξ are the dimensional velocities in the η - and ξ - directions respectively. At the surface of the spheroid, the no-slip conditions give

$$\frac{\partial v'_\xi}{\partial\eta} = v'_\eta = v'_\xi = 0$$

and equation 156 becomes

$$\tau'_{\xi\eta}\Big|_{\xi=\xi_a} = \mu\, h_1 \frac{\partial v'_\eta}{\partial\xi}\Big|_{\xi=\xi_a} \qquad (157)$$

The vorticity in general curvilinear coordinates is defined as

$$\bar{\zeta}' = \nabla\times\bar{v}' = h_1h_2h_3\begin{vmatrix} \frac{i_\xi}{h_1} & \frac{i_\eta}{h_2} & \frac{i_\phi}{h_3} \\ \frac{\partial}{\partial\xi} & \frac{\partial}{\partial\eta} & \frac{\partial}{\partial\phi} \\ \frac{v'_\xi}{h_1} & \frac{v'_\eta}{h_2} & \frac{v'_\phi}{h_3} \end{vmatrix} \qquad (158)$$

For axisymmetric and two-dimensional flows all derivatives in ϕ are zero and $v'_\phi = 0$. The only non-vanishing vorticity is that in the ϕ-direction and is given by $\bar{\zeta}' = i_\phi \zeta'$, where

$$\zeta' = h_1^2 \left[\frac{\partial}{\partial \xi} (v'_\eta / h_2) - \frac{\partial}{\partial \eta} (v'_\xi / h_1) \right] \qquad (159)$$

and $h_1 = h_2$ for both spheroidal and elliptical coordinates. Using the no-slip condition at the surface ($\xi = \xi_a$), equation 159 becomes

$$\zeta'_{\xi=\xi_a} = h_1 \left. \frac{\partial v'_\eta}{\partial \xi} \right|_{\xi=\xi_a} \qquad (160)$$

Substituting equation 157 into equation 160 yields

$$\tau'_{\xi\eta}\Big|_{\xi=\xi_a} = \mu \, \zeta'_{\xi=\xi_a} \qquad (161)$$

Making all terms dimensionless by putting

$$\tau_{\xi\eta} = \tau'_{\xi\eta}/2\rho U^2 \qquad \text{and} \qquad \zeta = \zeta' a/U \ ,$$

the dimensionless local shear stress at the surface is then given by

$$\tau_{\xi\eta}\Big|_{\xi=\xi_a} = 4 \ \zeta_{\xi=\xi_a} / \mathrm{Re} \qquad (162)$$

The surface of the oblate spheroid for $z = 0$ is given by

$$\frac{y^2}{c^2 \sinh^2 \xi_a} + \frac{x^2}{c^2 \cosh^2 \xi_a} = 1 \qquad (163)$$

with

$$y = c \sinh \xi_a \cos \eta \qquad (164)$$

and

$$x = c \cosh \xi_a \sin \eta \qquad (165)$$

The surface area of the strip on which the shear stress is considered to act is $2\pi \times (dx^2 + dy^2)^{1/2}$.

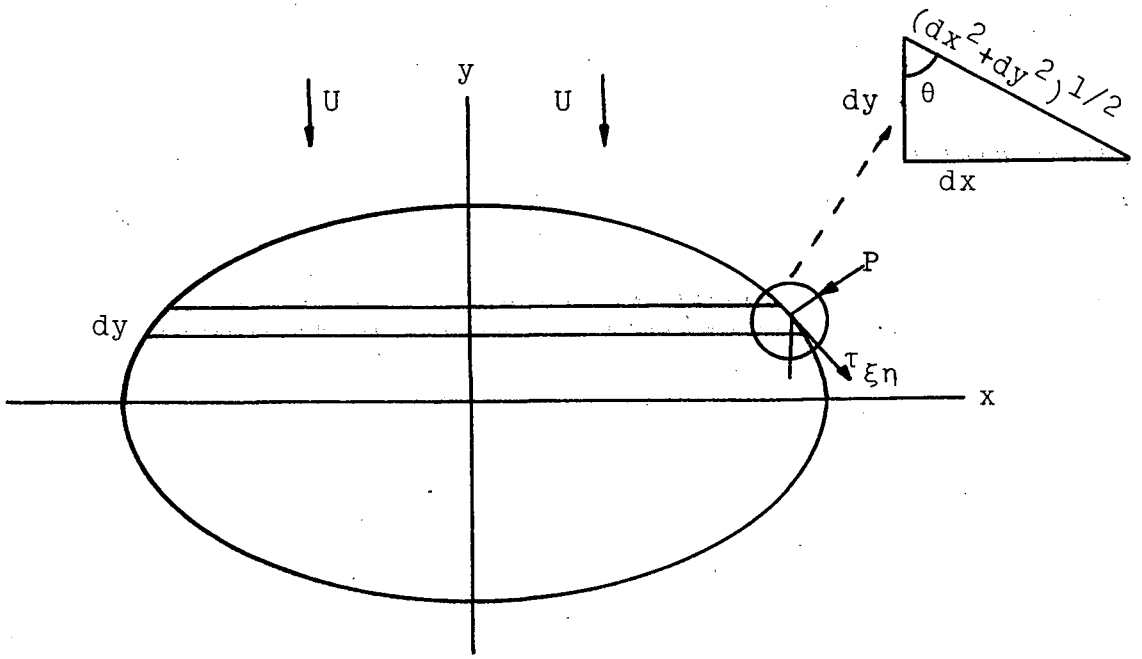

Diagram 1. Action of the normal and tangential stresses on an element of area of the oblate spheroid.

The drag force in the direction of the streaming flow acting on the whole surface due to shear stress alone is then given by

$$F = 2\pi \times (dx^2 + dy^2)^{1/2} \tau'_{\xi\eta}\Big|_{\xi=\xi_a} \cos\theta \qquad (166)$$

The drag on a body is usually expressed in terms of a dimensionless drag coefficient

$$C_D = \frac{\text{drag force in the flow direction}}{\text{(Projected area normal to the) (direction of flow)}} \text{ x kinetic pressure}$$

From equation 166 the skin drag coefficient then becomes

$$C_{DS} = \frac{\int_\eta 2\pi \times (dx^2 + dy^2)^{1/2} \tau'_{\xi\eta}\big|_{\xi=\xi_a} \cos\theta}{(\pi c^2 \cosh^2 \xi_a)(\frac{1}{2}\rho U^2)} \qquad (167)$$

Now

$$\cos\theta = \frac{dy}{(dx^2 + dy^2)^{1/2}} \quad ,$$

$$dx = c \cosh \xi_a \cos\eta \, d\eta \quad ,$$

$$dy = - c \sinh \xi_a \sin\eta \, d\eta \quad ,$$

and making use of equation 162 and equation 167 yields

$$C_{DS} = \frac{8}{Re} \tanh \xi_a \int_0^{\pi} \sin^2\eta \; \zeta_{\xi=\xi_a} \, d\eta \qquad (168)$$

The above equation gives the skin (friction) drag coefficient for an oblate spheroid. In the limiting case of sphere, $\tanh \xi_a$ is unity and equation 168 becomes identical to that given by Jenson (55) for a perfect sphere. For an infinitesimally thin circular disc, $\tanh \xi_a$ is zero and thus equation 168 shows a zero skin drag coefficient, in conformity with simple geometrical considerations. For a prolate spheroid, $\tanh\xi_a$ is transformed as usual to $\coth \xi_a$, but it then becomes difficult to predict C_{DS} in the limit of a very long needle, for which $\zeta_{\xi=\xi_a} \to 0$ and $\coth \xi_a \to \infty$.

The pressure distribution around an oblate spheroid is obtained by considering the i_η and i_ξ directions of the Navier-Stokes equation. The Navier-Stokes equation as given by equation 3 can be transformed (8) to

$$\bar{v}' \times \bar{\zeta}' = \frac{1}{\rho} \bar{\nabla} P' + \frac{1}{2} \bar{\nabla} \bar{v}'^2 + \nu \bar{\nabla} \times \bar{\zeta}' \qquad (169)$$

by using simple vector identities and the continuity equation, $\bar{\nabla} . \bar{v}' = 0$.

Let us now consider the i_η component of equation 169 term by term. By definition, we have

$$\bar{v}' \times \bar{\zeta}' = h_1 h_2 h_3 \begin{vmatrix} i_\xi/h_1 & i_\eta/h_2 & i_\phi/h_3 \\ v_\xi' & v_\eta' & v_\phi' \\ \zeta_\xi'/h_1 & \zeta_\eta'/h_2 & \zeta_\phi'/h_3 \end{vmatrix} \qquad (170)$$

As mentioned previously for axisymmetric and two-dimensional flows, $\zeta_\xi' = \zeta_\eta' = 0$. Putting $\zeta_\phi' = \zeta'$, the term in the i_η -direction on the left-hand side of equation 169 is $- h_1 v_\xi' \zeta'$. The first and second terms on the right-hand side of equation 169 yield

$$\frac{h_2}{\rho} \frac{\partial P'}{\partial \eta} + \frac{1}{2} h_2 \frac{\partial \bar{v}'^2}{\partial \eta} ,$$

where $\bar{\nabla}$ is defined by equation 4. By definition, we have

$$\bar{\nabla}' \times \bar{\zeta}' = h_1 h_2 h_3 \begin{vmatrix} i_\xi/h_1 & i_\eta/h_2 & i_\phi/h_3 \\ \partial/\partial\xi & \partial/\partial\eta & \partial/\partial\phi \\ \zeta_\xi'/h_1 & \zeta_\eta'/h_2 & \zeta_\phi'/h_3 \end{vmatrix} \qquad (171)$$

and the third term in the i_η -direction on the right-hand side of equation 169 becomes

$$-\nu h_1 h_3 \frac{\partial}{\partial \xi} (\zeta' / h_3) .$$

The i_η-component of equation 169 thus becomes

$$-h_1 v_\xi' \zeta' = \frac{h_2}{\rho} \frac{\partial P'}{\partial \eta} + \frac{1}{2} h_2 \frac{\partial \bar{v}'^2}{\partial \eta} - \nu h_1 h_3 \frac{\partial}{\partial \xi}(\zeta'/h_3) \qquad (172)$$

At the surface, $\bar{v}'^2 = 0$, $v_\xi' = 0$ and for an oblate spheroid, $h_1 = h_2$, so that equation 172 becomes

$$\left.\frac{\partial P'}{\partial \eta}\right|_{\xi=\xi_a} = \mu \left\{ \left.\frac{\partial \zeta'}{\partial \xi}\right|_{\xi=\xi_a} + h_3 \zeta' \frac{\partial}{\partial \xi}(1/h_3) \right\} \qquad (173)$$

Introducing the dimensionless pressure

$$P = \frac{P' - P'_{st}}{\frac{1}{2} \rho U^2} \quad , \qquad (173a)$$

substituting for h_3 and rendering all terms dimensionless, then equation 173 becomes

$$\frac{Re}{4} \left.\frac{\partial P}{\partial \eta}\right|_{\xi=\xi_a} = \left.\frac{\partial \zeta}{\partial \xi}\right|_{\xi=\xi_a} + \zeta_{\xi=\xi_a} \tanh \xi_a \qquad (174)$$

Integration of equation 174 along AS of figure 2 gives

$$P - P_o = \frac{4}{Re} \int_0^\eta \left[\left.\frac{\partial \zeta}{\partial \xi}\right|_{\xi=\xi a} + \zeta_{\xi=\xi_a} \tanh \xi_a \right] d\eta \qquad (175)$$

where P_o is the dimensionless frontal stagnation pressure (at $\eta = 0$) and P is the dimensionless pressure at point S on the surface of the spheroid.

The dimensionless stagnation pressure P_o is obtained by consideration of the i_ξ-component of equation 169. Using equation 170, the term in the i_ξ-direction on the left-

hand side of equation 169 is $h_2 v_\eta' \zeta'$, since once again $\zeta_\phi' \equiv \zeta'$ and $\zeta_\xi' = \zeta_\eta' = 0$ for axisymmetric and two-dimensional flows. The first and second terms on the right-hand side of equation 169 yield for the i_ξ-direction

$$\frac{h_1}{\rho} \frac{\partial P'}{\partial \xi} + \frac{1}{2} h_1 \frac{\partial \bar{v}'^2}{\partial \xi} .$$

The last term of equation 169 gives $h_2 h_3 \frac{\partial}{\partial \eta} (\zeta' / h_3)$. The i_ξ-component of equation 169 thus becomes

$$h_2 v_\eta' \zeta' = \frac{h_1}{\rho} \frac{\partial P'}{\partial \xi} + \frac{1}{2} h_1 \frac{\partial \bar{v}'^2}{\partial \xi} + \nu h_2^2 h_3 \frac{\partial}{\partial \eta} (\zeta'/h_3) \quad (176)$$

Considering flow along the axis BA shown in figure 2 gives

$v_\eta' = 0$ (no-cross flow)

$v_\phi' = 0$ (axial symmetry)

Hence $\bar{v}'^2 = \bar{v}_\xi'^2 + \bar{v}_\eta'^2 + \bar{v}_\phi'^2 = \bar{v}_\xi'^2$,

and equation 176 along $\eta = 0$ becomes

$$- \frac{4}{Re} \left(\zeta \cot \eta + \frac{\partial \zeta}{\partial \eta} \right) \Big|_{\eta=0} = 2 v_\xi \frac{\partial v_\xi}{\partial \xi} + \frac{\partial P}{\partial \xi} \quad (177)$$

where all quantities have been rendered dimensionless and the values of h_1 , h_2 and h_3 for an oblate spheroid have been substituted.

Integrating along BA yields

$$P_A - P_B + v_A^2 - v_B^2 = \frac{4}{Re} \int_A^B \left(\zeta \cot \eta + \frac{\partial \zeta}{\partial \eta} \right) \Big|_{\eta=0} d\xi \quad (178)$$

As point B lies on the outer boundary and point A on the surface of the spheroid (stagnation point), it follows respectively that $P_B = 0$, $v_B = 1$ and $P_A = P_o$, $v_A = 0$. Equation 178 therefore becomes

$$P_o = 1 + \frac{4}{Re} \int_{\xi_a}^{\xi_b} \left(\zeta \cot \eta + \frac{\partial \zeta}{\partial \eta} \right) \Bigg|_{\eta=0} d\xi \qquad (179)$$

Along the axis $\eta = 0$, $\cot \eta = \infty$ and $\zeta = 0$, using L' Hospital's rule, equation 179 becomes

$$P_o = 1 + \frac{8}{Re} \int_{\xi_a}^{\xi_b} \frac{\partial \zeta}{\partial \eta} \Bigg|_{\eta=0} d\xi \qquad (180)$$

Equation 180 gives the dimensionless frontal stagnation pressure and equation 175 gives the dimensionless pressure distribution around the surface of the oblate spheroid. It is interesting to note that P becomes anti-symmetrical about $\eta = \pi/2$ as $Re \to 0$ and that the unity term in equation 180, which arises from the inertial term of the Navier-Stokes equation, does not appear when the identical analysis is made on the creeping flow equation.

Using diagram 1, the form (pressure) drag coefficient is given by

$$C_{DF} = \frac{\int_{\eta} 2\pi \, x \, (dx^2 + dy^2)^{1/2} \sin \theta \, P}{\pi \, c^2 \cosh^2 \xi_a} \qquad (181)$$

where $\sin\theta = dx / (dx^2 + dy^2)^{1/2}$

and at the surface,

$$x = c \cosh \xi_a \sin \eta$$

$$dx = c \cosh \xi_a \cos \eta \, d\eta ,$$

rendering equation 181

$$C_{DF} = \int_0^{\pi} P \sin 2\eta \, d\eta \qquad (182)$$

The total drag coefficient is obtained by adding the skin and form drag coefficients. The corresponding equations for a prolate spheroid could be derived by the usual transformation.

B. Elliptical Cylinders

Following the analysis given for an oblate spheroid, equation 162 is also applicable to an elliptical cylinder, for which the shear stress at the surface is therefore

$$\tau_{\xi\eta}\Big|_{\xi=\xi_a} = 4 \, \zeta_{\xi=\xi_a} / Re \qquad (162)$$

The surface of the elliptical cylinder at $z = 0$ is given by

$$\frac{y^2}{c^2 \sinh^2 \xi_a} + \frac{x^2}{c^2 \cosh^2 \xi_a} = 1 \qquad (183)$$

with

$$y = c \sinh \xi_a \sin \eta \tag{184}$$

and

$$x = c \cosh \xi_a \cos \eta \tag{185}$$

The surface area of the strip on which the shear stress is acting is $\ell \left(dx^2 + dy^2 \right)^{1/2}$,

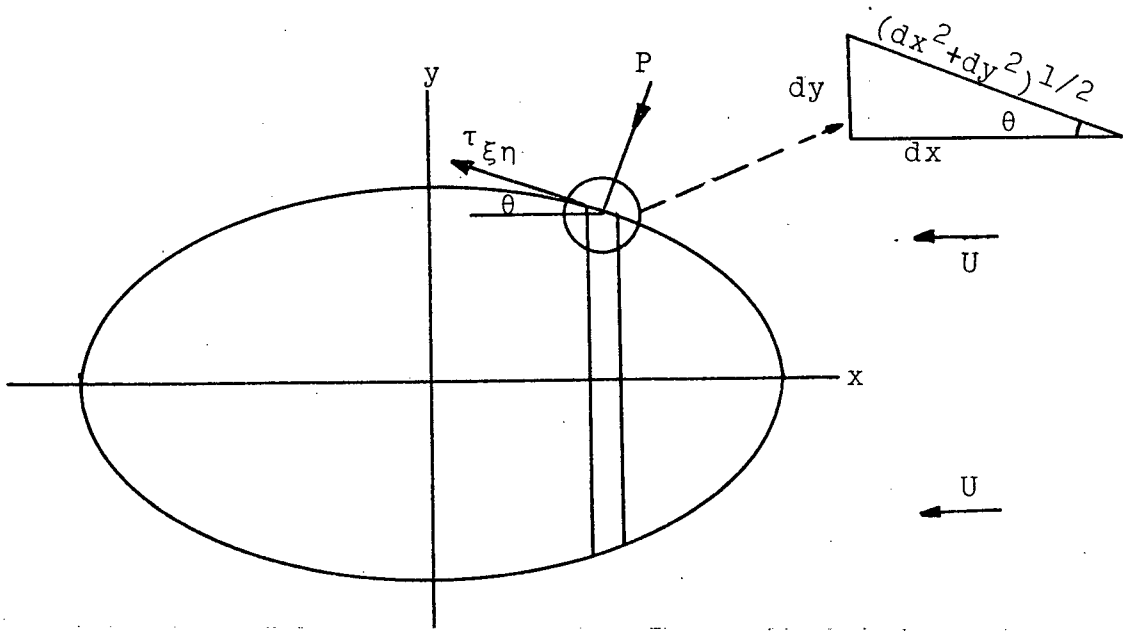

Diagram 2. Action of the normal and tangential stresses on an element of area of the elliptical cylinder.

where ℓ is the length of the strip in the z-direction. The skin drag coefficient is then given by

$$C_{DS} = \frac{2 \int_{\eta} \tau'_{\xi\eta}\Big|_{\xi=\xi_a} \ell \left(dx^2 + dy^2 \right)^{1/2} \cos \theta}{\left(\frac{1}{2} \rho U^2 \right) 2 c \sinh \xi_a \ \ell} \tag{186}$$

where $\cos \theta = \dfrac{dx}{\left(dx^2 + dy^2 \right)^{1/2}}$,

$$dx = - c \cosh \xi_a \sin \eta \, d\eta \ ,$$

and using equation 162, equation 186 becomes

$$C_{DS} = \frac{4}{Re} \coth \xi_a \int_0^{\pi} \zeta_{\xi=\xi_a} \sin \eta \, d\eta \qquad (187)$$

The above expression gives the skin drag coefficient for an elliptical cylinder with the main flow parallel to its major axis. For an elliptical cylinder with the main flow parallel to its minor axis, coth ξ_a becomes tanh ξ_a and hence in the limiting case of a flat plate set perpendicular to the flow direction, $C_{DS} \to 0$ as tanh $\xi_a \to 0$, which is intuitively correct.

The dimensionless surface pressure, P, can be deduced from the analysis of the oblate spheroid by appropriately modifying equation 173 and 175, the result being

$$P - P_o = \frac{4}{Re} \int_0^{\eta} \left. \frac{\partial \zeta}{\partial \xi} \right|_{\xi=\xi_a} d\eta \qquad (188)$$

since the last term of both equations 173 and 175 becomes zero because $h_3 = 1$ for elliptical cylindrical coodinates. The stagnation pressure P_o can be similarly obtained from equations 176 and 178, where the last term of equation 176 again reduces to zero for $h_3 = 1$, so that the resulting equation 179 is modified to

$$P_o = 1 + \frac{4}{Re} \int_{\xi_a}^{\xi_b} \frac{\partial \zeta}{\partial \eta} \Big|_{\eta=0} \, d\xi \qquad (189)$$

Using diagram 2, the form (pressure) drag coefficient is given by

$$C_{DF} = \frac{2 \int_{\eta} P \sin\theta \; \ell \; (dx^2 + dy^2)^{1/2}}{\ell \; 2 \, c \sinh \xi_a} \qquad (190)$$

$$C_{DF} = \int_0^{\pi} P \cos\eta \; d\eta \qquad (191)$$

where $\sin\theta = \dfrac{dy}{(dx^2 + dy^2)^{1/2}}$

and

$$dy = c \sinh \xi_a \cos\eta \; d\eta$$

The expression given by equation 191 is identical to that obtained by Hamielec and Raal (61) for circular cylinders.

The total drag coefficient, C_{DT}, is again obtained by adding C_{DS} and C_{DF}.

CHAPTER V

Discussion and Presentation of Results

1. Applicability of the Navier-Stokes Equations and Choice of the Numerical Technique

The steady state form of the Navier-Stokes equation is a special case of the general momentum equation governing the flow field where both the viscosity and density of the fluid are constant. The momentum equation is derived for a continuous fluid, even though real fluids are composed of finite elementary particles in continuous motion in a relatively large expanse of space. As the fluid under study is continuous even to the infinitesimal limit, its properties such as pressure, velocity and temperature can be regarded as continuous and can be mathematically defined. When a body is immersed within a real fluid and its dimensions are much larger than the mean free path of the fluid molecules, then the momentum equation is adequate in describing the flow field. However, for small body dimensions, the Brownian Movement of the fluid molecules contributes to the flow field. Lapple (148) has shown that the contribution to the drag force experienced by a 10μ diameter sphere from Brownian Movement is about 0.5%, whereas for a 1μ diameter sphere it is over 130%, of the gravitationally induced drag. This indicates that the analysis in the present work is only valid where the particle(s) under consideration is large enough that the details of its shape are "seen" by the fluid. The

axisymmetric steady state form of the Navier-Stokes equation is used, which means that there is complete symmetry between "top" and "bottom" of the flow field and hence that any asymmetric phenomena such as vortex shedding and wake instability could not be detected.

The main objective of this work is to find the flow characteristics for isolated spheroids and elliptical cylinders and for their respective clusters using the cell models, rather than to investigate and experiment with various numerical techniques. Jenson's relaxation technique has been found (58-61) to be very adequate and successful in accurately describing the flow field for both circular cylinders and spheres. Its adaptation to spheroids and elliptical cylinders follows quite readily.

2. Relaxation Procedure

The relaxation technique used involved calculating new values for $\psi(I,J)$ and $G(I,J)$ from the four adjacent points lying on the orthogonal lines crossing at (I,J), as shown in figure 1 for spheroids and figure 3 for elliptical cylinders. The new values of ψ and G are calculated by means of equations 110 and 111 for the spheroids and 142 and 143 for the elliptical cylinders. As the relaxation procedure is the same for the spheroids and the cylinders, the technique for the former only is discussed in detail. In the iterative procedure for solving the difference equations, relaxation parameters α_s and α_g were introduced to stabilize the computations as follows:

$$\psi_n(I,J) = \psi_{n-1}(I,J) + \alpha_s[\ \psi_n^*(I,J) - \psi_{n-1}(I,J)\ ] \qquad (192)$$

$$G_n(I,J) = G_{n-1}(I,J) + \alpha_g[\ G_n^*(I,J) - G_{n-1}(I,J)\ ] \qquad (193)$$

where the subscript n denotes the nth iteration and superscript * signifies the unmodified result of the nth iteration. The proper choice of α_s and α_g were very important for controlling the rate of convergence. A Gauss-Seidel solution uses a relaxation parameter of unity, i.e. the new value calculated for point (I,J) is used unaltered in the next iteration. It has been shown by Forsythe and Wasow (152) that for linear equations, successive over-relaxation using $1<\alpha<2$ greatly improves the rate of convergence. Also they suggest that it is better to be slightly on the high side of the optimum α than on the low side for higher rate of convergence. In the present problems equations 111 and 143 are linear, and in general a value of 1.8 was assigned to α_s for spheroids and 1.8 - 1.6 for elliptical cylinders. On the other hand, equations 110 and 142 are linear only when Re is equal to zero, and their "nonlinearity" becomes more pronounced as Re increases. This necessitated a continual reduction in α_g as Re was increased for the single bodies, in order to obtain convergence. The present work substantiates the comments made by Burggraf (153) that the relaxation parameter α appears to be fairly insensitive to mesh size, but strongly dependent on the precise method of iteration used. In this work, for each alternative cycle of these calculations, points were considered from the surface of the spheroid to the

outer boundary, starting with $\eta=0$ at the front to $\eta=\pi$ at the rear. Once a cycle was completed, the next cycle was started from $\eta = \pi$ proceeding down to $\eta=0$, points being taken from the outer boundary to the solid surface. Corrected values of ψ and G were used as soon as they became available. However, if the corrected values obtained during a given cycle were not utilized once available, it was found that the optimum value of α_g would be less than that of the former method, and consequently the number of iterations would be increased for proper convergence. Rhodes (57) used the latter method and found that he required an excessive number of iterations, for example 10,000 iterations for convergence in the case of flow past a sphere at Re = 100. The number of iterations for the limiting case of a sphere using the former method was 1000 as obtained in the present work.

During the course of the work it was found that large values of α_g introduced an oscillation of the vorticity at the surface, and that such an oscillation sometimes led to divergence. For this reason a separate relaxation parameter, α_{gs}, was introduced to the vorticity at the surface. This made it possible to assign a higher value to α_g than was previously possible, α_{gs} being smaller than α_g. Values of α_g and α_{gs} for various values of Re and aspect ratio, A.R., are given in tables 2 and 3 for spheroids and tables 4 and 5 for elliptical cylinders.

Calculations were begun by first assigning approximate values to ψ and G on the grid from the creeping flow equation for a sphere in the case of the spheroids and from the

Table 2

Relaxation factors for oblate spheroids

Re	A.R.	α_g	α_{gs}	No. iterations for convergence
1	0.999	0.7	0.5	400
1	0.9	0.7	0.5	450
1	0.5	0.7	0.5	500
1	0.2	0.7	0.4	600
5	0.999	0.5	0.3	400
5	0.9	0.5	0.3	400
5	0.5	0.5	0.3	450
5	0.2	0.5	0.3	450
10	0.999	0.3	0.15	1750
10	0.9	0.3	0.15	2100
10	0.5	0.3	0.15	2200
10	0.2	0.3	0.15	2300
20	0.999	0.25	0.13	1100
20	0.9	0.25	0.13	1050
20	0.5	0.25	0.13	1200
20	0.2	0.20	0.10	1300
50	0.999	0.2	0.1	900
50	0.9	0.2	0.1	1000
50	0.5	0.2	0.1	1000
50	0.2	0.15	0.08	1500
100	0.999	0.08	0.05	1000
100	0.9	0.08	0.05	1150
100	0.5	0.08	0.05	1250
100	0.2	0.08	0.05	1800
0.01	9-0.2	0.8	0.6	250 - 400 swarms

Table 3

Relaxation factors for prolate spheroids

Re	A.R.	α_g	α_{gs}	No. iterations for convergence
1	0.9	0.70	0.55	450
1	0.5	0.70	0.55	500
1	0.2	0.60	0.50	400
5	0.9	0.5	0.3	550
5	0.5	0.5	0.3	550
5	0.2	0.45	0.3	600
10	0.9	0.25	0.15	700
10	0.5	0.25	0.15	550
10	0.2	0.25	0.15	900
20	0.9	0.25	0.15	800
20	0.5	0.25	0.15	750
20	0.2	0.40	0.30	600
50	0.9	0.20	0.10	850
50	0.5	0.20	0.10	850
50	0.2	0.15	0.10	650
100	0.9	0.08	0.05	1000
100	0.5	0.08	0.05	1000
100	0.2	0.06	0.04	650
0.01	0.9-0.5	0.6	0.50	400 swarms
0.01	0.2	0.5	0.40	800 swarms

Table 4

Relaxation factors for elliptical cylinders with O.R. ≥ 1

Re	O.R.	α_g	α_{gs}	No. iterations for convergence
1.0	$\sim$1.0	0.6	0.45	1900
5.0	$\sim$1.0	0.2	0.15	2500
1.0	10/9	0.4	0.3	2150
5.0	10/9	0.2	0.15	2950
15.0	10/9	0.08	0.05	2250
40.0	10/9	0.03	0.02	2500
90.0	10/9	0.005	0.003	3500
.5	2	0.65	0.55	1150
1.0	2	0.40	0.3	1750
5.0	2	0.2	0.15	1800
15.0	2	0.06	0.03	2000
50.0	2	0.02	0.01	2150
.2	5	0.6	0.5	1150
1.0	5	0.5	0.4	1500
5.0	5	0.12	0.10	2150
10.0	5	0.05	0.035	1800
20.0	5	0.03	0.015	1950
40.0	5	0.02	0.01	1500
0.01	10/9-5	0.7	0.5	450 - 600 swarms

Table 5

Relaxation factor for elliptical cylinders with O.R. < 1

Re	O.R.	α_g	α_{gs}	No. iterations for convergence
1.0	0.2	0.4	0.3	1900
5.0	0.2	0.3	0.15	2500
15.0	0.2	0.06	0.03	5500
40.0	0.2	0.018	0.012	3500
0.01	0.9-0.2	0.7	0.5	450 - 600 swarms

numerical solution for a circular cylinder in case of the elliptical cylinders. Using equation 111 , for oblate spheroids a new value of ψ was calculated and then modified by equation 192. The new value of ψ was used in equation 110 to find an improved value of G, which was subsequently modified by equation 193. This procedure was repeated until no further change was apparent in the desired significant figure of any function between successive iterations.

3. Computer Programs

The numerical analysis of flow past oblate spheroids, including the cell models, were carried out using an IBM 7044 digital computer, but the further work on prolate spheroids and elliptical cylinders was carried out on an IBM 360/67 in conjunction with Michigan Terminal Systems. Two general programs were written, one for the spheroids and the other for the elliptical cylinders. Each program was written to incorporate all possible variables to be studied: oblate or prolate in the case of the spheroids, flow past major or minor axis in the case of the elliptical cylinders, volumetric concentration, Reynolds number, grid size, relaxation parameters and number of iterations per run. Each program evaluated the skin and drag coefficients and the dimensionless surface pressure, and it initiated the contouring of streamlines, equi-vorticity lines and equi-velocity lines*. The listing

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* The contouring program was written by the Computing Centre Staff of the University of British Columbia.

of the two programs is given in Appendix IV.

The point values of the stream function and vorticity for all the cases are stored in a master tape in duplicate. The computer times to produce a new value for one grid point are 0.000441 and 0.000261 second per iteration for the spheroids and the elliptical cylinders, respectively, based on the IBM 360/67.

4. Validity of the numerical work

In the relaxation procedure, or in any other technique in which only point values of the field function under consideration are known, misleading results could be obtained from the values of the field functions at the lattice points unless great care were taken by considering the various computational parameters that could influence the flow field. These parameters are: (a) the number of Taylor expansion terms used, (b) Convergence tolerance, (c) mesh size, (d) position of the outer boundary for single bodies and (e) the differentiation technique. Comments on each parameter follow:

(a) The flow equations were transformed to finite difference equations by using second order Taylor expansions. Jenson (55), in his work on spheres, used both second and fourth order Taylor expansions for Re = 5, and found no difference in the accuracy of the final values of the drag coefficients for a lattice spacing of 12 degrees in the angular, and 0.2 units of ln r (where r = dimensionless radial coordinate) in the radial, direction. Although a

similar insensitivity to the order of the Taylor expansion would be less probable for a spheroid or elliptical cylinder of small aspect ratio, the second order expansion was nevertheless used throughout this analysis in order to keep the computer time within reasonable bounds.

(b) Convergence of the computed values for the stream function and vorticity was assumed when no further change was apparent in the fourth significant figure of any function between successive iterations. With such a tolerance the drag coefficients and surface pressure distributions would not change by more than 0.2% and 0.5%, respectively, for the case of a spheroid and 0.5% and 1.0% respectively, for the case of an elliptical cylinder, for a further 50 iterations. In some cases of low Re and large mean diameter for the elliptical cylinders, the convergence criterion was taken when no further change occurred in the fifth significant figure of any function between successive iterations. During the course of this work it was found that while the drag coefficients were not very sensitive to the degree of convergence of the lattice points, $P_{\eta=\pi}$ was very sensitive to the degree of convergence.

(c) The effect of the mesh size for the oblate spheroids at Re = 50 and Re = 100 was evaluated by changing the

grid size for the angles from $\sim 6°$ to $\sim 3°$, and the radial step from ~ 0.06 to ~ 0.03. The resulting changes in the total drag coefficients for the two Reynolds numbers at any aspect ratio were within the numerical error (e.g. approximately 2%). No appreciable change in the dimensionless frontal stagnation pressure was detected, but the rear stagnation pressure was altered by about 30% which, however, represented only a 5% change relative to the frontal stagnation pressure. For lower Re, the larger step size was used because the rate of change of the flow functions with step size was not as rapid as that for higher values of Re. The shape of the wake was found to be almost the same for the two mesh sizes used except for A.R. of 0.2, where the wake length was about 10% smaller for the finer grid size. For the prolate spheroids, the step size was found to be more critical, and therefore a smaller step size was used throughout. A change in step size of $\sim 6°$ in the angular and ~ 0.04 in the radial direction to $\sim 3°$ and $\sim 0.02°$ respectively, for Re = 100 and A.R.= 0.5, gave a 4% difference in the total drag coefficient, using the same differentiation and integration formulae. P_o was simultaneously changed by 1% and $P_{\eta=\pi}$ by about 6% relative to P_o. Some selected values for the drag coefficients and P_o are given in Table 6. The angle

Table 6

Some selected data for single spheroids

Mark	Type of spheroid	A.R.	Mean diameter d_m	IMxJM	Re	C_{DS}	C_{DF}		C_{DT}		P_o	
							3 points	5 points	3 points	5 points	3 points	5 points
266	Oblate	0.2	7.0	41x65	100	0.1947	1.155	1.145	1.350	1.340	1.060	1.061
137	"	0.2	17.11	33x59	100	0.1755	1.157	1.146	1.333	1.321	1.057	1.058
234	"	0.2	17.11	61x105	100	0.1666	1.123	1.118	1.289	1.285	1.056	1.057
113	"	0.2	17.11	33x59	50	0.2928	1.378	1.371	1.671	1.664	1.116	1.117
165	"	0.2	17.11	61x105	50	0.2855	1.368	1.366	1.653	1.651	1.115	1.115
97	"	0.2	17.11	33x59	10	0.9186	2.985	2.982	3.904	3.900	1.559	1.564
96	"	0.2	29.90	33x69	10	0.9055	2.940	2.936	3.846	3.842	1.554	1.560
128	"	0.5	17.13	33x59	100	3.747	0.812	0.809	1.187	1.184	1.077	1.078
224	"	0.5	17.13	61x105	100	3.627	0.769	0.774	1.132	1.137	1.076	1.076
111	"	0.5	17.13	33x59	50	0.601	0.9996	1.006	1.600	1.607	1.151	1.153
164	"	0.5	17.13	61x105	50	0.586	0.981	0.984	1.567	1.570	1.149	1.150
59	"	0.5	17.13	33x59	10	1.818	2.162	-	3.971	-	1.685	-
84	"	0.5	29.95	33x73	10	1.802	2.169	2.173	3.970	3.974	1.682	1.687
126	"	0.9	17.10	33x59	100	0.576	0.558	0.557	1.134	1.133	1.103	1.104
217	"	0.9	17.10	61x105	100	0.554	0.548	0.562	1.102	1.116	1.100	1.100
126	"	0.9	17.10	33x59	100	0.576	0.558	0.557	1.134	1.133	1.103	1.104
217	"	0.9	17.10	61x105	100	0.554	0.548	0.562	1.102	1.116	1.100	1.100
112	"	0.9	17.10	33x59	50	0.890	0.711	0.728	1.601	1.617	1.196	1.196
161	"	0.9	17.10	61x105	50	0.868	0.703	0.713	1.571	1.580	1.192	1.192
61	"	0.9	17.10	33x59	10	2.665	1.626	1.638	4.291	4.303	1.847	1.848
8	"	0.9	29.63	33x65	10	2.650	1.628	1.641	4.278	4.290	1.845	1.846
106	"	0.999	17.10	33x59	50	0.949	0.662	0.681	1.611	1.630	1.207	1.207
150	"	0.999	17.10	61x105	50	0.925	0.656	0.666	1.580	1.591	1.202	1.202
90	"	0.999	17.10	33x59	20	1.740	1.025	1.040	2.765	2.780	1.477	1.476
283	"	0.999	17.10	61x65	20	1.715	1.018	1.032	2.734	2.748	1.467	1.467
58	"	0.999	17.10	33x59	10	2.844	1.534	1.548	4.378	4.392	1.887	1.886

cont....

Table 6 (cont'd)

Mark	Type of spheroid	A.R.	Mean diameter	IMxJM	Re	C_{DS}	C_{DF}		C_{DT}		P_o	
							3 points	5 points	3 points	5 points	3 points	5 points
73	Oblate	0.999	29.96	33x69	10	2.833	1.525	1.539	4.357	4.371	1.885	1.885
249	"	0.999	7.00	41x65	100	0.611	0.533	0.551	1.144	1.162	1.108	1.108
124	"	0.999	17.10	33x59	100	0.617	0.516	0.515	1.133	1.132	1.109	1.110
218	"	0.999	17.10	61x105	100	0.591	0.508	0.524	1.099	1.115	1.106	1.106
588	Prolate	0.2	14.9	65x105	100	1.481	0.104	1.50	1.585	1.631	1.332	1.481
580	"	0.2	14.9	33x95	100	1.551	0.124	0.175	1.675	1.726	1.350	1.372
613	"	0.2	14.9	65x105	50	2.361	0.1508	0.190	2.511	2.551	1.599	1.573
578	"	0.2	14.9	33x95	50	2.40	0.160	0.205	2.560	2.606	1.630	1.661
572	"	0.2	14.94	33x95	10	7.49	0.430	0.507	7.920	7.997	3.389	3.461
590	"	0.5	14.95	65x105	100	0.895	0.279	0.303	1.174	1.198	1.162	1.16
555	"	0.5	14.95	33x65	100	0.935	0.278	0.293	1.213	1.228	1.172	1.167
549	"	0.5	14.95	33x65	50	1.408	0.374	0.404	1.782	1.813	1.317	1.408
537	"	0.5	14.95	33x65	10	4.316	0.987	1.018	5.303	5.334	2.285	2.249
530	"	0.5	29.67	33x65	10	4.292	0.954	1.001	5.246	5.293	2.284	2.248
566	"	0.9	15.08	65x95	100	0.626	0.447	0.466	1.074	1.093	1.112	1.112
558	"	0.9	15.08	33x65	100	0.655	0.473	0.487	1.128	1.142	1.115	1.115
550	"	0.9	15.08	33x65	50	.999	.607	0.626	1.606	1.625	1.218	1.217
534	"	0.9	15.08	33x65	10	3.085	1.674	1.685	4.759	4.77	1.923	1.920
531	"	0.9	29.93	33x65	10	3.023	1.447	1.465	4.470	4.489	1.929	1.926

cont....

Table 6 (cont'd)

Mark	Angle of Separation	$\frac{W_L'}{H'}$
266	99.3	2.3
137	100.3	3.9
234	99.7	3.6
113	104.3	2.3
165	103.4	2.3
97	122.4	0.52
96	122.3	0.52
128	110.9	2.8
224	110.1	2.7
111	118.8	1.7
164	118.3	1.6
59	-	-
84	161.4	0.08
126	125.1	1.9
217	124.5	1.8
126	125.1	1.9
217	124.5	1.8
112	136.1	1.0
161	135.1	1.0
61	-	-
8	-	-
106	139.9	0.85
150	138.6	0.95
90	173.9	-
283	175.5	-
58	-	-
73	-	-
249	128.3	1.65
124	128.4	1.7
218	127.7	1.7
588	-	-
580	-	-
613	-	-
578	-	-
572	-	-
590	151.8	0.65
555	155.4	0.55
549	172.2	-
537	-	-
530	-	-
566	129.4	1.55
558	132.0	1.50
550	143.4	0.75
534	-	-
531	-	-

of separation is seen to be sensitive to the step size chosen, for the prolate spheroids.

For single elliptical cylinders less extensive tests were made and, in general, smaller grid sizes were used. The grid sizes used varied from $\sim 6°$ to $\sim 3°$ in the angular direction and ~ 0.044 to about 0.053 in the radial direction. The details are given in Table 7 and Appendix II.

For both the spheroids and elliptical cylinders at Re = 0.01, using either Happel's free surface cell model or Kuwabara's zero vorticity cell model, where the outer envelope is relatively close to the inner surface of the body a relatively small grid size in the radial direction is possible even though the total number of points is not large. In general the grid size varied from $6°$ to $4.5°$ in the angular direction and from 0.08 to 0.003 in the radial direction. Table 8 shows that the grid sizes used in this work were adequate, as they gave very close results to the available analytical solutions, the details of which are once again given in Appendix II.

(d) For numerical analysis purposes the field of computation for single bodies must be restricted within an outer envelope which is made to coincide with one of the grid lines used. The position of such an envelope is an important factor in the numerical

Table 7

Some selected data for single elliptical cylinders

Mark	O.R.	Mean diameter d_m	IMxJM	Re	C_{DS}	C_{DF}		C_{DT}		P_o		Angle of separation	$\frac{W_L'}{H'}$
						3 points	5 points	3 points	5 points	3 points	5 points		
1254	0.2	133.04	65x105	40	0.1725	1.656	1.642	1.829	1.814	1.086	1.086	103.2	6.9
1143	0.2	133.04	33x93	15	0.3097	2.283	2.276	2.597	2.586	1.220	1.222	108.8	2.95
1112	0.2	133.04	33x93	1	1.7795	9.038	9.030	10.817	10.810	3.642	3.658	-	-
1139	5	133.04	33x93	40	1.138	0.573	0.594	1.711	1.732	1.438	1.630	-	-
1117	5	133.04	65x105	40	1.100	0.631	0.652	1.730	1.752	1.342	1.324	-	-
1021	5	59.78	33x69	1	11.577	2.436	2.437	14.013	14.014	6.264	6.239	-	-
1023	5	89.18	33x85	1	11.247	2.408	2.417	13.655	13.665	6.150	6.124	-	-
1028	5	133.04	33x93	1	11.236	2.370	2.370	13.606	13.607	6.118	6.092	-	-
1096	2	111.05	33x93	50	0.7163	0.744	0.752	1.460	1.469	1.185	1.183	150.6	1.14
1251	10/9	133.79	65x105	90	0.3156	0.8014	0.8017	1.117	1.117	1.070	1.067	118.1	7.1
1266	10/9	133.79	65x105	40	0.5587	0.861	0.861	1.420	1.420	1.151	1.151	128.4	3.45
1066	∿1.0	121.5	33x93	5	1.891	2.158	2.161	4.049	4.052	1.86	1.856	-	-
1045	∿1.0	257.23	33x93	1	5.3144	5.461	5.464	1.077	1.078	4.001	3.989	-	-

Table 8

Effect of grid size on C_{DT} and a comparison with analytical solutions for Re = 0.01

Mark	A.R. (spheroids)	O.R. (cylinders)	Concentration c	IMxJM	C_{DT}	Model
1525	-	1000/995	0.4025	33x33	0.265×10^{5}	Happel
Analytical	-	1.0	0.4025	-	0.266×10^{5}	Happel
1544	-	1000/999	0.01005	33x33	0.140×10^{4}	Happel
1535	-	999/1000	0.01005	33x33	0.140×10^{4}	Happel
Analytical	-	1.0	0.01005	-	0.140×10^{4}	Happel
1526	-	1000/995	0.4025	33x33	0.373×10^{5}	Kuwabara
Analytical	-	1.0	0.4025	-	0.372×10^{5}	Kuwabara
1272	-	1000/995	0.01005	33x33	0.161×10^{4}	Kuwabara
1276	-	999/1000	0.01005	33x33	0.161×10^{4}	Kuwabara
Analytical	-	1.0	0.01005	-	0.162×10^{4}	Kuwabara
5517	0.2, prolate	-	0.5959	65x21	0.505×10^{6}	Happel
5516	0.2, prolate	-	0.5959	33x21	0.505×10^{6}	Happel
5138	o.2, oblate	-	0.4011	41x33	0.336×10^{5}	Happel
5117	0.2, oblate	-	0.4011	61x33	0.336×10^{5}	Happel
5150	0.999,oblate	-	0.4066	33x33	0.474×10^{5}	Happel
Analytical	1.0 sphere	-	0.4066	-	0.475×10^{5}	Happel
5051	0.999,oblate	-	0.0498	33x33	0.529×10^{4}	Happel
Analytical	1.0, sphere	-	0.0498	-	0.529×10^{4}	Happel
272	0.999,oblate	-	0.0498	33x33	0.619×10^{4}	Kuwabara
Analytical	1.0, sphere	-	0.0498	-	0.620×10^{4}	Kuwabara

results. The analytical solution of the creeping flow equations for a sphere surrounded by an outer spherical envelope under the boundary conditions of zero vorticity at the outer envelope is given by equation 90 :

$$F = \frac{30\pi\mu U\, a}{5 - 9\gamma + 5\gamma^3 - \gamma^6} \qquad (90)$$

where γ is the diameter ratio of solid sphere to spherical envelope ,then

$$\frac{F|_{\gamma=0.01}}{F|_{\gamma=0}} = 1.018$$

This indicates that even when the outer envelope is located at 100 diameters from the sphere, its influence on the drag force or drag coefficient is still perceptible. The drag coefficients at Re = 1.0 for both oblate and prolate spheroids were extrapolated to infinite envelope volume from a plot of C_{DT} against the reciprocal of the mean dimeter, d_m $(=\gamma^{-1}=c^{-1/3})$, defined as the total volume of the outer envelope divided by the volume of the spheroid, all raised to the power one-third. The range of d_m actually computed was 17-102, as shown in figure 5. At Re = 10 the difference between the computed values of the drag coefficients for d_m of 17 and 30 was negligible for both the oblate and prolate spheroids. For higher Re the values of d_m used to represent an infinite medium were 15 and

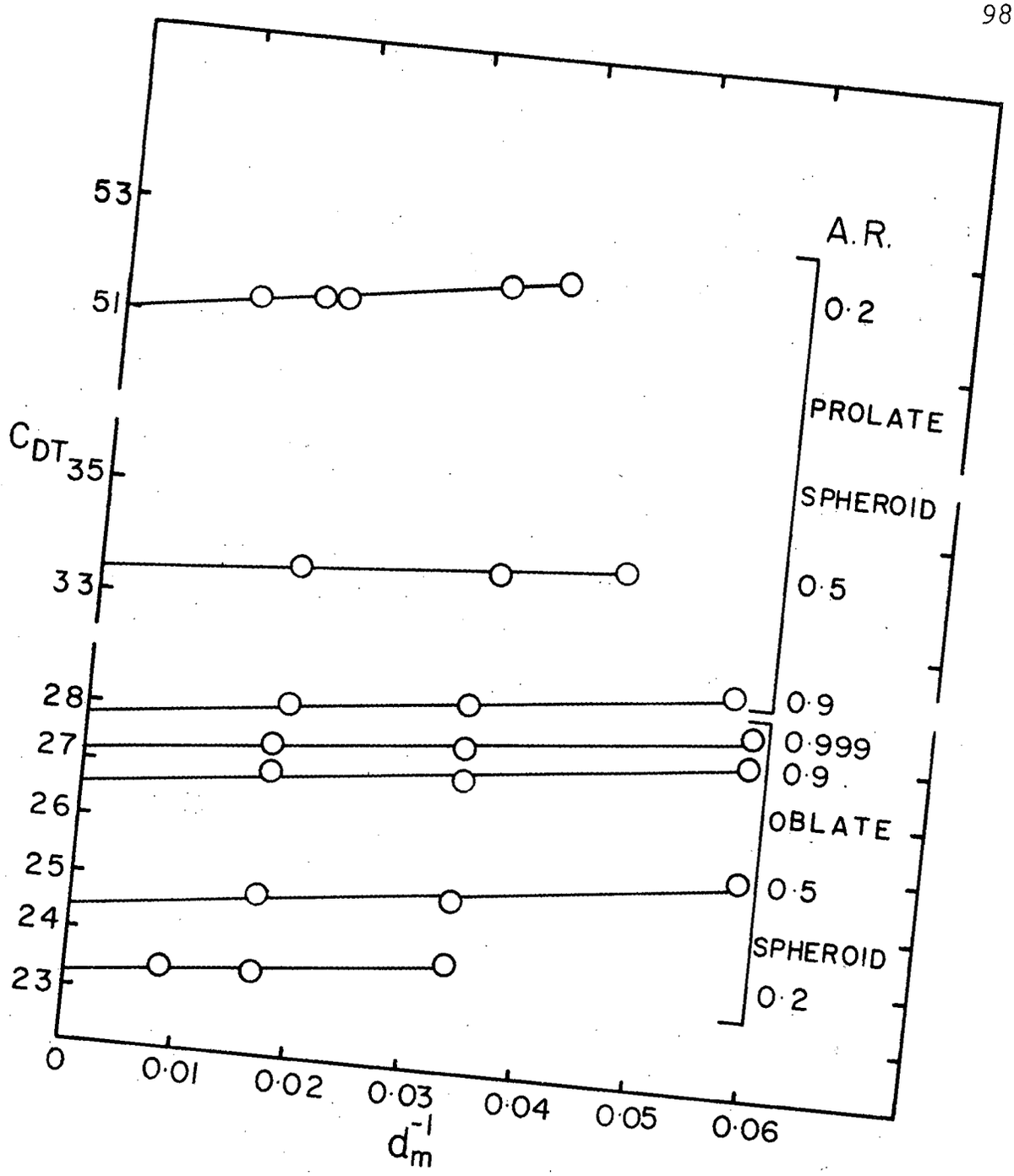


Figure 5. Variation of total drag coefficient with the mean diameter.

17 for prolate and oblate spheroids, respectively. It is interesting to note that a d_m of 7.0 for an oblate spheroid with A.R. = 0.2 gave a much smaller wake than d_m = 17, even though the respective values of C_{DT} were within 2% of each other. However, for A.R. = 0.999 the wake shape was not affected by decreasing d_m to 7.0.

For elliptical cylinders no analytical solution of the creeping flow equation is available and hence no direct comparisons could be made as in the case of spheroids. Results for an elliptical cylinder of O.R. = 5 at Re = 1.0 with d_m = 60-133 indicated that there is no appreciable difference in results between d_m = 89 and d_m = 133. For higher Reynolds numbers the values of d_m used to represent an infinite medium were in the range 111 - 133.

For the clusters, the position of the outer envelope was used to evaluate the concentration of the swarm in the cell model.

(e) The evaluation of the pressure distribution as given by equations 175 and 180 involved both differentiation and integration. The latter posed no difficulty and initial tests indicated that Simpson's rule (3 points) and Boole's rule (5 points) gave almost identical results. On the other hand, numerical differentiation could give an uncertainty

in the computed values of P, and consequently in the form drag coefficient. In order to examine the stability of the differentiation, Lagrange differentiation formulae for 3 and 5 points were used (initial tests were made using 3,4 and 5 points). In general for an oblate spheroid with small A.R. the variation in the computed values of C_{DF} was within 0.5%. For a prolate spheroid, however, difficulty was encountered, C_{DF} varying as much as 20% for small A.R. An examination of equation 175 and its numerical evalution indicates that the value of $\frac{\partial \zeta}{\partial \xi}\Big|_{\xi=\xi_a}$ at low aspect ratio is negative and nearly equal to $\zeta_a \tanh \xi_a$, except near the tips of the spheroid, resulting in the flatness of the surface pressure distribution for A.R. = 0.2 shown in figures 23 - 26. This gave rise to a large error in the computed value of P and hence C_{DF}. Fortunately, for small aspect ratio the major contribution to C_{DT} is from the skin drag coefficient, which could be obtained with good accuracy. For Re = 1, and A.R. = 0.2 and 0.5, the Lagrange 5-point differentiation formula as compared to the 3-point formula gave a closer value of C_{DF}/C_{DS} to that given by equation 34. For higher Re the 5-point formula was used. For elliptical cylinders, C_{DF} is given by one term only and hence the error in using different different-

iation formulae was not as severe as for the case of prolate spheroids. The worst case was the elliptical cylinder of A.R. = 5 at Re = 40, for which the variation in C_{DF} was about 3%. It is unfortunate that most publications in this field discuss in detail the several methods of obtaining converged and stable local flow functions, but fail to discuss the method used in obtaining the dependent cumulative functions, which usually require numerical integration and differentiation.

5. Results for Single Spheroids

The boundary conditions used for the isolated spheroids are given in Chapter III. At the outer envelope the zero vorticity model as given by Case I was used.

For an aspect ratio of unity, the spheroid becomes a perfect sphere. In this study an oblate spheroid with A.R. of 0.999 was considered to be a sphere. The variation of the total drag coefficient with Re obtained for the limiting case of a sphere is shown in figure 6. The present computed results agree well with the experimental values summarized by Lapple and Shepherd (154). The reason that the computed values of C_{DT} in general are above the experimental curve seems mainly to be that the outer envelope was not taken far enough for its influence to be negligible. The same direction of influence would be expected from the presence of walls confining the flow field.

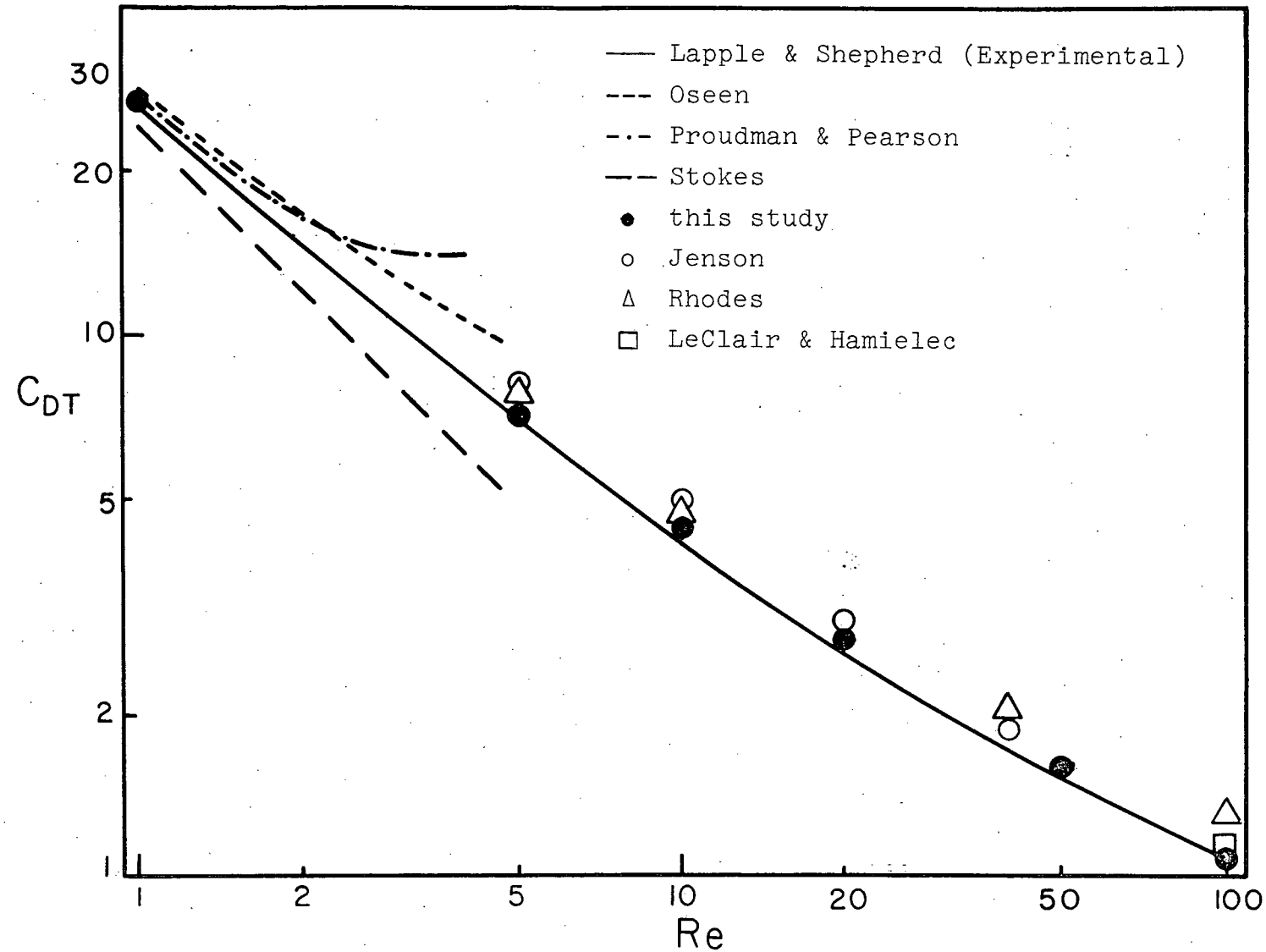


Figure 6. Variation of the total drag coefficient with Reynolds number for a sphere.

The variation of the total drag coefficient with Reynolds number of an oblate spheroid having various aspect ratios is given in figure 7. At low Re, an oblate spheroid with higher A.R. gives a higher drag coefficient, i.e., C_{DT} for a sphere is higher than that for a circular disc. For higher Re, this tendency is eventually reversed and a spheroid with lower A.R. gives a higher C_{DT}. At low Re, for which the contribution of C_{DS} to C_{DT} is large, this result appears to be quite reasonable, since at a fixed value of Re all the spheroids may be considered to have the same equatorial diameter (for constant U and ν), and consequently the surface area and hence the skin drag coefficient increases with A.R. For higher values of Re the wake bubble becomes larger for an oblate spheroid as A.R. decreases and since, normally, high form drag coefficients are associated with large wakes, and increasing Re increases the relative contribution of C_{DF} to C_{DT}, the result is that at sufficiently high Re, C_{DT} for a low aspect ratio is higher than that for a sphere. Experimental work on discs by Schmiedel (155) indicates that the C_{DT} - Re curve for a disc (crosses that of a sphere at Re $\simeq$ 50. A disc may be thought of as the limiting oblate spheroid of zero aspect ratio. Figure 8 shows the variation of C_{DT} with Re for various aspect ratios of a prolate spheroid. The comparison at a fixed value of Re may once again be considered as based on spheroids having the same equatorial diameter for fixed U and ν .

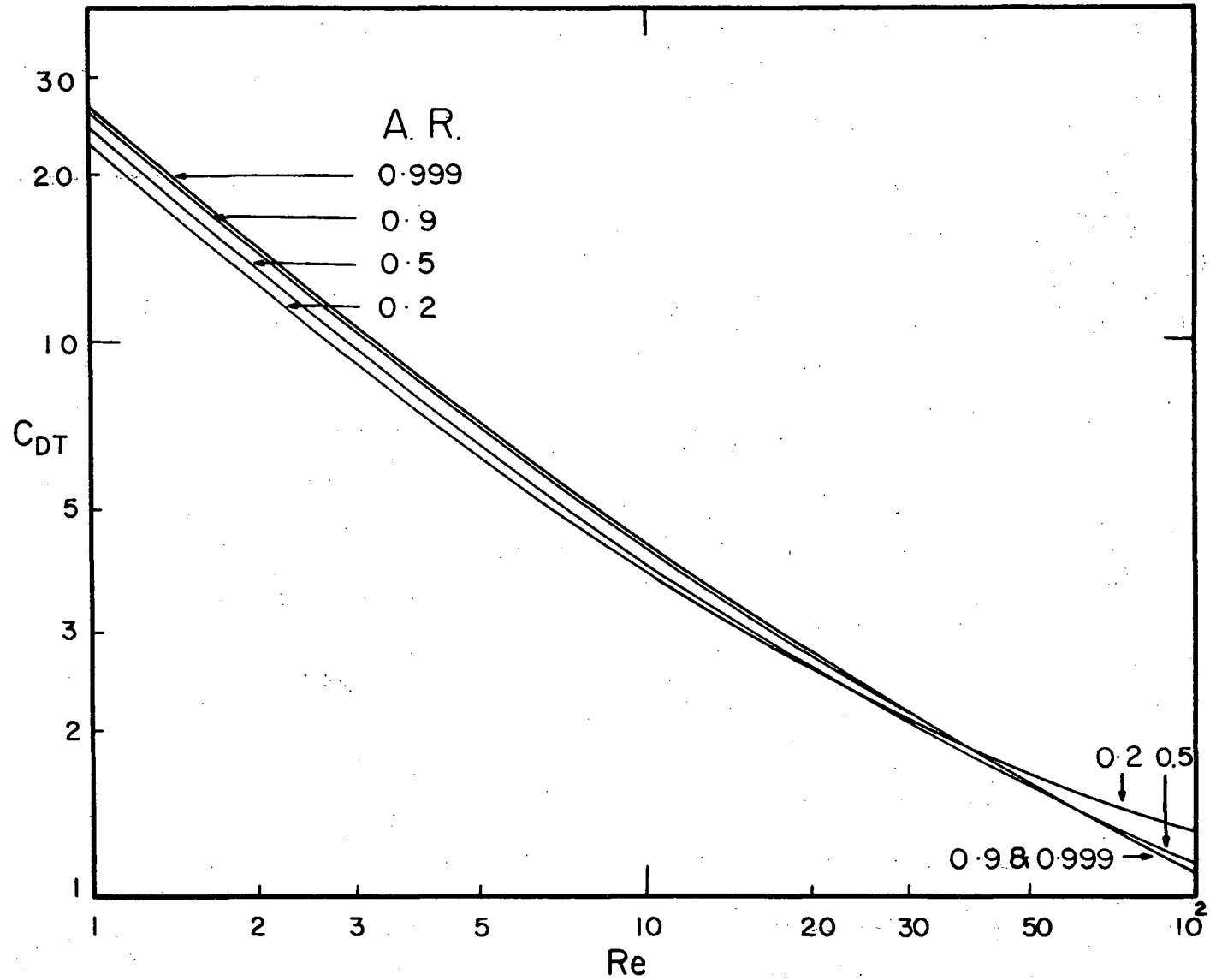


Figure 7. Variation of total drag coefficient with Reynolds number for various aspect ratios of an oblate spheroid.

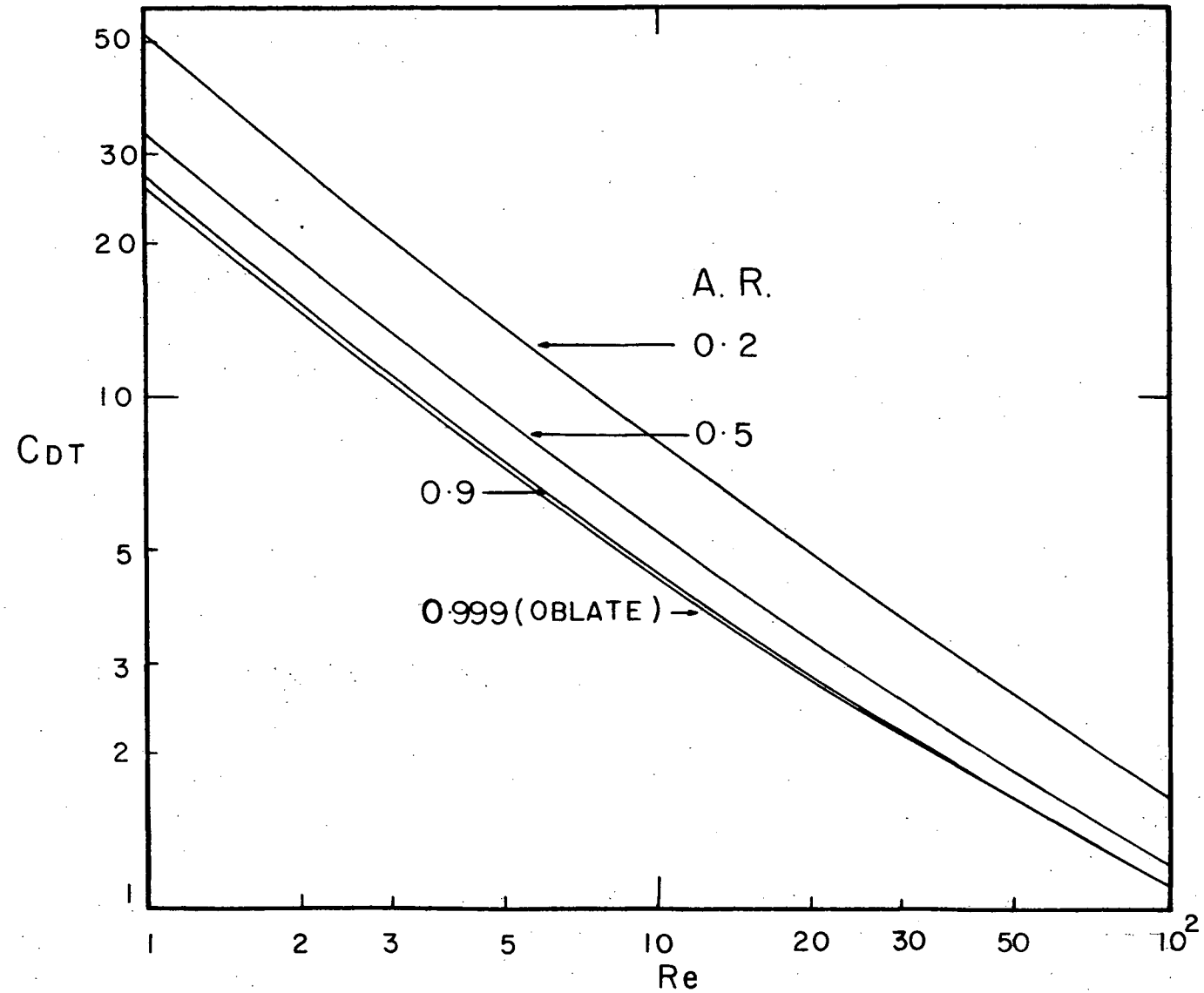


Figure 8. Variation of total drag coefficient with Reynolds number for various aspect ratios of a prolate spheroid.

The ratio of skin to form drag coefficient for oblate spheroids at different Reynolds numbers is shown in figure 9 as a function of aspect ratio. At Re = 1.0 , Aoi's expression as given by equation 35 is in good agreement with the present numerical study. The relative contribution of C_{DS} to C_{DT} decreases with Re for all aspect ratios. The same is observed for prolate spheroids as given by the plot of C_{DF}/C_{DS} vs. A.R. in figure 10. Aoi's expression, equation 34, is again in good agreement at Re = 1.0. However, the relative contribution of C_{DS} to C_{DT} increases with A.R. for an oblate, but decreases for a prolate spheroid.

The variation of the dimensionless frontal stagnation pressure with Re for an oblate and a prolate spheroid is shown in figures 11 and 12, respectively. It is interesting that the frontal stagnation pressure for the various aspect ratios of both oblate and prolate spheroids differ considerably from each other and from unity, P_o for an oblate spheroid with A.R. = 0.2 being the closest to unity at each Re. Moreover the deviation of P_o from unity increases with decreasing Reynolds number. This seems to confirm two well observed characteristics of static pitot tubes, namely that the correction factor is large for low Re and that it varies considerably for different tip shapes (156).

A comparison of the surface pressure distribution obtained by several workers (25a,55,57,163) for a sphere at Re = 10 is made with the present limiting case of a sphere in

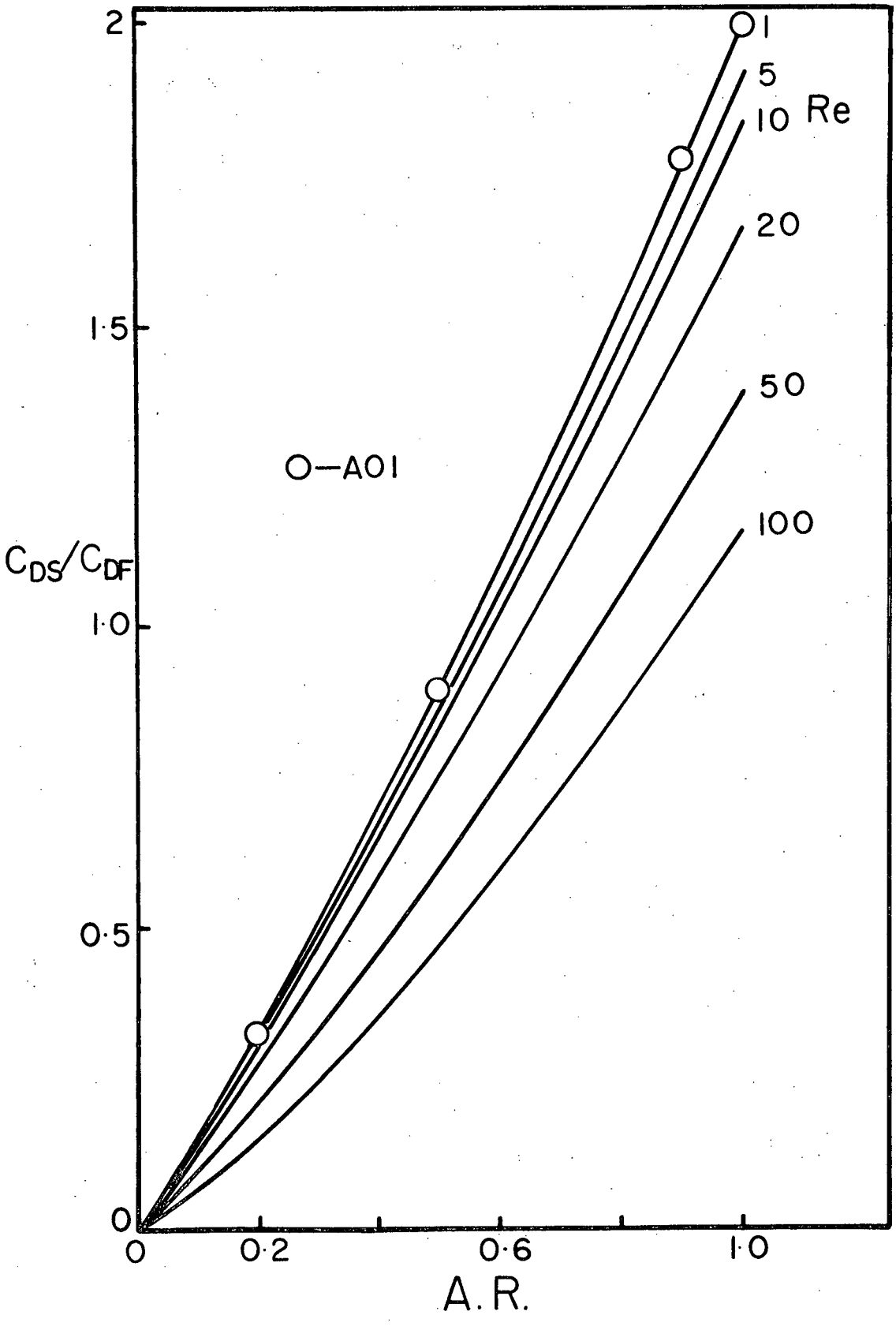


Figure 9. Variation of C_{DS}/C_{DF} with aspect ratio for oblate spheroids.

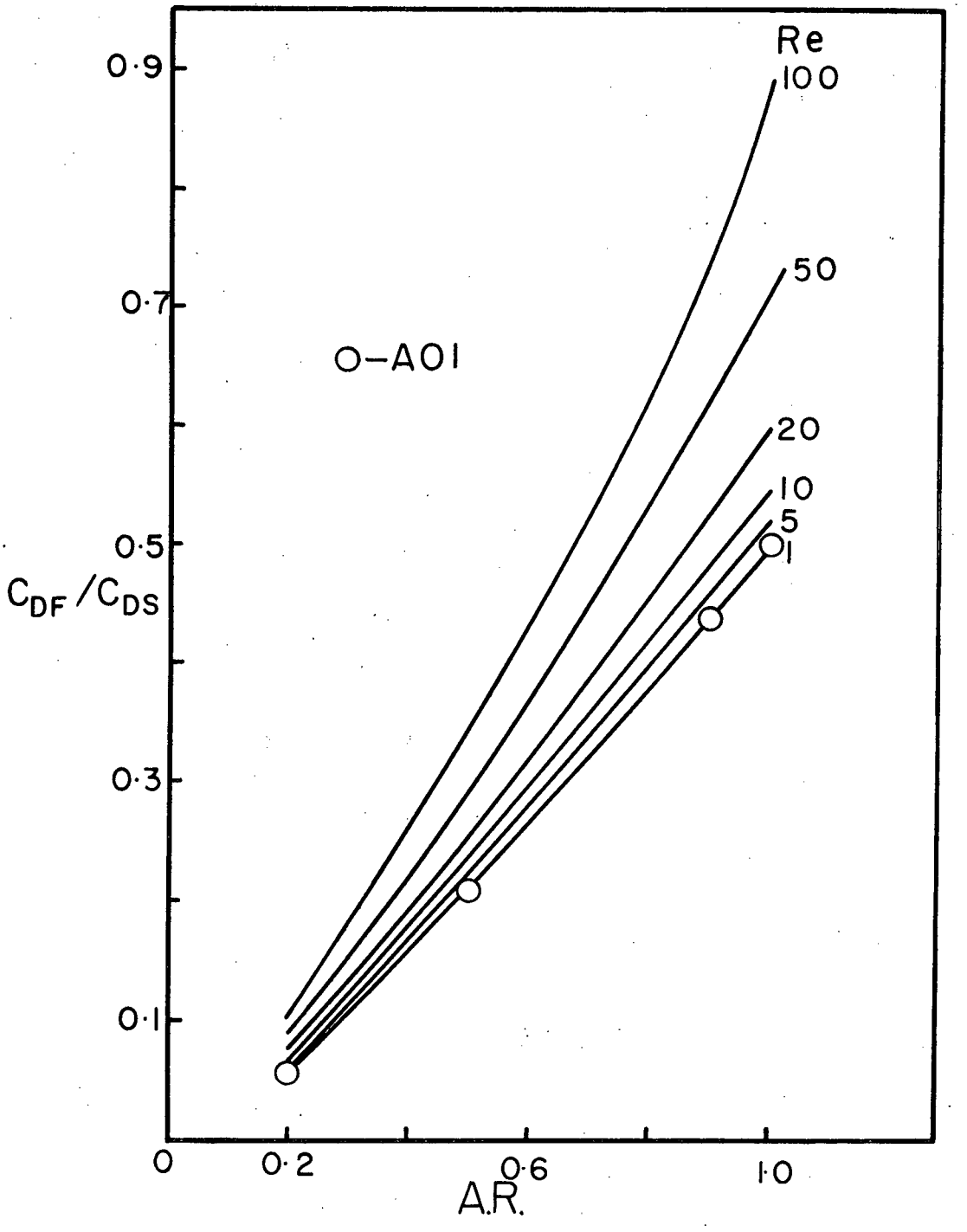


Figure 10. Variation of C_{DF}/C_{DS} with aspect ratio for prolate spheroids.

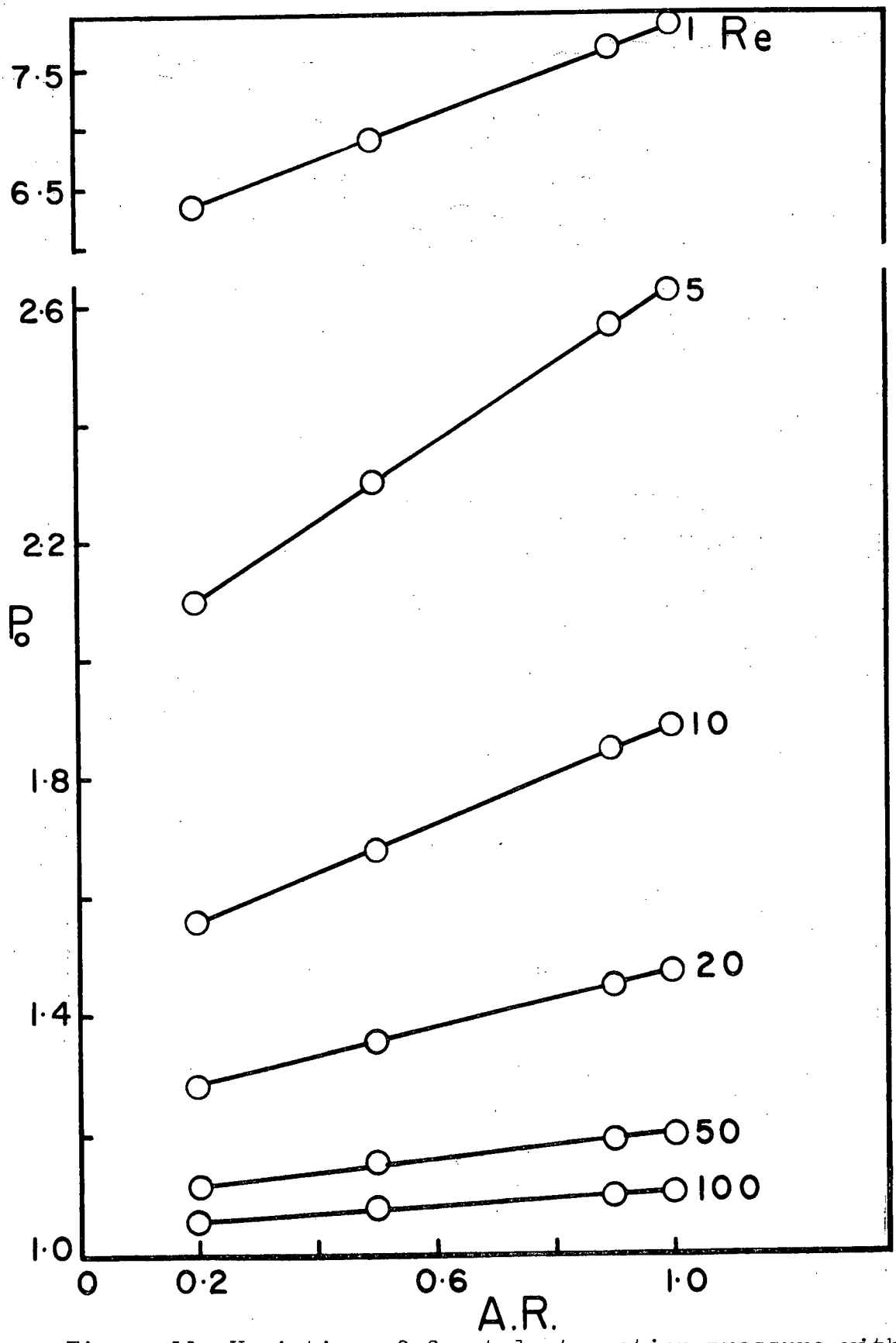


Figure 11. Variation of frontal stagnation pressure with A.R. for oblate spheroids.

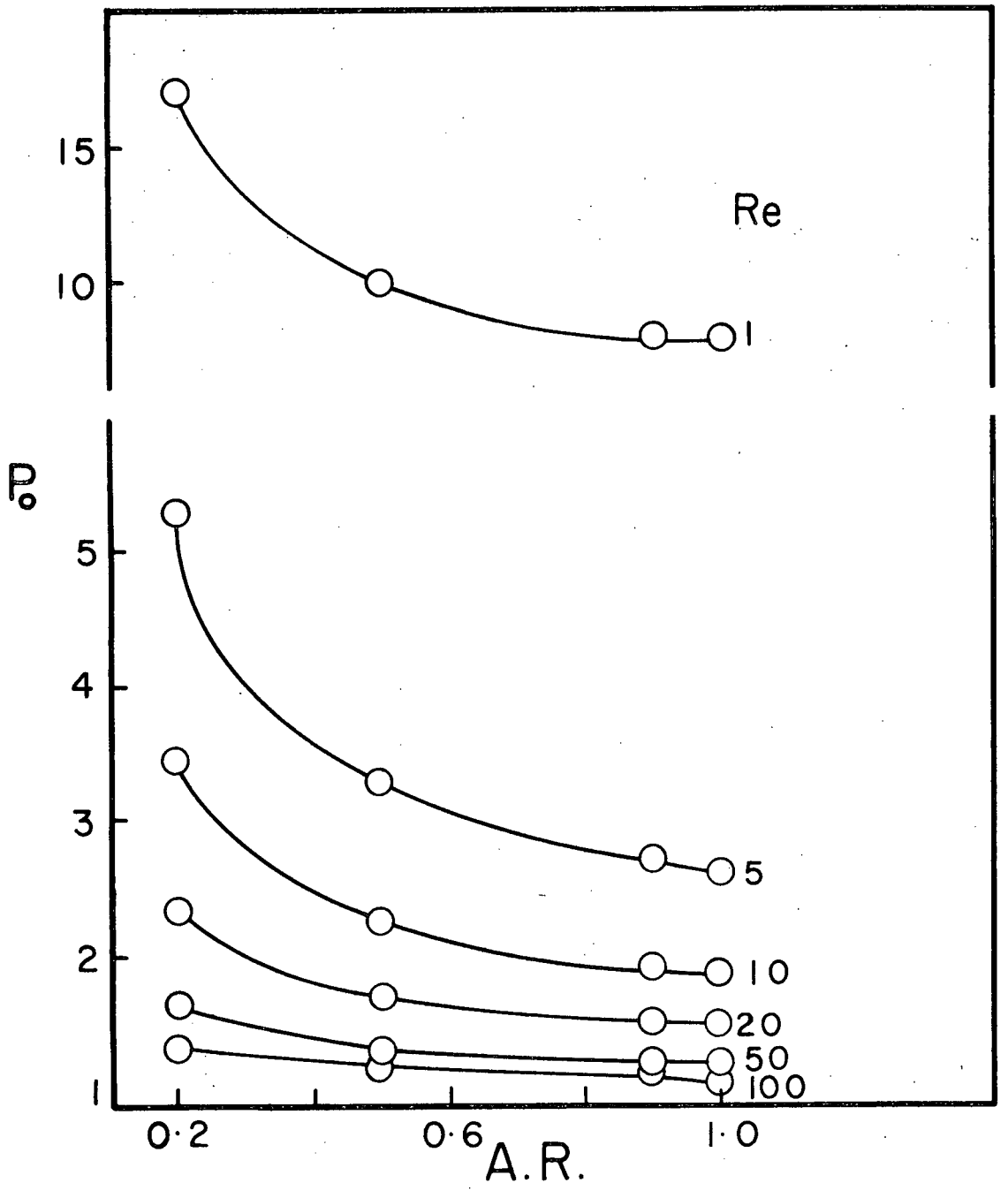


Figure 12. Variation of frontal stagnation pressure with A.R. for prolate spheroids.

figure 13, which shows good agreement between the numerical work and the analytical solution of Oseen's equations as given by Piercey and McHugh (25a). Figure 14 shows the comparison of P for a sphere at Re=100 and Re→∞, Stewartson (25b, equation 32).

The dimensionless pressure distribution at the surface of an oblate spheroid for different A.R. is shown in figure 15 for Re = 1.0. The Stokes pressure distribution for both a sphere and an oblate spheroid with A.R. = 0.2 are in good agreement with the computed distribution, considering that even for a sphere the Stokes regime is strictly valid only for Re $\leq$ 0.1. It is interesting to note sharp maxima and minima for A.R. = 0.2, less pronounced ones for A.R. = 0.5 and none at all for A.R. of 0.9. The exact value of A.R. where maxima and minima would be obliterated for Stokes flow could be found from equation 22a. Such surface pressure maxima are still exhibited for A.R. = 0.2 up to Re = 10, as shown in figures 16 and 17. The surface pressure distribution on an oblate spheroid for still higher Reynolds numbers are shown in figures 18 - 20.

For an oblate spheroid with A.R. = 0.2, figures 18, 19 and 20 show that the pressure at the surface increases rapidly just before the boundary layer separation point, whereas for a prolate spheroid with the same A.R. the surface pressure at corresponding Reynolds numbers increases slowly or not at all, and no separation is observed, according to figures 24, 25 and 26. The dimensionless surface pressure distribution on a prolate spheroid with different A.R. is

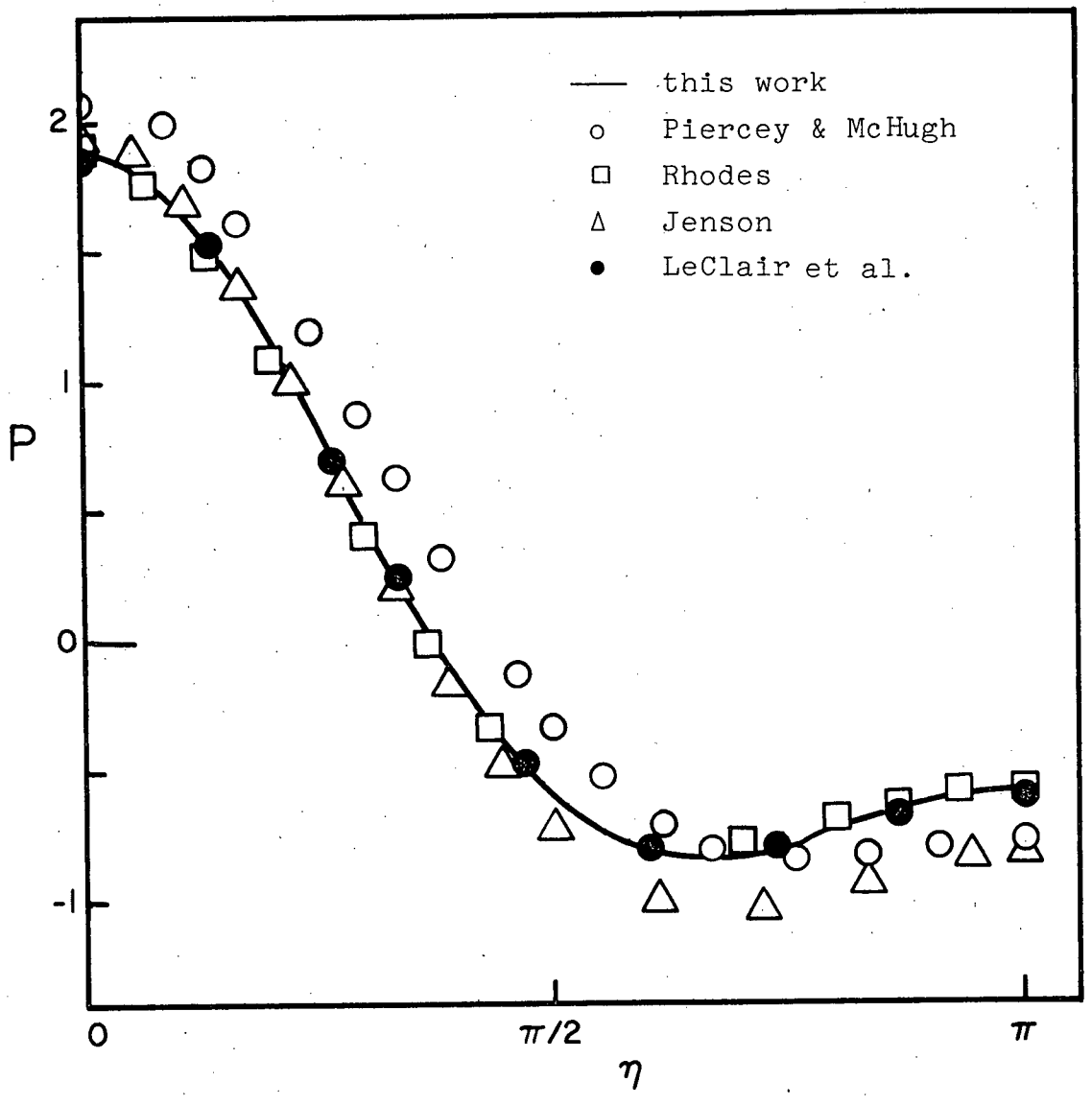


Figure 13. Surface pressure distribution for a sphere at Re=10.

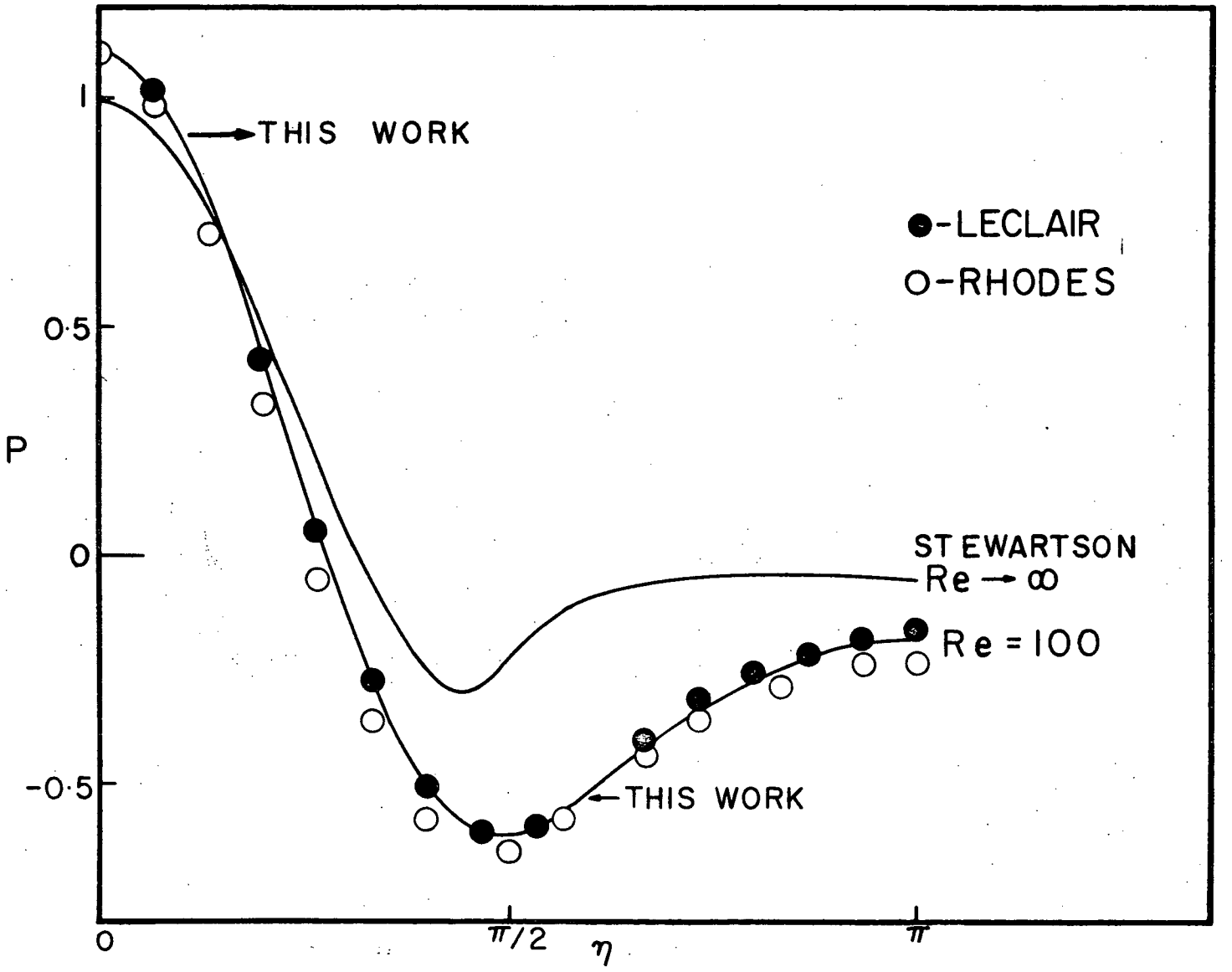


Figure 14. Surface pressure distribution of a sphere at high Reynolds number.

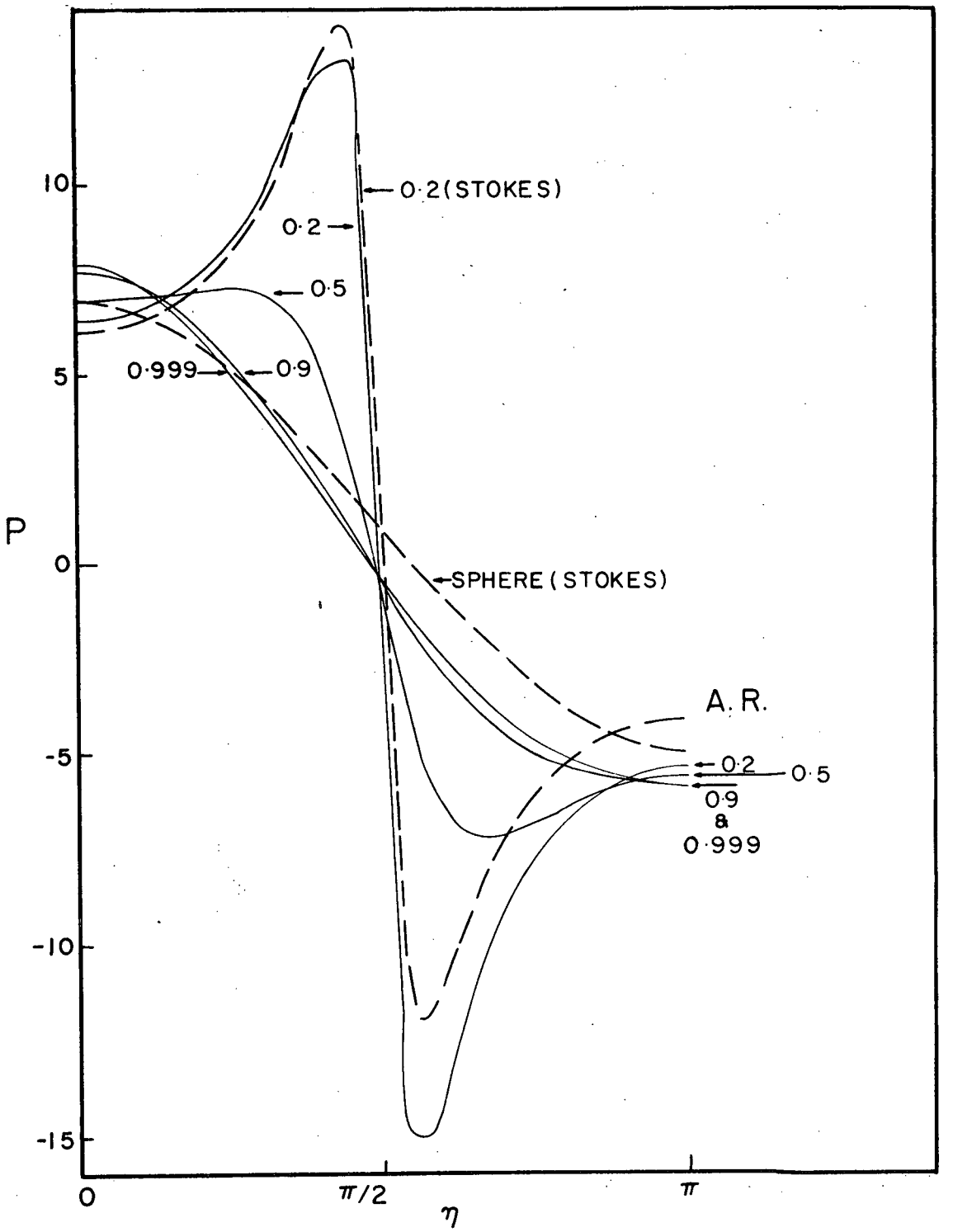


Figure 15. Surface pressure distribution for oblate spheroids at Re=1.0.

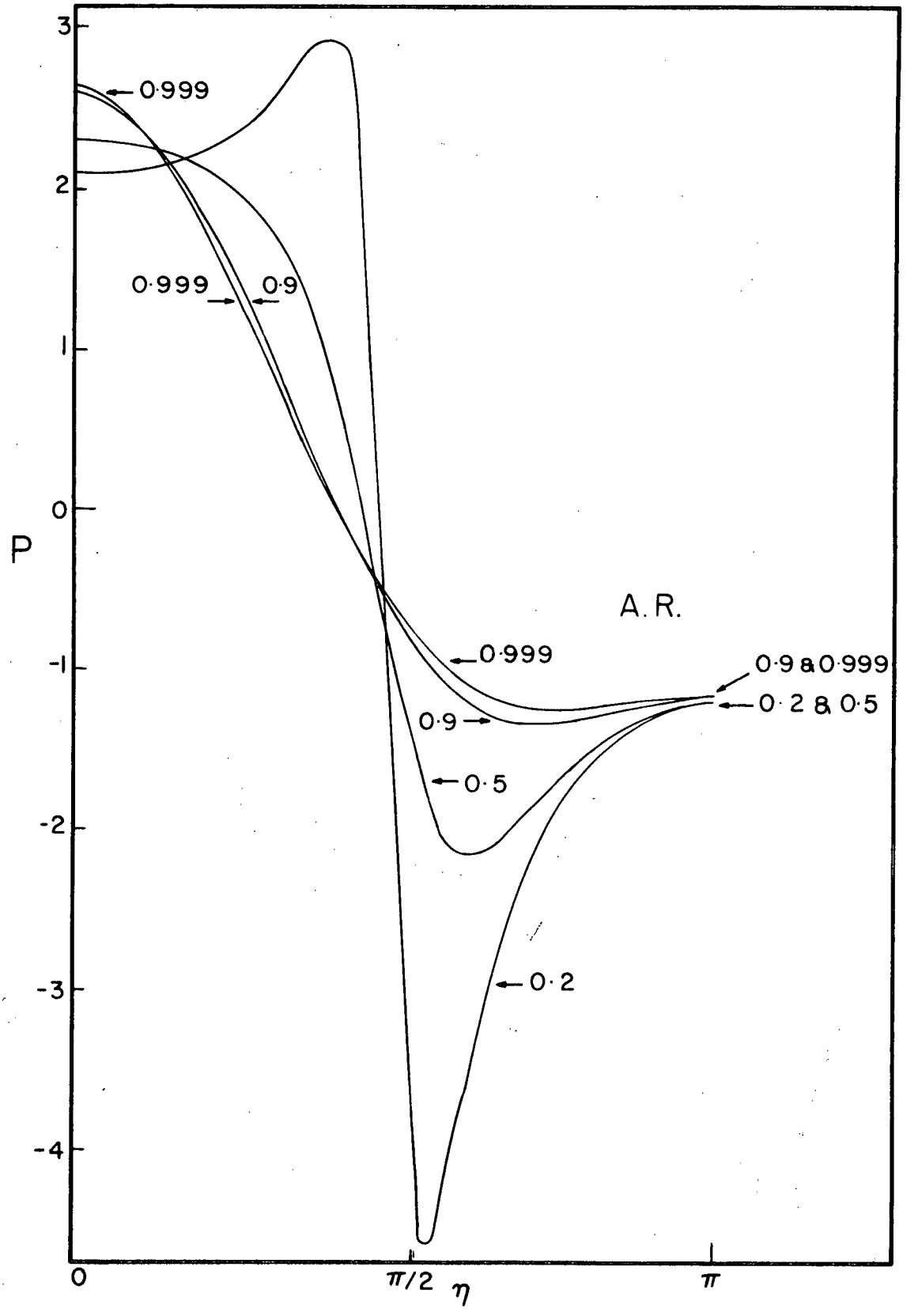


Figure 16. Surface pressure distribution for oblate spheroids at Re=5.0.

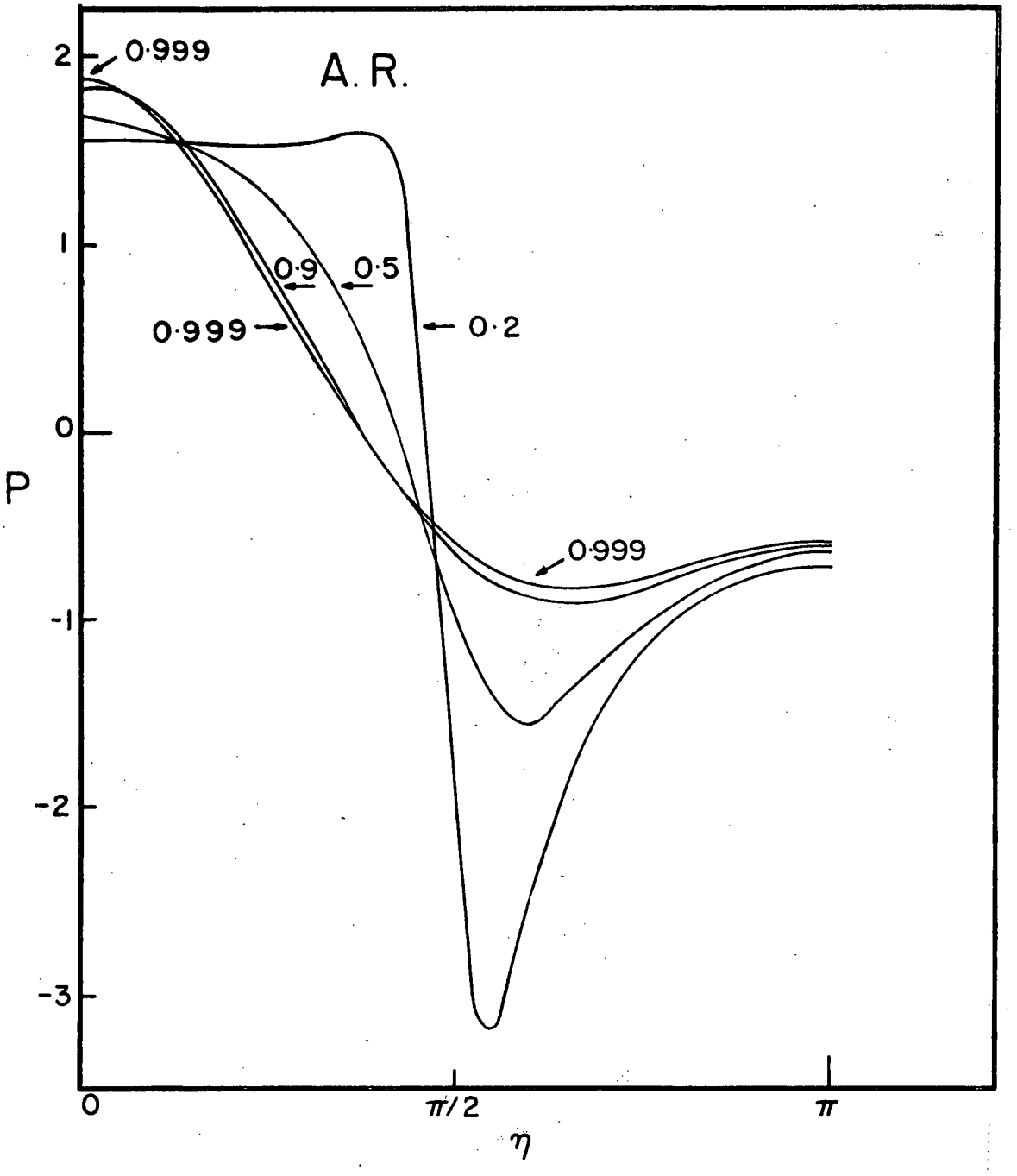


Figure 17. Surface pressure distribution for oblate spheriods at Re=10.

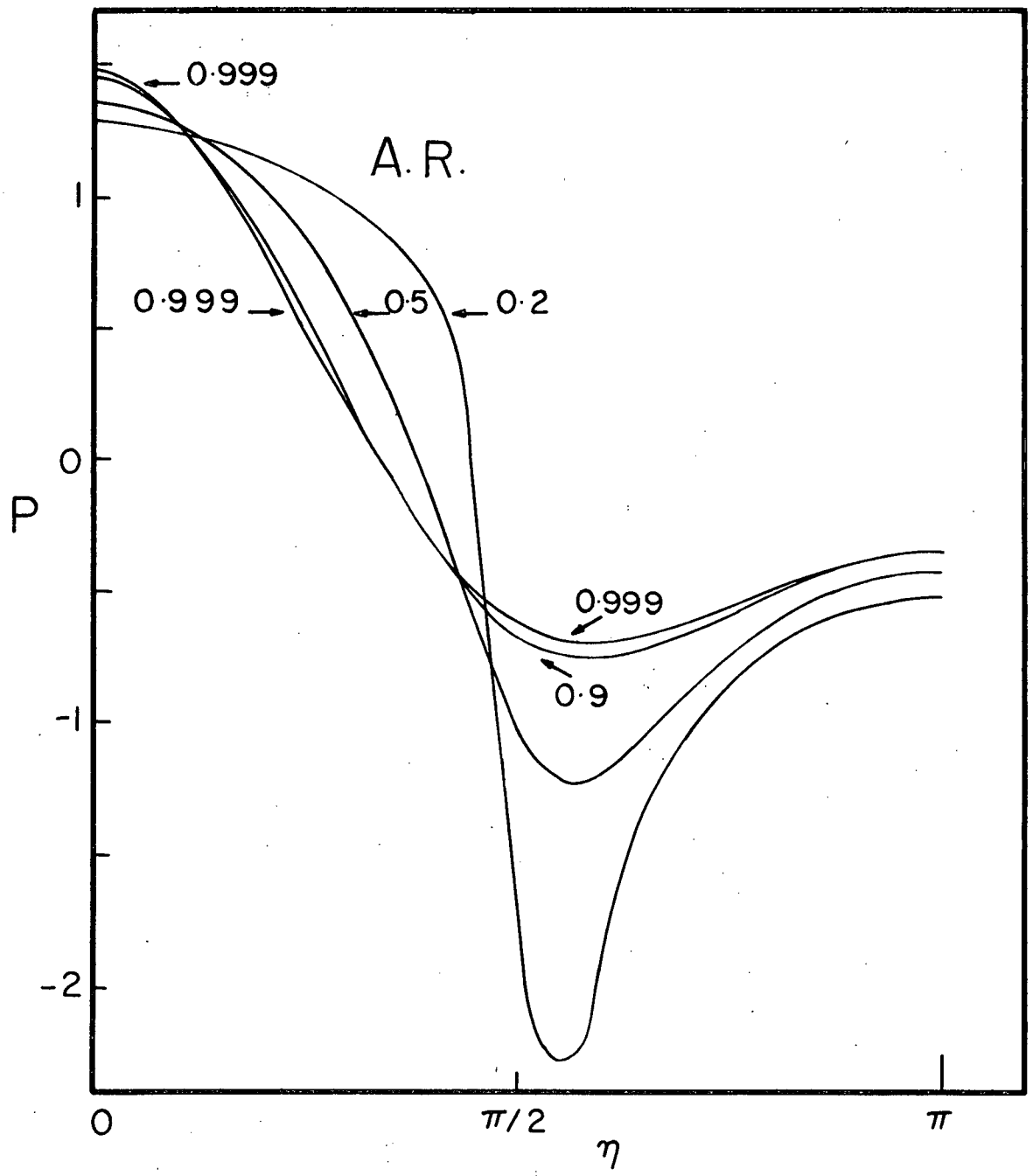


Figure 18. Surface pressure distribution for oblate spheroids at Re=20.

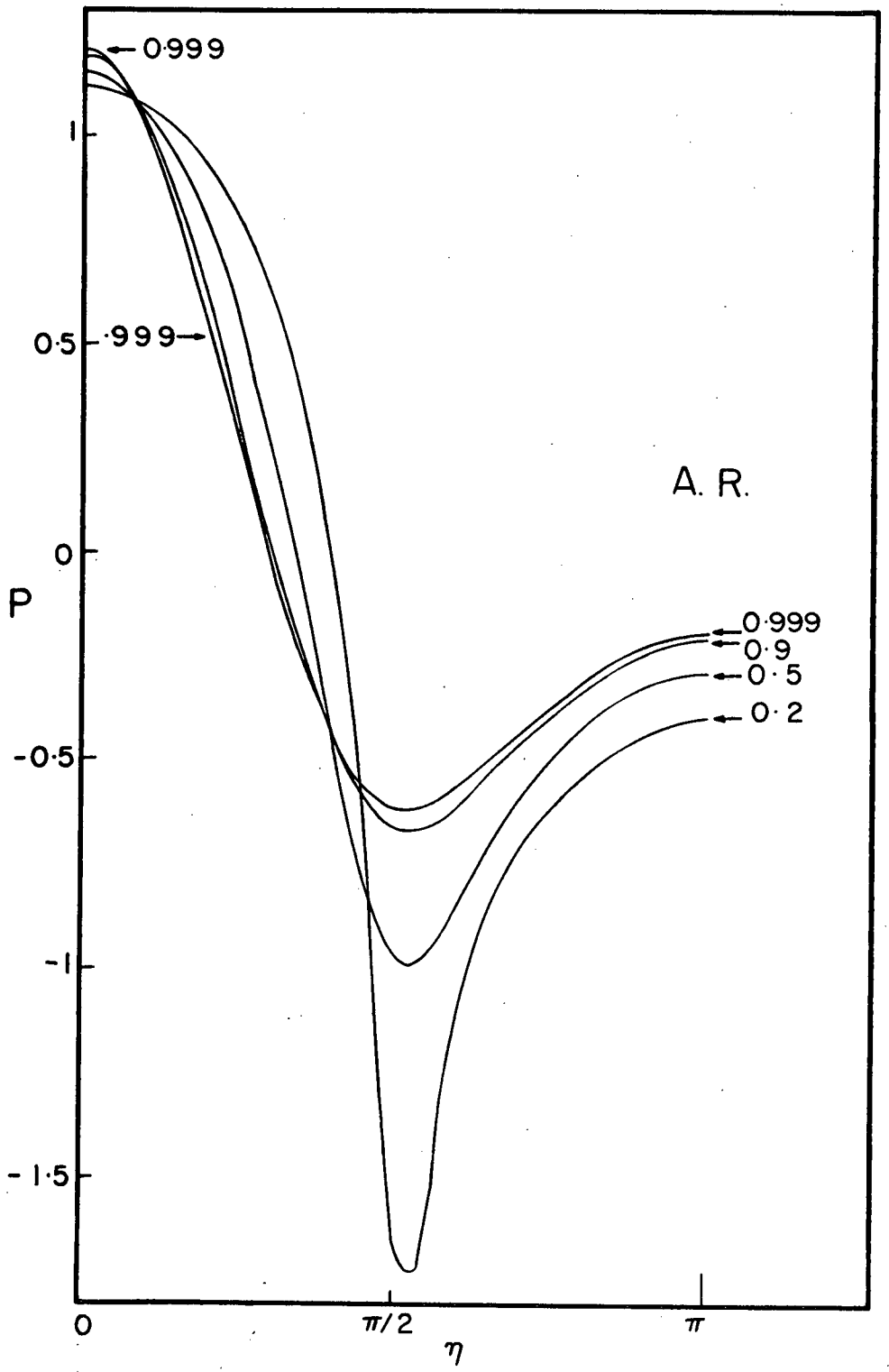


Figure 19. Surface pressure distribution for oblate spheroids at Re=50.

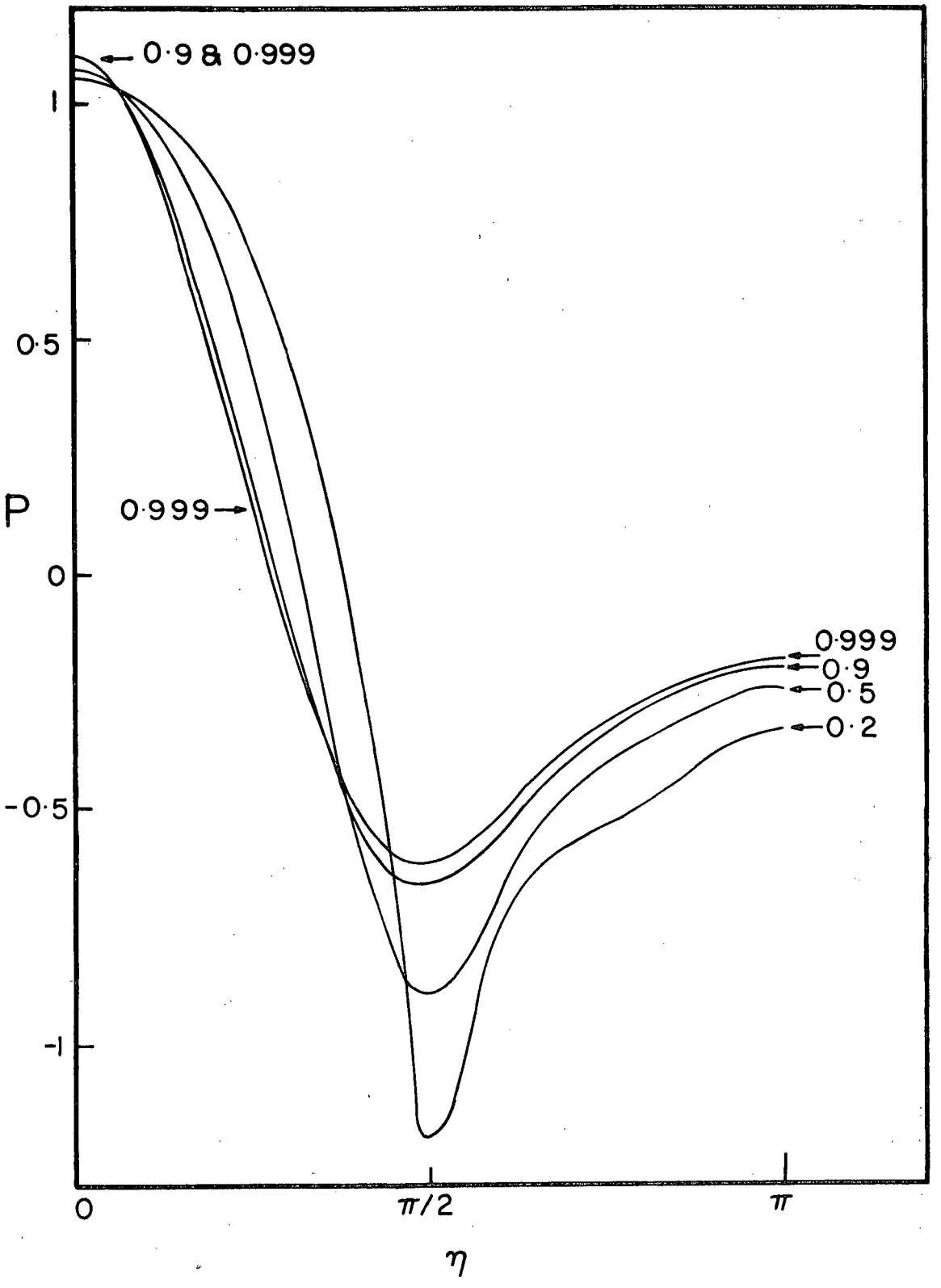


Figure 20. Surface pressure distribution for oblate spheroids at Re=100.

given in figure 21 for Re = 1.0. A comparison with the Stokes pressure distribution for A.R. = 0.2 shows general agreement in the shape of the curve, but a considerable difference in the frontal stagnation pressure. Figures 22, 23, 24, 25 and 26 show the surface pressure distribution on a prolate spheroid for various A.R. at Re = 5, 10, 20, 50 and 100, respectively.

The dimensionless surface vorticity is a direct measure of the shear stress at the surface of the spheroid, and its change in sign indicates the onset of separation, i.e., a reversal in the flow direction in the immediate vicinity of the body. The dimensionless surface vorticity is plotted in figures 27 - 30 for an oblate spheroid in figures 31 - 33 for a prolate spheroid, at the various A.R. and Re. For the oblate spheroid a maximum is observed, which shifts toward the frontal stagnation point with increase of Re, thus rendering the curve more asymmetric about $\eta = \pi/2$. For the prolate spheroid with A.R. = 0.2 at Re = 1.0, figure 33 shows that there are two maxima, the one nearer the rear of the spheroid disappearing with increase of Reynolds number. The corresponding asymmetry of the flow is a result of increasingly dominant inertial effects. The maximum near the front of the prolate spheroids with A.R. of 0.2 (figure 33) and A.R. of 0.5 (figure 32) seems to be rather fixed for the various Re at 11° and 28°, respectively.

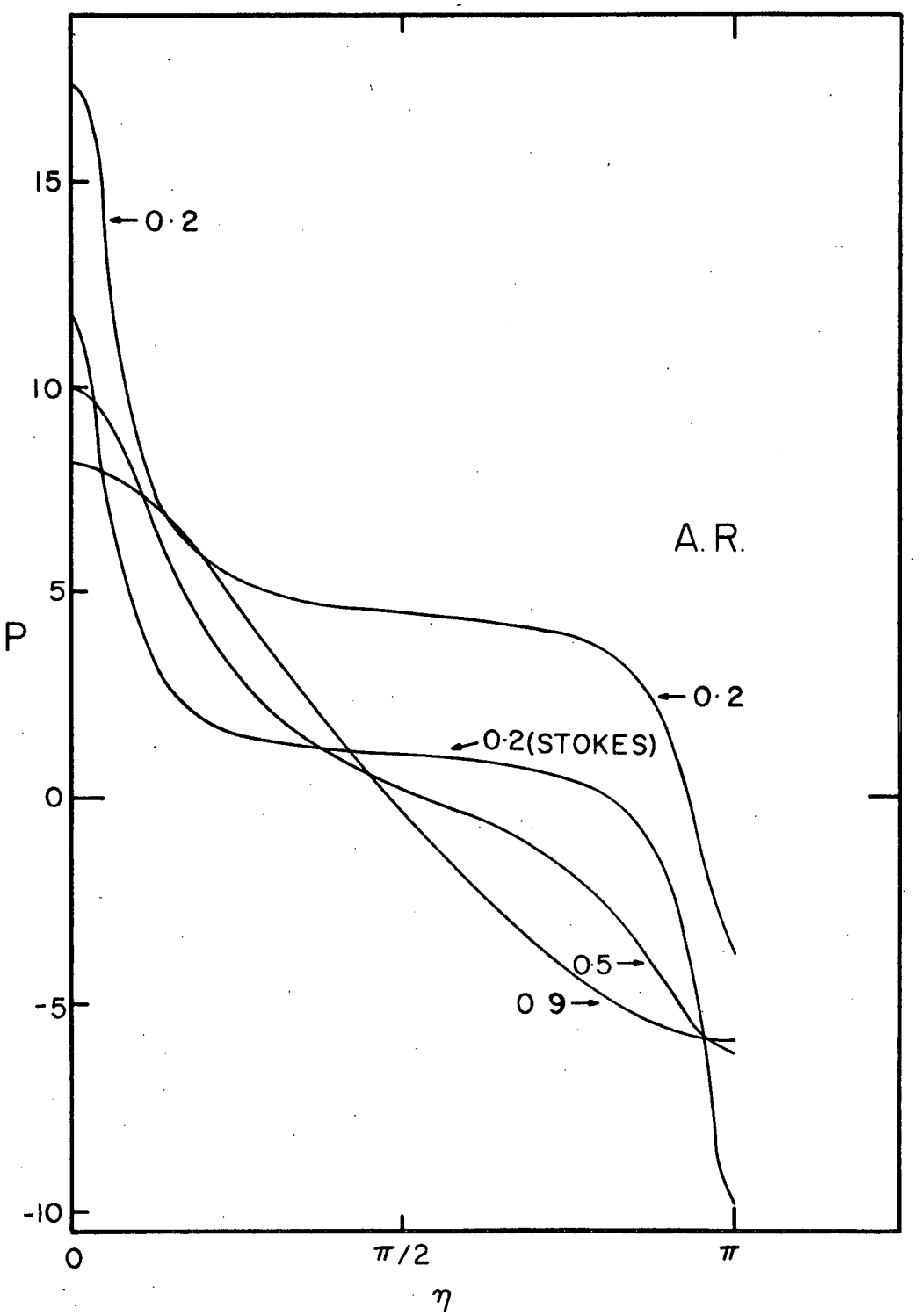


Figure 21. Surface pressure distribution for prolate spheroids at Re=1.0.

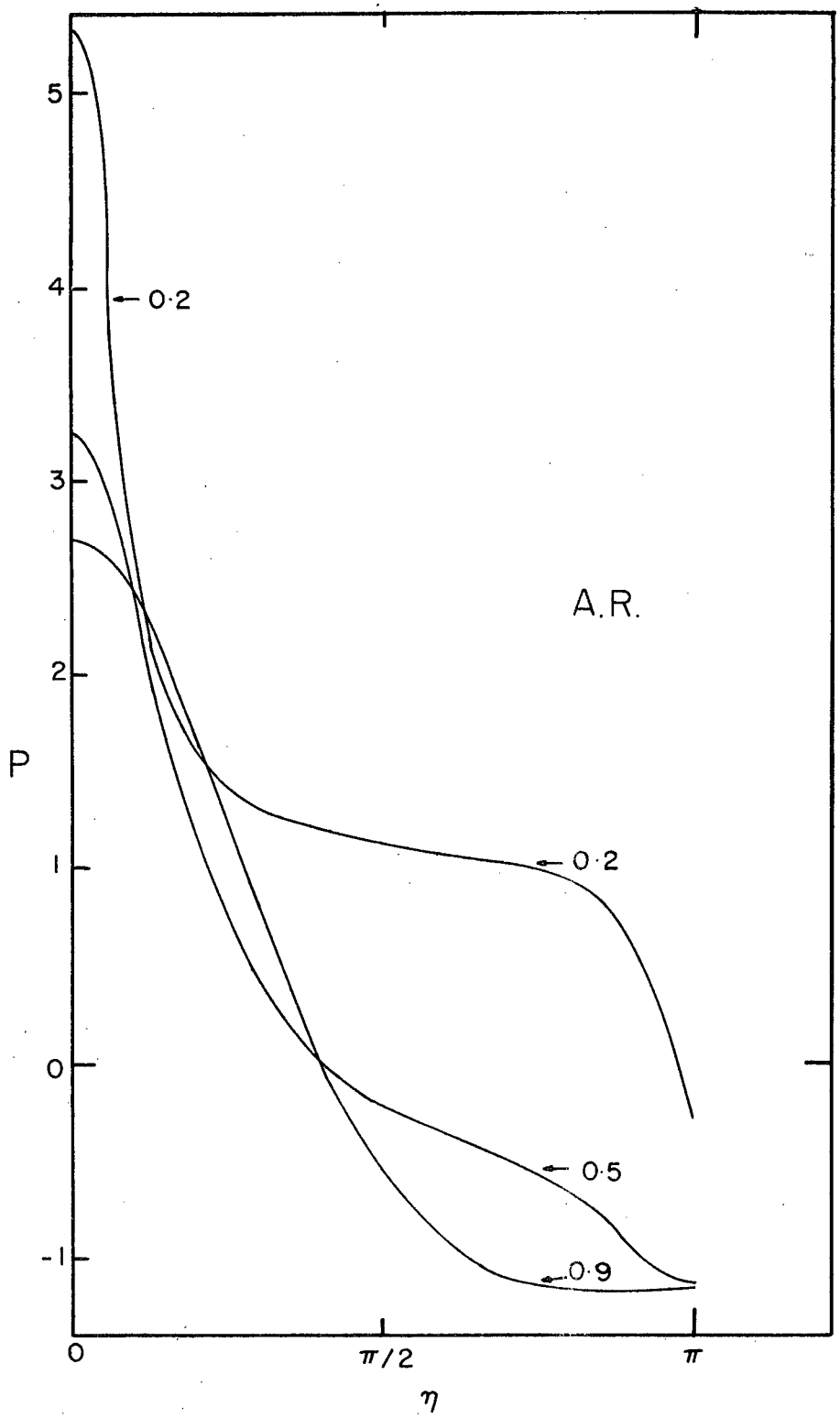


Figure 22. Surface pressure distribution for prolate spheroids at Re=5.0.

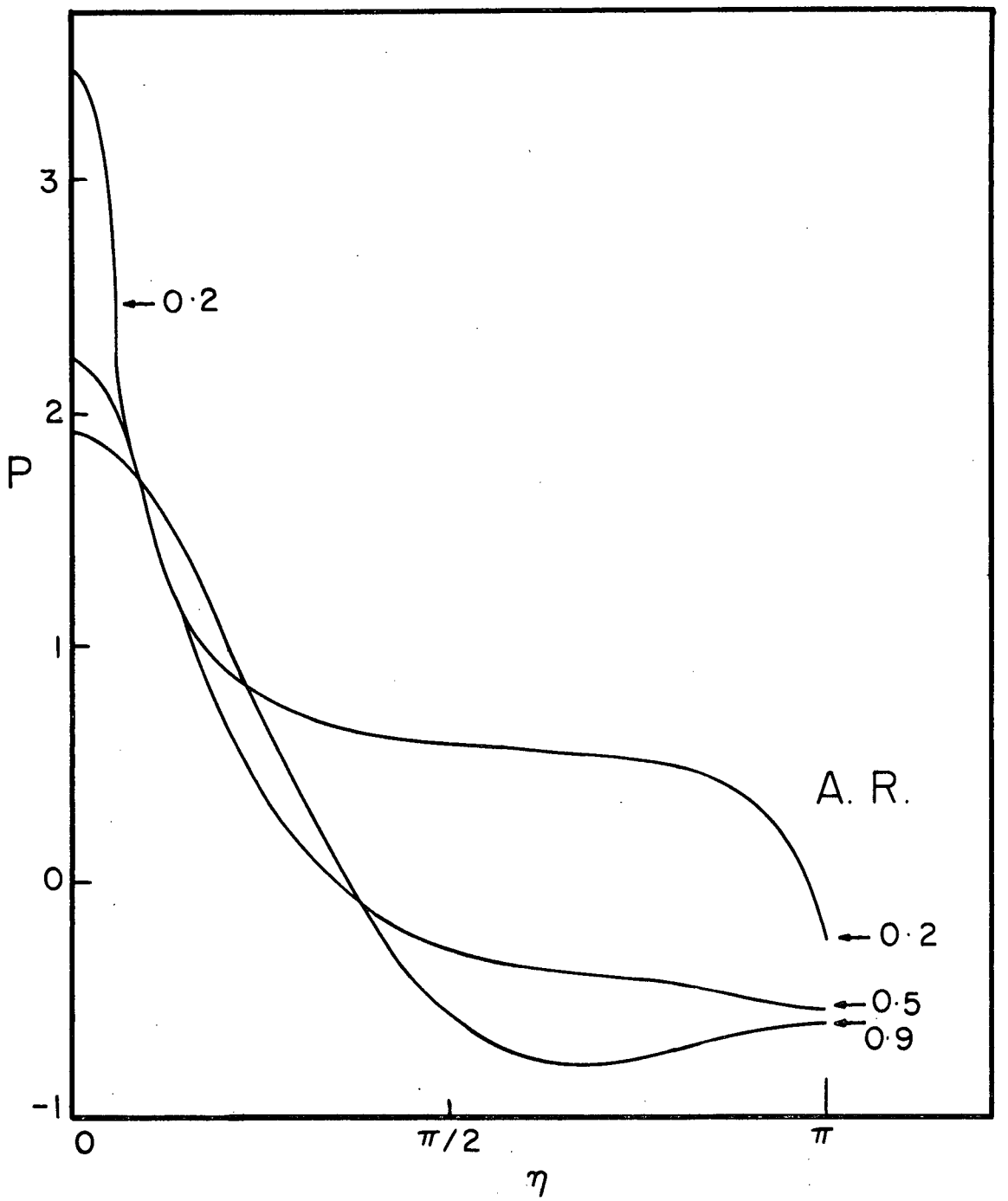


Figure 23. Surface pressure distribution for prolate spheroids at Re=10.

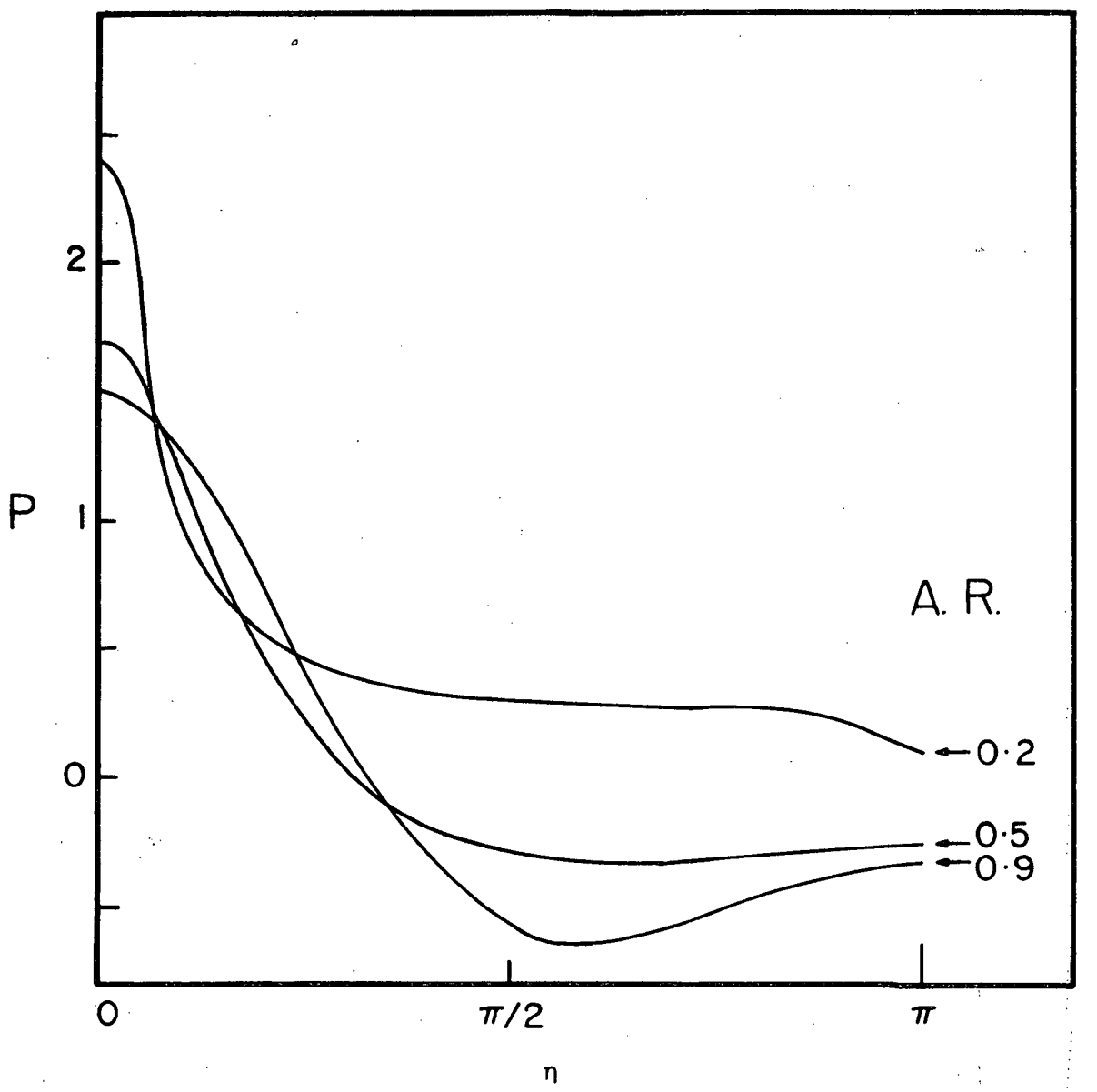


Figure 24. Surface pressure distribution for prolate spheroids at Re=20.

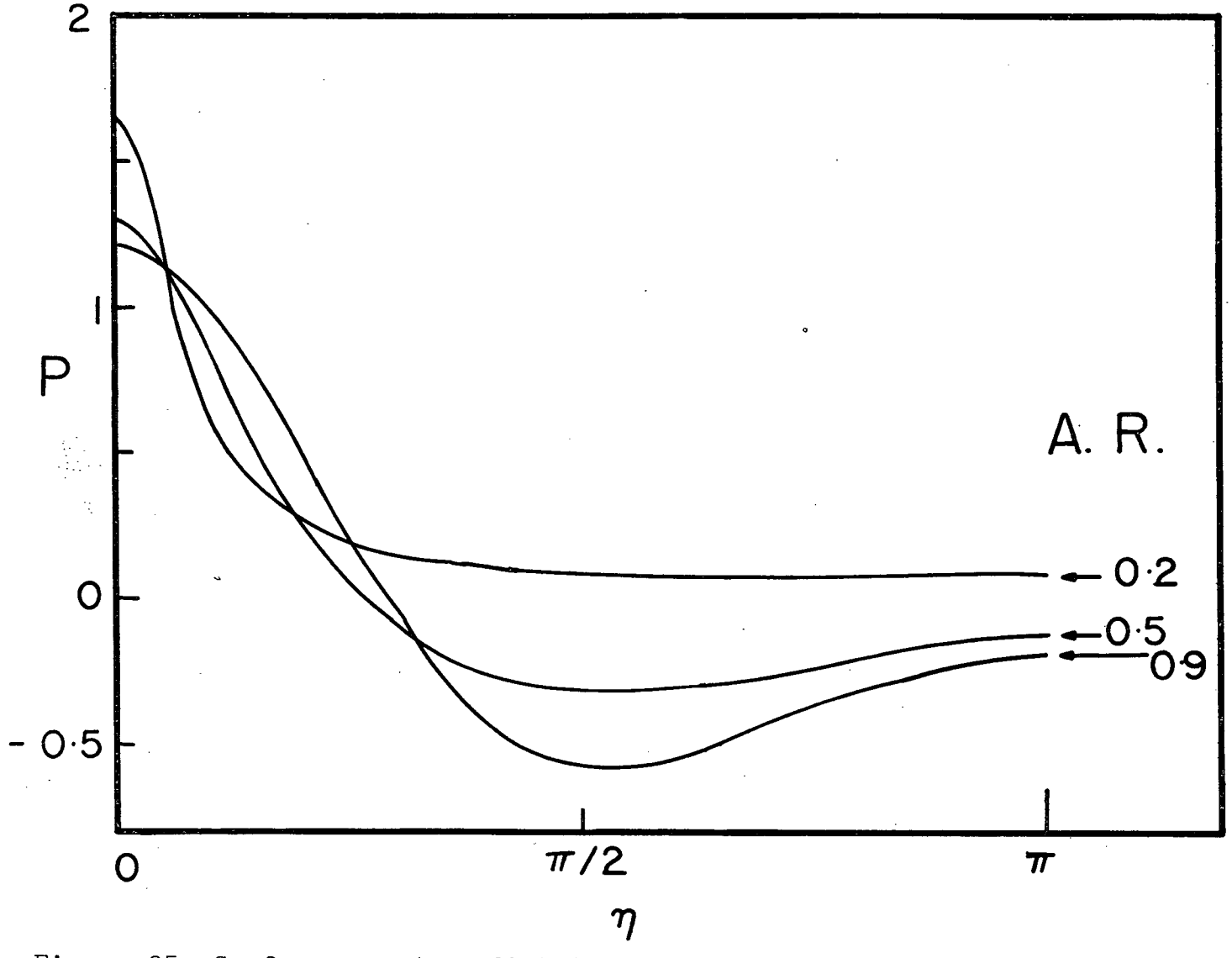


Figure 25. Surface pressure distribution for prolate spheroids at Re=50.

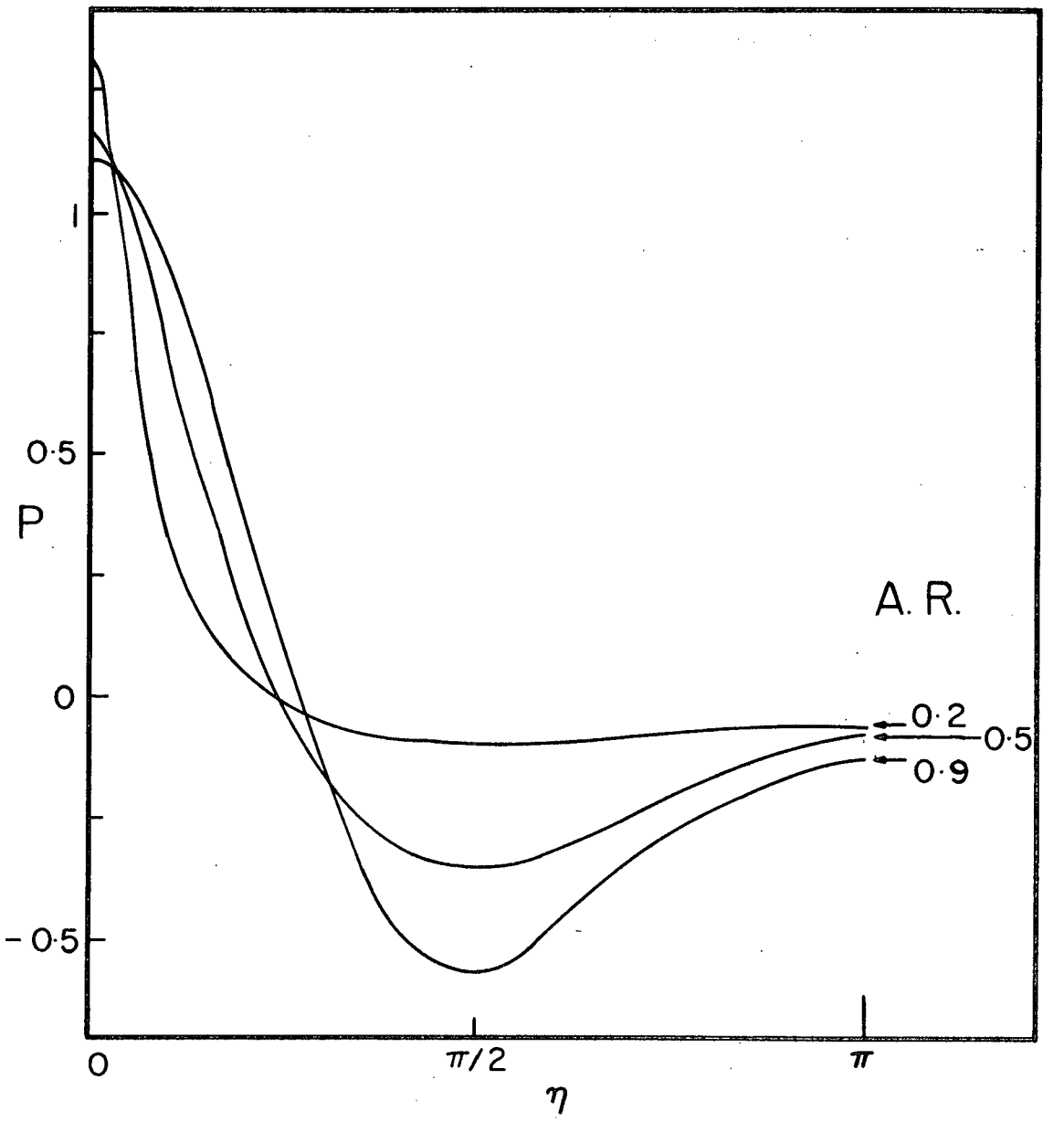


Figure 26. Surface pressure distribution for a prolate spheroid at Re=100.

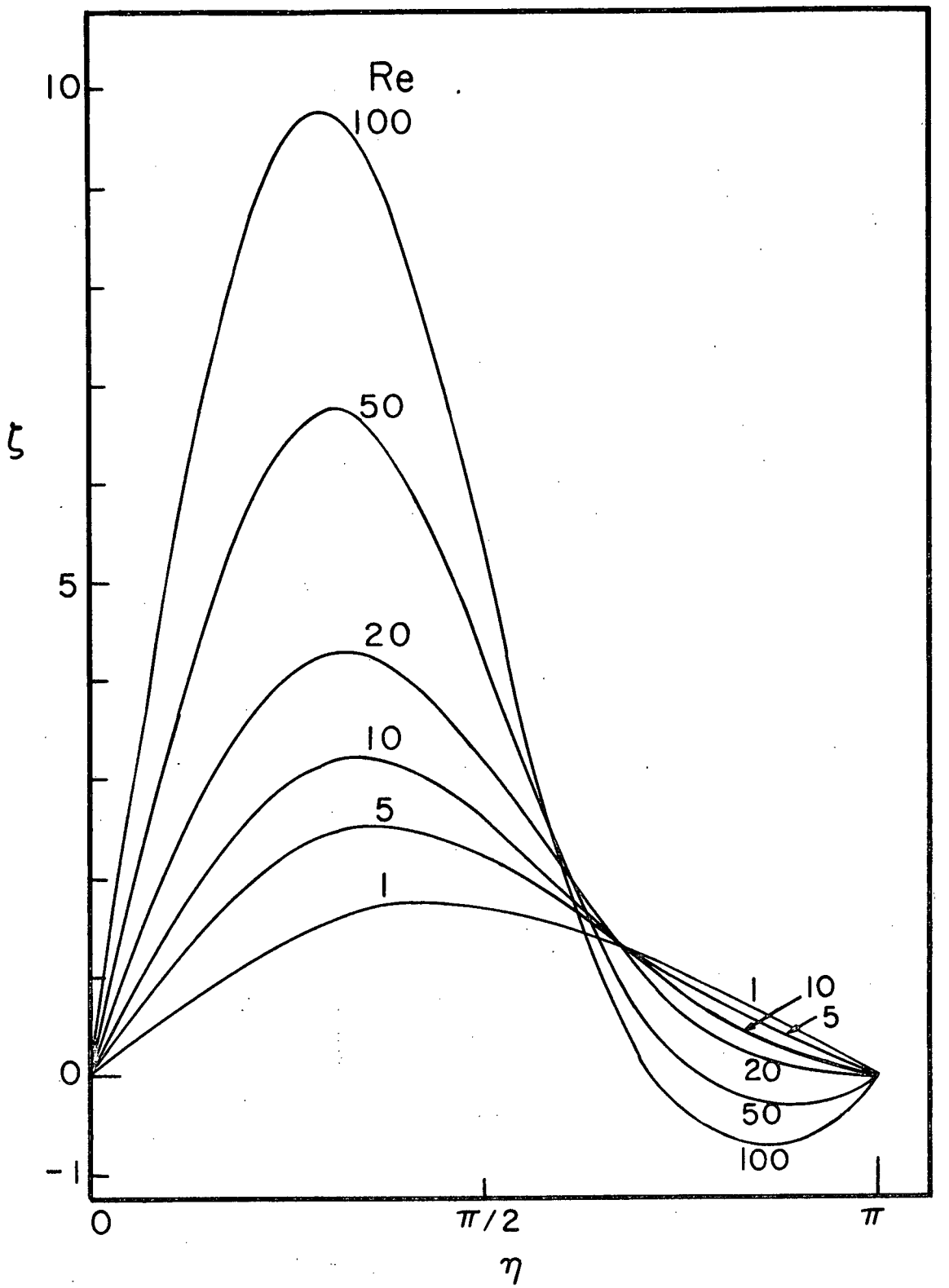


Figure 27. Surface vorticity distribution for an oblate spheroid with A.R. = 0.999 (sphere).

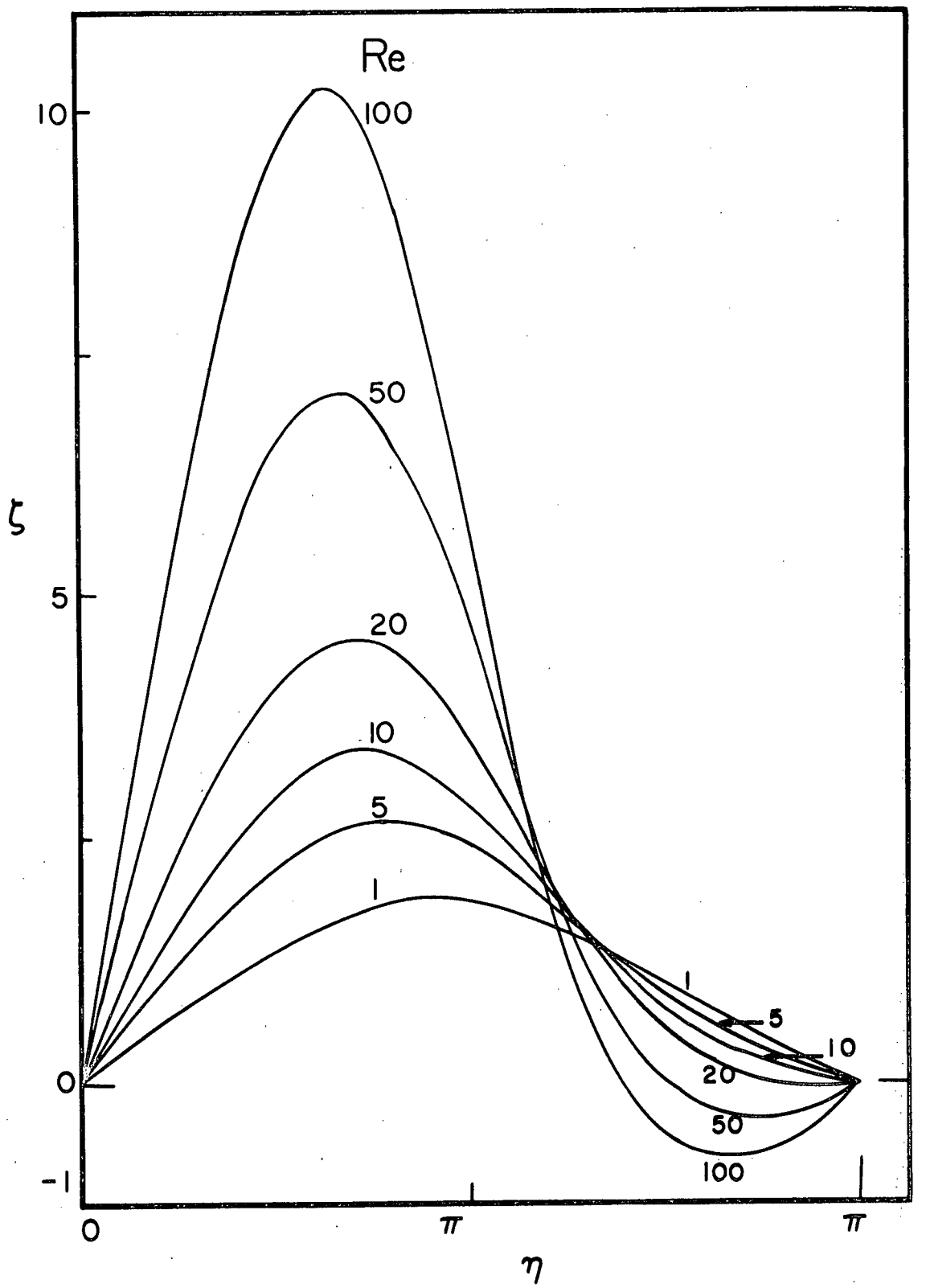


Figure 28. Surface vorticity distribution for an oblate spheroid with A.R. = 0.9.

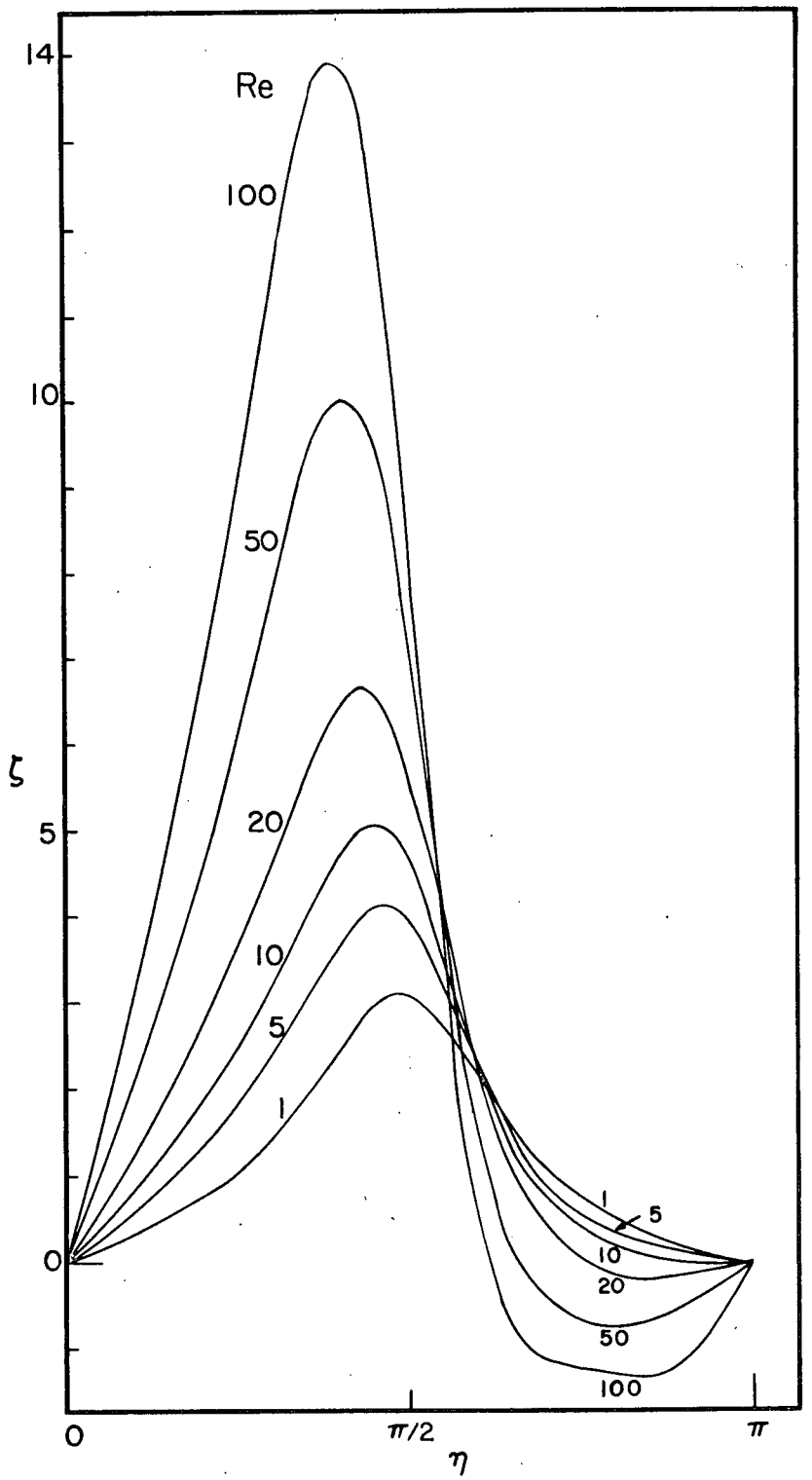


Figure 29. Surface vorticity distribution for an oblate spheroid with A.R. = 0.5.

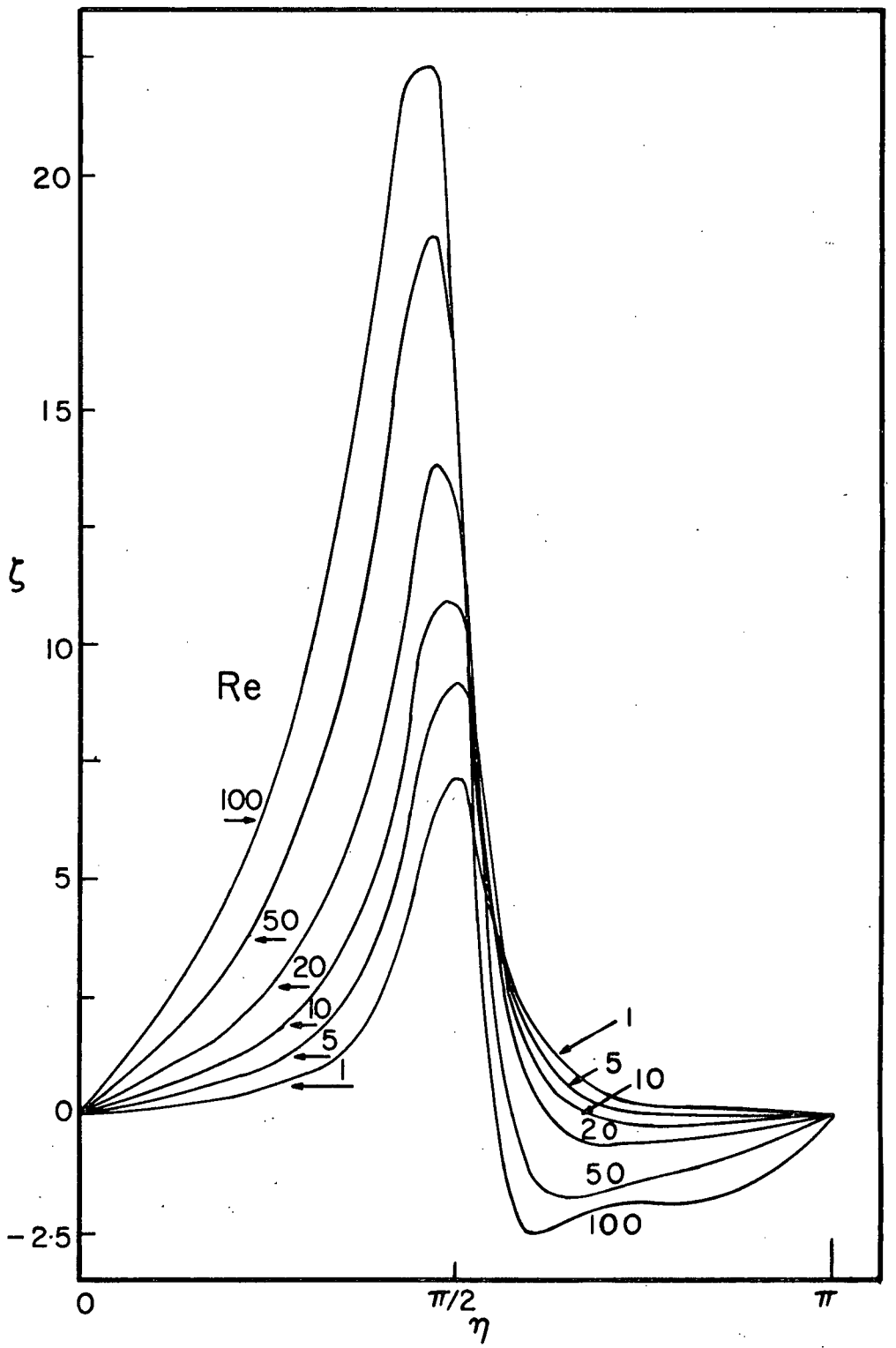


Figure 30. Surface vorticity distribution for an oblate spheroid with A.R. = 0.2.

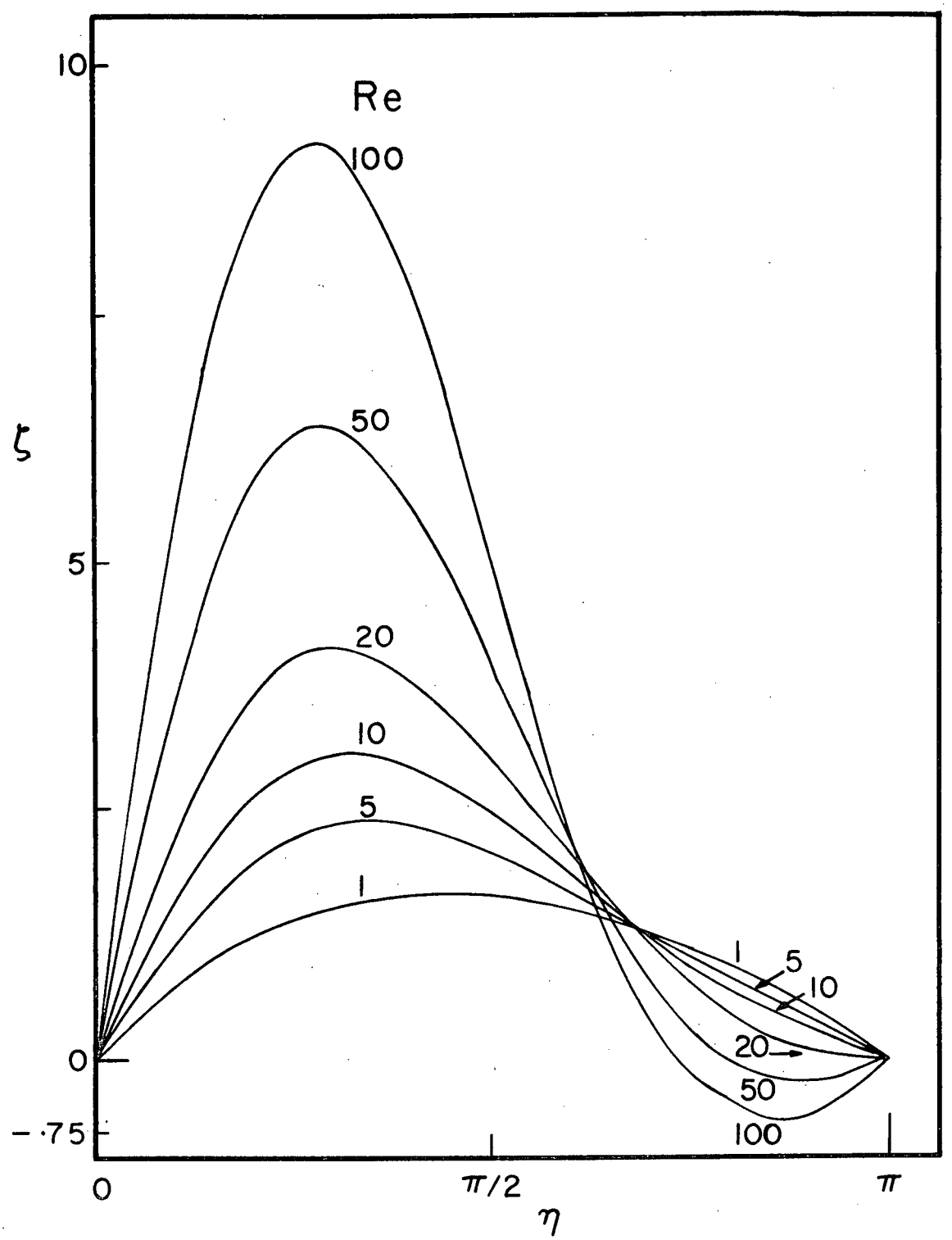


Figure 31. Surface vorticity distribution for a prolate spheroid with A.R. = 0.9.

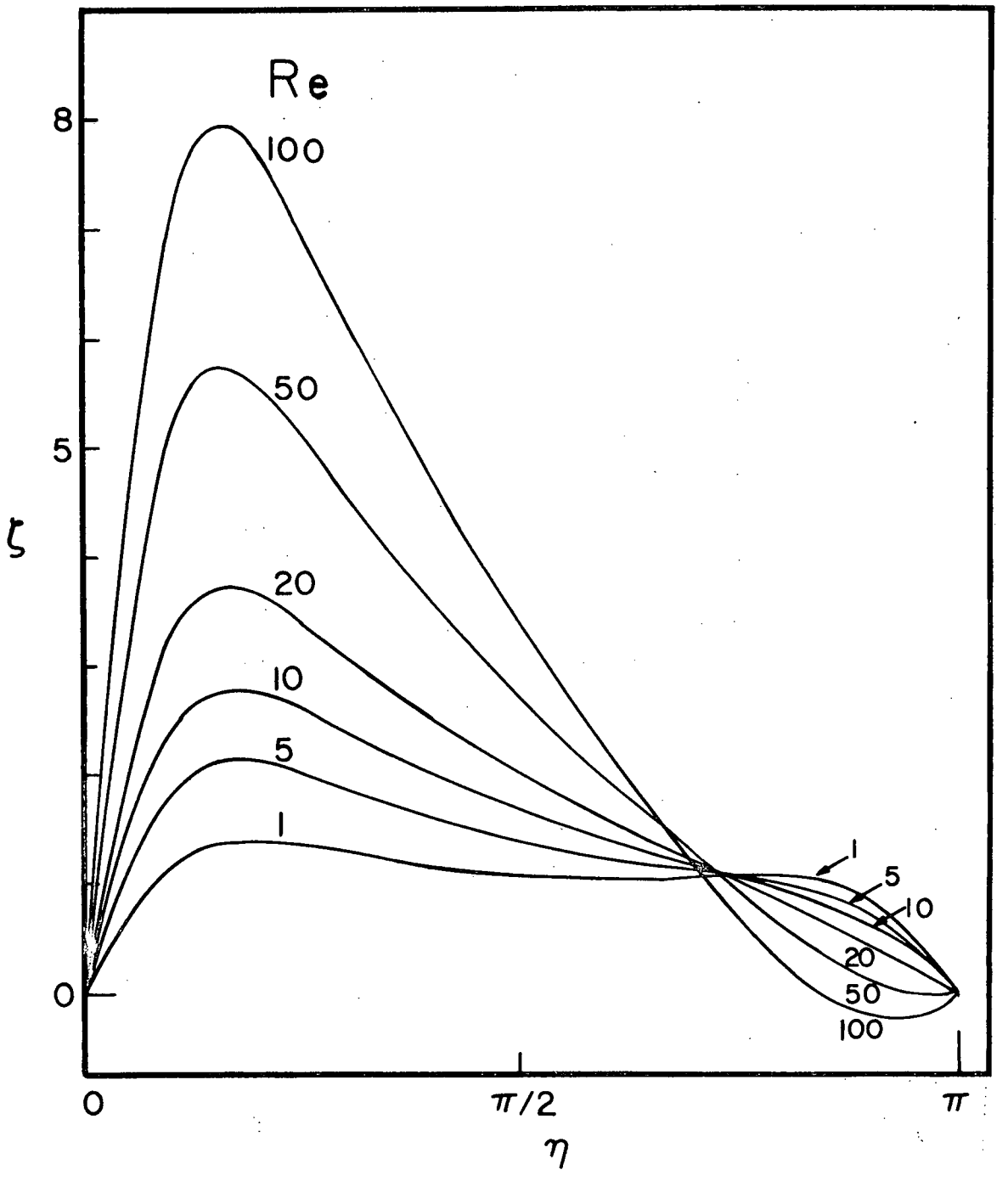


Figure 32. Surface vorticity distribution for a prolate spheroid with A.R. = 0.5.

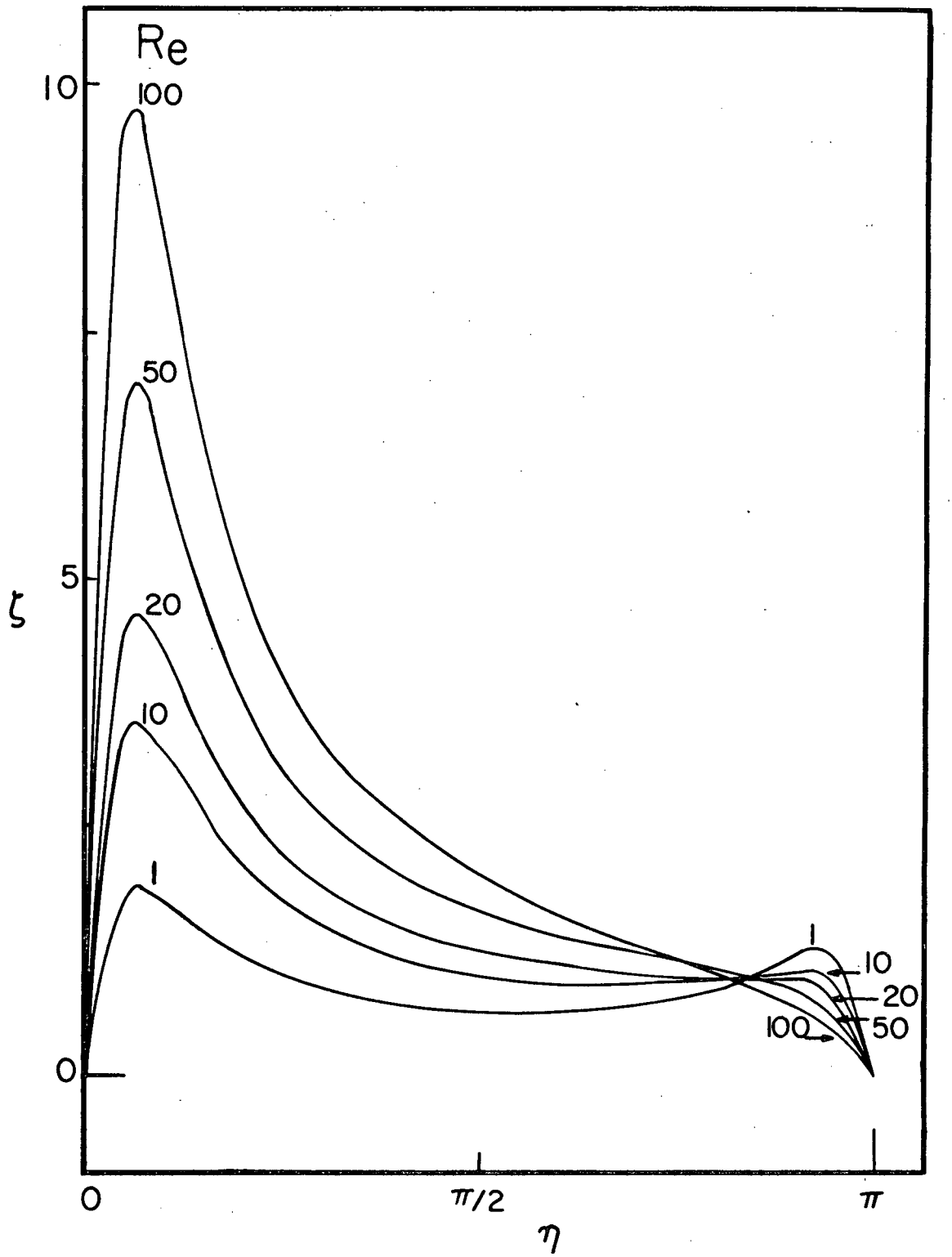


Figure 33. Surface vorticity distribution for a prolate spheroid with A.R. = 0.2.

The appearance of the wake bubble behind a spheroid is clearly a function of the solid body's shape and of the Reynolds number. It was found that a wake bubble develops at Re as low as 20, 10 and 5 for an oblate spheroid with A.R. of 0.9, 0.5 and 0.2 respectively. For an almost spherical oblate-spheroid (A.R. = 0.99), however, the present work shows no marked vortex development at Re=20, though a separation was indicated at this Reynolds number, by a negative vorticity at the surface. Taneda's (160) extrapolation of his experimental work gave the onset of separation at Re = 24, while Jenson's work (55) indicated the Re at separation to be 17. The corrected value of Porter and Nisi (157) is Re = 17 (158). For a prolate spheroid of A.R. = 0.2, no vortex was observed even for Re of 100. The variation of the dimensionless wake length with Re is shown in figure 34. It is interesting that Van Dyke's (159) equation, derived from Oseen's approximation for the wake length behind a sphere is in excellent agreement with the values of wake length computed for a nearly spherical oblate spheroid (A.R. = 0.999). Figure 35 gives the point of separation for the various shapes and Reynolds numbers. Taneda's (160) experimental data for a sphere are in excellent agreement with those computed for the oblate spheroid of A.R. = 0.999, but Van Dyke's theoretical equation for the separation point is at variance with these results.

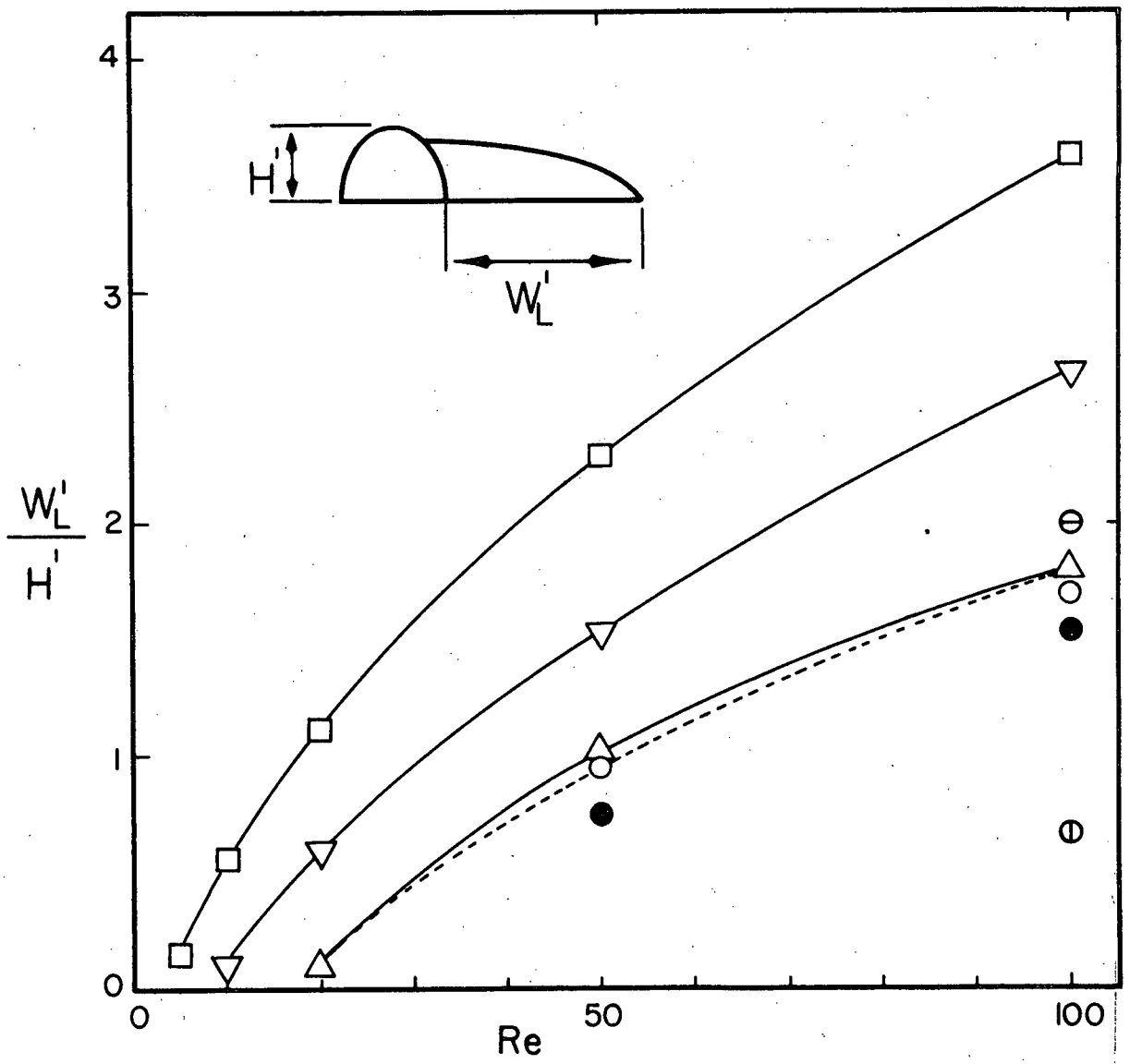


Figure 34. Variation of wake length with Re for spheroids. Oblate spheroids: □ , A.R. = 0.2; ▽ , A.R. = 0.5; △ , A.R. = 0.9; ○ , A.R. = 0.999 (sphere). Prolate spheroids: ● , A.R. = 0.9; ⊕ , A.R. = 0.5. Sphere: ⊖ , (Hamielec et al); _ _ _ _, Van Dyke (theoretical).

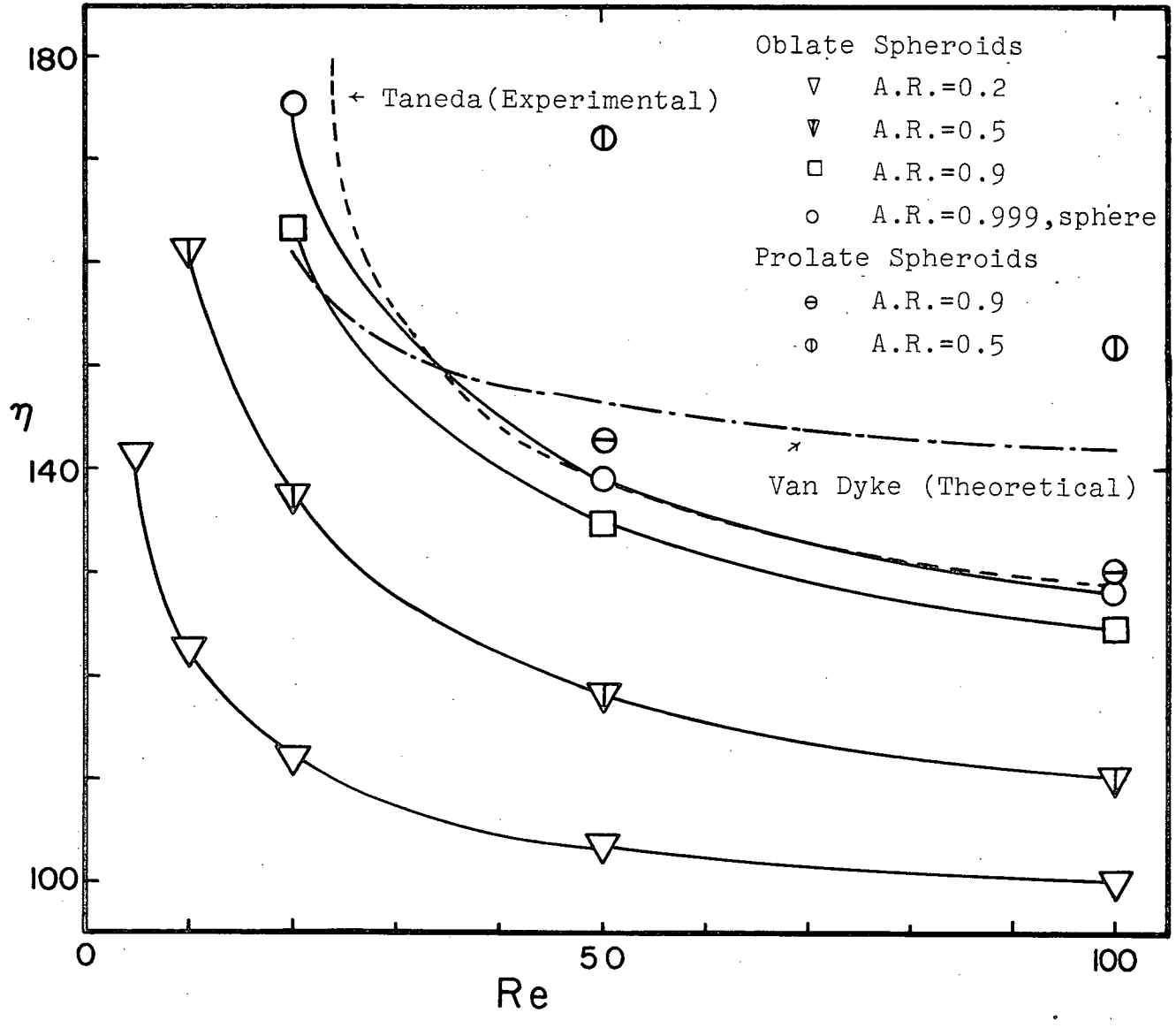


Figure 35. Location of separation point for spheroids.

Streamlines and equi-vorticity lines at various Reynolds numbers and aspect ratios for oblate and prolate spheroids are shown in figures 36 - 49. It is interesting to note that the streamline of magnitude 4.0 tends to be less curved with increasing Re, indicating that the flow becomes undisturbed at a shorter distance from the spheroid as Re increases. This result correlates with the fact that the wall effect on the drag coefficient decreases with increasing Re, as experimentally shown by McNown et al. (161).

The deviation of the flow from the Stokes regime, in which symmetry prevails, is best observed by the asymmetry of the vorticity lines. The vorticity is generated upstream and is carried by the fluid around the spheroid to considerable distances downstream, these distances increasing with Reynolds number. The heat-flow analogy indicates that in time t vorticity would diffuse outwards a distance $d'=(t\mu/\rho)^{1/2}$ while it is being convected downstream for a distance $S' = Ut$. Eliminating t yields the result $\frac{S}{d}^{1/2} \propto Re^{1/2}$, where S and d have been rendered dimensionless by use of the equatorial radius of the spheroid. The equi-vorticity lines for a given spheroid clearly support the above result in that for Re = 1.0 the convection of vorticity is much less than that at Re = 100 (see figures 40 - 42 and 47 - 49).

The equi-velocity lines at Re = 100 for both an oblate and a prolate spheroid having an aspect ratio of 0.2, and for an almost spherical oblate spheroid, are shown in

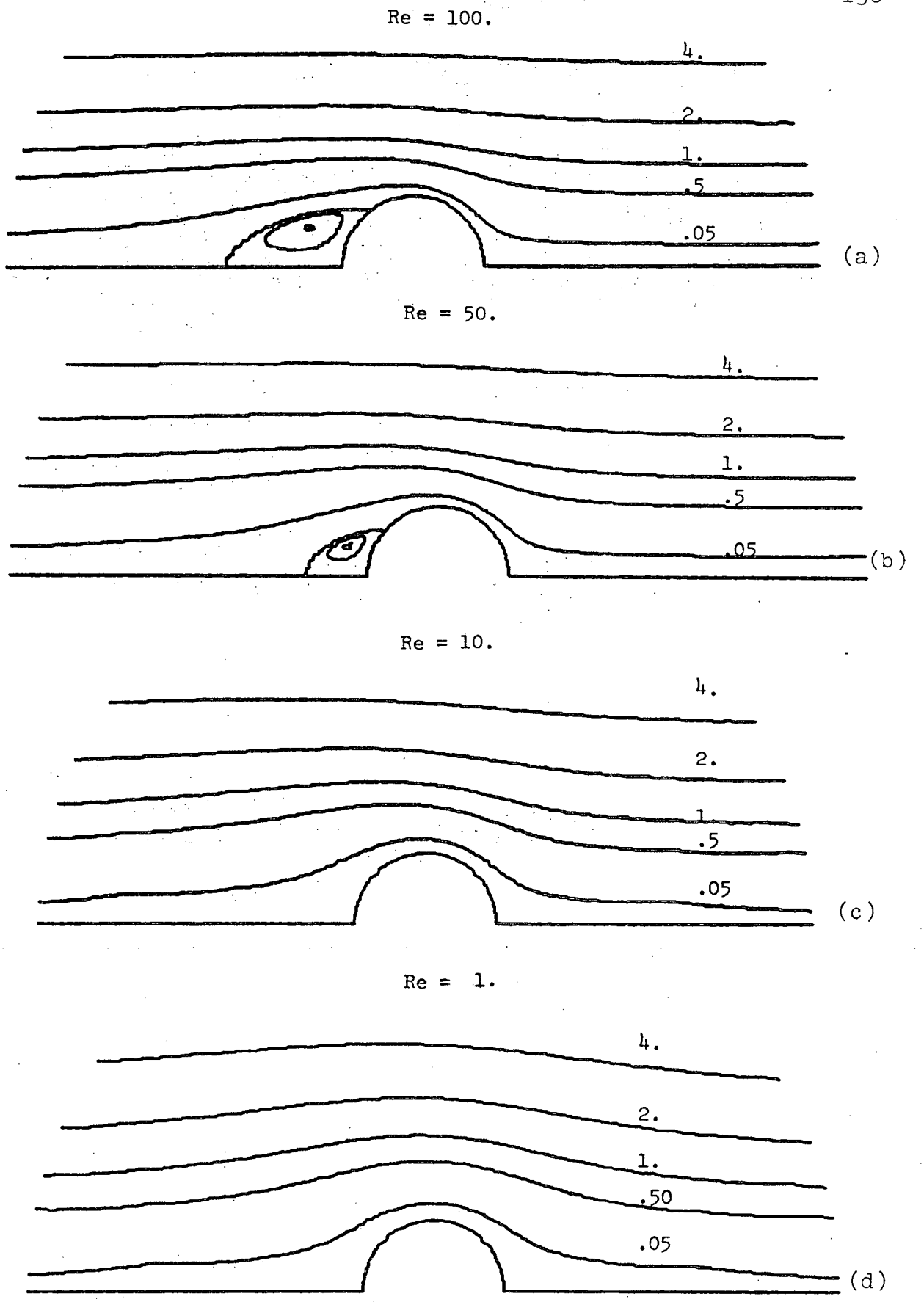


Figure 36, Streamlines for a nearly spherical oblate spheroid (A.R. = 0.999).

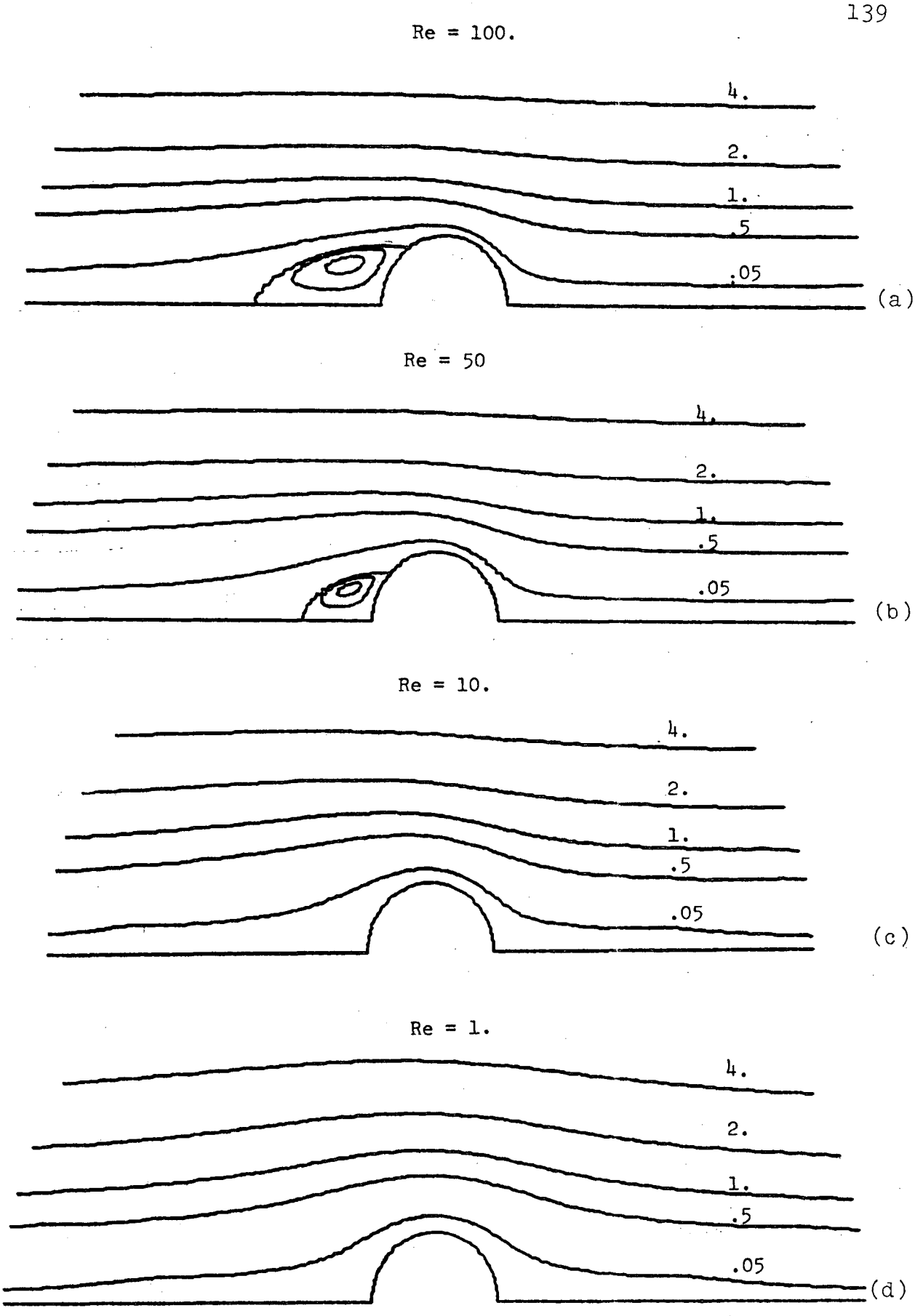


Figure 37. Streamlines for an oblate spheroid with aspect ratio 0.9.

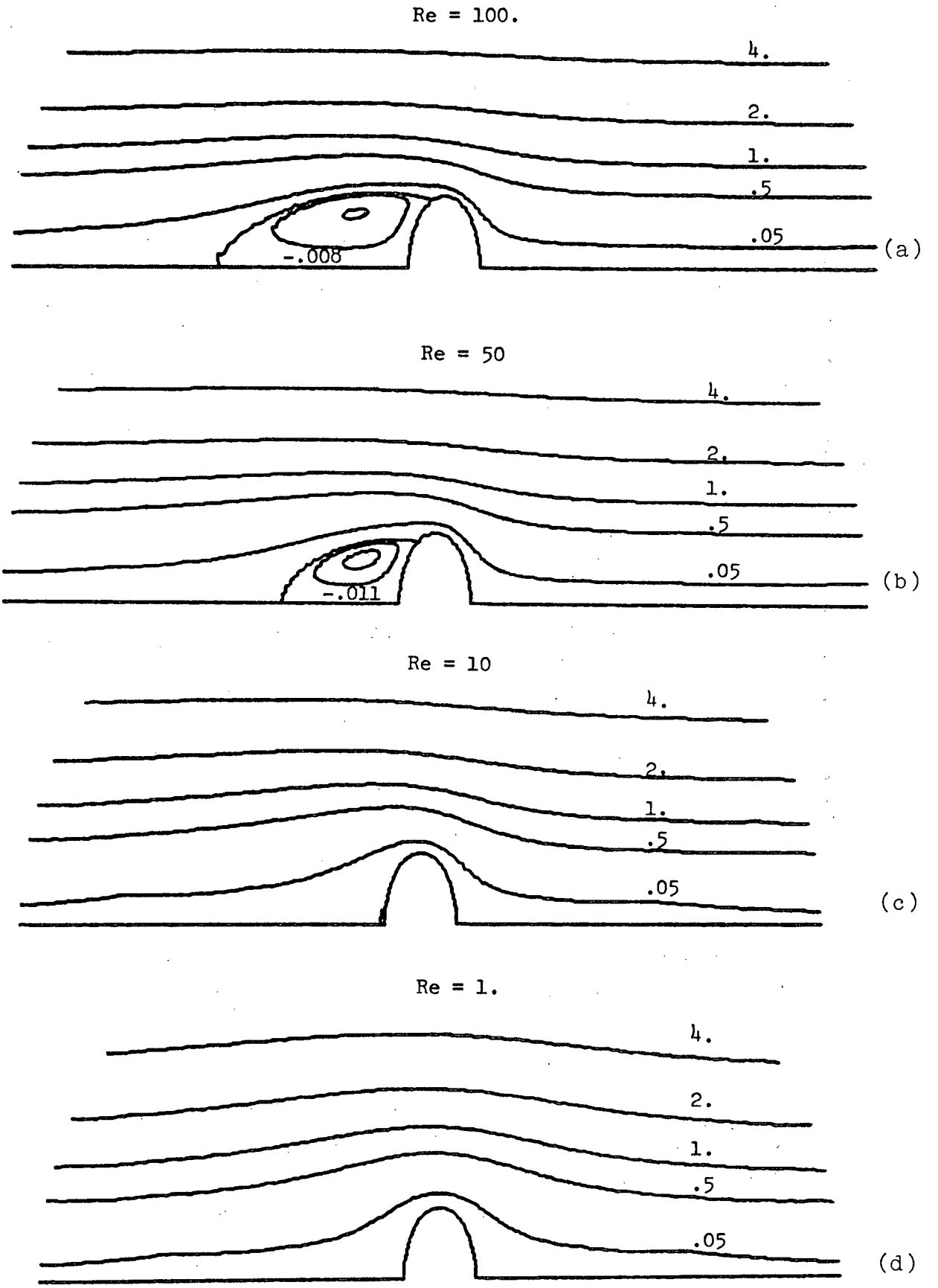


Figure 38. Streamlines for an oblate spheroid with aspect ratio 0.5.

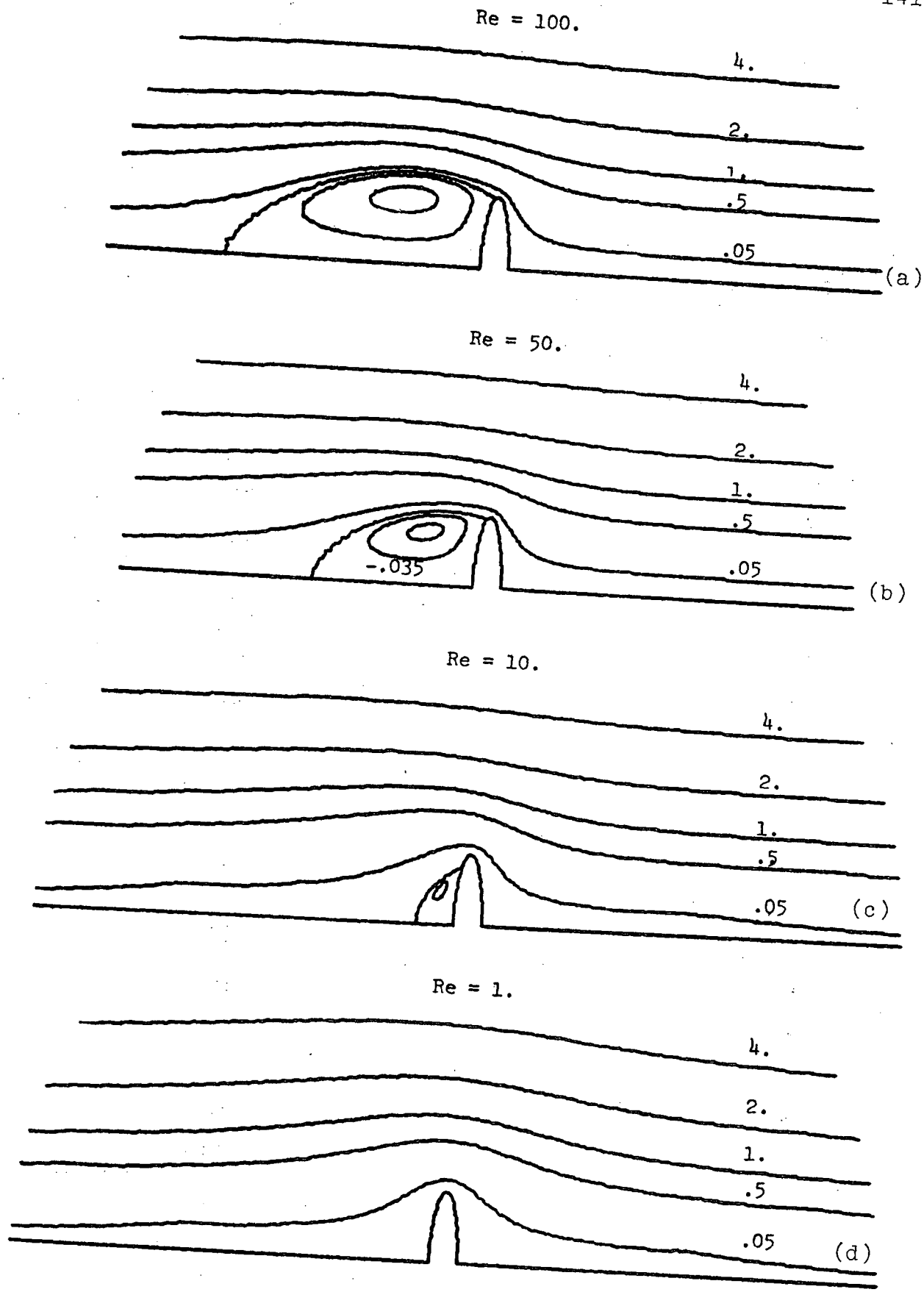


Figure 39. Streamlines for an oblate spheroid with aspect ratio 0.2.

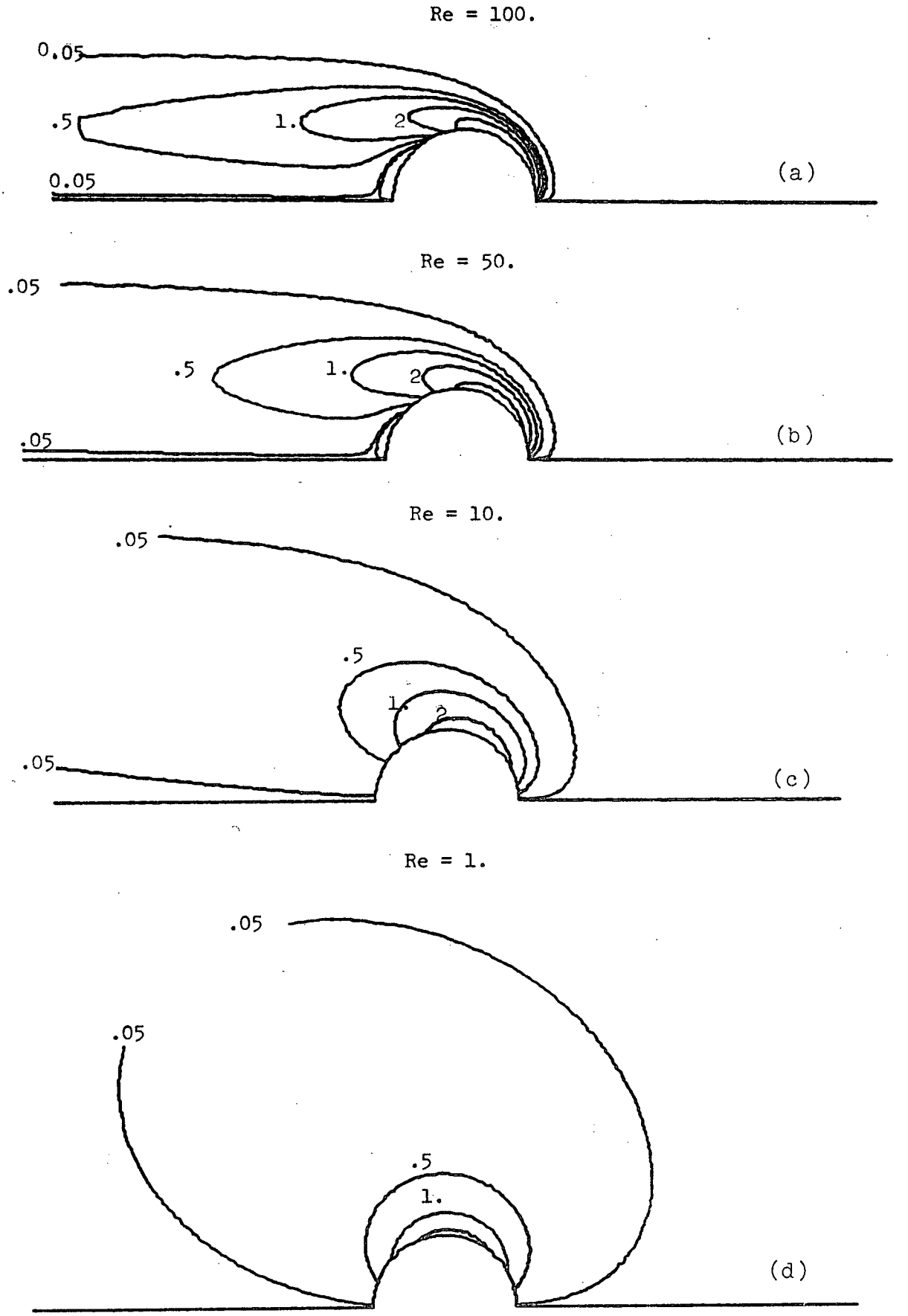


Figure 40. Vorticity lines for a nearly spherical oblate spheroid (A.R. = 0.999).

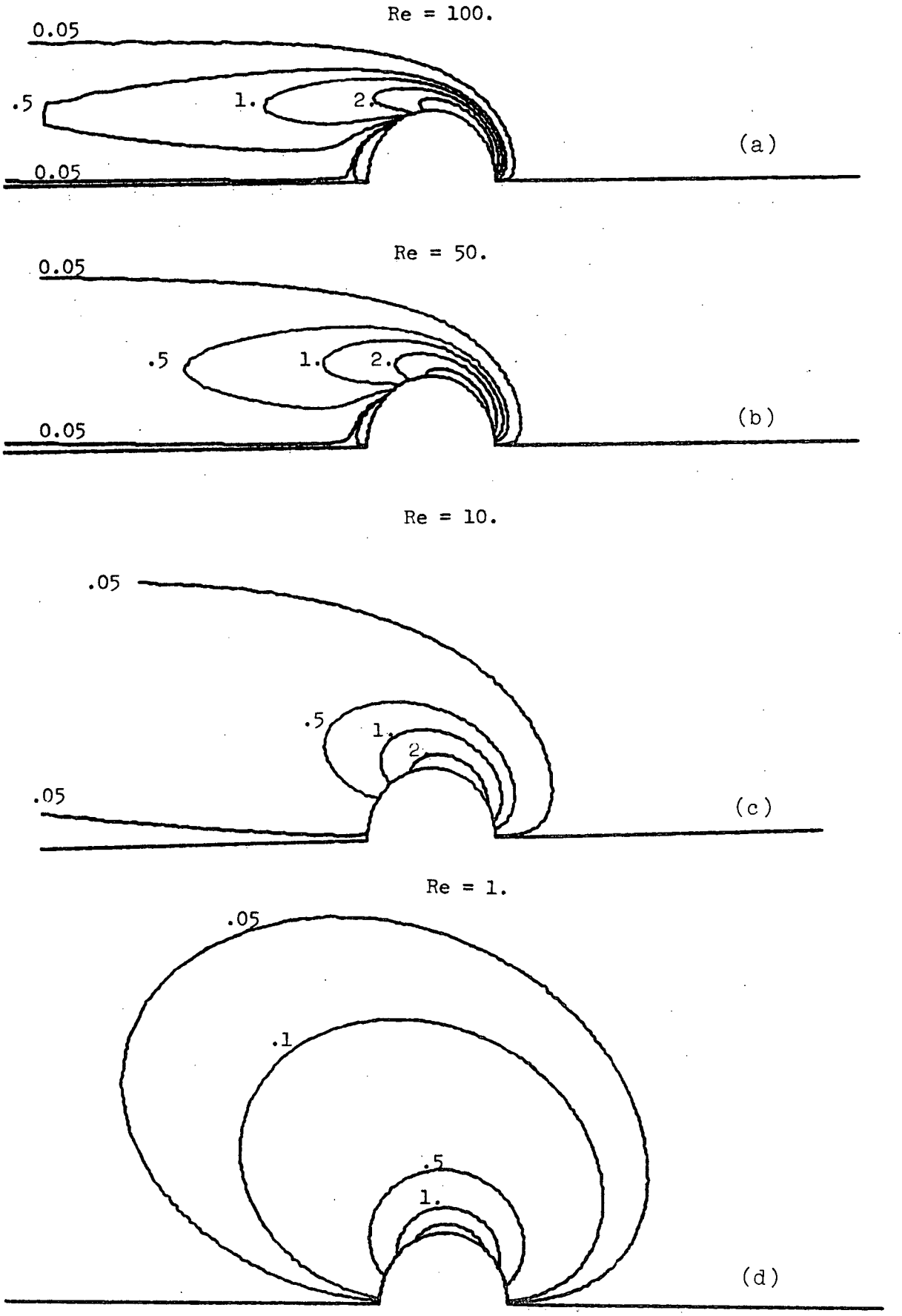


Figure 41. Vorticity lines for an oblate spheroid with aspect ratio 0.9.

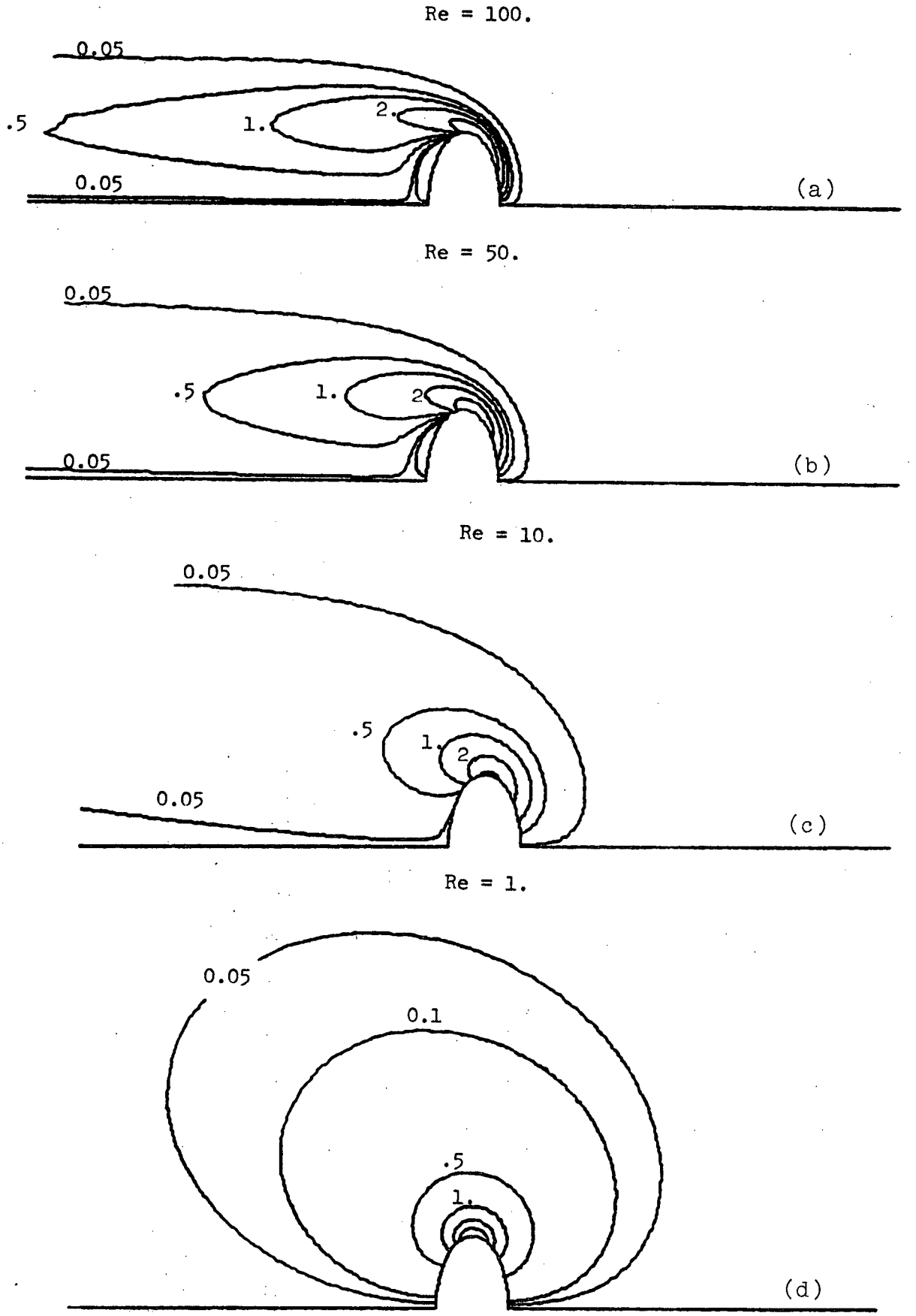


Figure 42. Vorticity lines for an oblate spheroid with aspect ratio 0.5.

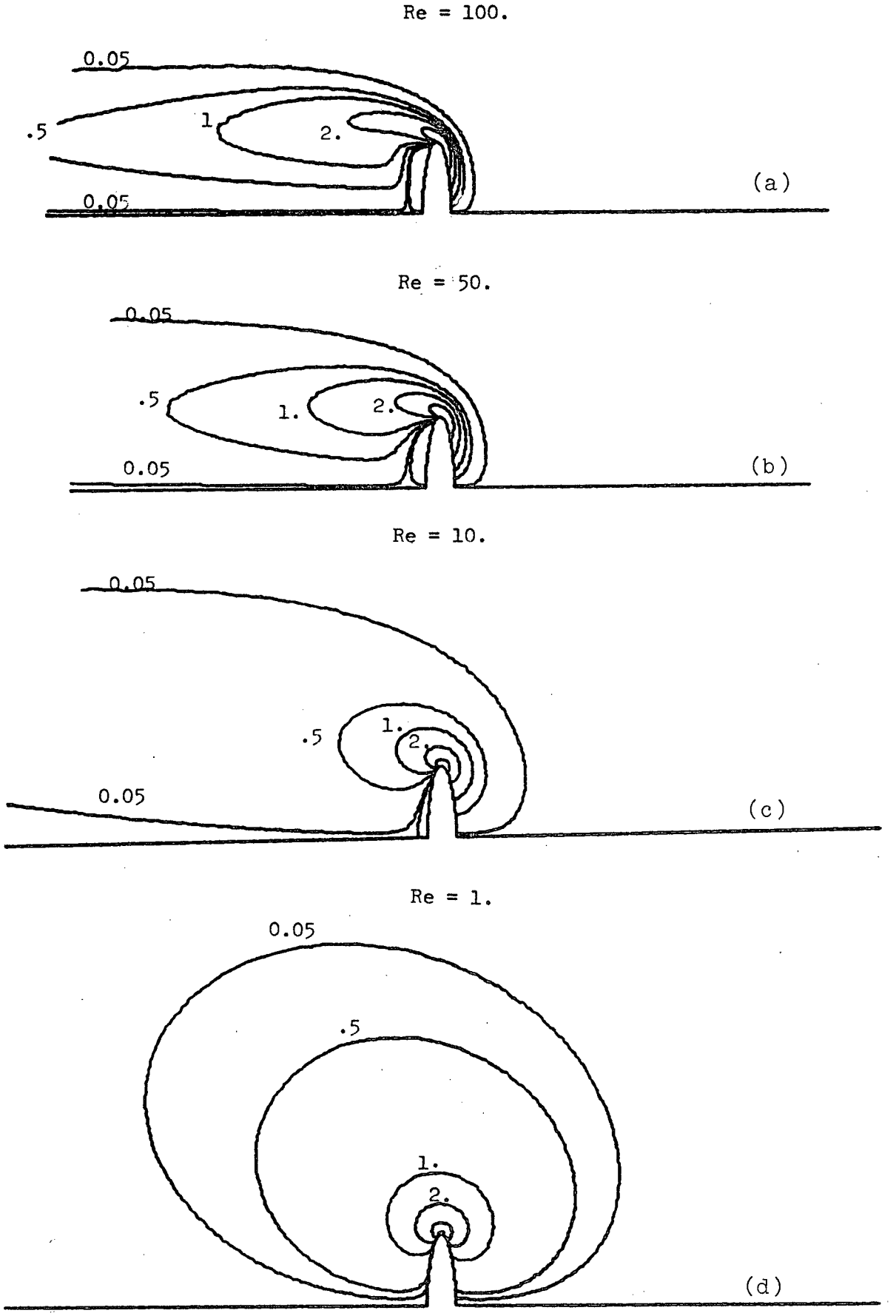


Figure 43. Vorticity lines for an oblate spheroid with aspect ratio 0.2.

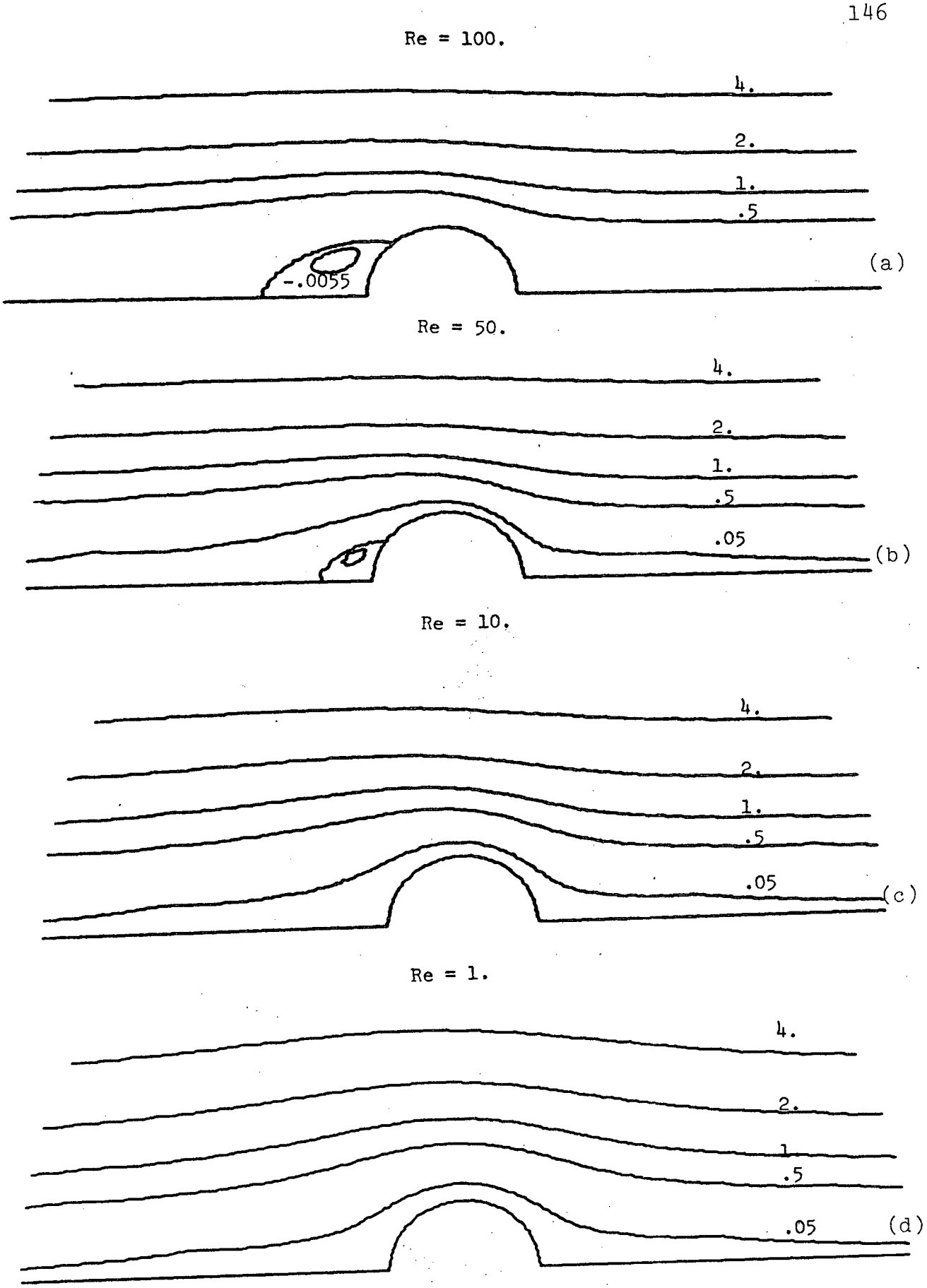


Figure 44. Streamlines for a prolate spheroid with aspect ratio 0.9.

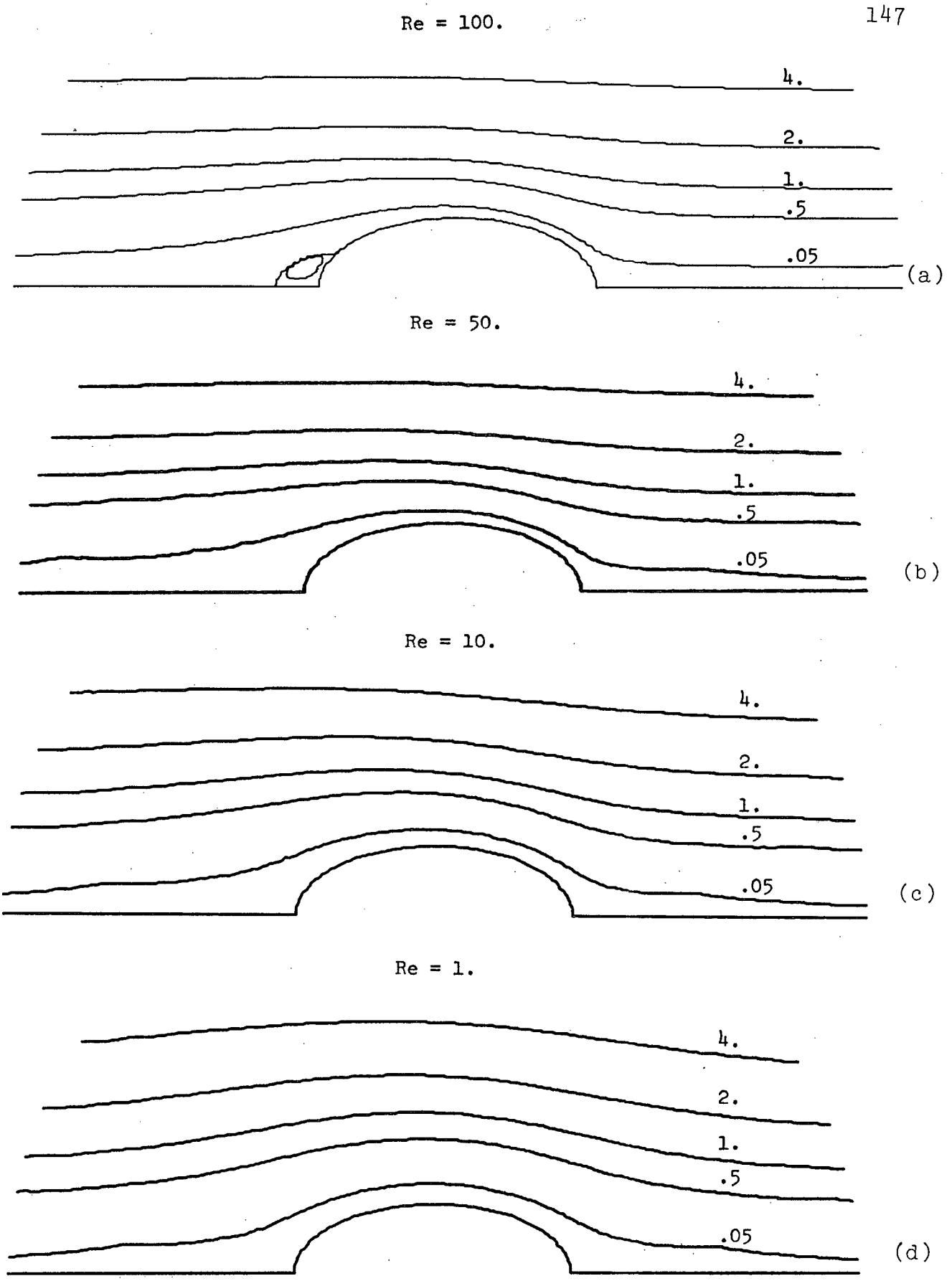


Figure 45. Streamlines for a prolate spheroid with aspect ratio 0.5.

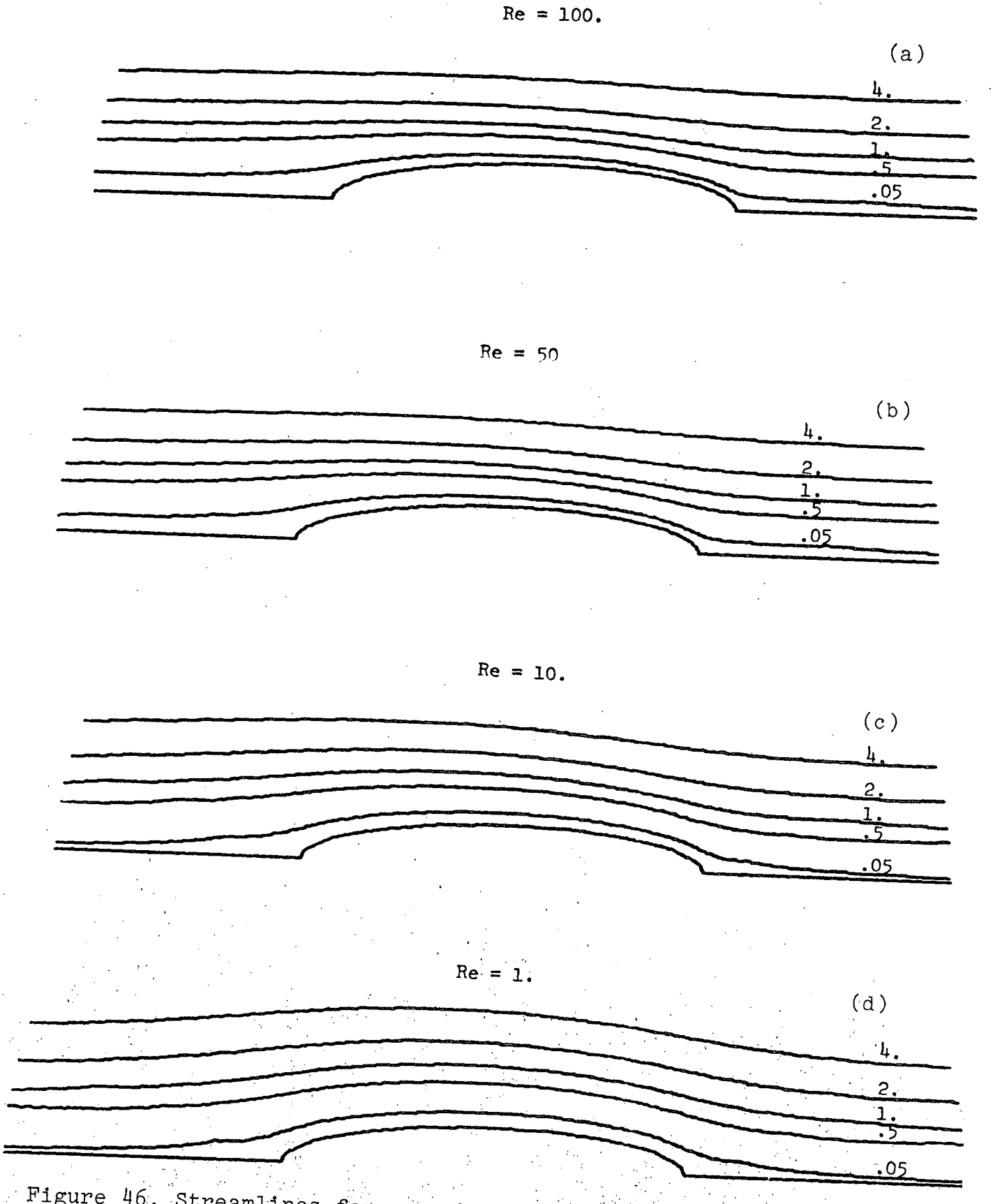


Figure 46. Streamlines for a prolate spheroid with aspect ratio 0.2.

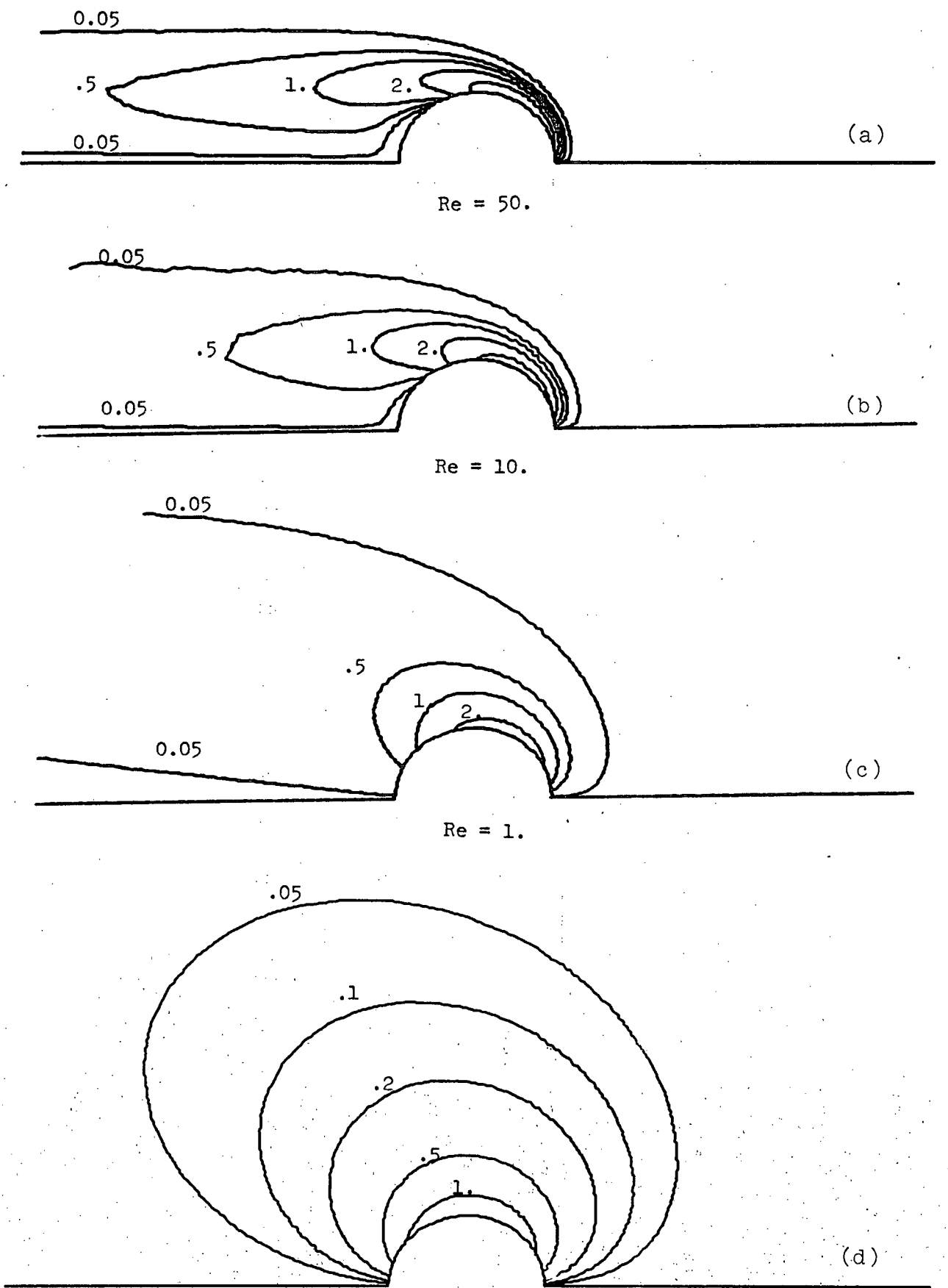


Figure 47. Vorticity lines for a prolate spheroid with aspect ratio 0.9.

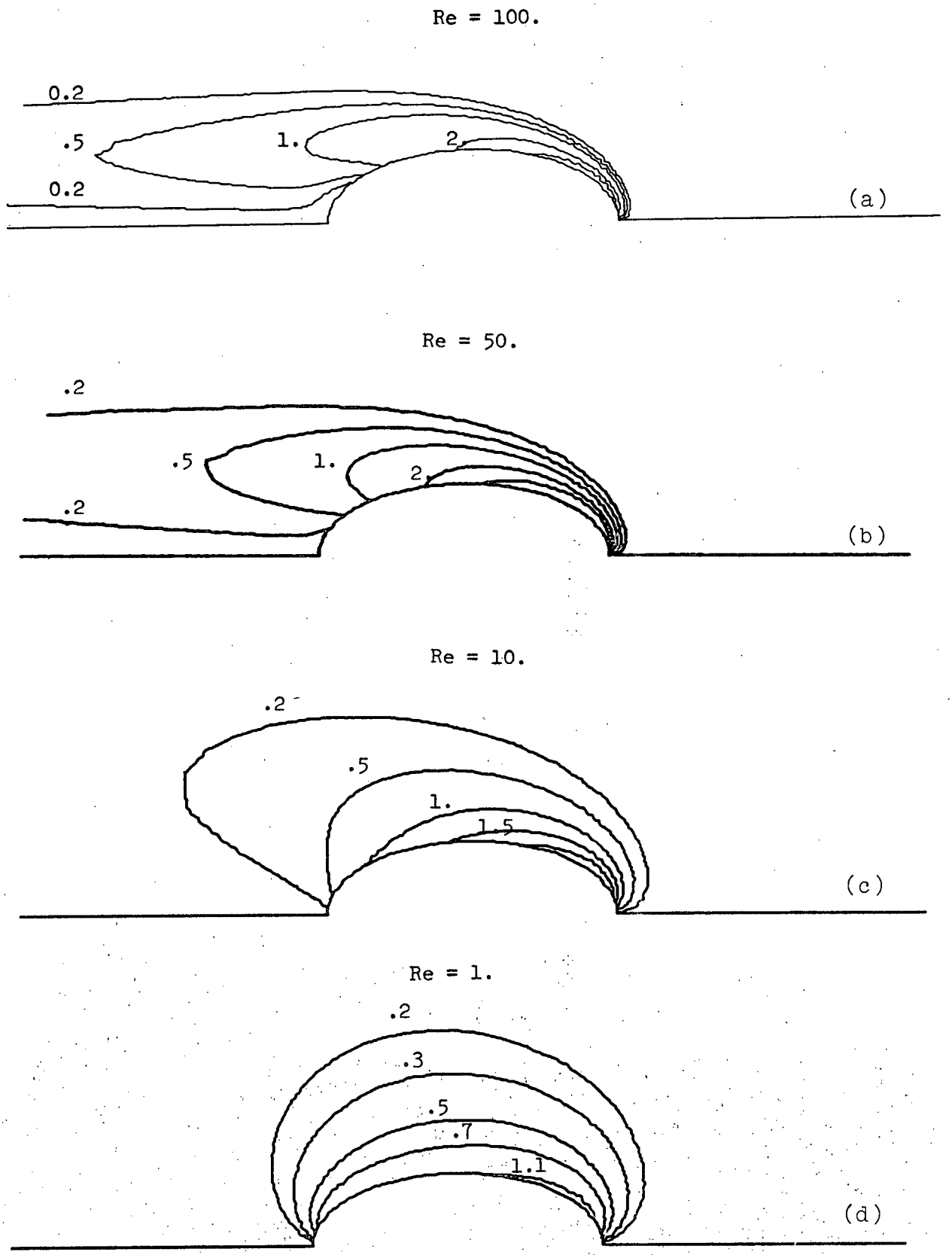


Figure 48. Vorticity lines for a prolate spheroid with aspect ratio 0.5.

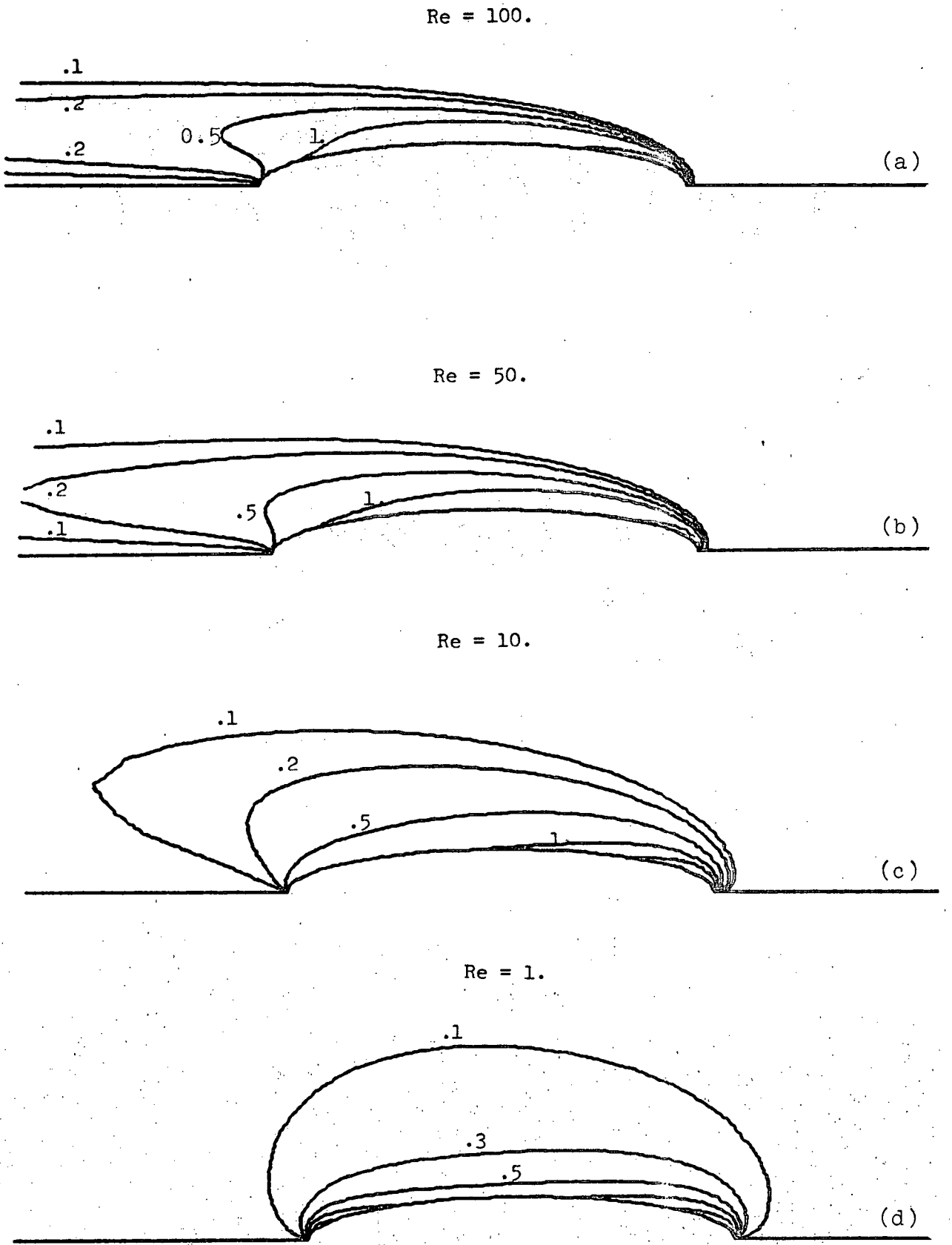


Figure 49. Vorticity lines for a prolate spheroid with aspect ratio 0.2.

figure 50. The modulus of the velocity vector was found by using the Lagrange 3-point formula on the stream function lattice. It is interesting to note that the streamline enclosing the wake for the 0.2 aspect ratio oblate spheroid (figure 39a) has approximately the same curvature over the wake region as the equi-velocity line of unity (figure 50a), and it may be a conjecture that both lines coincide with each other when the Reynolds number is increased indefinitely. Also it can be seen that the centre of the vortex (figure 39a) lies in a region of low velocity (figure 50a).

In potential flow, i.e. when an ideal fluid flows past a spheroid, symmetry exists between the upstream flow and the downstream flow. This is a result of no frictional energy losses due to the absence of viscous forces. The dimensionless surface pressure distribution for potential flow past a sphere, as given in Appendix I , is plotted in figure 51 together with the numerical results at Re = 50 and Re = 100 for a spheroid having A.R. = 0.999. The curve for the higher Re shows closer agreement with the pressure distribution for potential flow than that for the lower Re. This agreement is best for points near the front end of the spheroid. Similar plots for A.R. = 0.2 of an oblate and a prolate spheroid are given in figures 52 and 53 respectively. For the prolate spheroid at Re = 100 the agreement with the potential flow extends to about $3\pi/2$, which is undoubtedly related to the absence of separation for the real flow at Re = 100.

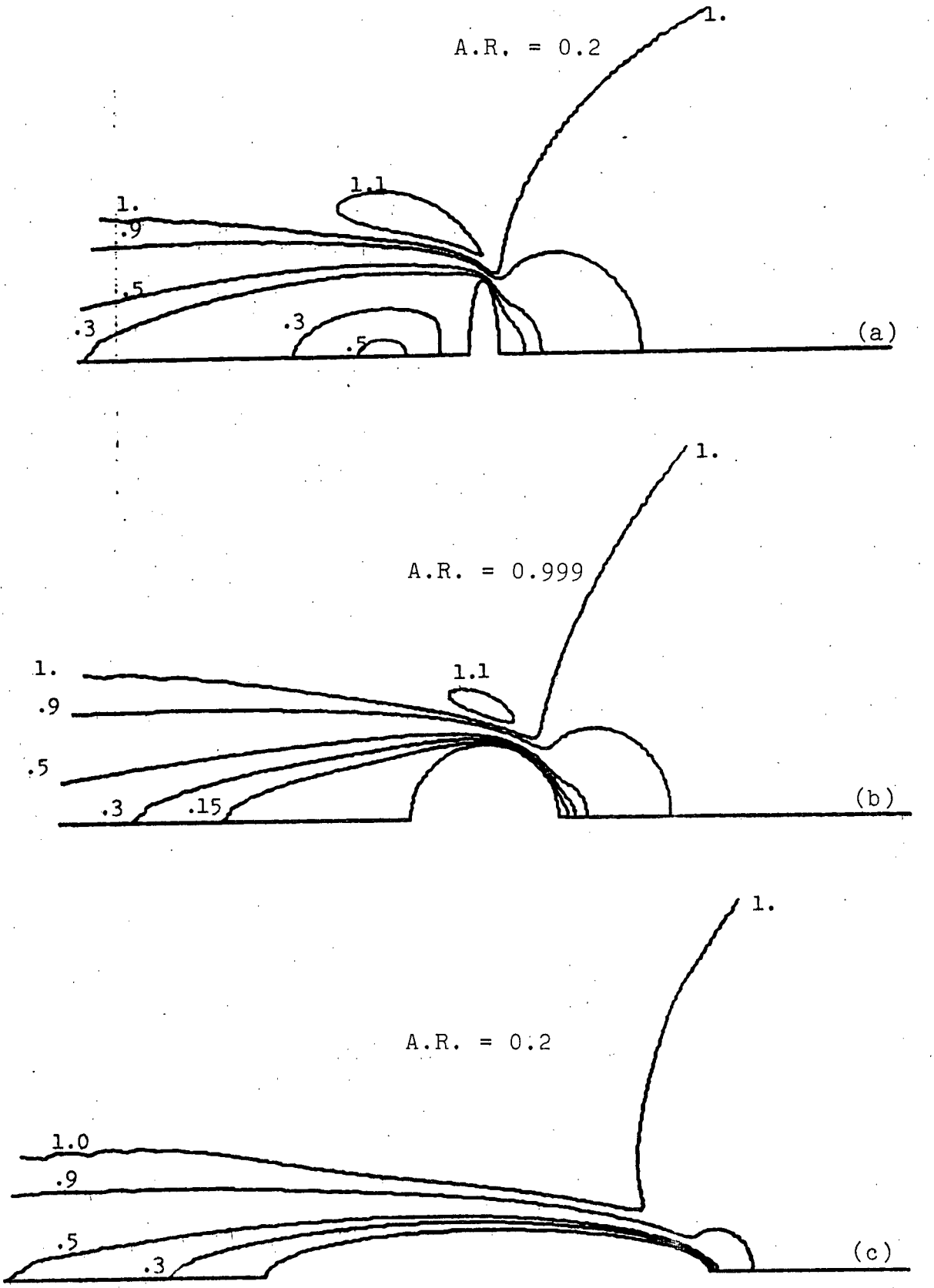


Figure 50. Velocity lines for spheroids at Re=100.

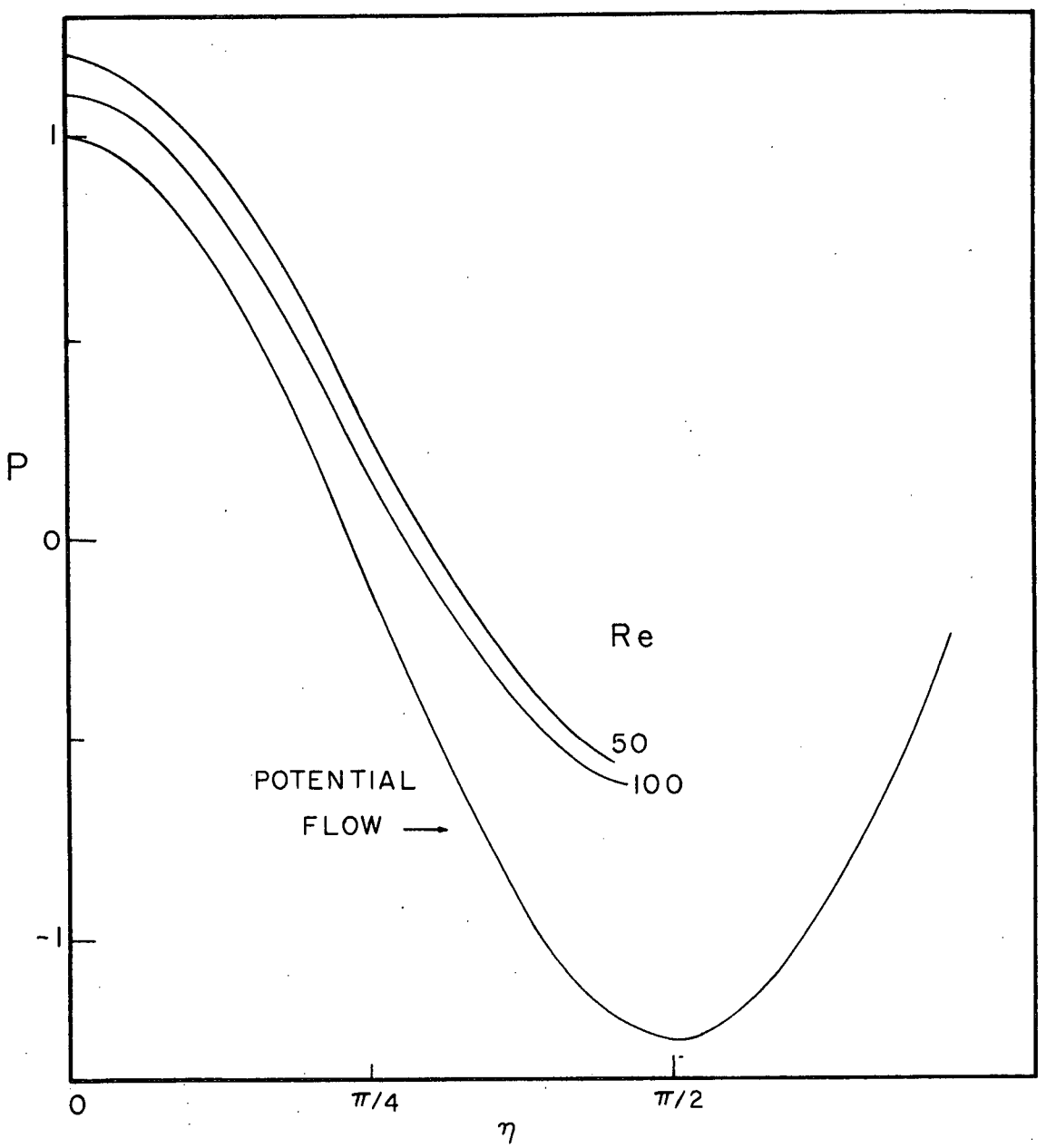


Figure 51. Surface pressure distribution at high Re for an oblate spheroid with A.R. = 0.999 (sphere).

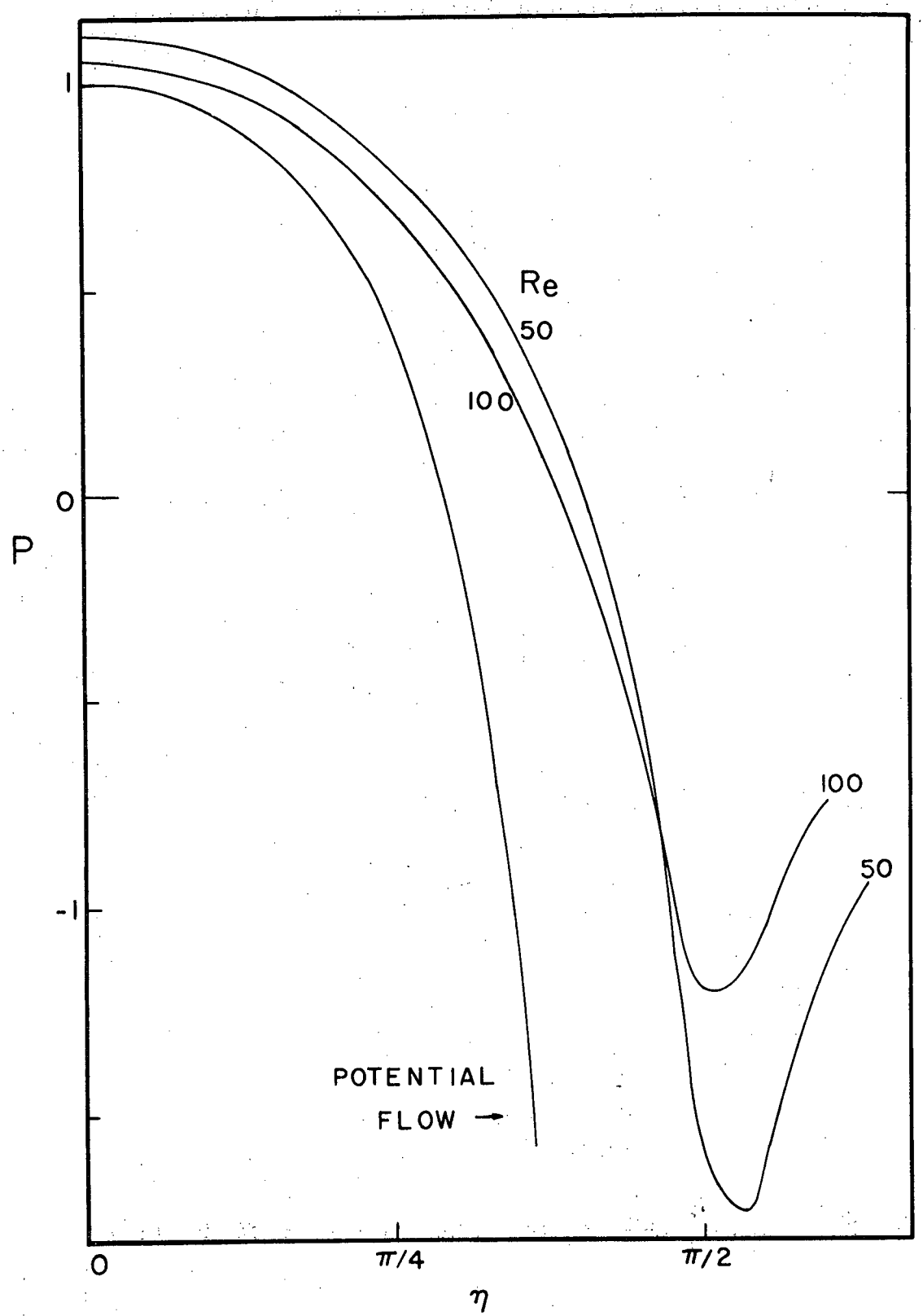


Figure 52. Surface pressure distribution at high Re for an oblate spheroid with A.R.=0.2.

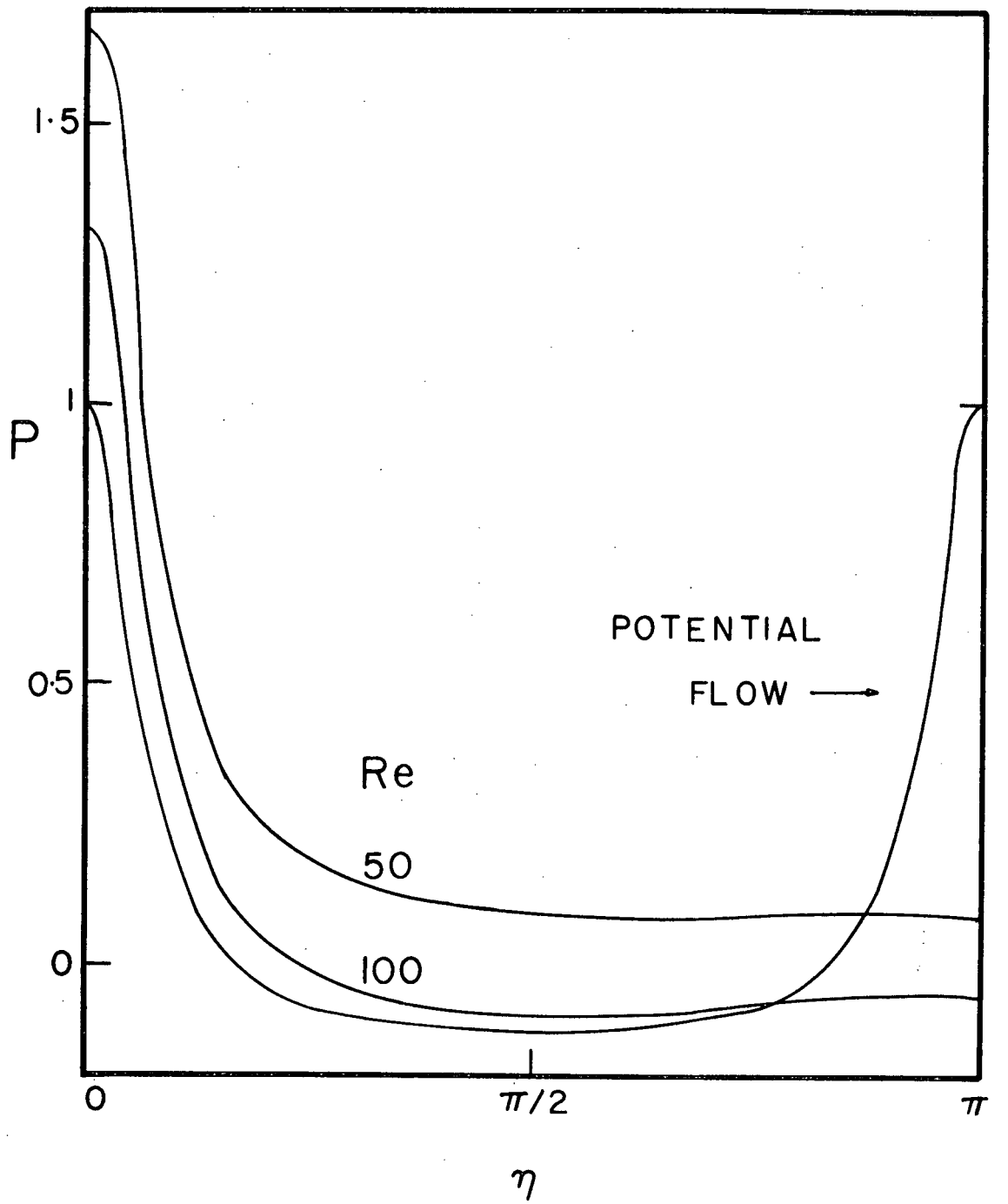


Figure 53. Surface pressure distribution at high Re for a prolate spheroid with A.R. = 0.2.

Figure 54a shows the excellent agreement of Homann's results with those obtained in the work on a nearly perfect sphere and by other numerical and analytical work. Figures 54 - 57 compare the dimensionless frontal stagnation pressure for various aspect ratios of oblate and prolate spheroids with the solution derived in Appendix I using boundary layer theory and the potential flow solution for spheroids. In all cases the agreement is much closer for high than low Reynolds number which is not surprising since the boundary layer theory is strictly applicable for the higher Re. The modified Stokes solution (which adds the first term of unity) to the unmodified solution gives surprisingly close results to the numerical values obtained in this work.

The modulus of the velocity vector in the η-direction was determined at $\eta=\pi/2$, i.e. $|v_\eta|$ was evaluated along $\eta = \pi/2$ and the position of its maximum value was taken as the edge of the boundary layer. This position was non-dimensionalized by the use of the equatorial radius of the spheroid, and the dimensionless boundary thickness, δ , was plotted against the Reynolds number in figure 58. The plot gave straight lines having slopes of about $-1/2$, in agreement with boundary layer theory (162).

6. Results for Single Elliptical Cylinders

The boundary conditions used for the isolated elliptical cylinders are given in Chapter III as Case I, in which the vorticity is taken as zero at the outer boundary.

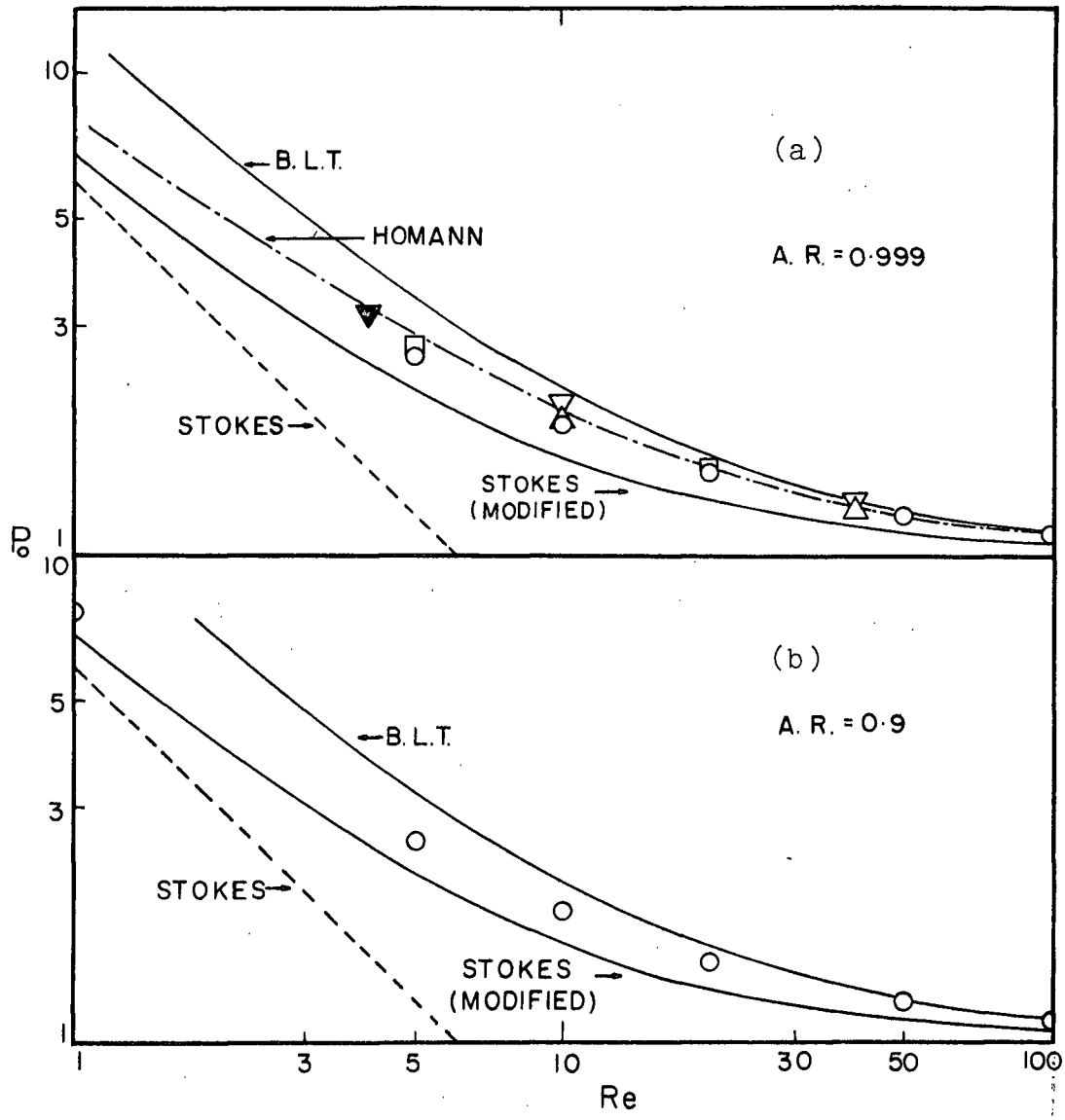


Figure 54. Variation of the frontal stagnation pressure with Reynolds number for oblate spheroids of high aspect ratio: B.L.T., Boundary layer theory; o , this work; □ , Jenson, Δ , Rhodes; ▽ , Hamielec et al; ▼ , Pearcey and McHugh.

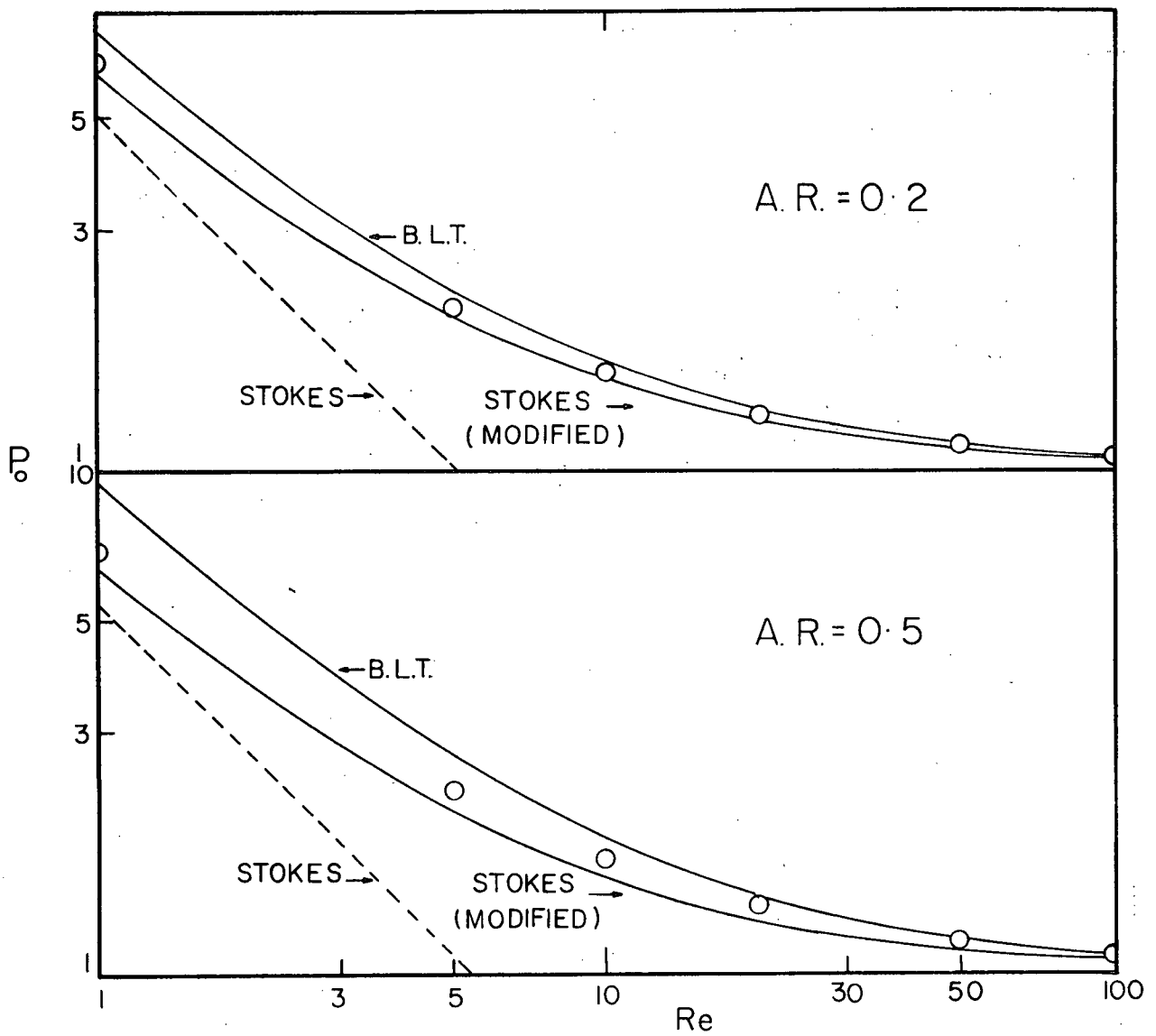


Figure 55. Variation of the frontal stagnation pressure with Reynolds number for oblate spheroids of low aspect ratio: B.L.T., Boundary layer theory; o , this work.

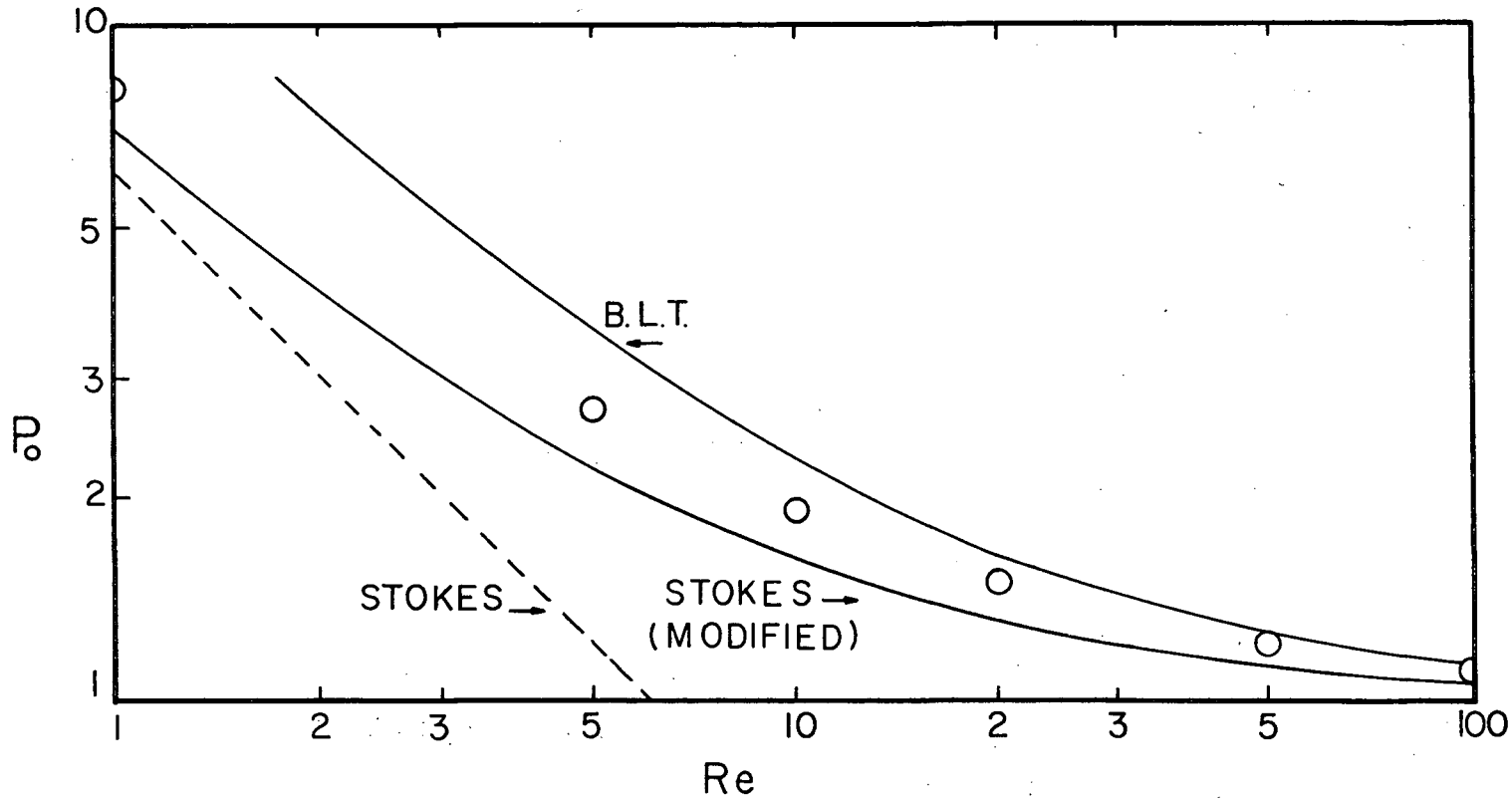


Figure 56. Variation of the frontal stagnation pressure with Reynolds number for prolate spheroids with A.R. = 0.9: B.L.T., Boundary layer theory; o , this work.

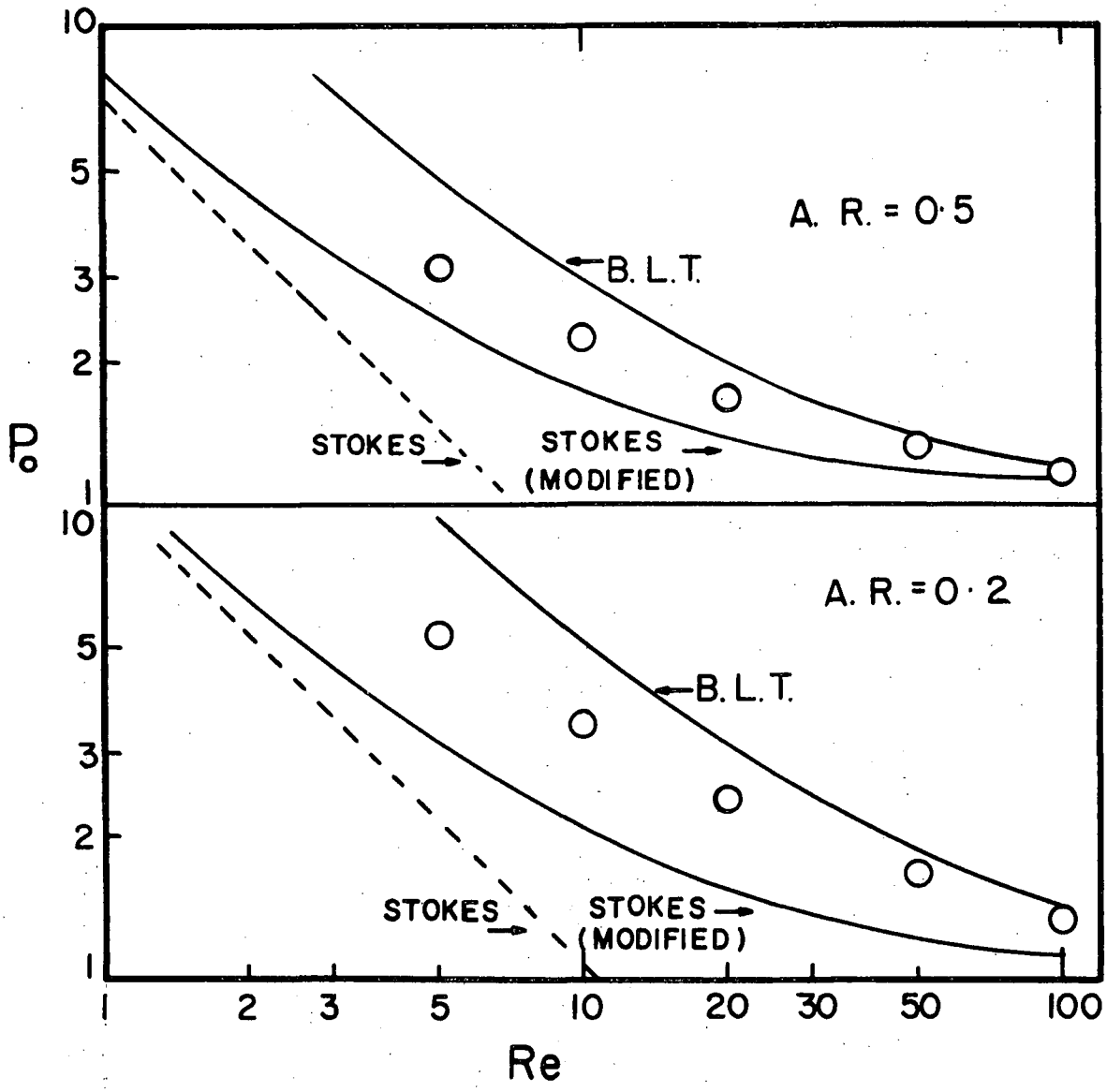


Figure 57. Variation of the frontal stagnation pressure with Reynolds number for prolate spheroids of low aspect ratio: B.L.T., Boundary layer theory; o , this work.

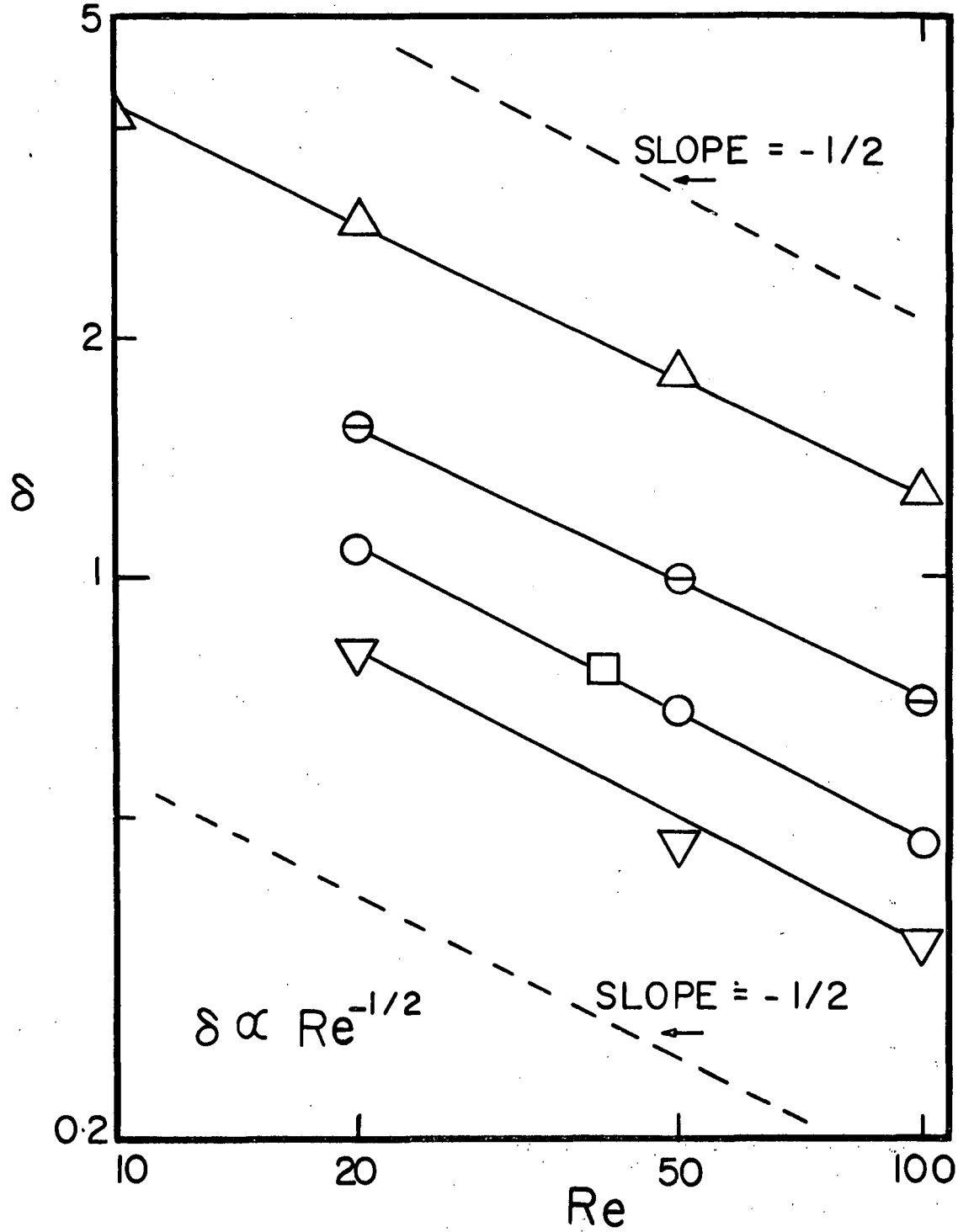


Figure 58. Variation of the boundary layer thickness with Reynolds number for spheroids at $\eta = \pi/2$. Oblate spheroids: ○, A.R. = 0.999 (sphere); ▽, A.R. = 0.2. Prolate spheroids: ⊖, A.R. = 0.5; △, A.R. = 0.2. Sphere: □, Jenson.

The numerical work on circular cylinders has been well covered by previous workers. Initial work on a nearly circular elliptical cylinder was done to test the computer program. An aspect ratio of 0.995 was used. Figure 59 shows the experimental data of various workers together with the solutions of Lamb (5) and Kaplun (29) as well as the present work. The C_{DT} results at Re = 0.01 for O.R. = 0.995 and at Re = 1 and 5 for O.R. = 1/0.995 agree very well with the experimental data of the various workers (145, 146, 147). It is interesting that Lamb's solution is quite accurate in estimating the total drag coefficient up to Re = 1.0. The recent experimental work of Jayaweera and Mason (145) at Re $\simeq$ 0.02 shows that Lamb's solution still holds at this very low Reynolds number. It should be borne in mind that there is no valid creeping flow solution for the circular cylinder, since Stokes solution gives zero drag coefficient when the outer envelope is at infinity. At Re = 0.01 the presence of the outer boundary is very influential in determining the exact value of the total drag coefficient. For d_m = 257, it was found that C_{DT} obtained by the numerical solution of the complete Navier - Stokes equation agrees with that obtained by the creeping flow solution as given by equation 89. However, this C_{DT} value is about 30% higher than the experimental value (see Appendix II, Mark 1524). At d_m = 1808 the numerically computed value of C_{DT} is very close to the experimental data, indicating that the influence of the outer

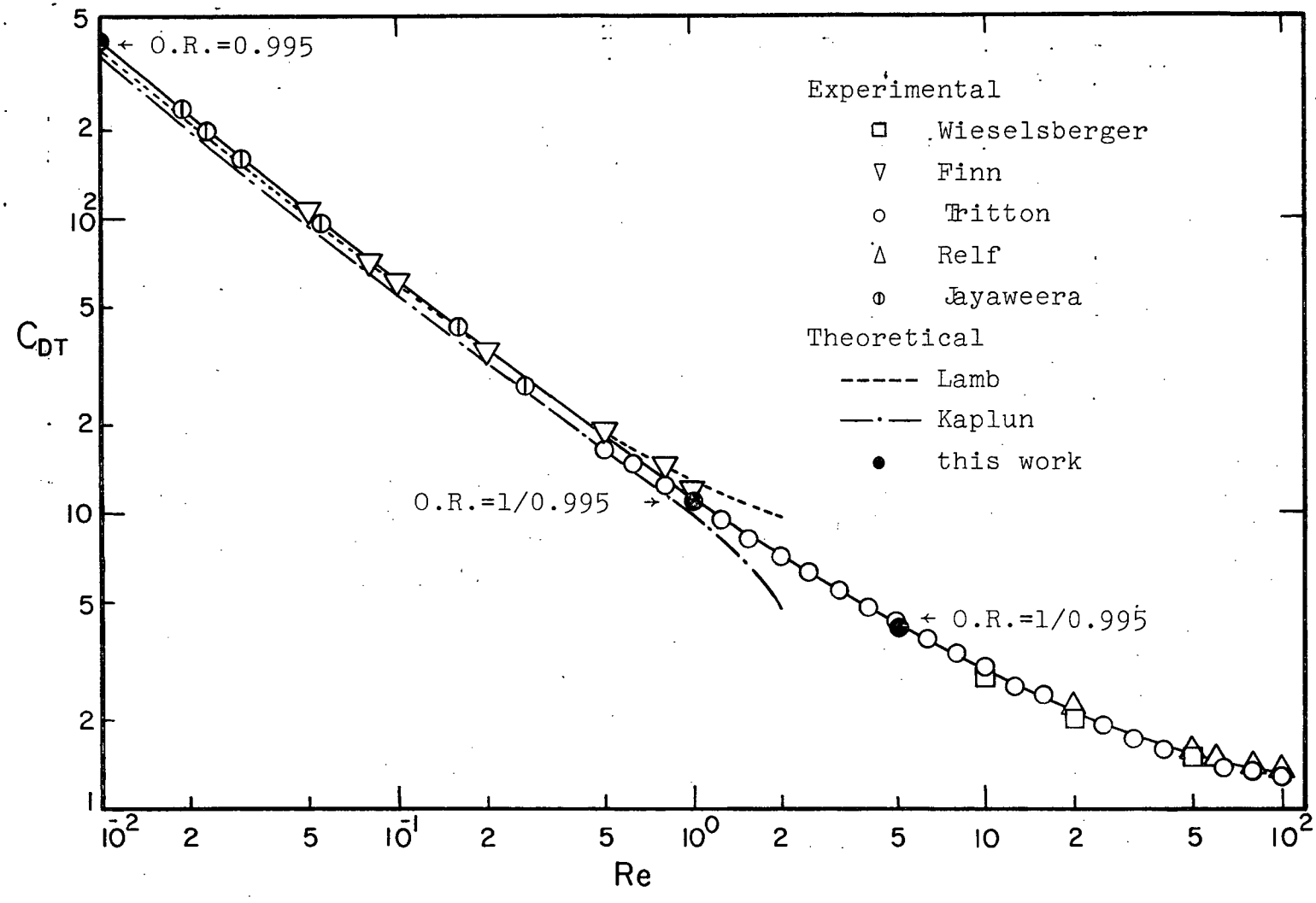


Figure 59. Drag coefficients for circular cylinders.

envelope is negligible, while the creeping flow solution gives a lower value than the experimental data. For spheroids, the influence of the outer envelope becomes negligible at much shorter distances than for cylinders. This could be due to the fact that a two-dimensional body creates a larger disturbance than a three dimensional body. Lamb's solution of Oseen's equations and Kaplun's inner and outer expansion solution for low Reynolds number give lower values of C_{DT} on a cylinder than the experimental data, whereas the corresponding solutions for a spheroid fall higher than the experimental curve of C_{DT} vs. Re.

The total drag coefficient based on the length of the elliptical cylinder (axis perpendicular to the flow direction) is shown in figure 60, where it is seen that C_{DT} does not vary much with O.R. It is interesting that at Re < 6, flow along the minor axis of an elliptical cylinder with O.R. = 0.2 shows values of C_{DT} lower than those obtained for flow along the major axis (O.R.=0). However, for higher Re, the curve of C_{DT} vs. Re for O.R. = 0.2 crosses and exceed all the others. The work of Miyagi (81a) for flow perpendicular to flat plates (O.R. = 0) gives values of C_{DT} much higher even than those computed for O.R. = 0.2 at higher Re. The reason for the slower rate of decrease in C_{DT} with Re for the low orientation ratios is probably the early formation of a wake bubble when the flow is along the minor axis at low aspect ratios.

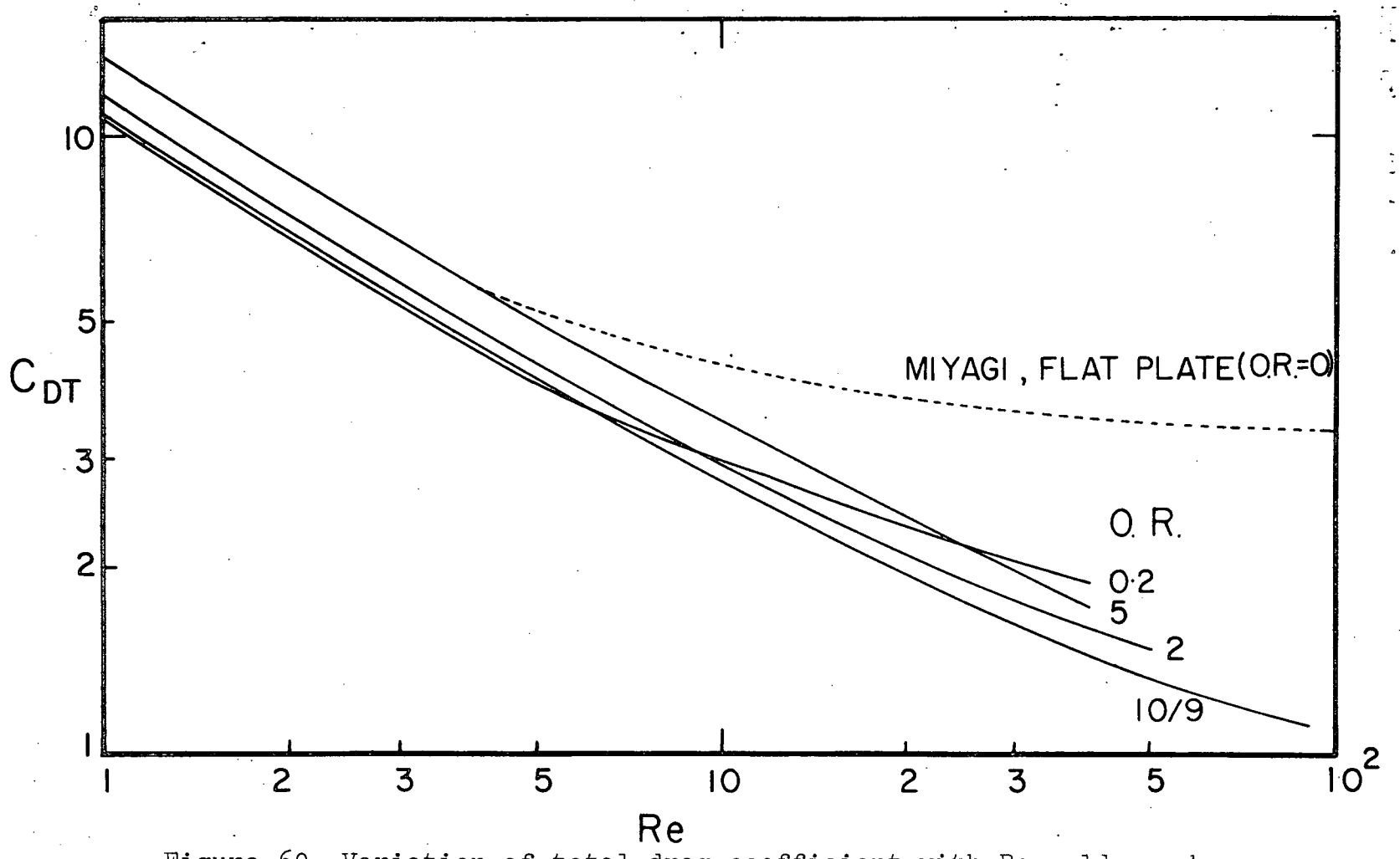


Figure 60. Variation of total drag coefficient with Reynolds number for elliptical cylinders.

In order to compare the total drag coefficient with that of a flat plate, C_{DTW} is plotted against Rew in figure 61, the subscript w signifying that the coordinates are both based on the width of the elliptical cylinder (axis along the flow direction). It is seen that the results for O.R.=5,2 and 10/9 lie between those of a circular cylinder (O.R. = 1.0) and those of a flat plate (O.R. = ∞), as computed numerically by Dennis and Dunwoody (41). The Blasius (83) and Kuo (82) solutions for a flat plate, using boundary layer theory, fall below the latter.

Figure 62 shows that as Re increases the ratio of C_{DS} to C_{DF} decreases, that this ratio approaches that of Oseen's solution at low Reynolds number, and that it increases with orientation ratio. From simple geometrical considerations the skin drag coefficient is zero for O.R. =0, whereas the form drag coefficient is zero for O.R. = ∞ .

The variation of the dimensionless frontal stagnation pressure, P_o , for the elliptical cylinders is quite similar to that of the spheroids. For low Re, the deviation from unity is large and P_o increase rapidly with O.R., as shown in figure 63. For higher Re the deviation from unity is smaller and P_o does not increase much with O.R.

The variation of the dimensionless pressure distribution on the surface of a nearly circular cylinder is shown in figure 64. Any tendency towards antisymmetry about $\eta = \pi/2$ at Re = 1 is no longer present at Re = 5. In figures 65, 66, 67 and 68 the surface pressure distribution

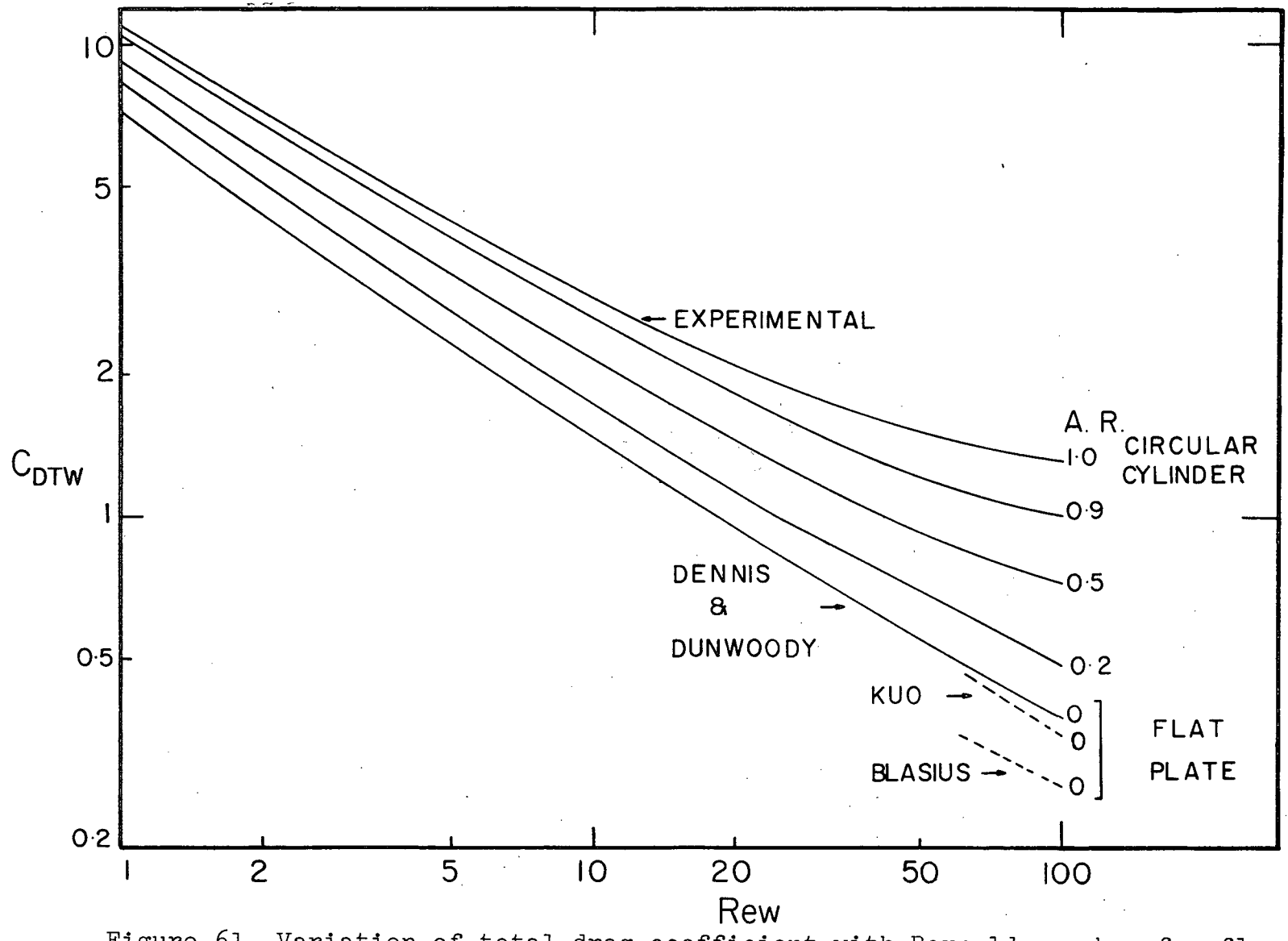


Figure 61. Variation of total drag coefficient with Reynolds number for flow along the major axis, which is taken as the characteristic length.

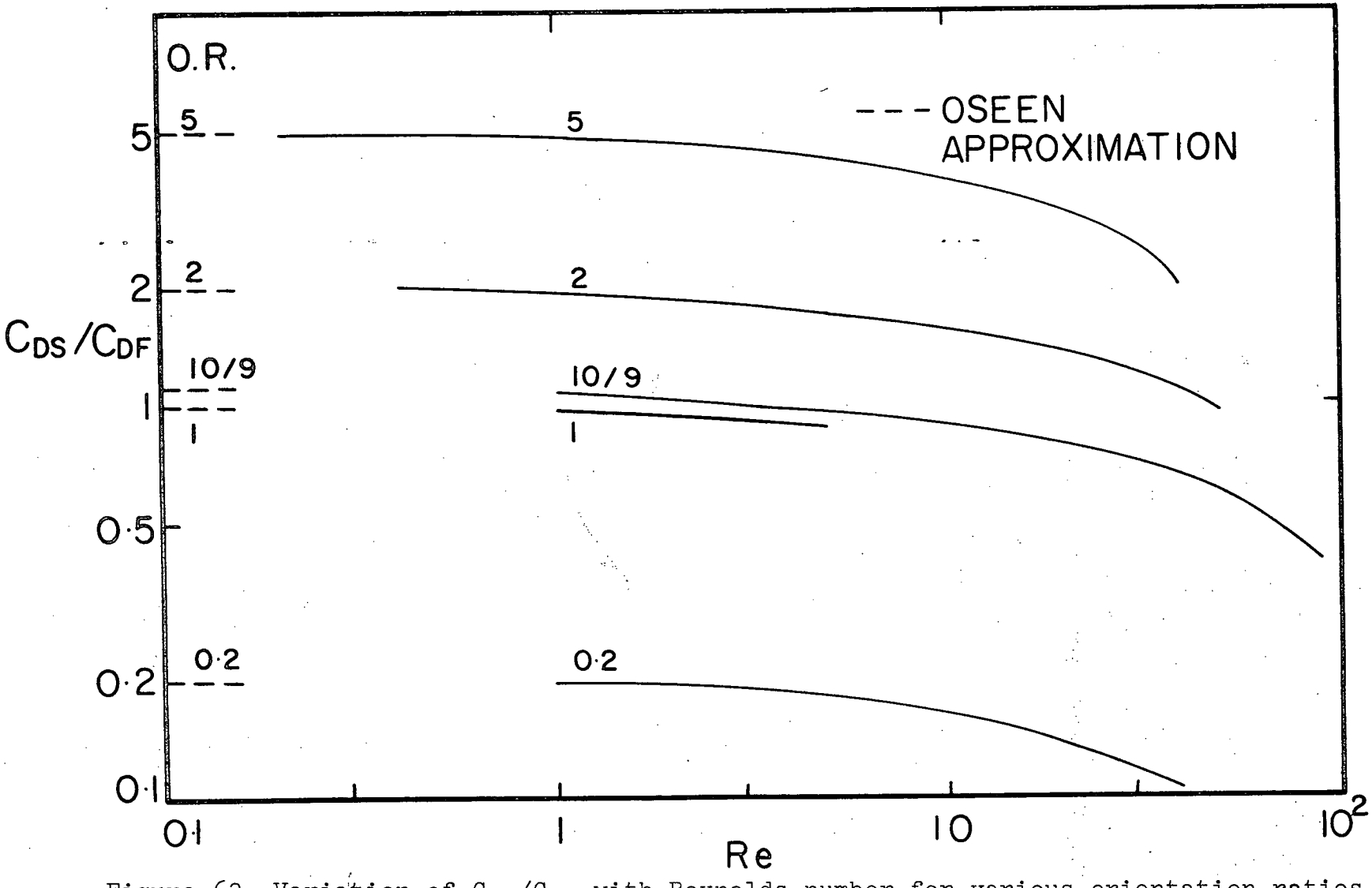


Figure 62. Variation of C_{DS}/C_{DF} with Reynolds number for various orientation ratios of elliptical cylinders.

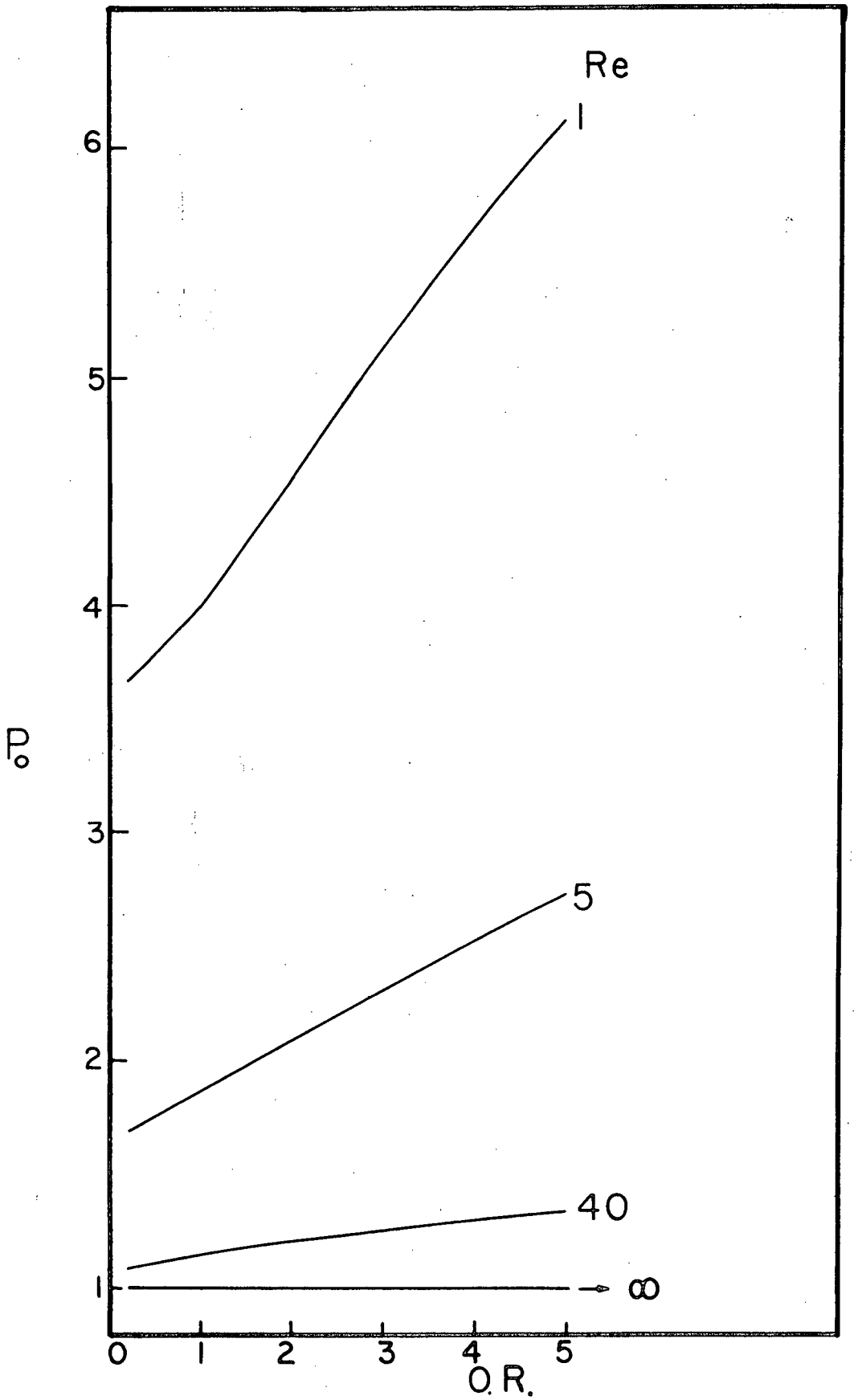


Figure 63. Variation of the frontal stagnation pressure with orientation ratio for elliptical cylinders.

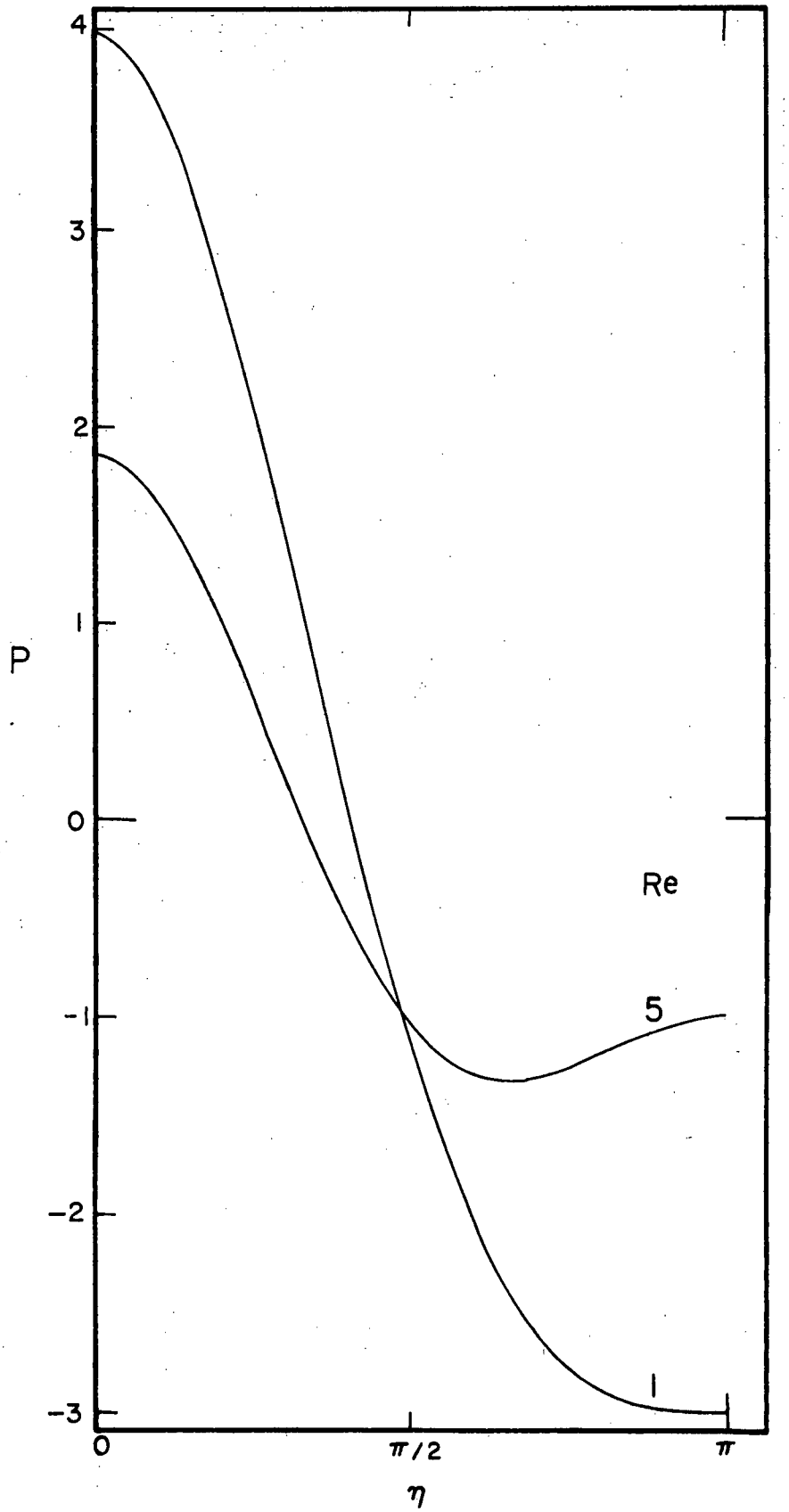


Figure 64. Surface pressure distribution for a nearly circular cylinder (O.R. = 1/0.995).

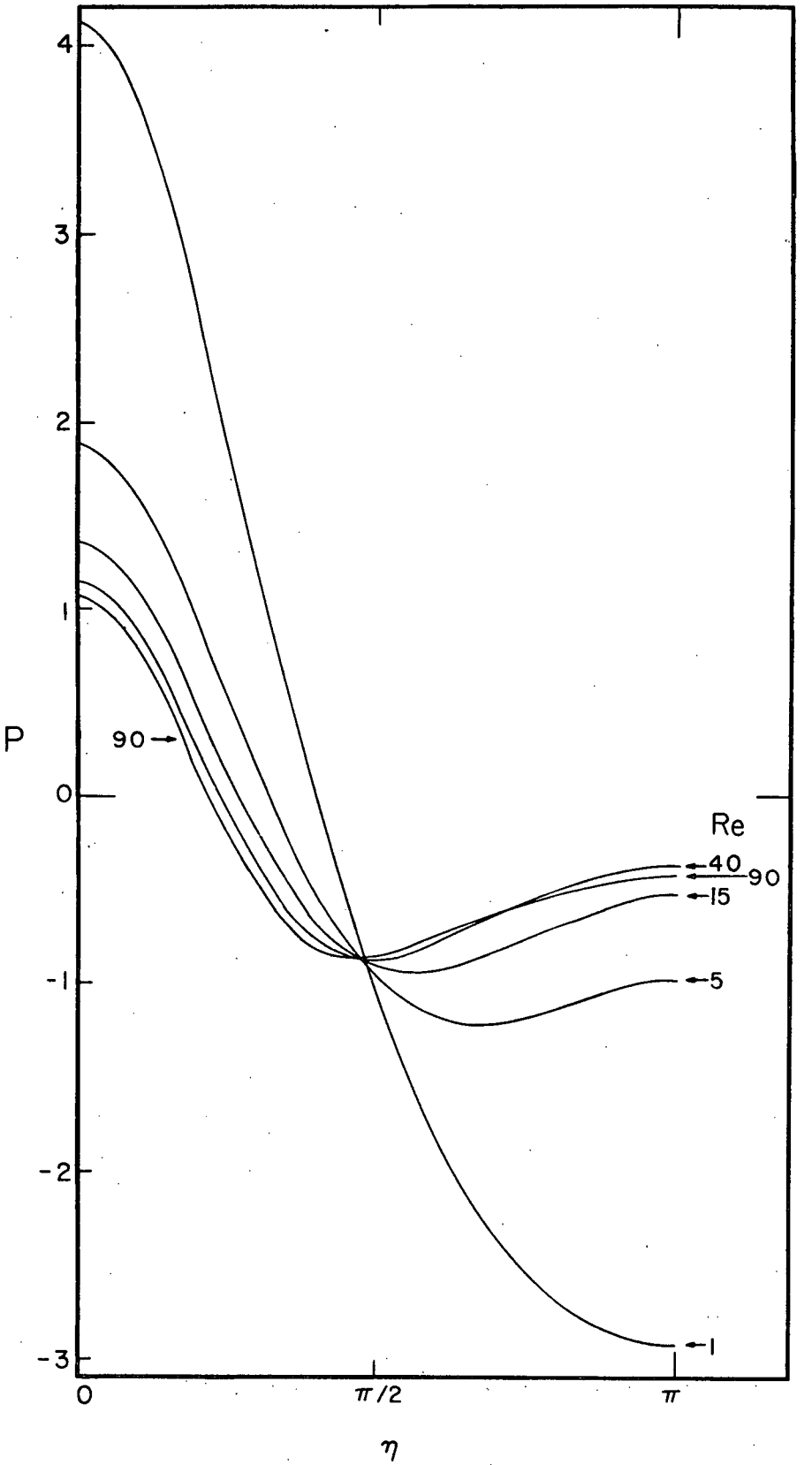


Figure 65. Surface pressure distribution for an elliptical cylinder with O.R. = 10/9.

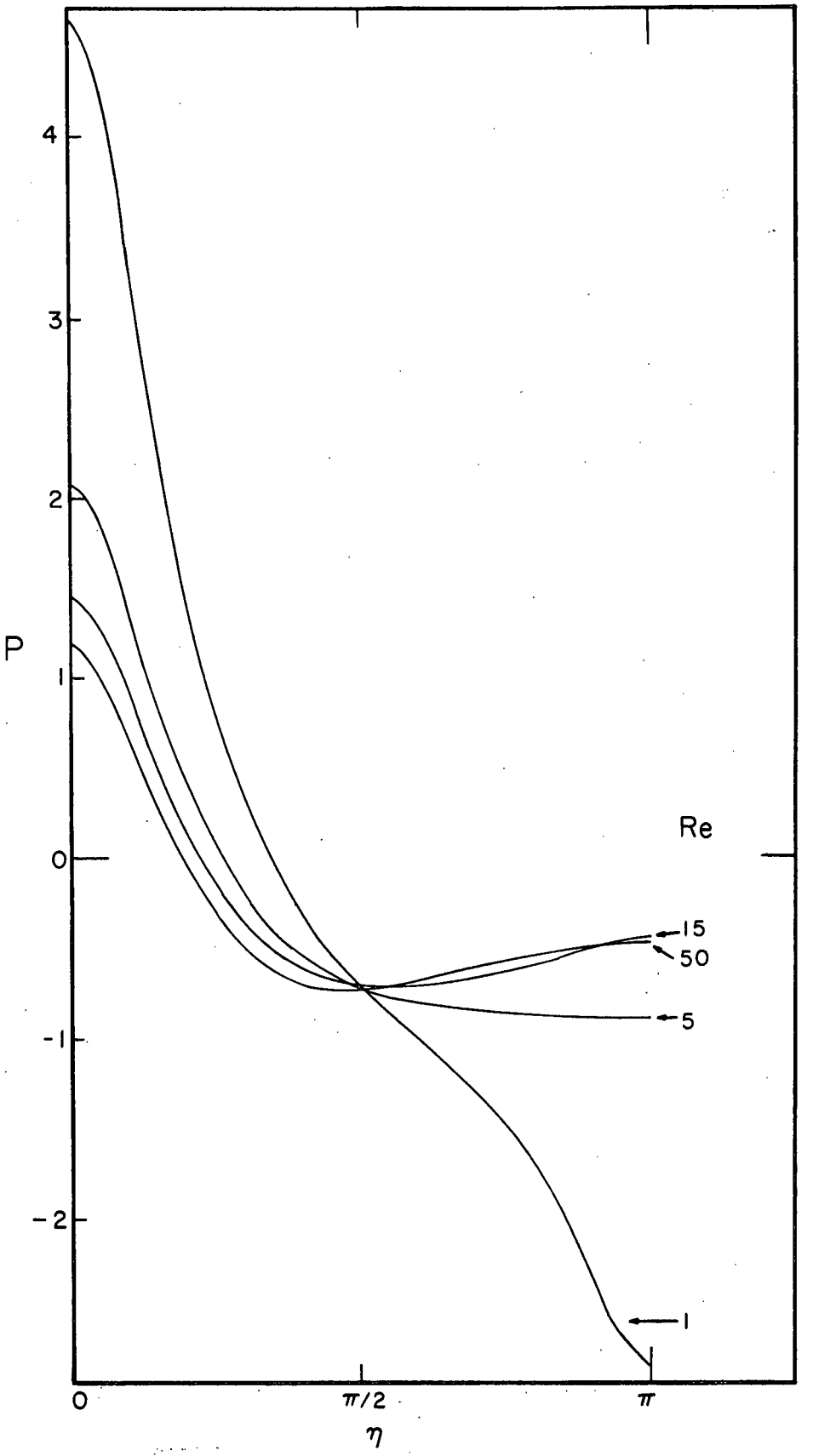


Figure 66. Surface pressure distribution for an elliptical cylinder with O.R. = 2.

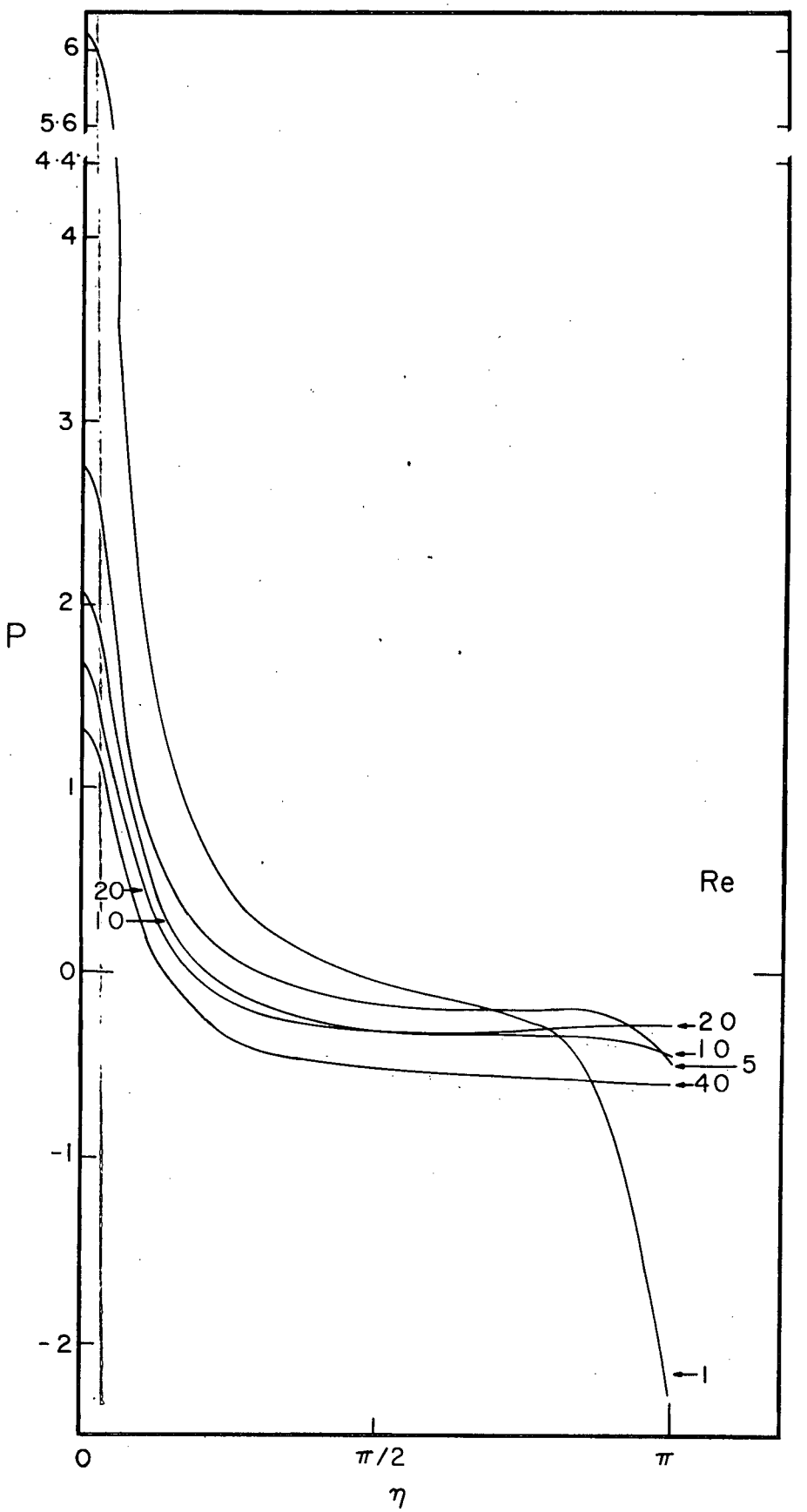


Figure 67. Surface pressure distribution for an elliptical cylinder with O.R. = 5.

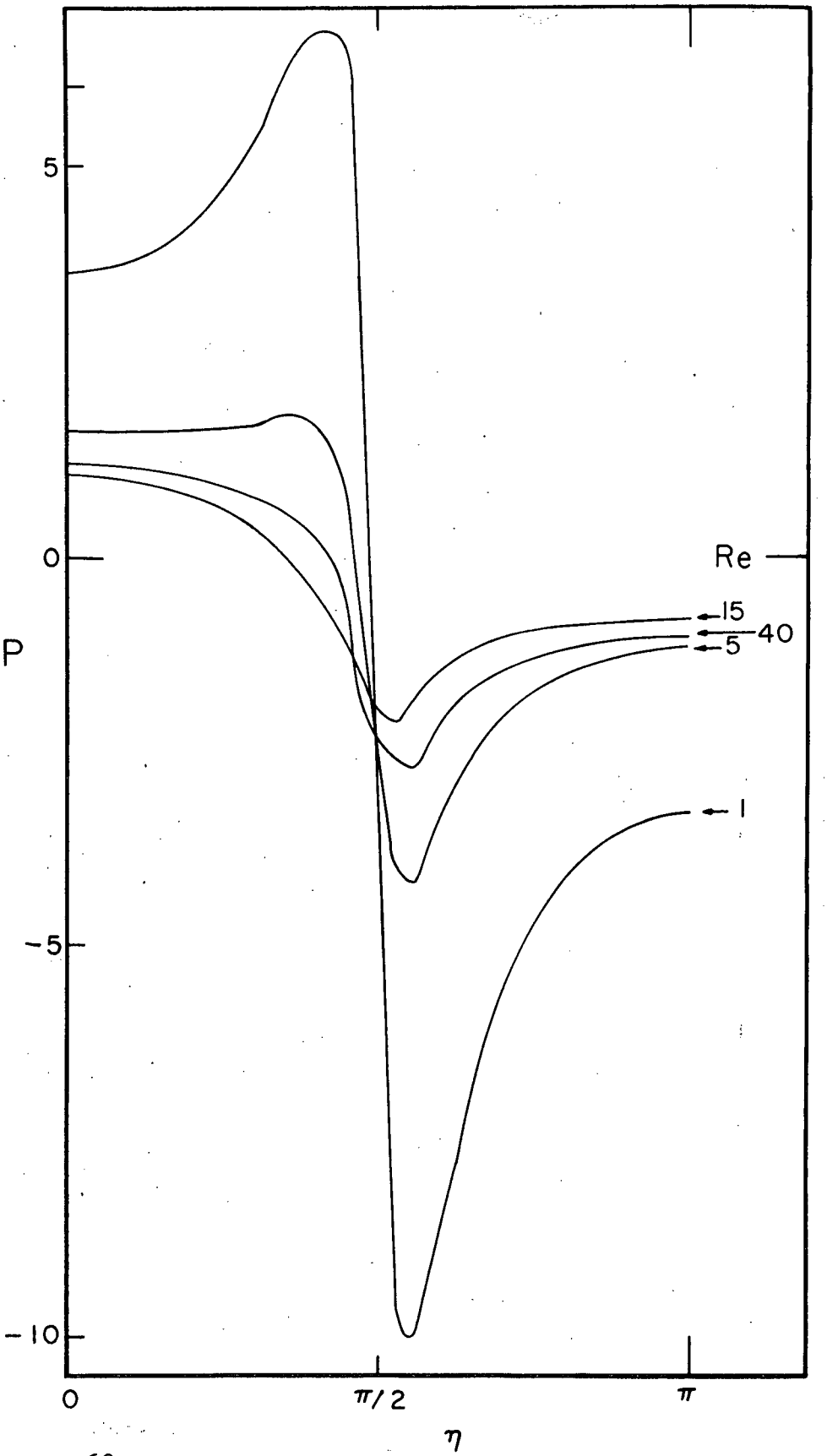


Figure 68. Surface pressure distribution for an elliptical cylinder with O.R. = 0.2.

is given at various Re for O.R. = 10/9, 2,5, and 0.2, respectively. At O.R. = 5 (figure 65) a flat pressure distribution was obtained on the elliptical cylinder, except for the leading and trailing edges at low Re and the leading edge at high Re. At O.R. = 0.2 (figure 68) a maximum was observed for P as in the case of the oblate spheroid with A.R. = 0.2 (figure 17). Such a maximum did not, however, appear for Re higher than about 5.

The dimensionless surface vorticity distribution for the various orientation ratios and Reynolds numbers are given in figures 69 - 73. As indicated previously, the change in the sign of the surface vorticity is an indication of a reversal in the flow direction and hence of separation. Once again the maximum of the $\zeta - \eta$ curve shifts slightly towards $\eta = 0$ with increase of Re. At O.R. = 5 (figure 72) there exists two maxima for Re = 1.0. The maximum nearer the trailing edge disappears for Re > 5. At O.R. = 0.2 (figure 73) the surface vorticity changes signs very rapidly just beyond $\eta=\pi/2$ for the higher Re.

The variation of the dimensionless wake length with Re for the elliptical cylinders is shown in figure 74. It is clear that the wake lengths are longer than those produced by the corresponding spheroids. However, such long two-dimensional wakes are in general not stable, and shedding usually occurs. The experimental data of Taneda (160) on cylinders are plotted for comparison. Figure 75 shows

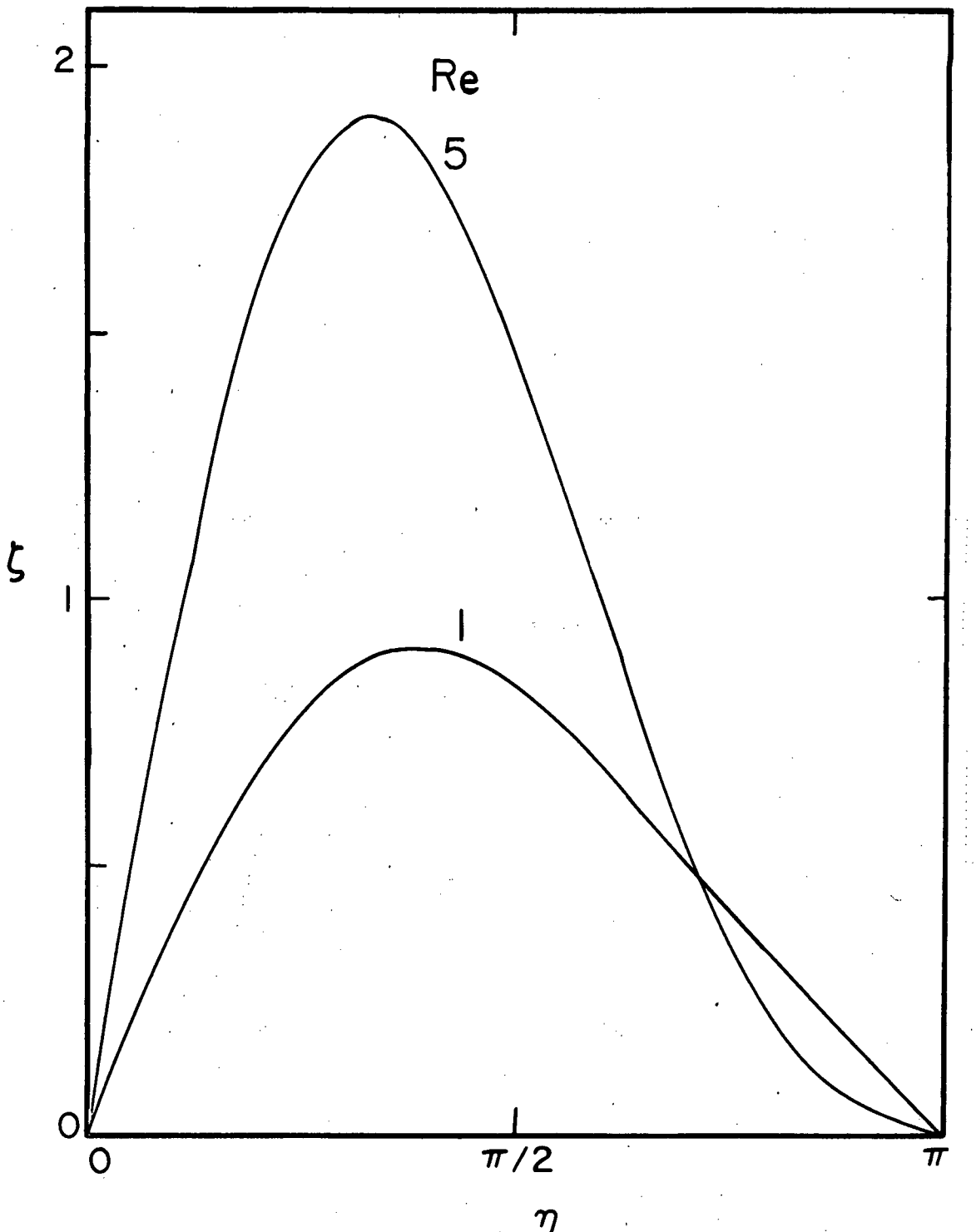


Figure 69. Surface vorticity distribution for a nearly circular cylinder (O.R. = 1/0.995).

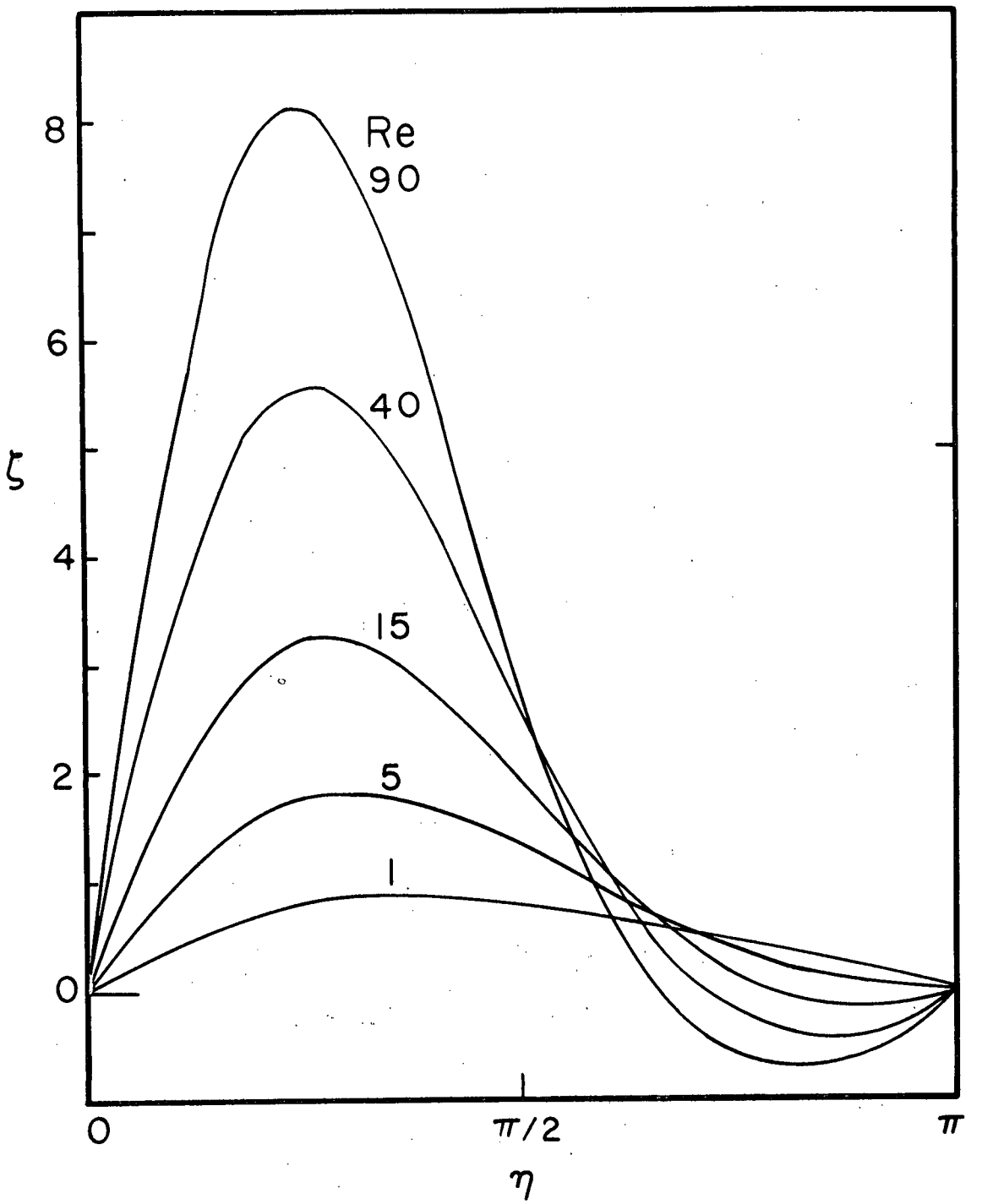


Figure 70. Surface vorticity distribution for an elliptical cylinder with O.R. = 10/9.

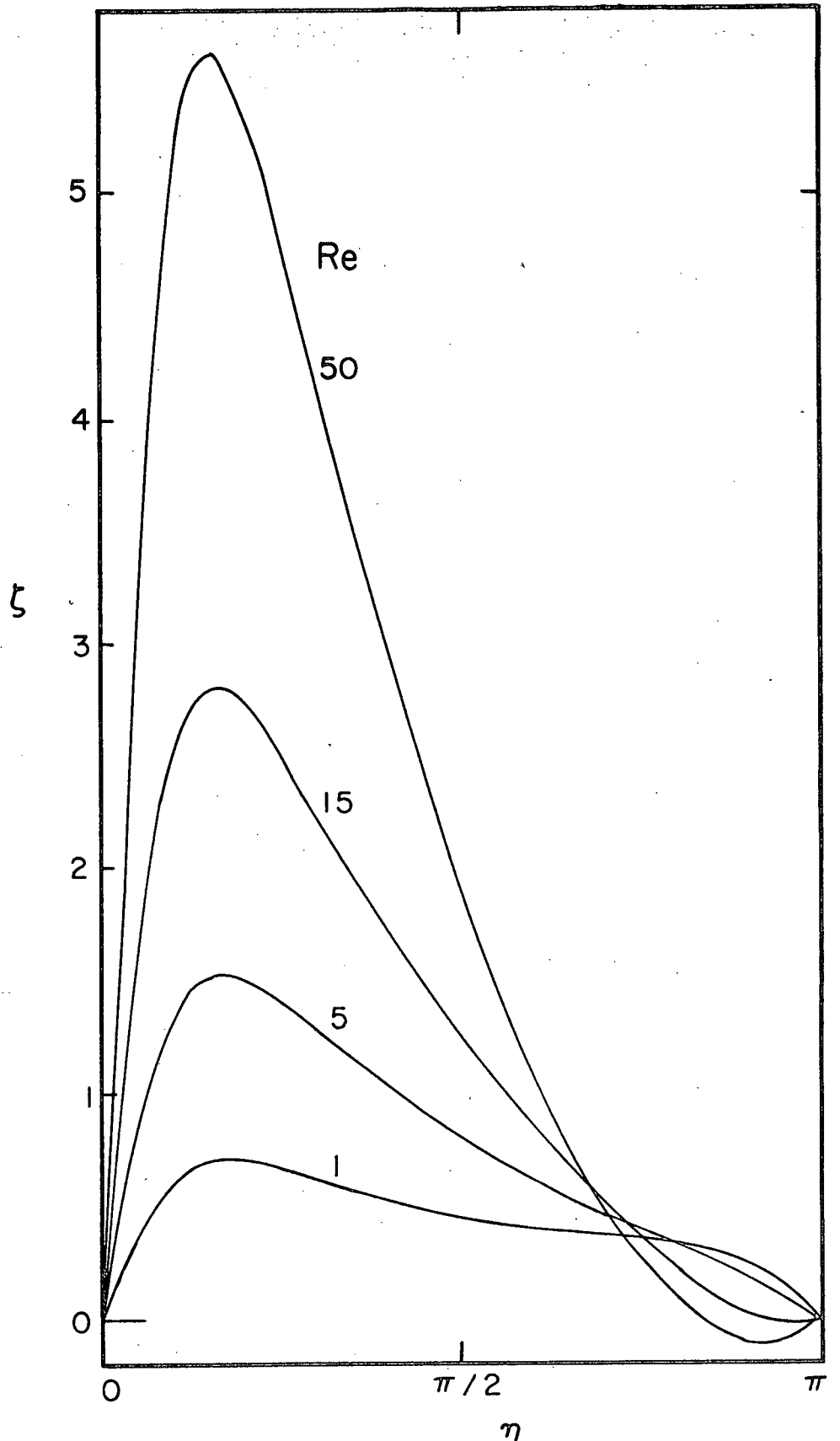


Figure 71. Surface vorticity distribution for an elliptical cylinder with O.R. = 2.

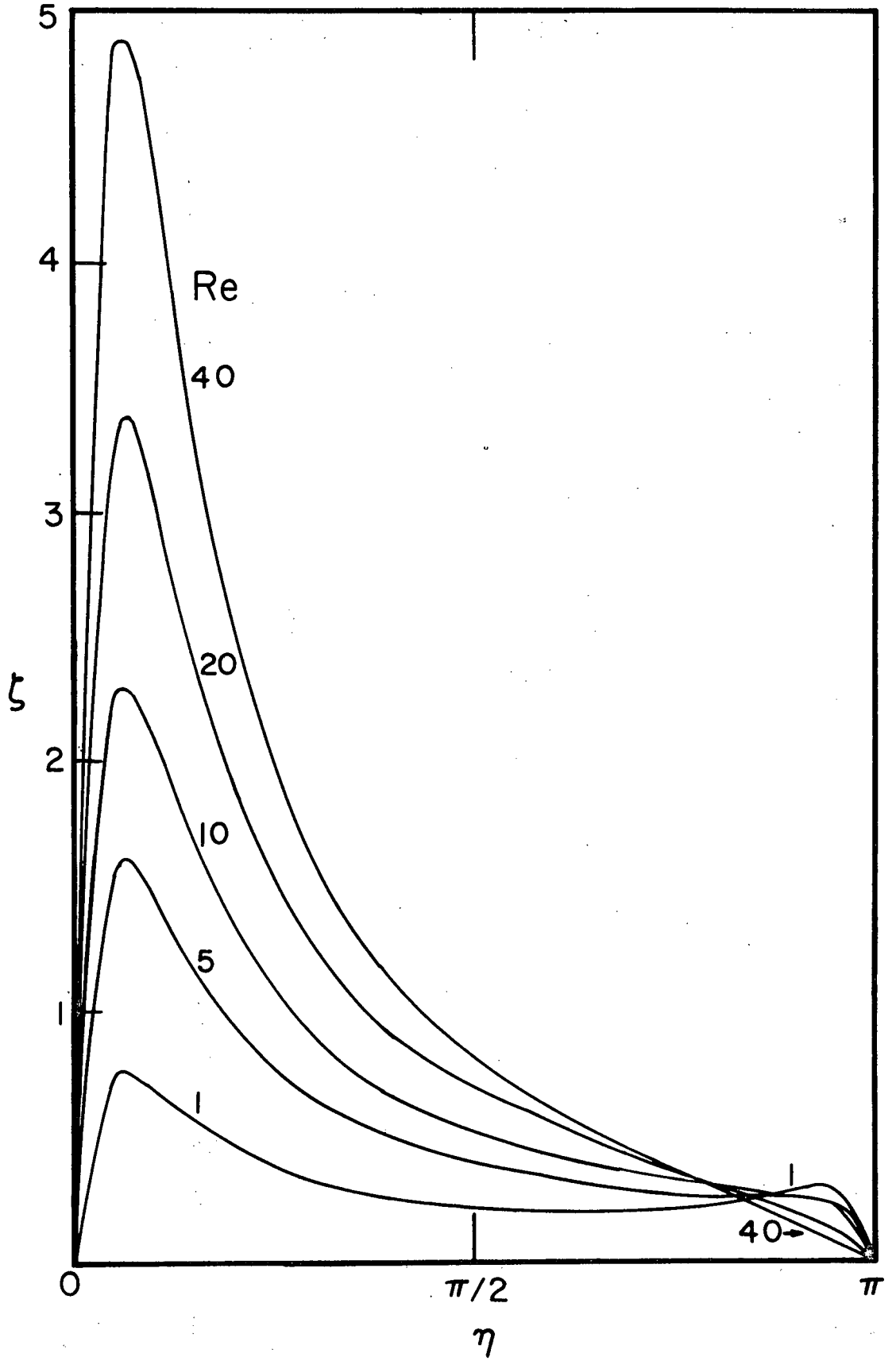


Figure 72. Surface vorticity distribution for an elliptical cylinder with O.R. = 5.

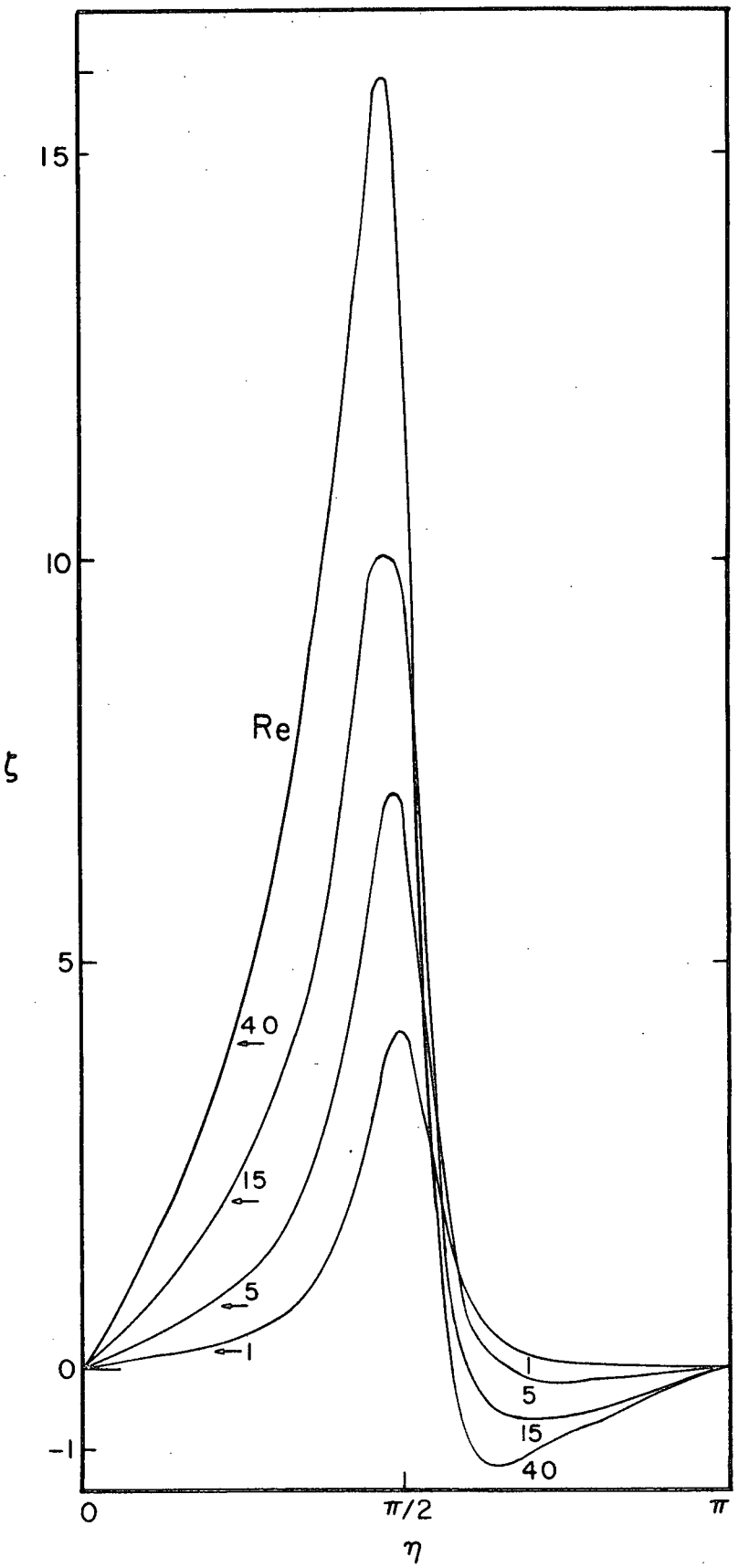


Figure 73. Surface vorticity distribution for an elliptical cylinder with O.R. = 0.2.

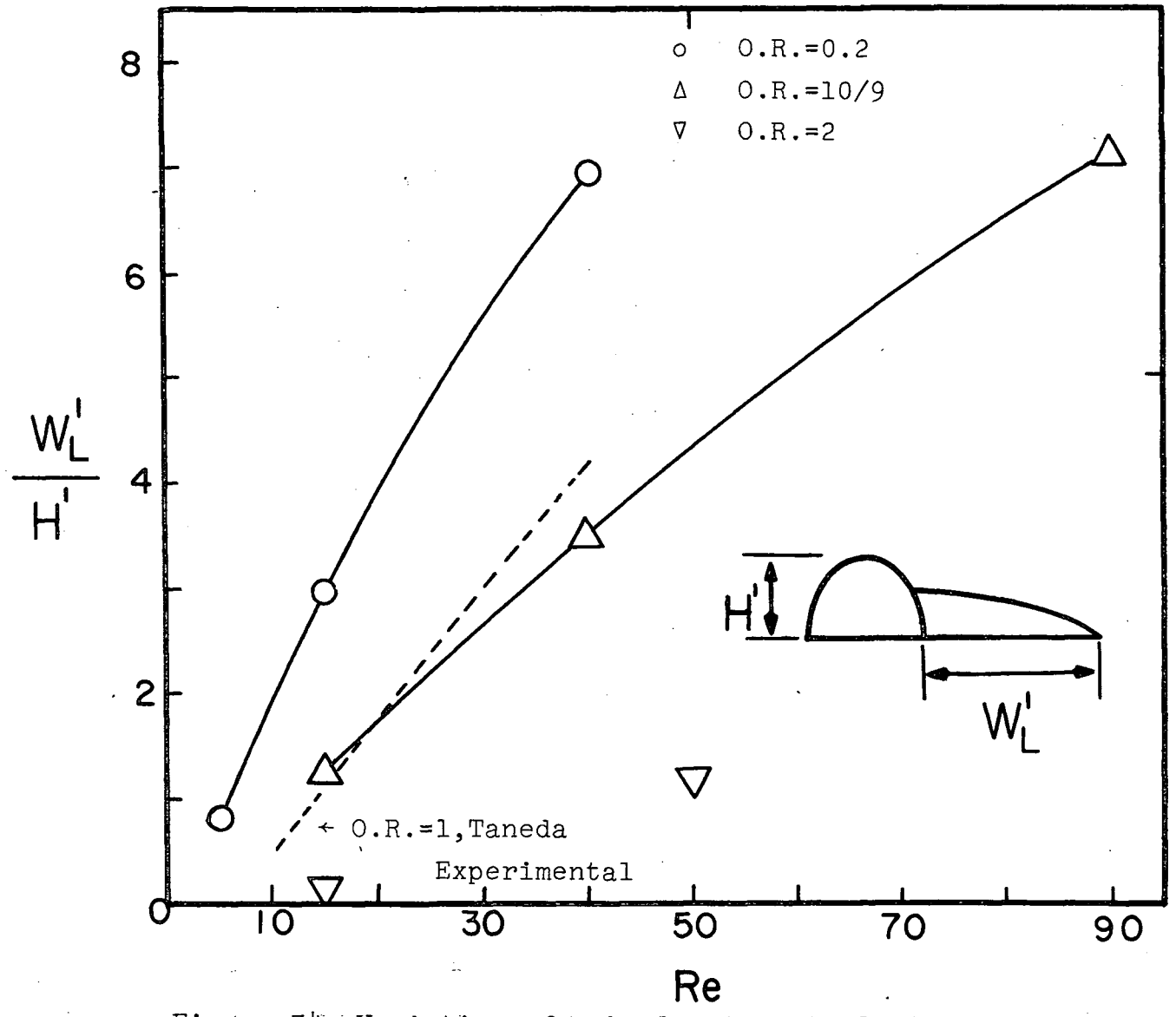


Figure 74. Variation of wake length with Re for elliptical cylinders.

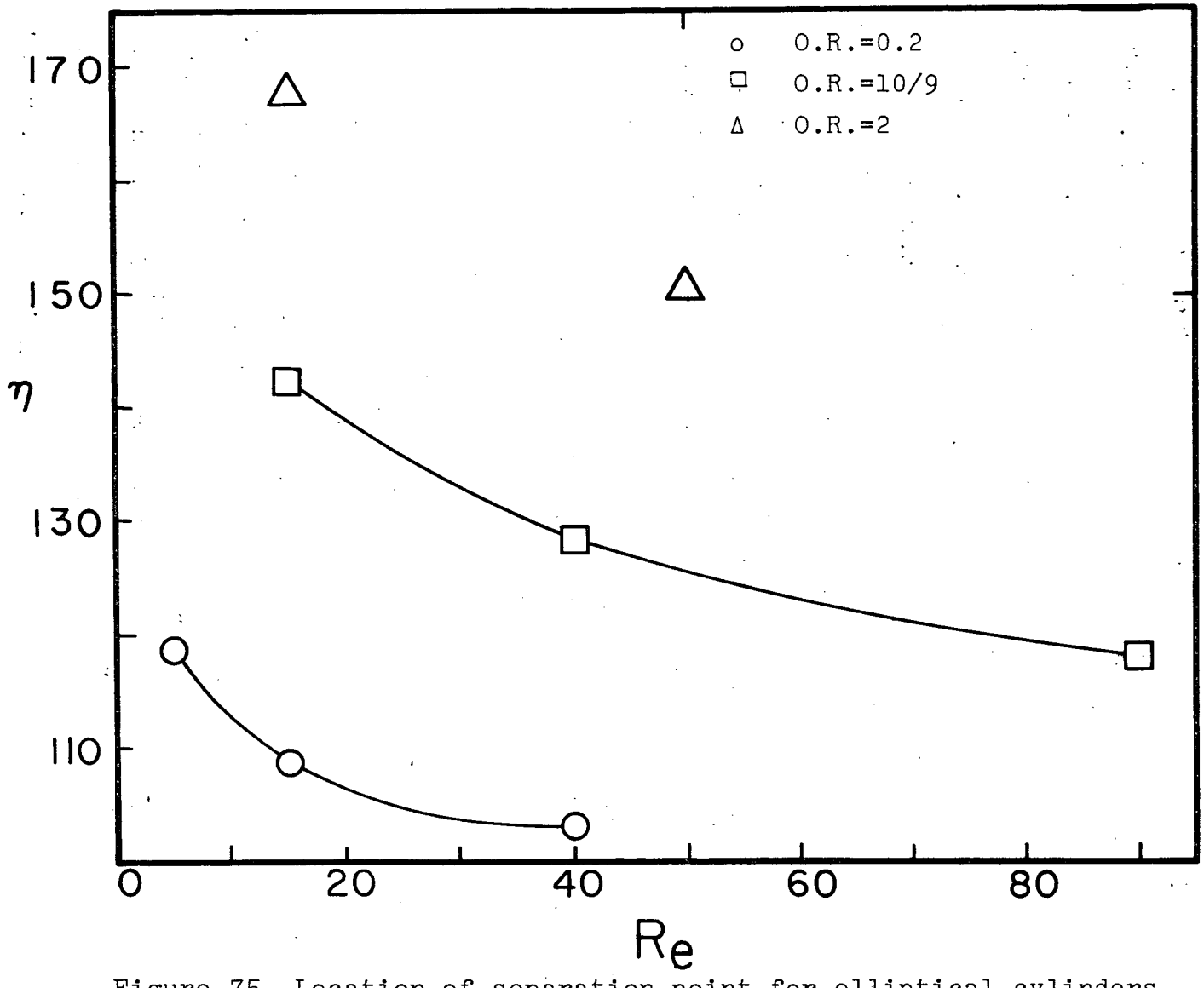


Figure 75. Location of separation point for elliptical cylinders.

the angle of separation for O.R. = 0.2, 10/9 and 2. For a nearly circular cylinder (O.R. ≃ 1.0) at Re = 5 no separation was observed, and for O.R. = 5 no flow reversal was noted at Re as high as 40.

The surface pressure distributions at Re = 40 for A.R. = 0.2 with the flow along both the minor axis (O.R. = 0.2) and the major axis (O.R. = 5.0) are compared with the corresponding potential flow distributions in figure 76. As expected, for the flow along the major axis there was fairly close agreement to η greater than $\pi/2$ due to the absence of separation. For the flow along the minor axis the agreement was reasonable only for the front of the elliptical cylinder. Figures 77 and 78 show the variation of the dimensionless pressure with Re for the frontal stagnation point, compared with the first approximation of the boundary layer theory where the outside flow is taken to be a potential flow. The agreement is very good for the higher Reynolds numbers, as would be expected. The derivation of the expression used for P_o is given in Appendix I.

The boundary layer thickness at $\eta = \pi/2$ for the various elliptical cylinders is shown in figure 79. The edge of the boundary layer is again taken at $\left|\frac{\partial v_\eta}{\partial \xi}\right| = 0$. From the plots of figure 79 it is seen that the boundary layer thickness varies as $Re^{-1/2}$, as predicted by boundary layer theory. Separation for the cases considered occurs well after $\eta = \pi/2$.

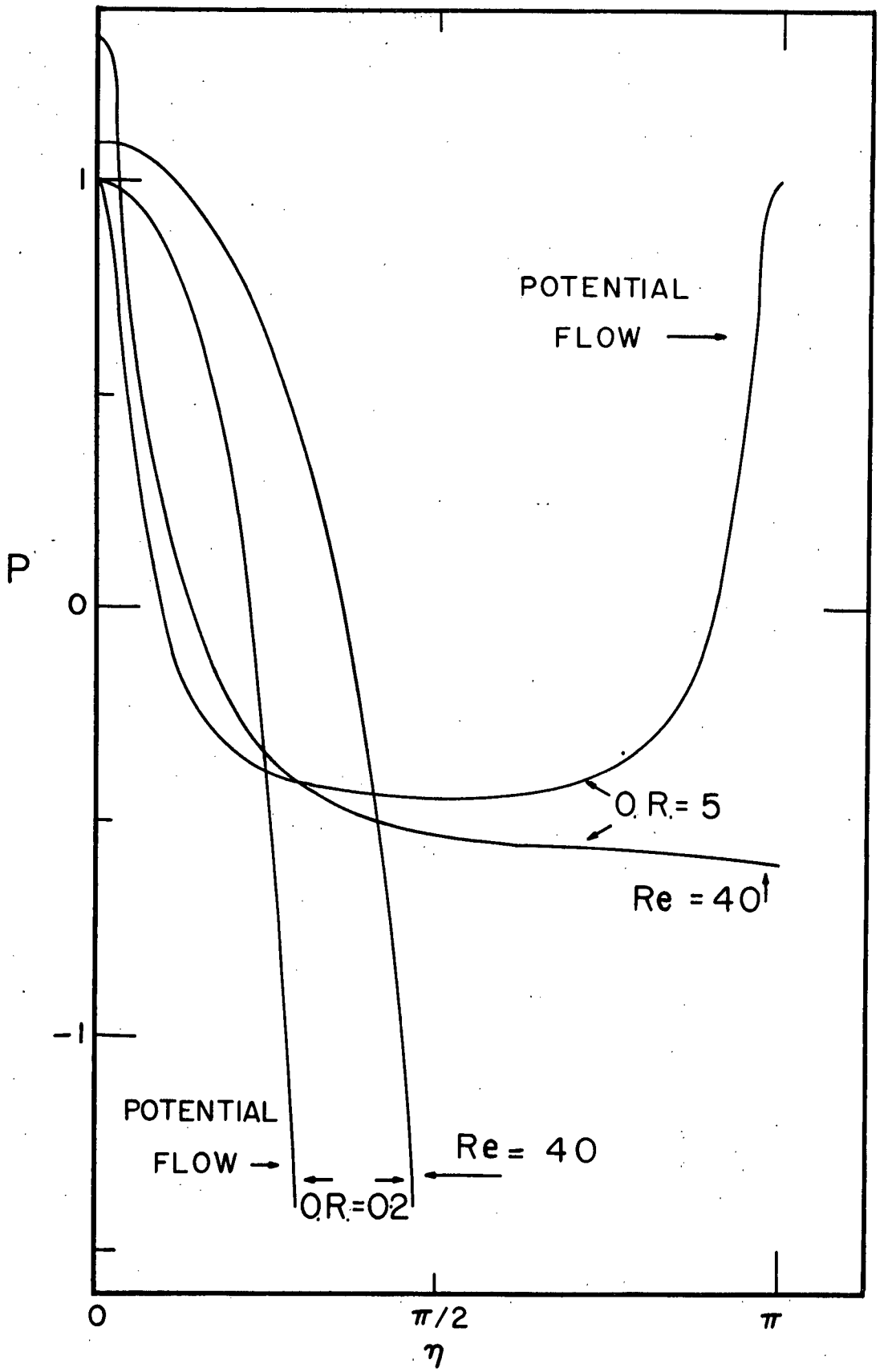


Figure 76. Comparison of surface pressure distribution on elliptical cylinders at Re=40 with potential flow.

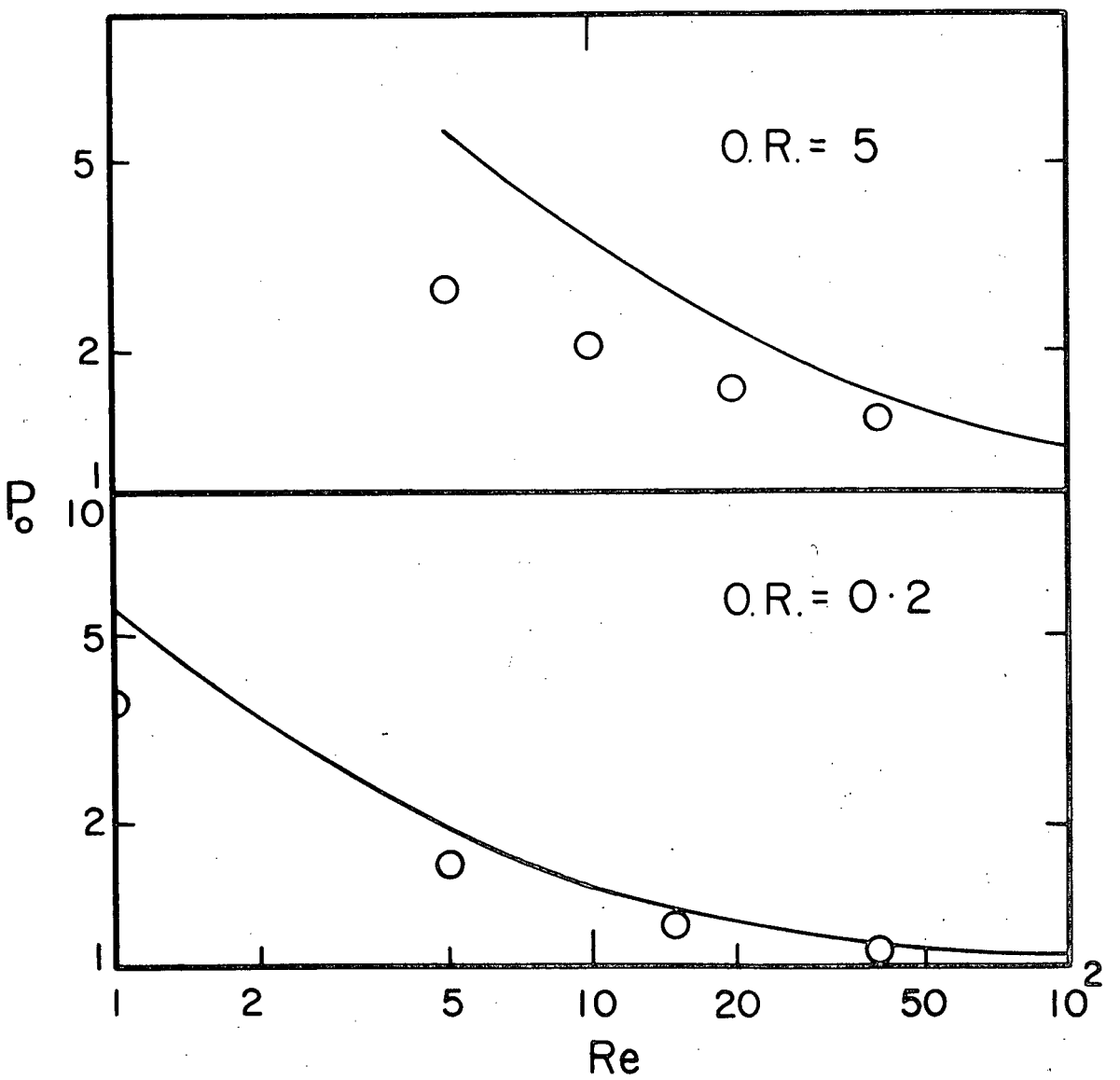


Figure 77. Variation of the frontal stagnation pressure with Reynolds number for elliptical cylinder of A.R. = 0.2: ——, Boundary layer theory; o, this work.

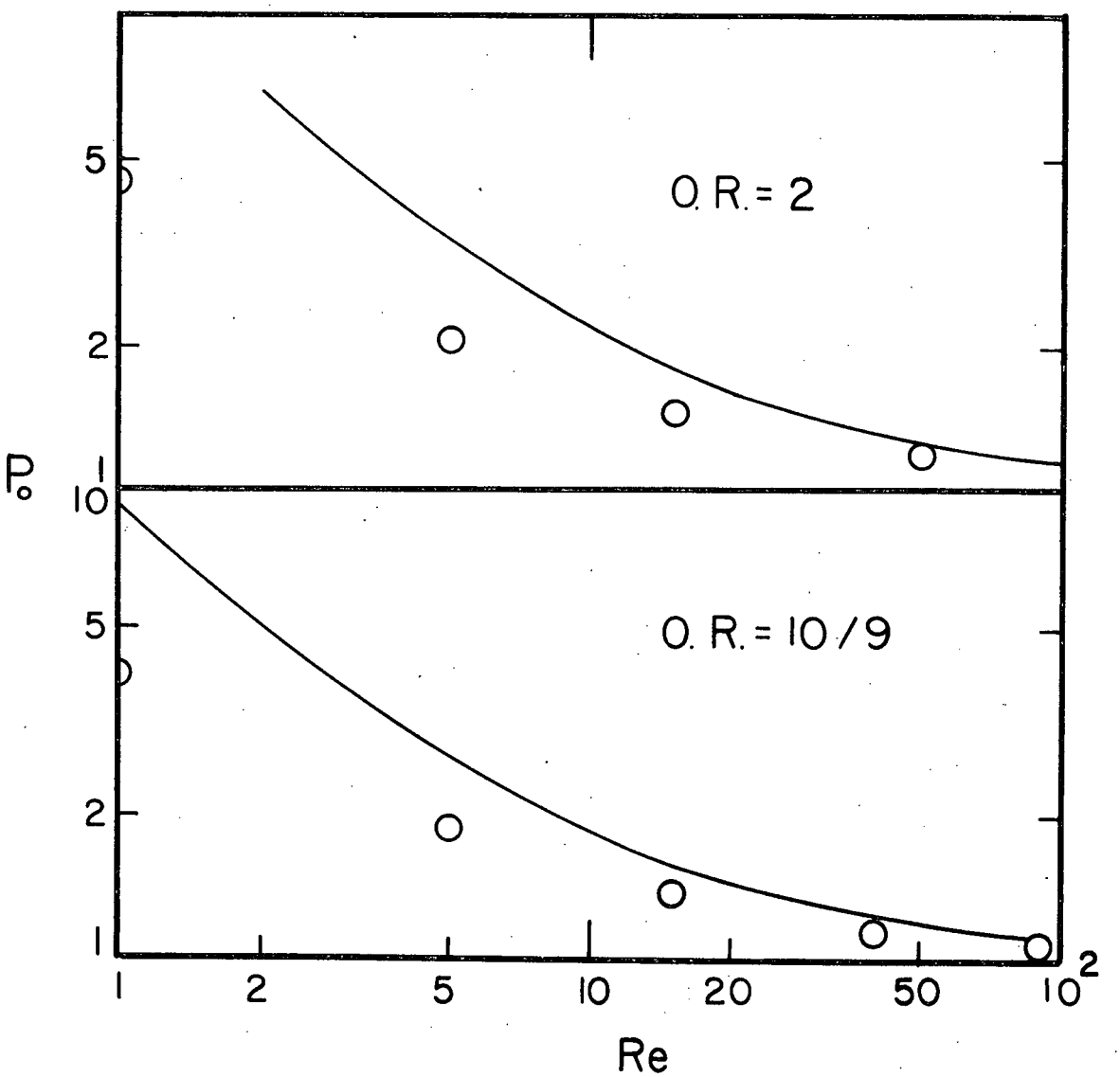


Figure 78. Variation of the frontal stagnation pressure with Reynolds number for elliptical cylinders: ——, Boundary layer theory; o, this work.

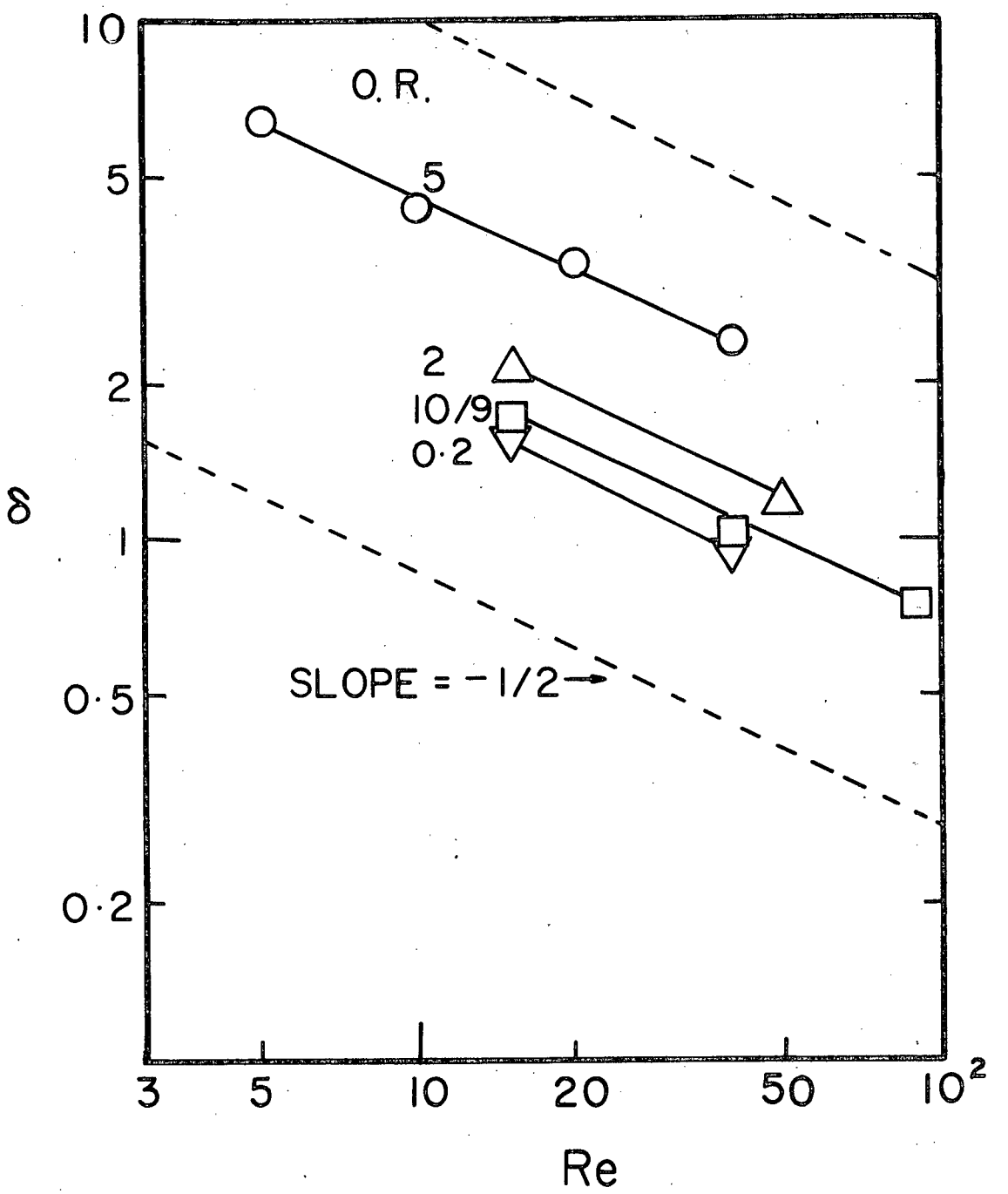


Figure 79. Variation of the Boundary layer thickness with Reynolds number for elliptical cylinders at $\eta=\pi/2$.

The contouring of the streamlines and equi-vorticity lines for the elliptical cylinders is shown in figures 80 - 90. For O.R. = 2.0 at Re = 0.01, the contours of stream function, vorticity and velocity indicated that symmetry prevailed between the upstream and downstream regions of the flow. At this low Reynolds number, as opposed to those plotted in figures 81 - 90 the diffusion of vorticity is dominant and there is no apparent convection of vorticity in the downstream region. It is well known that the disturbance due to a two-dimensional object is more intense than for a three-dimensional one (159). This is confirmed in the present work, in that at a given distance from the elliptical cylinder the streamline is more curved than that for the corresponding spheroid (same A.R.; also O.R. < 1 for elliptical cylinder corresponds to oblate spheroid and O.R. > 1 to prolate spheroid). Moreover, even for the higher Re, the $\psi = 4.0$ line is still curved for the cylinders (as opposed to the spheroids), indicating that the effect of a wall would be more appreciable for the cylinders than for the corresponding spheroids. For a given Re, the wakes for the elliptical cylinders are much longer than those of the corresponding spheroids. The behaviour of the vorticity for the cylinders is similar to that of the spheroids. The velocity contour in figure 91 indicates that the velocity inside the wake is very small.

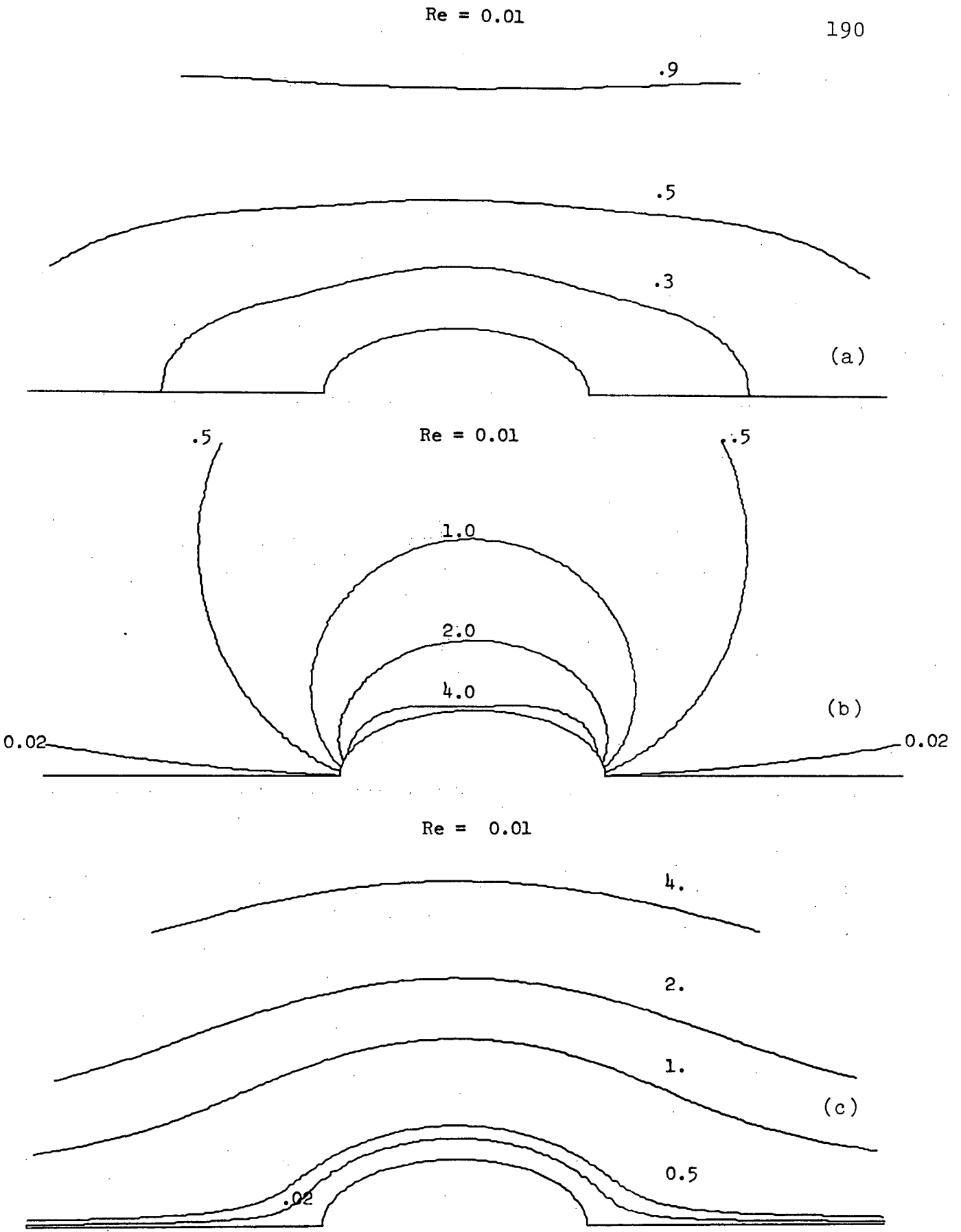


Figure 80. Flow characteristics for an elliptical cylinder with O.R. = 2 at Re = 0.01: a) velocity lines, b) vorticity lines, c) streamlines.

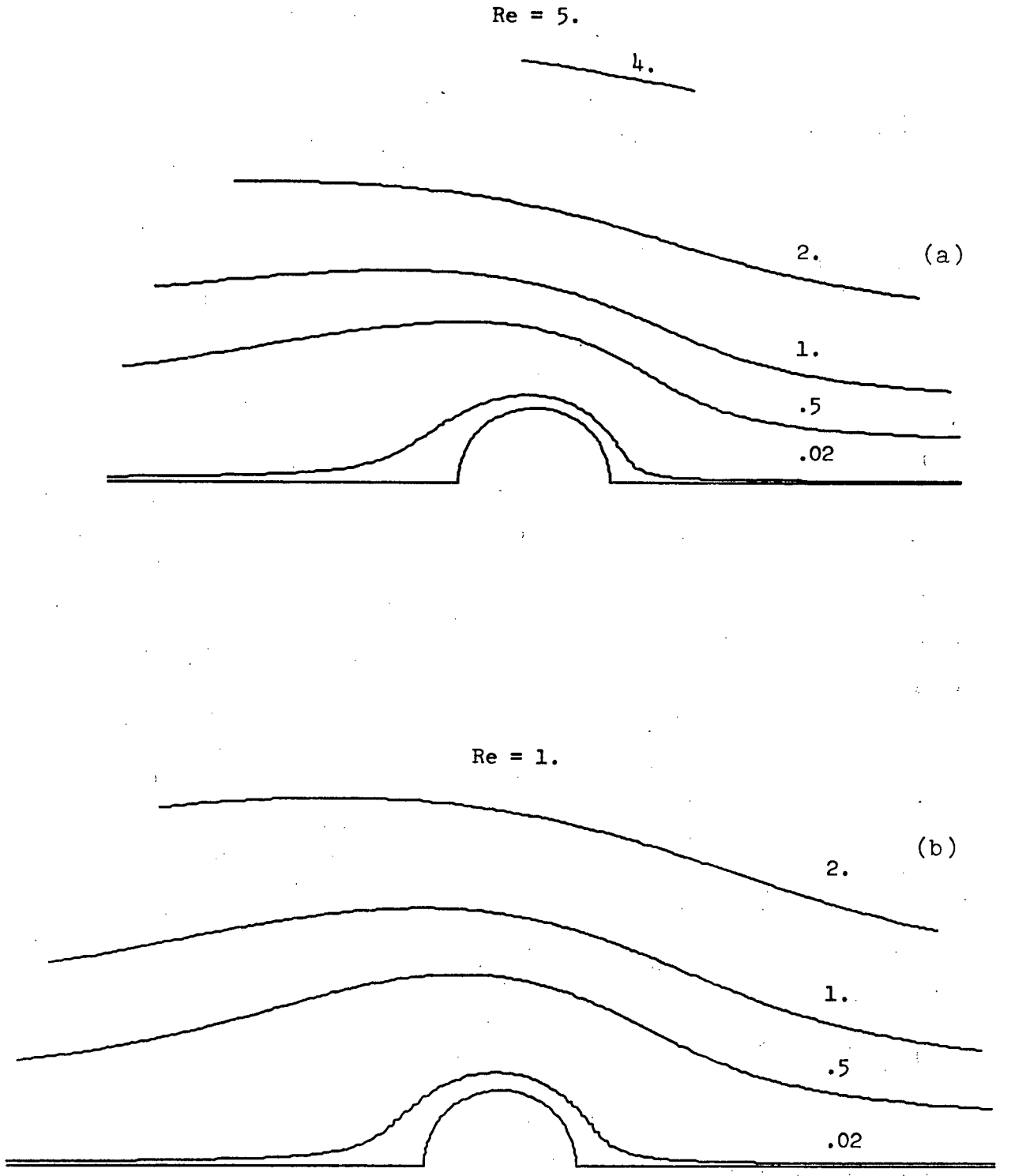


Figure 81. Streamlines for a nearly circular cylinder (O.R.=1/0.995).

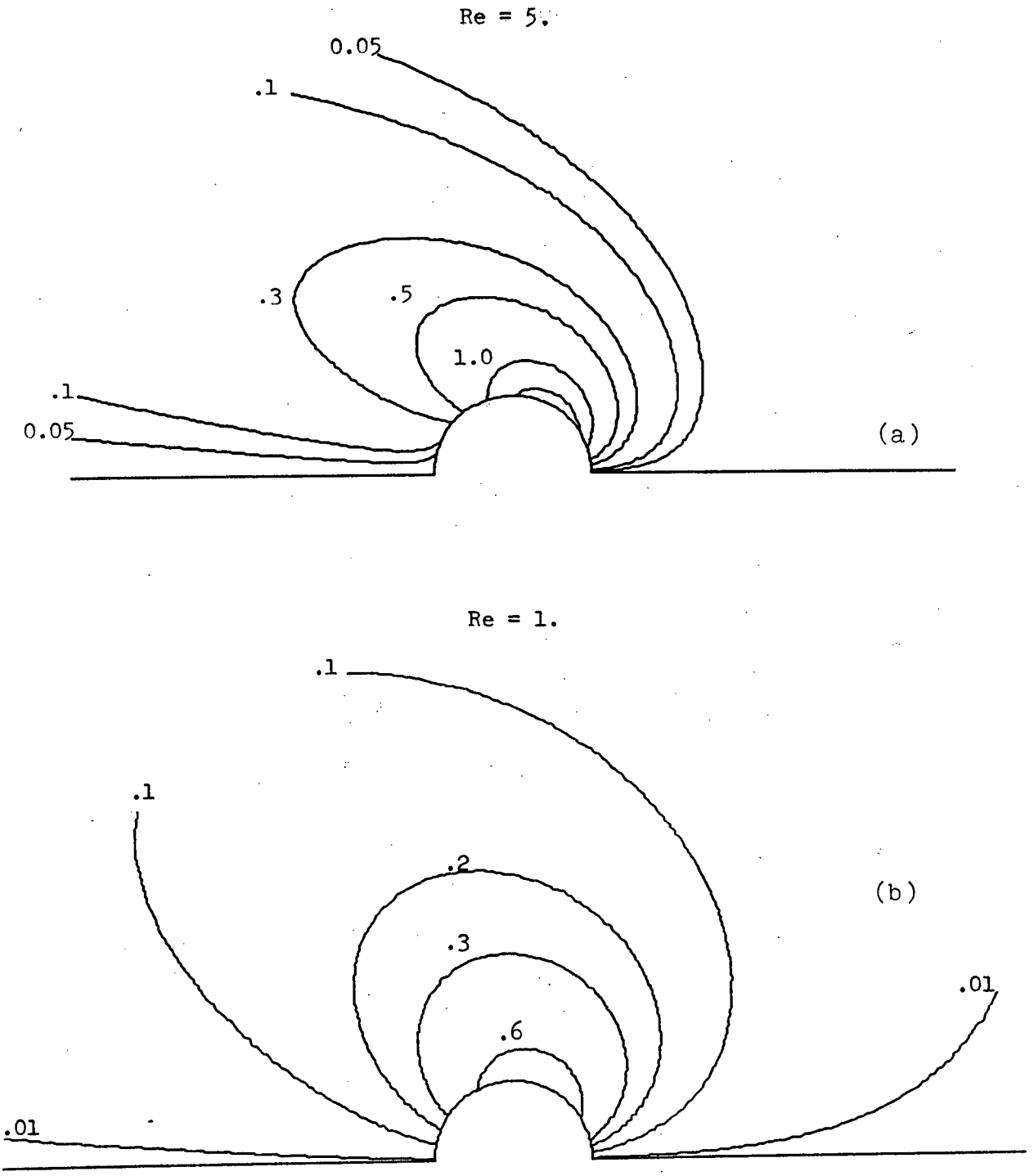


Figure 82. Vorticity lines for a nearly circular cylinder (O.R. = 1/0.995).

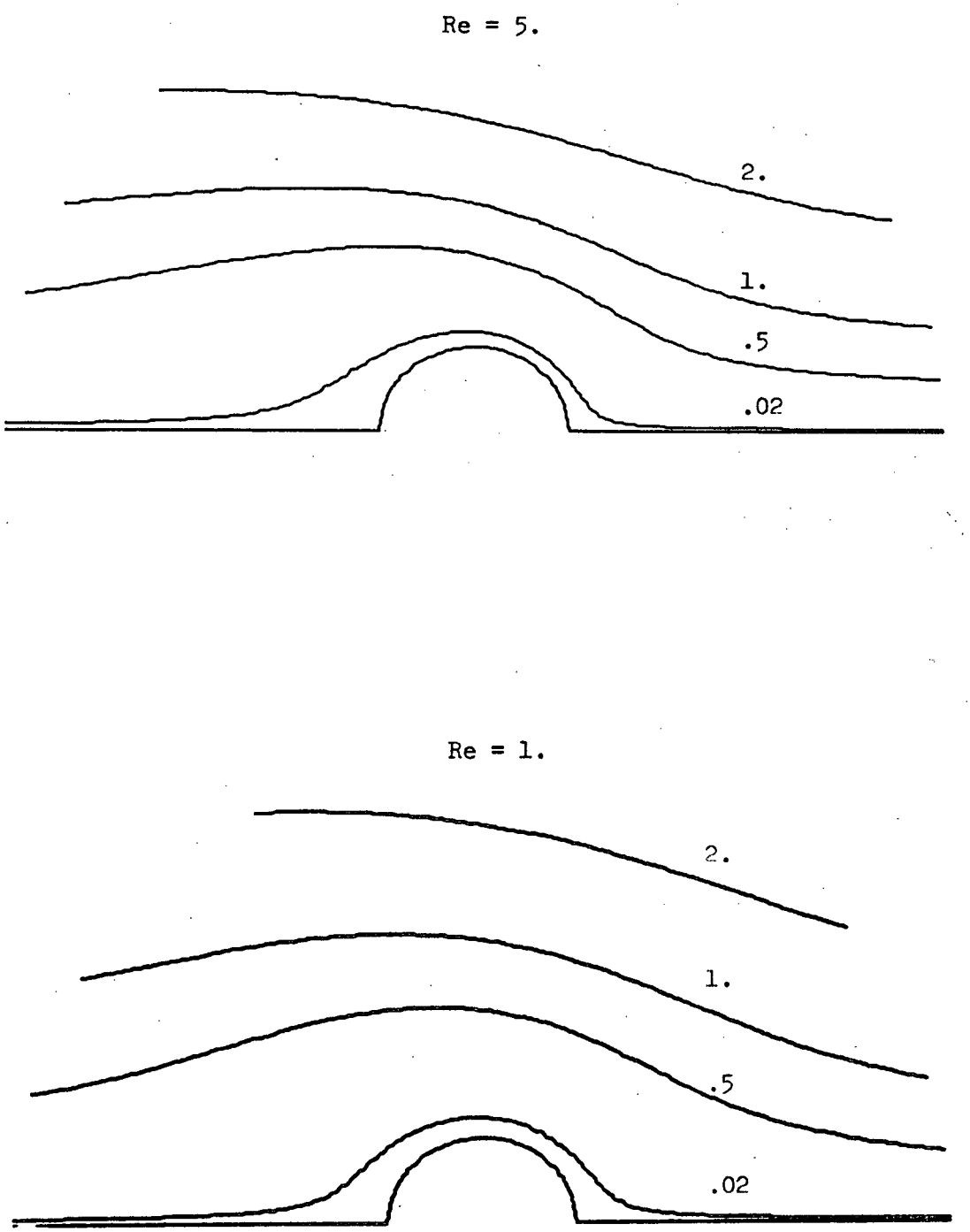


Figure 83a. Streamlines for an elliptical cylinder with O.R. = 10/9 at Re=1 and 5.

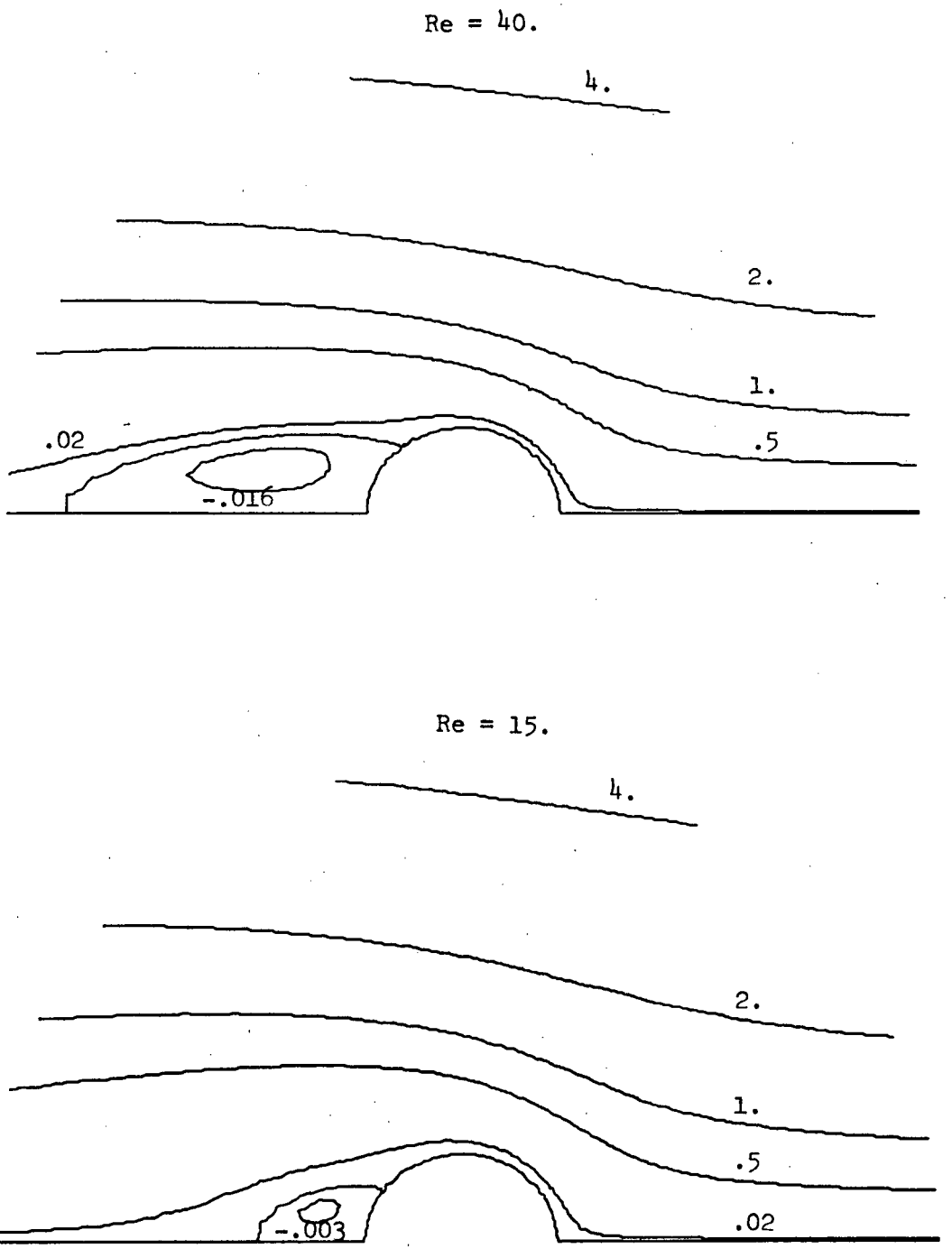


Figure 83b. Streamlines for an elliptical cylinder with O.R. = 10/9 at Re=15 and 40.

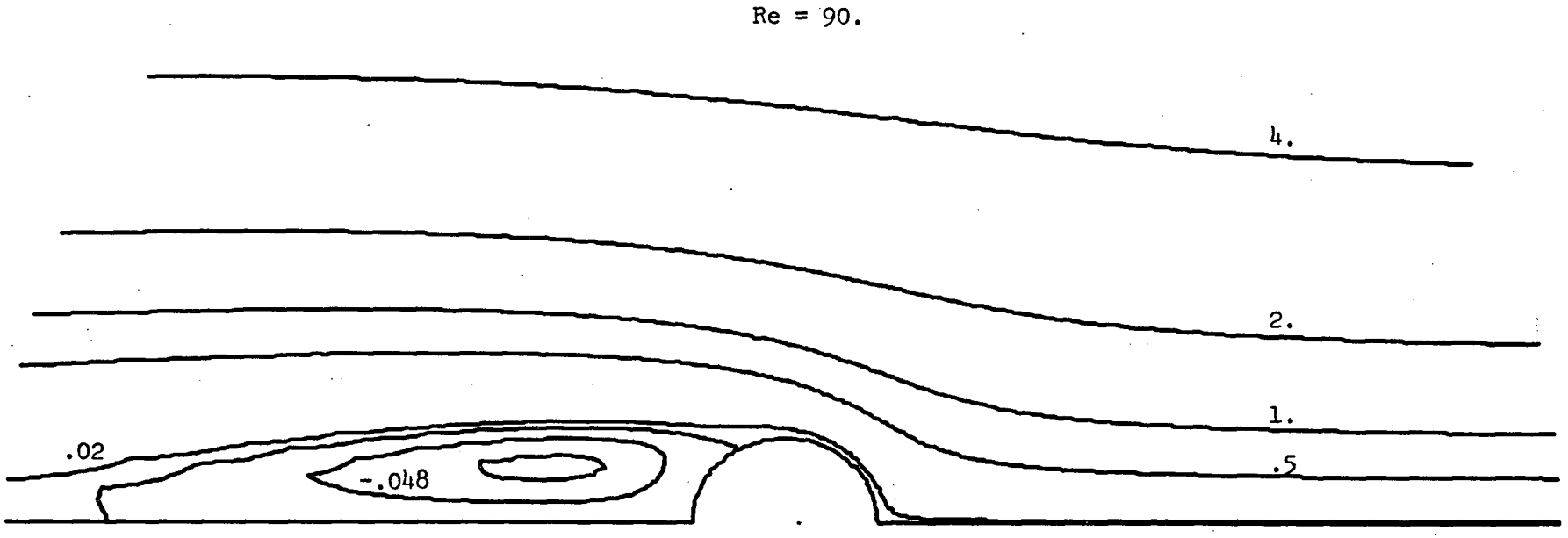


Figure 83c. Streamlines for an elliptical cylinder with O.R. = 10/9 at Re=90.

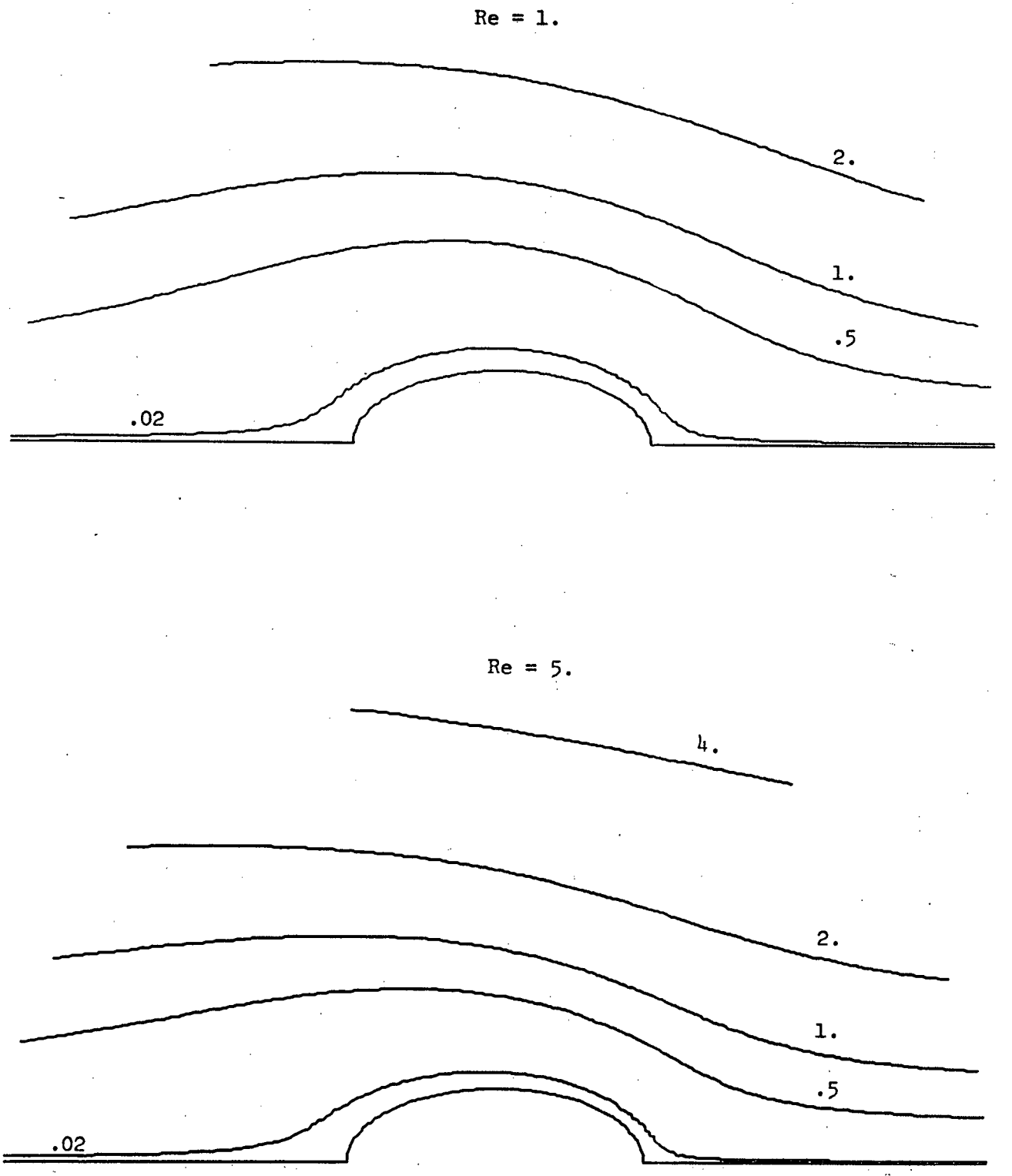


Figure 84a. Streamlines for an elliptical cylinder with O.R.=2 Re=1 and 5.

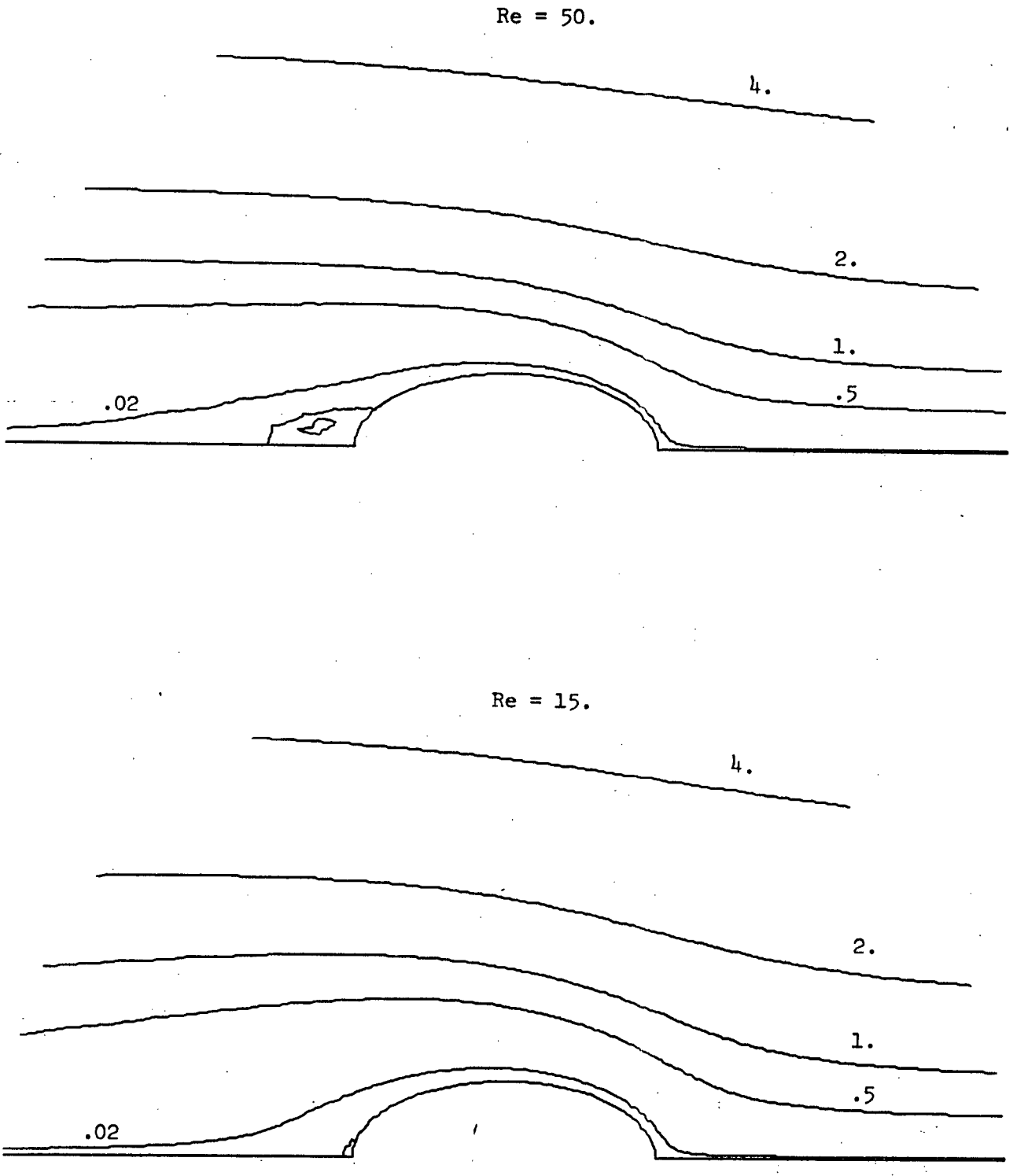
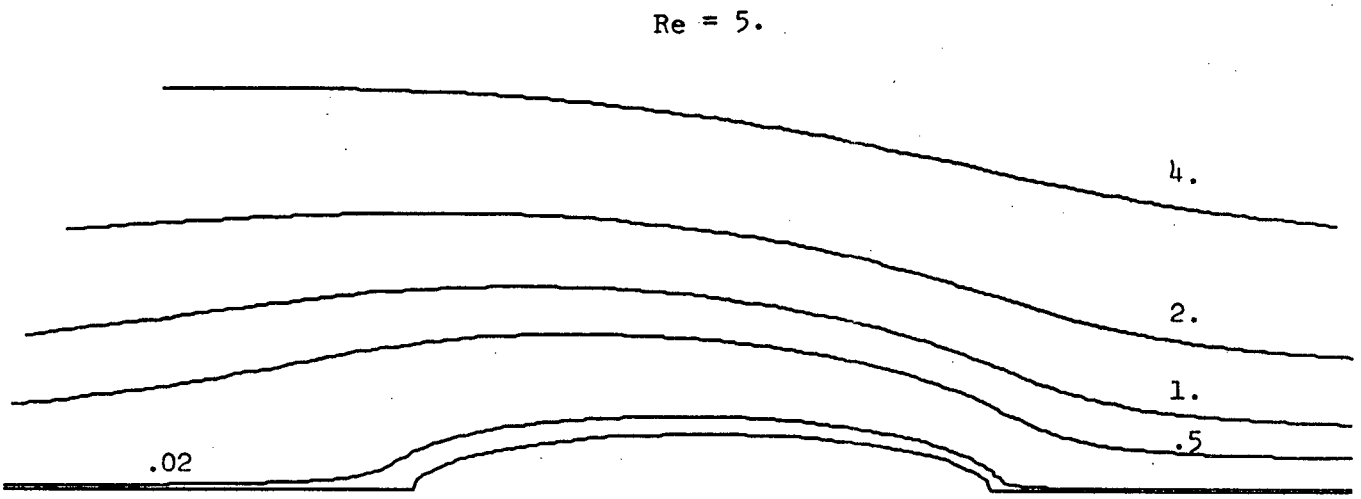


Figure 84b. Streamlines for an elliptical cylinder with O.R. = 2 Re=15 and 50.



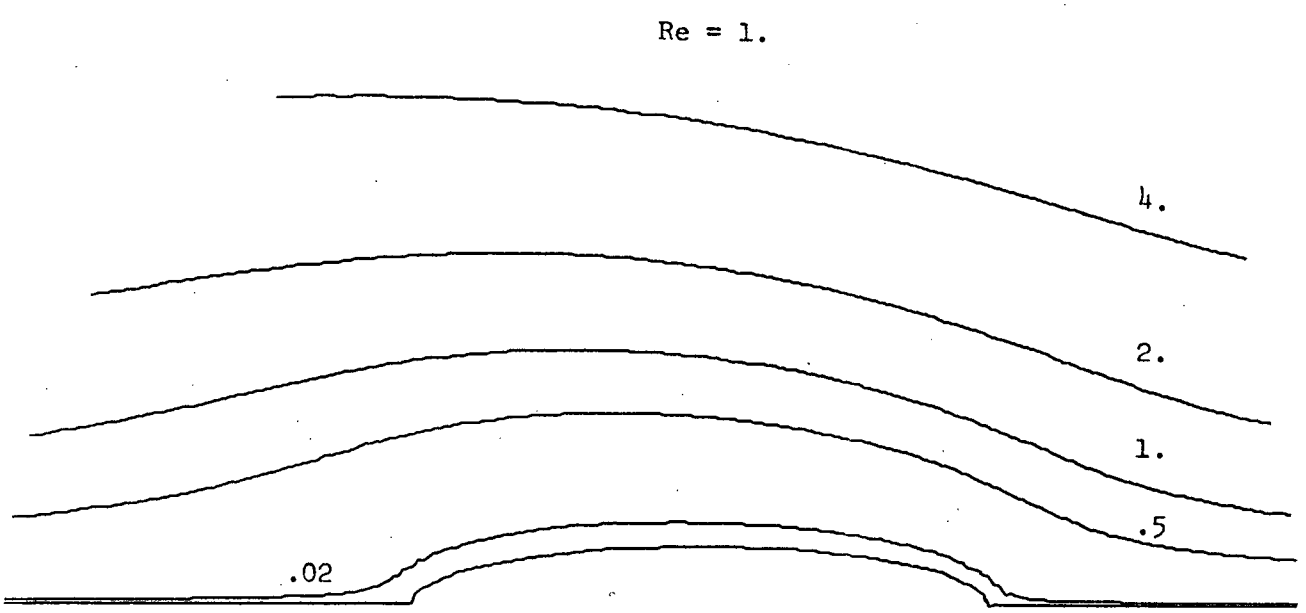
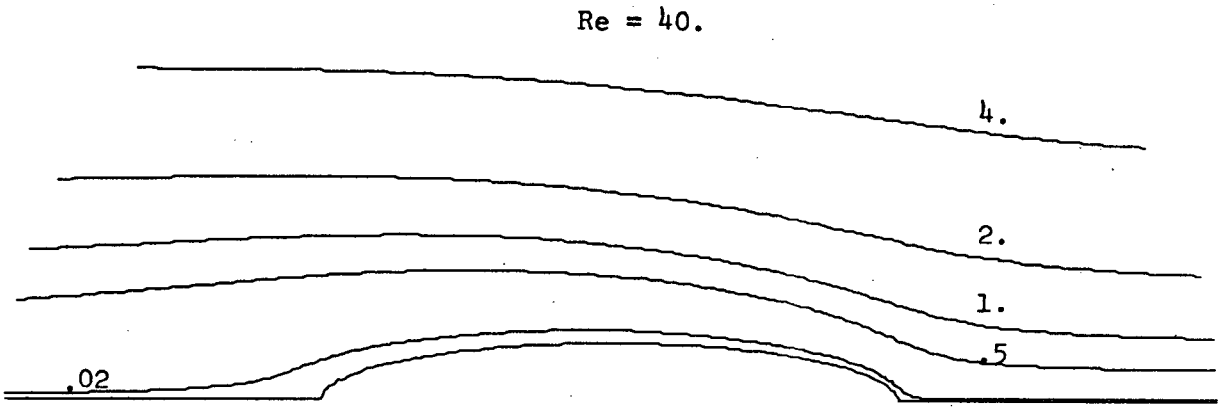


Figure 85a. Streamlines for an elliptical cylinder with O.R. = 5 at Re=1 and 5.



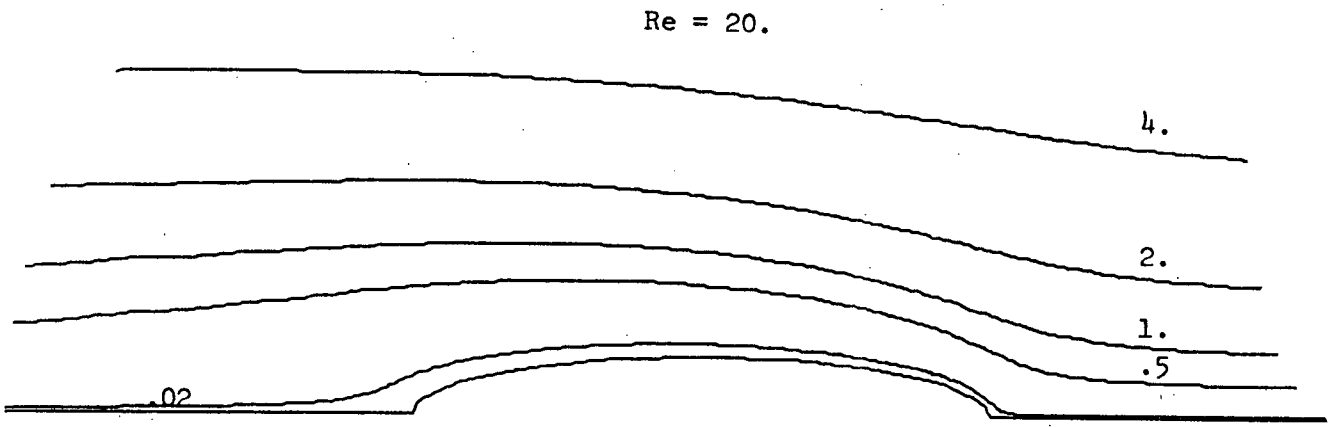


Figure 85b. Streamlines for an elliptical cylinder with O.R. = 5 at Re = 20 and 40.

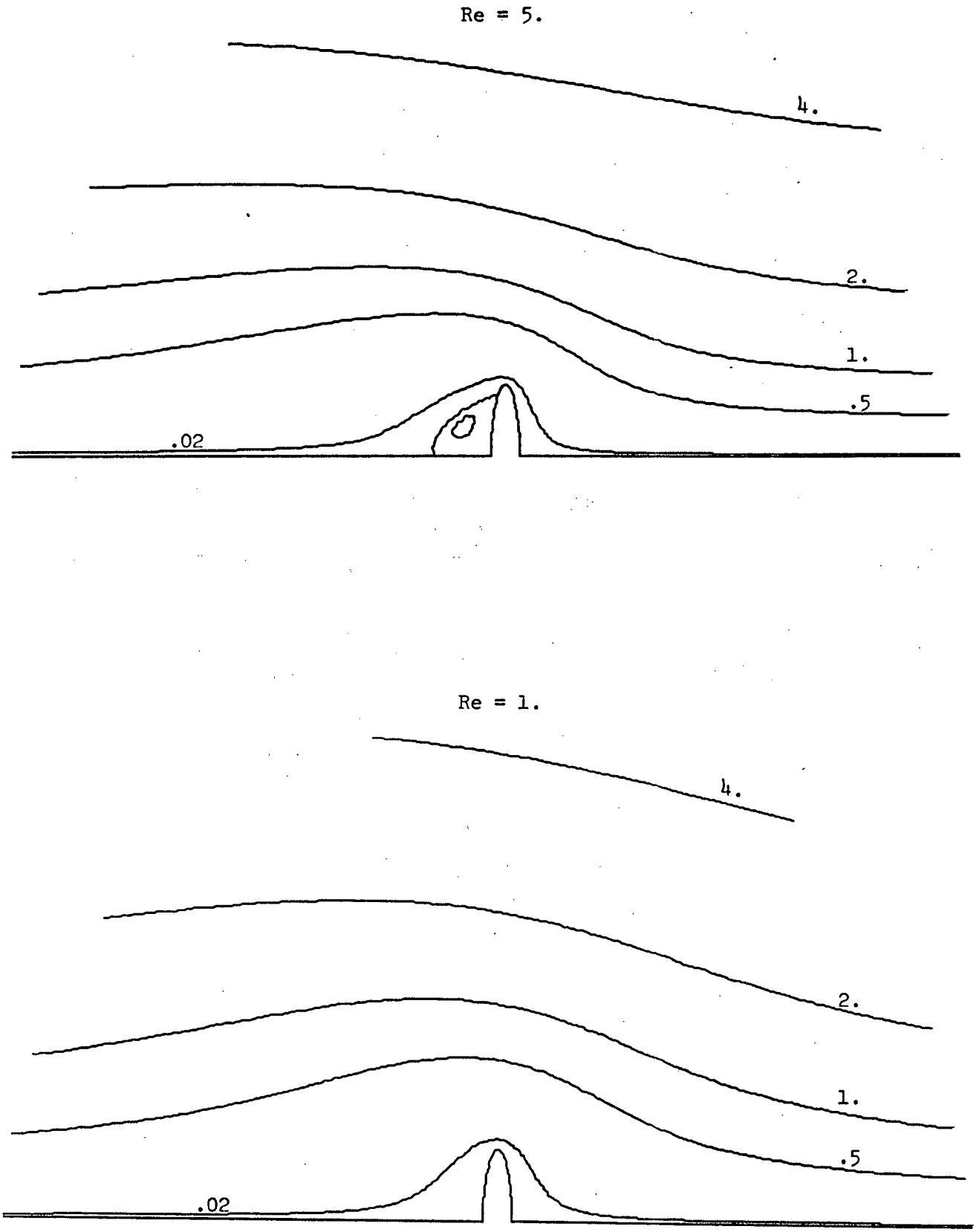


Figure 86a. Streamlines for an elliptical cylinder with O.R. = 0.2 at Re=1 and 5.

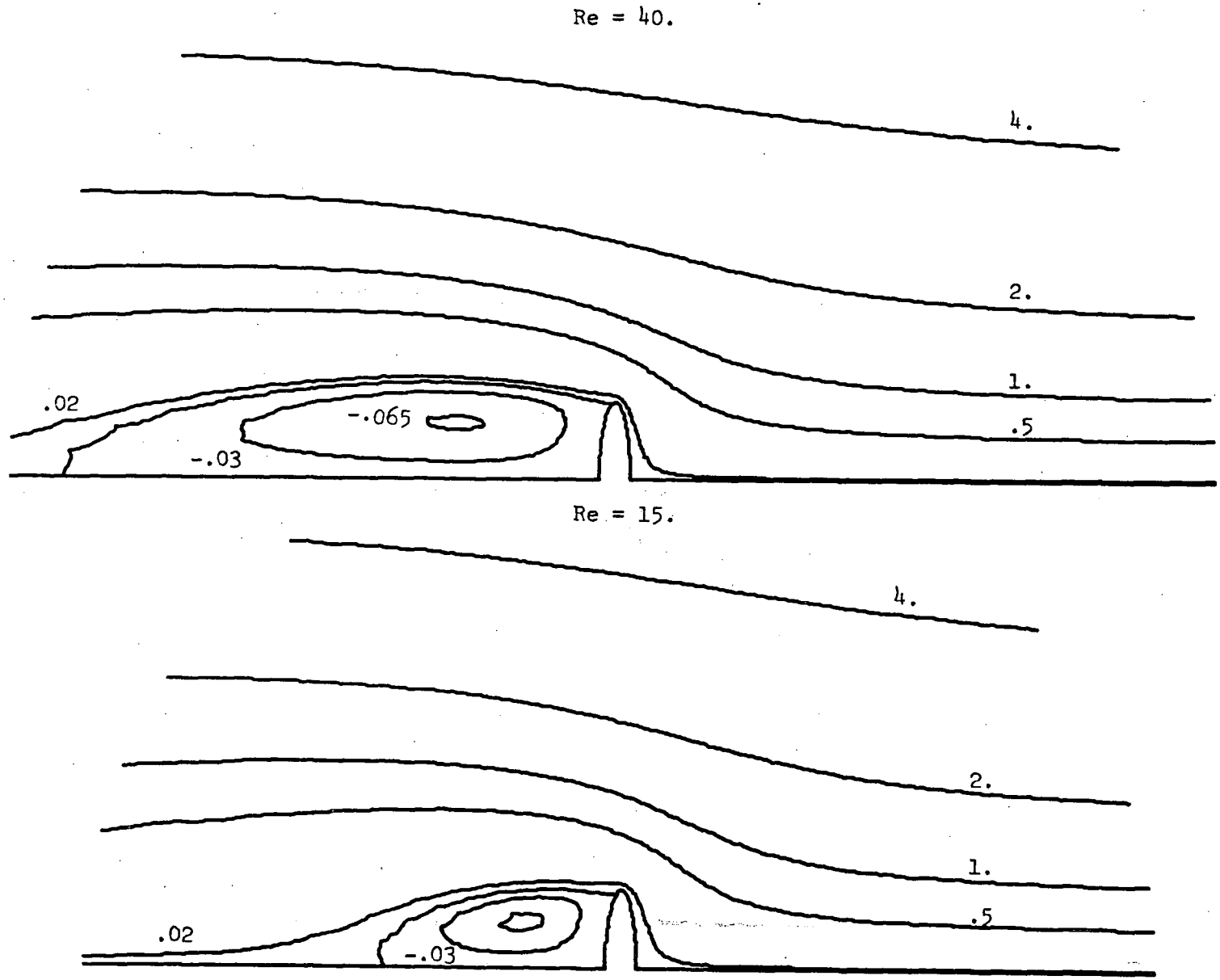


Figure 86b. Streamlines for an elliptical cylinder with O.R. = 0.2 at Re = 15 and 40.

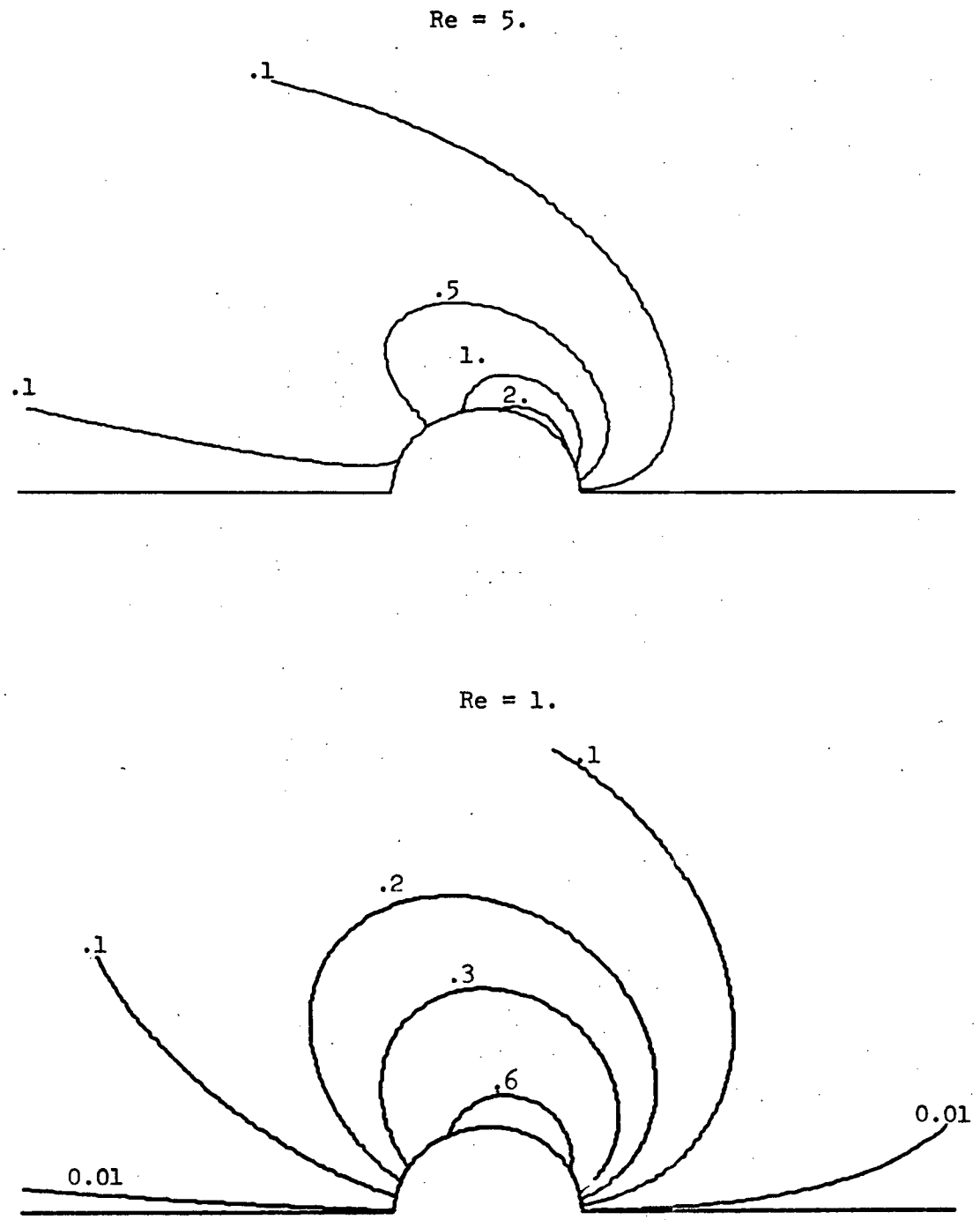


Figure 87a. Vorticity lines for an elliptical cylinder with O.R. = 10/9 at Re=1 and 5.

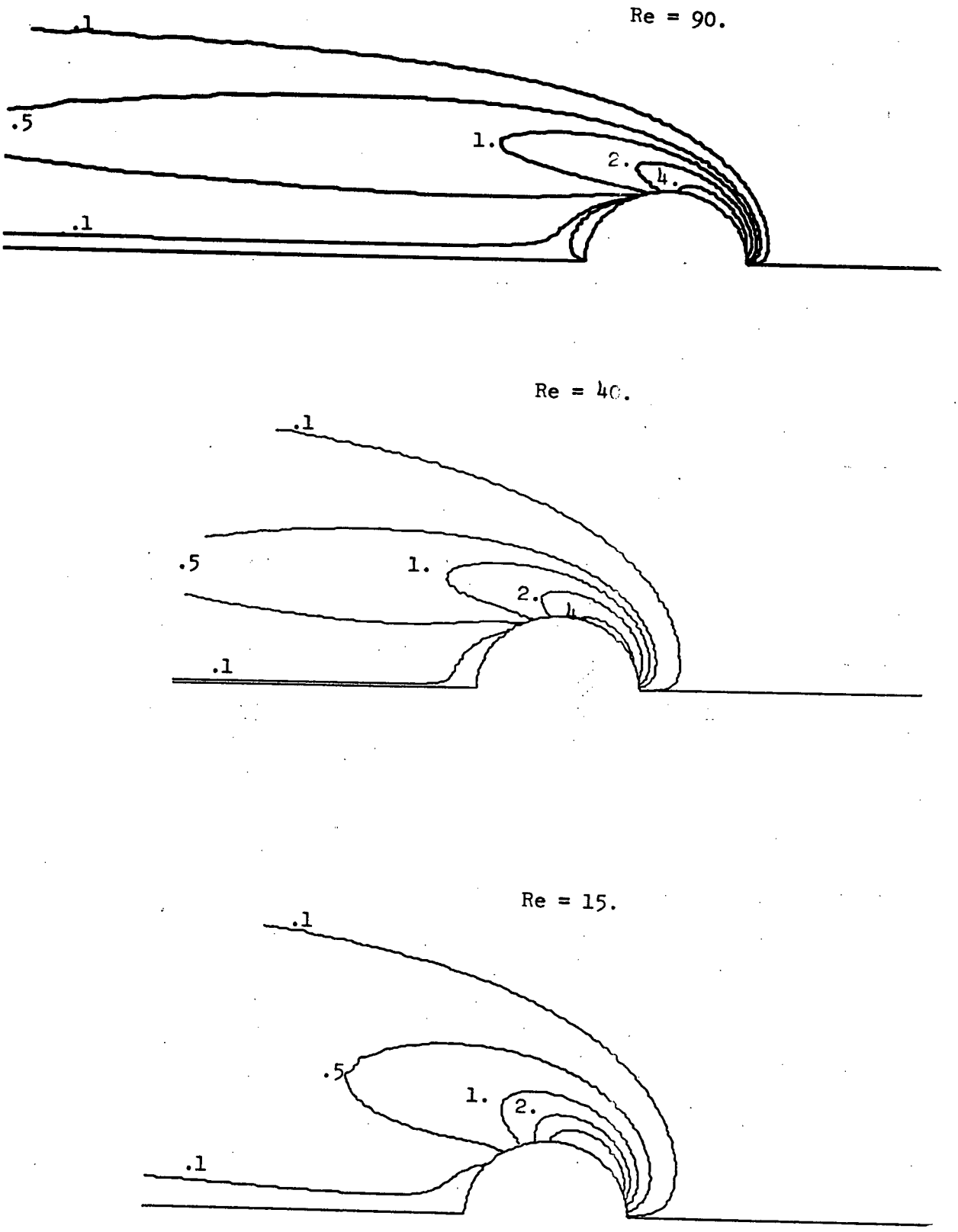
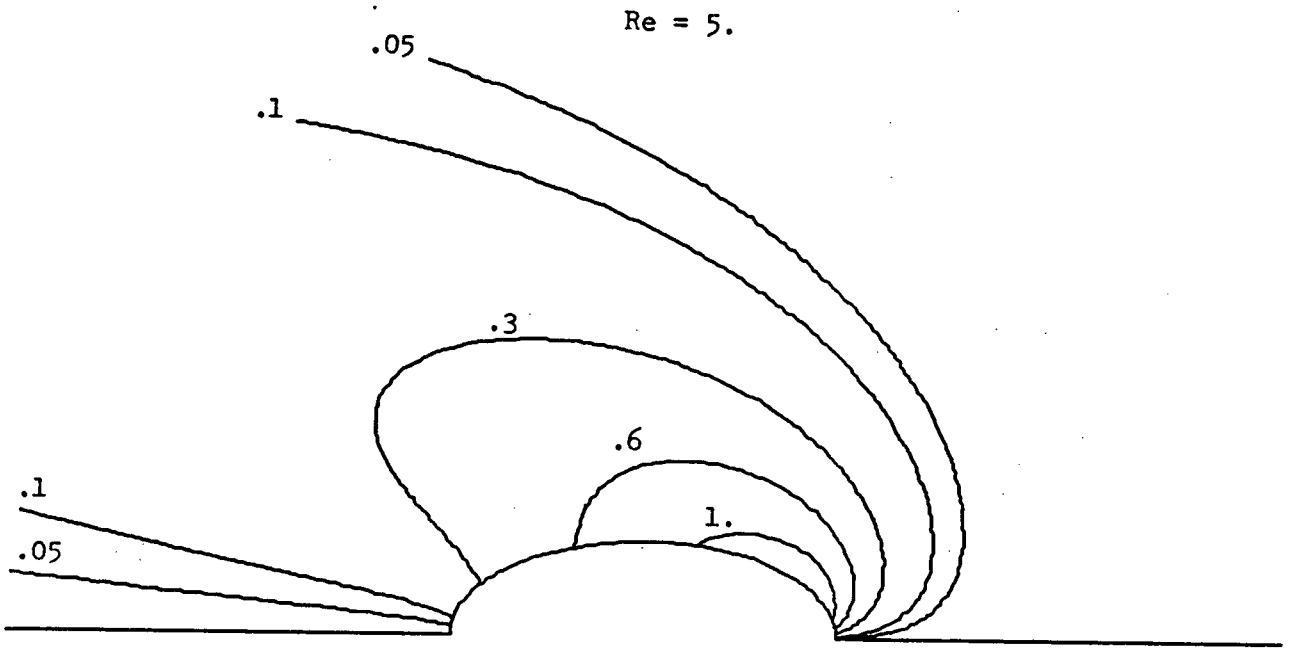


Figure 87b. Vorticity lines for an elliptical cylinder with O.R. = 10/9 at Re=15,40 and 90.



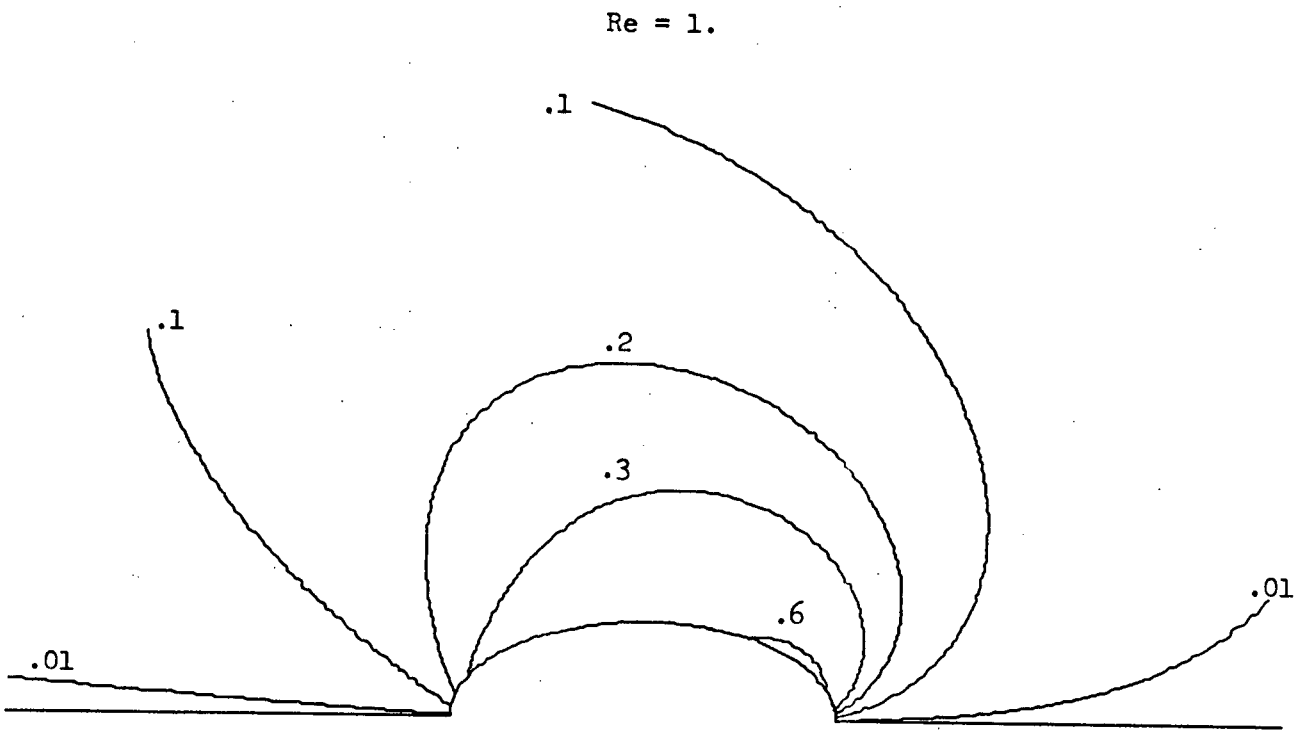


Figure 88a. Vorticity lines for an elliptical cylinder with O.R. = 2 at Re=1 and 5.

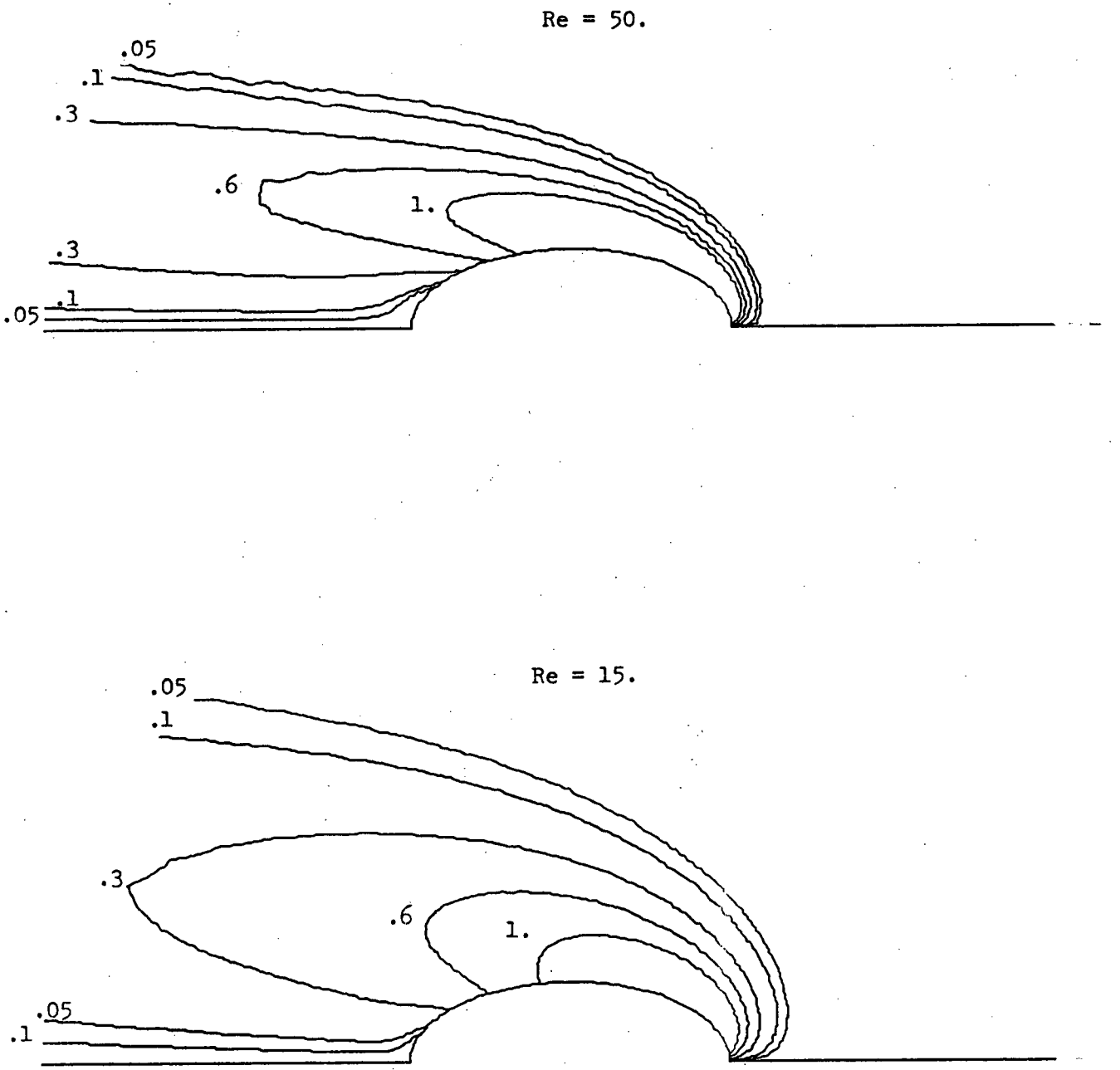


Figure 88b. Vorticity lines for an elliptical cylinder with O.R. = 2 at Re=15 and 50.

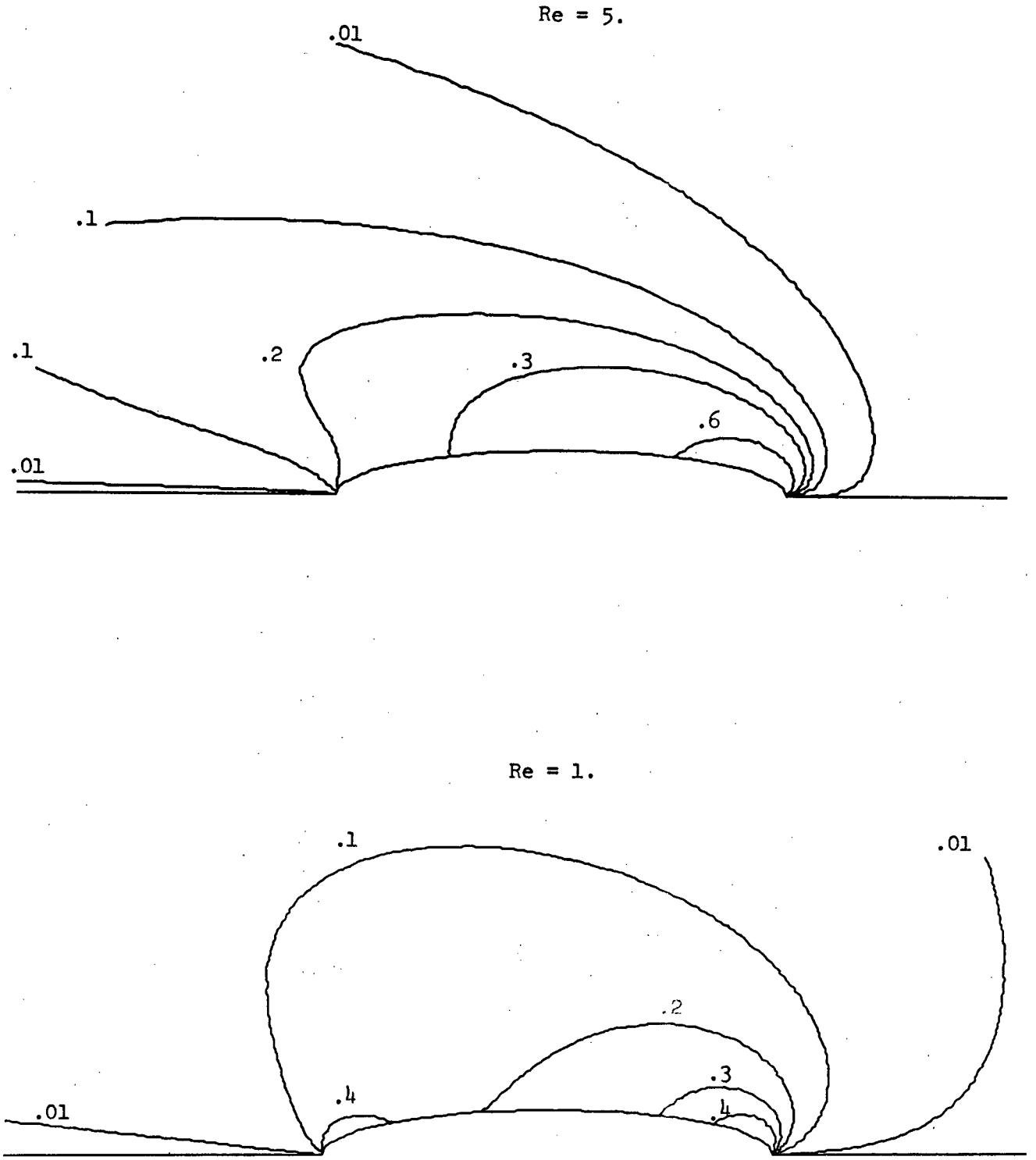


Figure 89a. Vorticity lines for an elliptical cylinder with O.R. = 5 at Re=1 and 5.

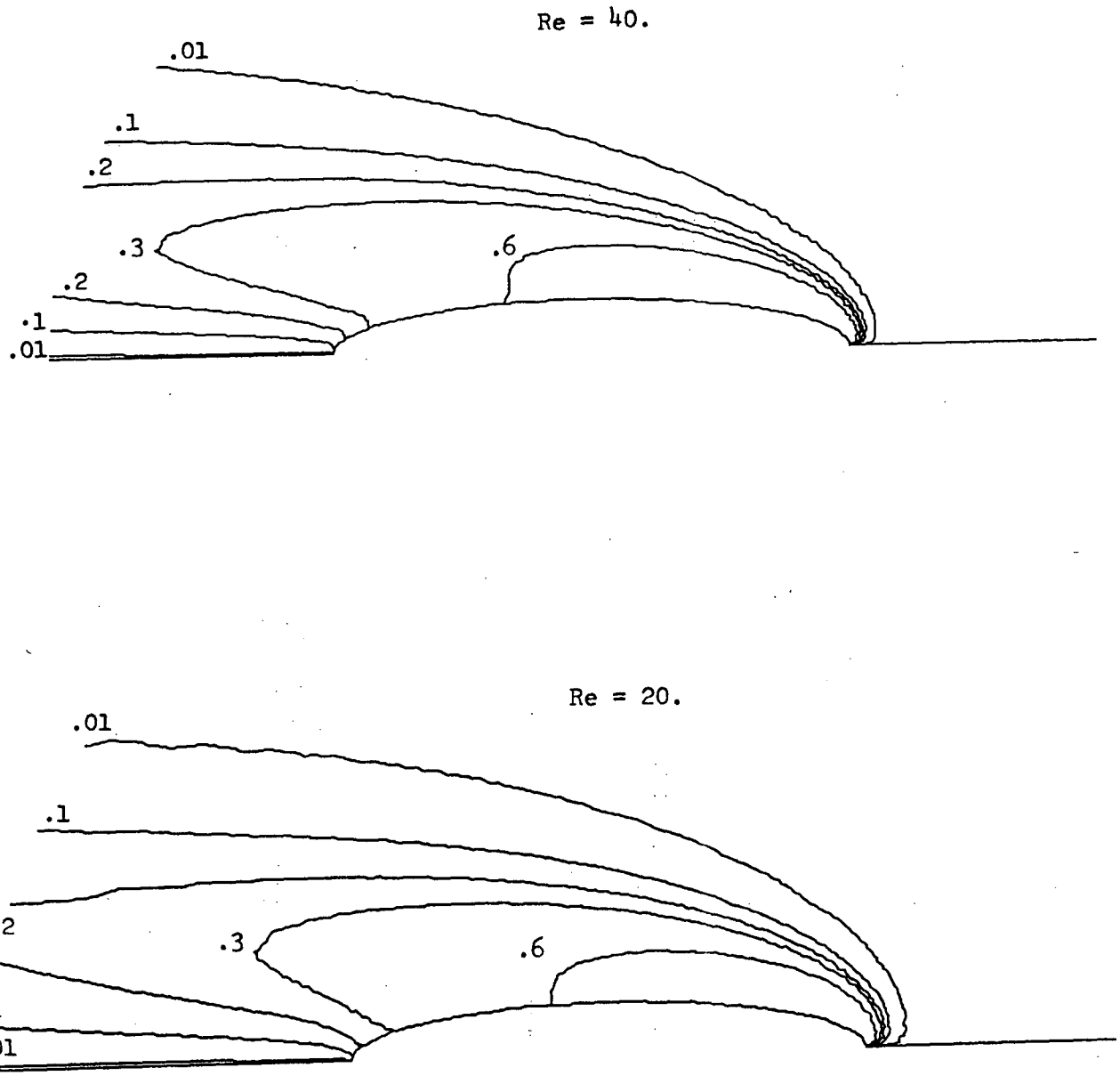
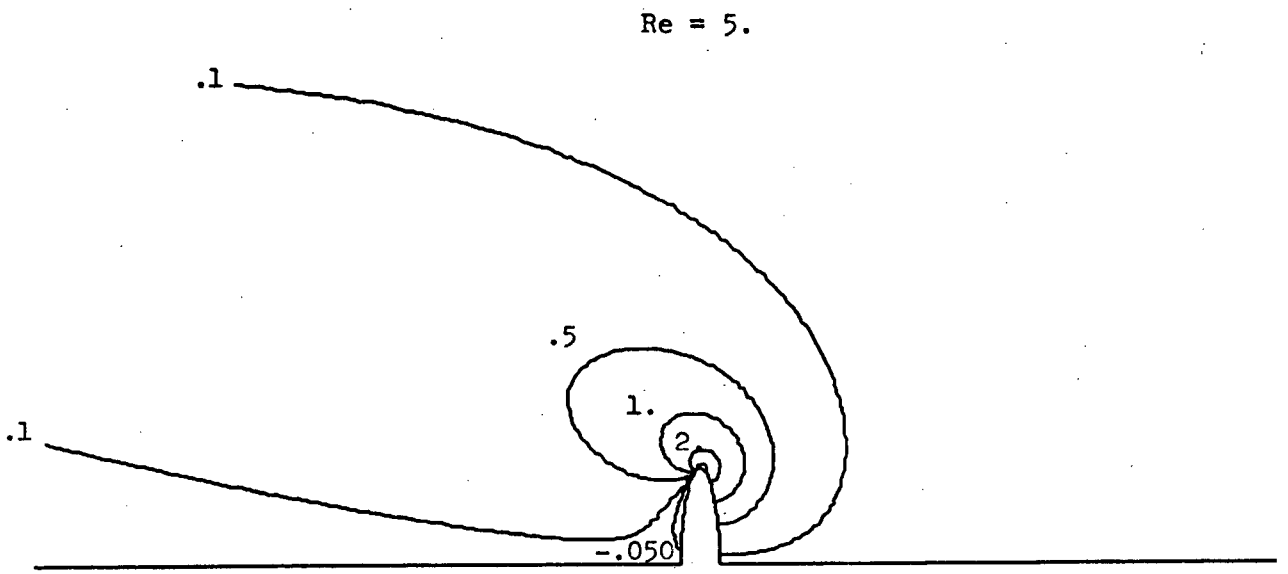


Figure 89b. Vorticity lines for an elliptical cylinder with O.R. = 5 at Re=20 and 40.



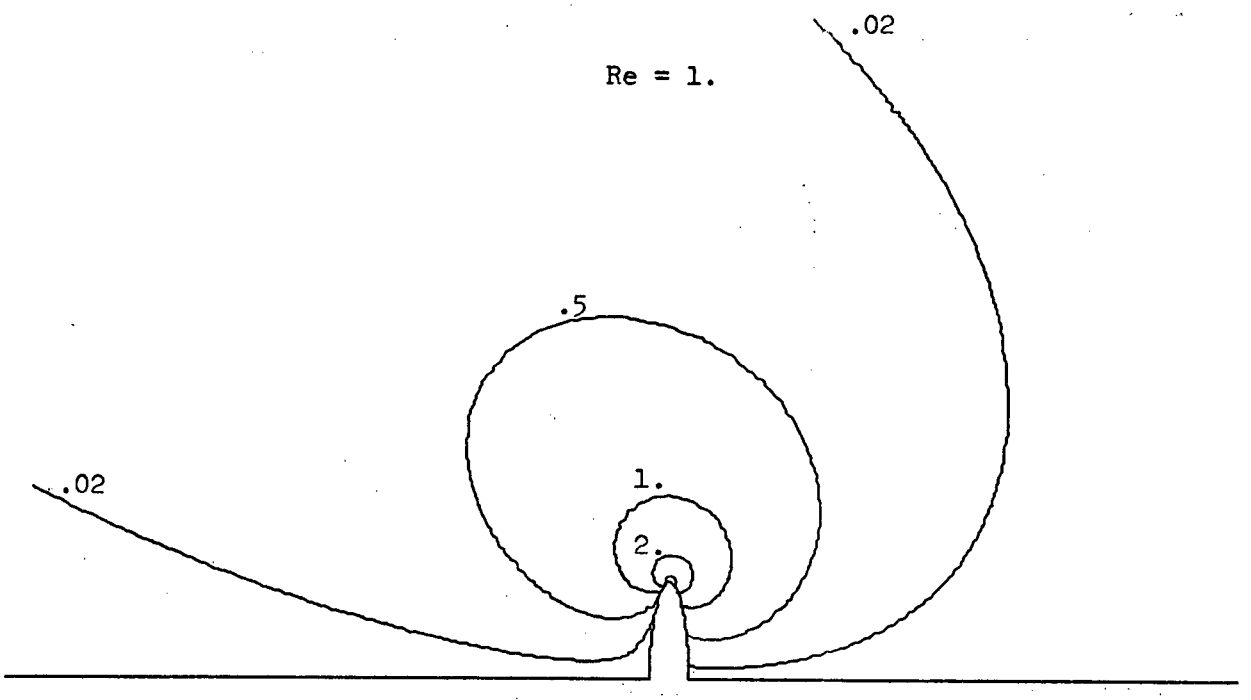
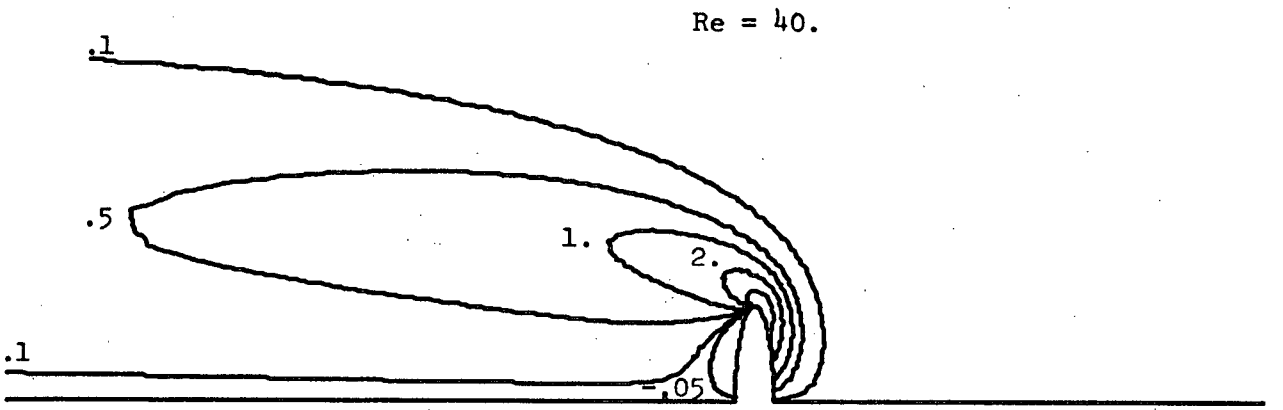


Figure 90a. Vorticity lines for an elliptical cylinder with O.R. = 0.2 at Re=1 and 5.



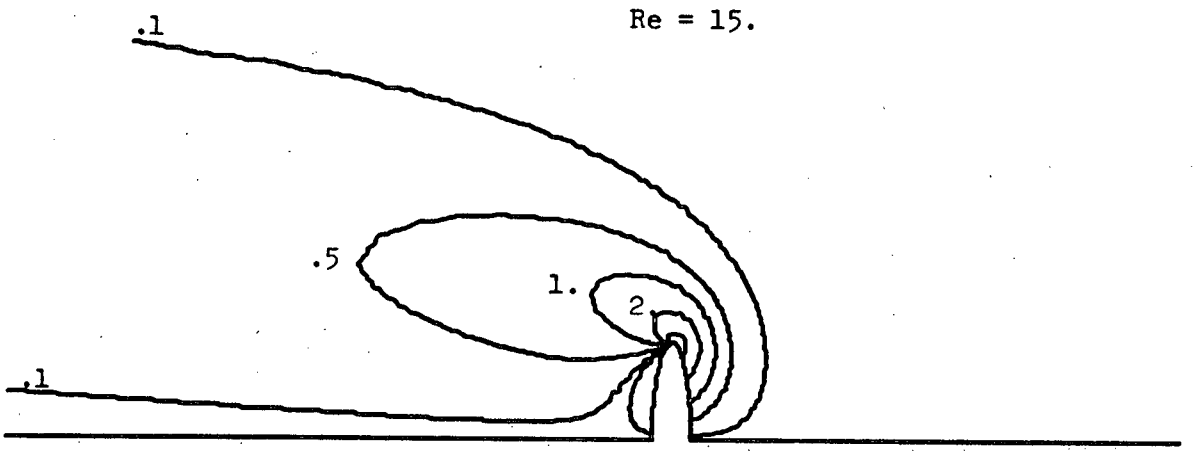


Figure 90b. Vorticity lines for an elliptical cylinder with O.R. = 0.2 at Re=15 and 40.

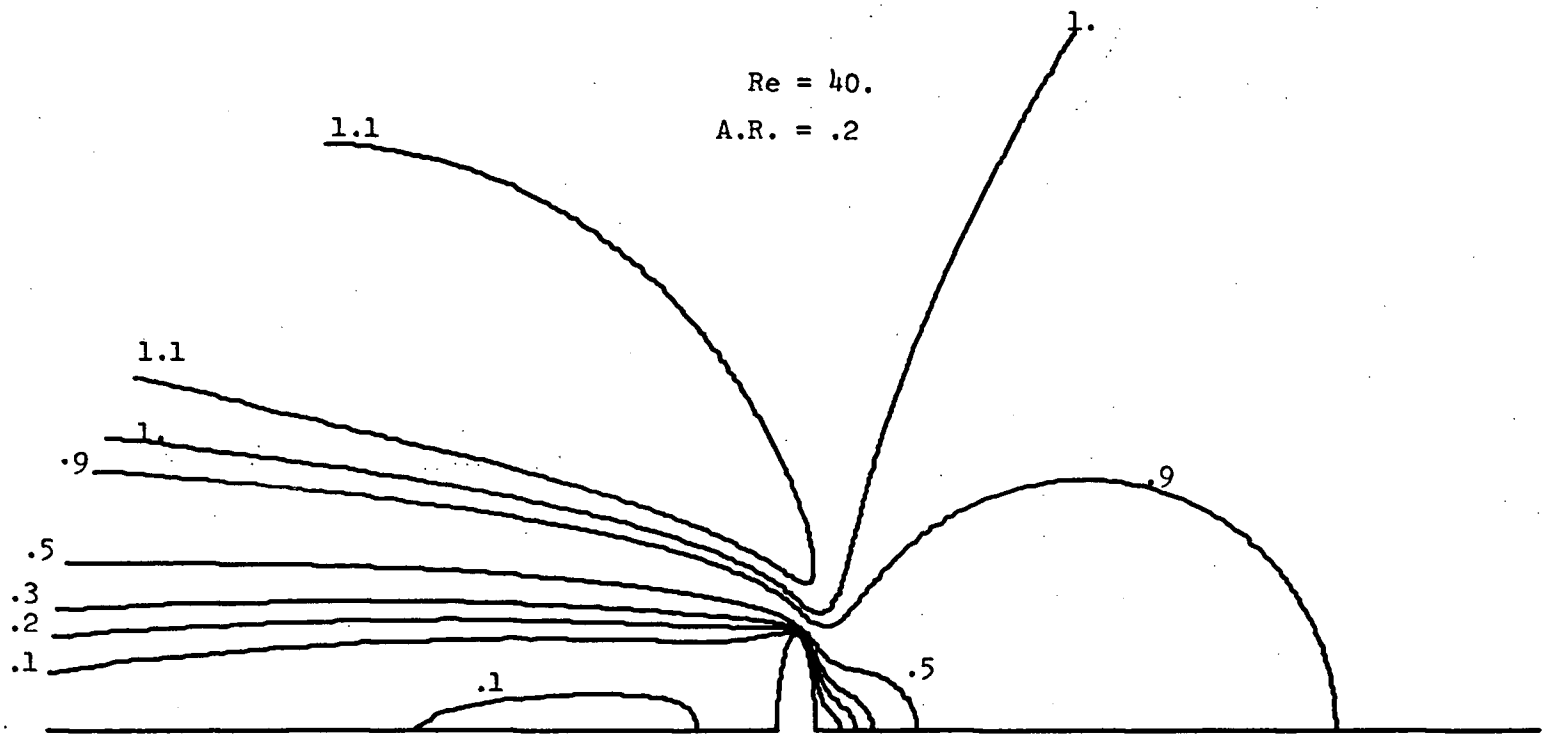


Figure 91a. Velocity lines for an elliptical cylinder with O.R. = 0.2.

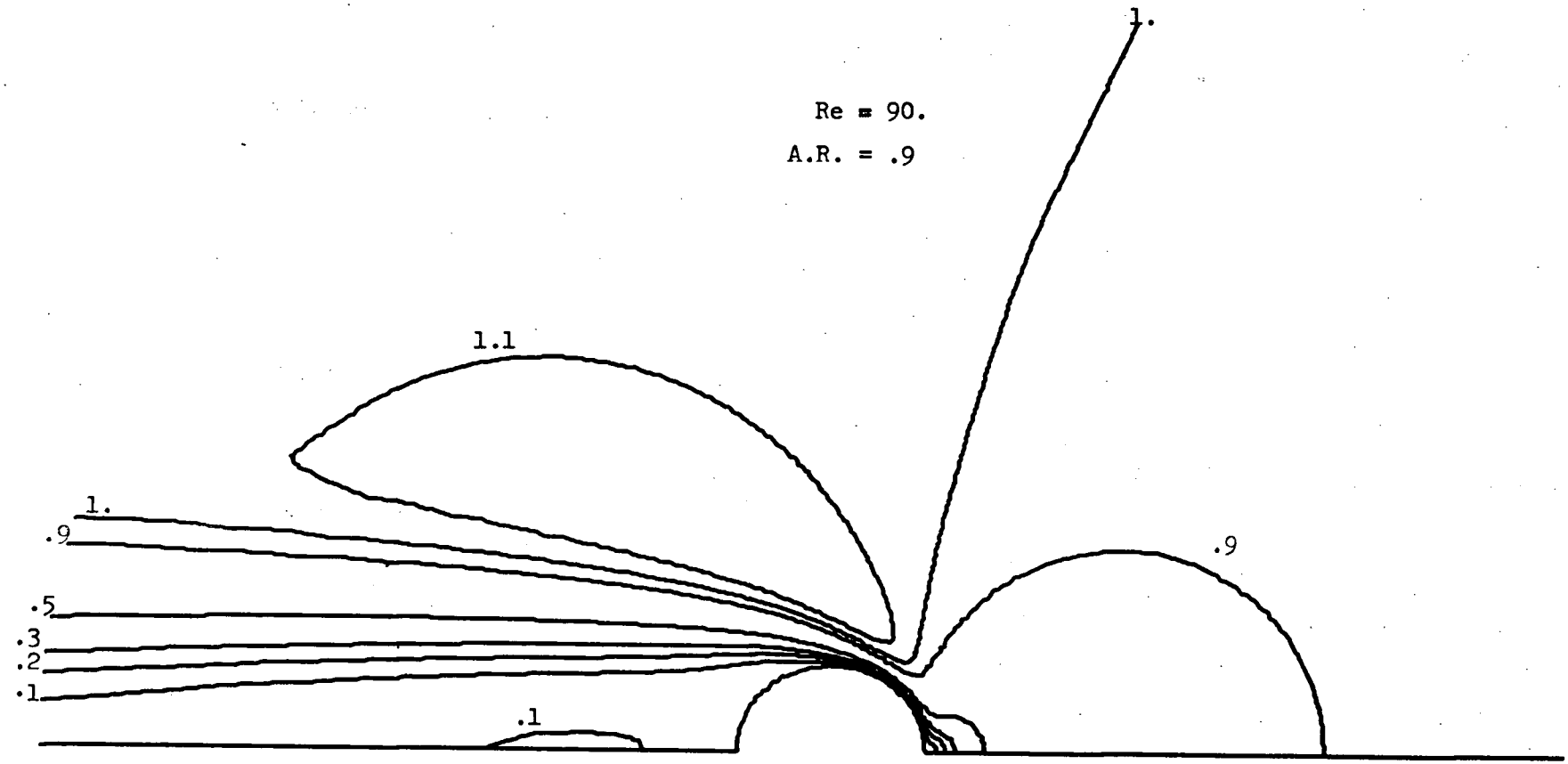


Figure 91b. Velocity lines for an elliptical cylinder with O.R. = 10/9.

7. Results for Swarms of Particles in Creeping Flow

The Reynolds number used throughout was 0.01, based on the equatorial diameter and on the axis perpendicular (except in figure 105) to the main flow direction, in the case of spheroids and elliptical cylinders respectively. The concentration of the swarms was taken up to about 0.6 and the ratio of minor to major axis considered ranged from 0.999 to 0.2.

A. Swarms of Spheroids

Figures 92 and 93 show the variation of V/V_o with concentration, c, for various aspect ratios of oblate spheroids using the Happel free surface and Kuwabara zero vorticity models, respectively. Both models predict that the velocity ratio V/V_o is much lower for A.R. = 0.2 than for spheres. This indicates that the drag forces on a swarm of disc-shaped spheroids aligned perpendicular to the main flow are much larger than those experienced by spheres having the same equatorial diameter. Happel's model predicts a lower value of V/V_o than Kuwabara's for a given A.R. and c.

The variation of V/V_o with concentration for prolate spheroids is shown in figure 94 and 95 for the Happel and Kuwabara models, respectively. The curves of V/V_o vs. c for the different A.R. are close to each other, but it is interesting to note that the curve for A.R. = 0.2 (needle-shaped spheroids) falls below the others. This can be

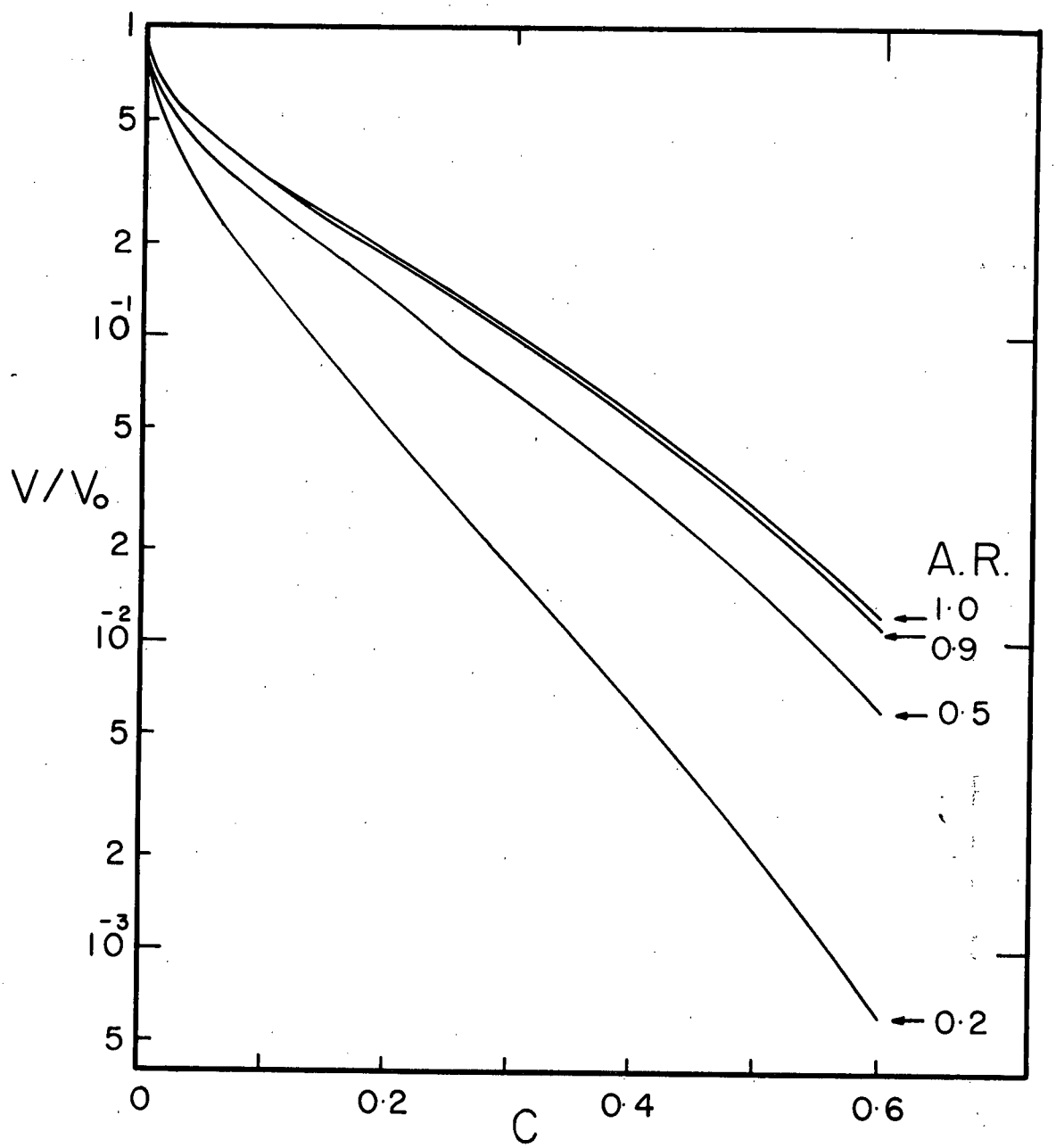


Figure 92. Variation of velocity ratio with concentration for oblate spheroids: Happel's model, Re=0.01.

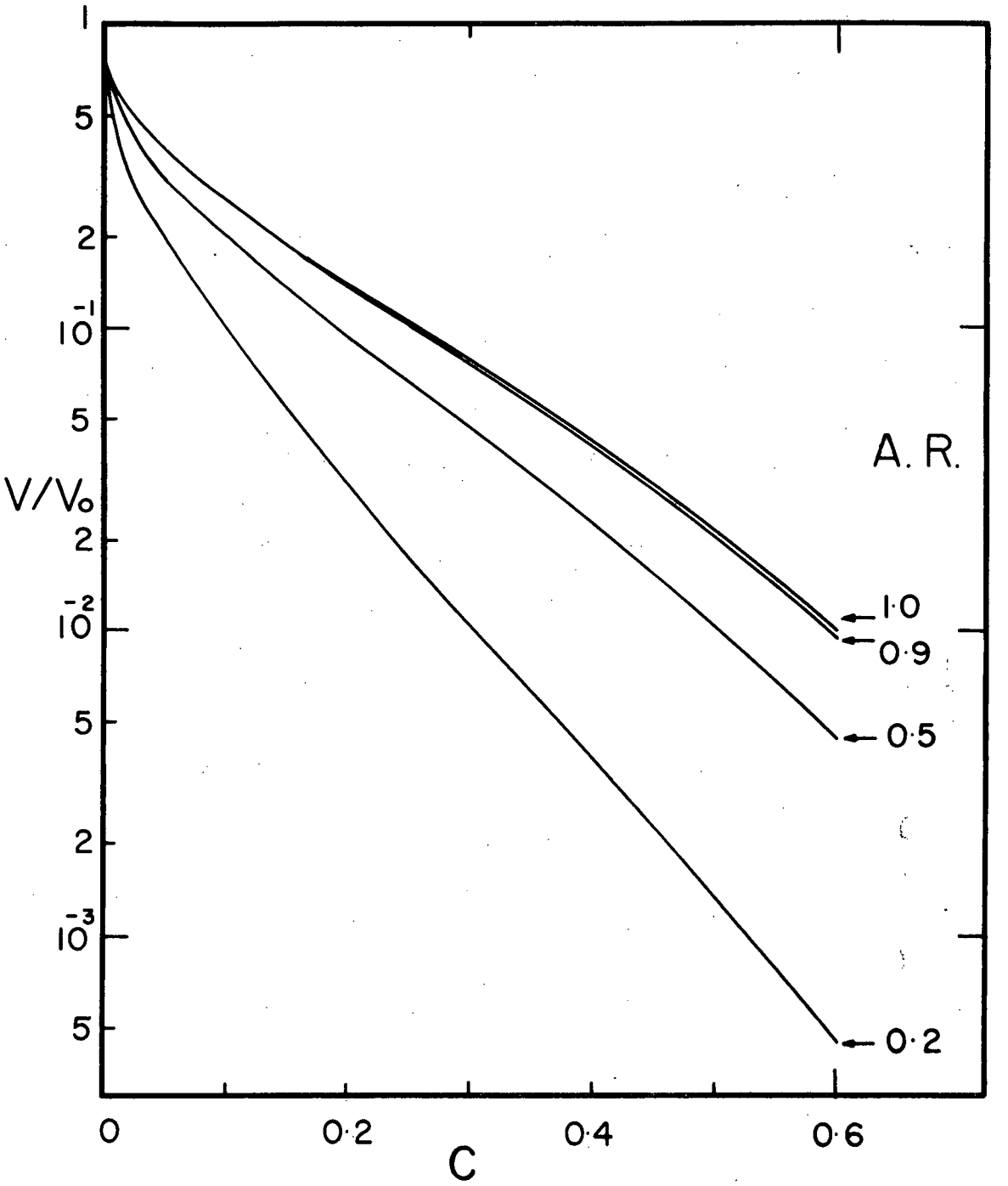


Figure 93. Variation of velocity ratio with concentration for oblate spheroids: Kuwabara's model, Re=0.01.

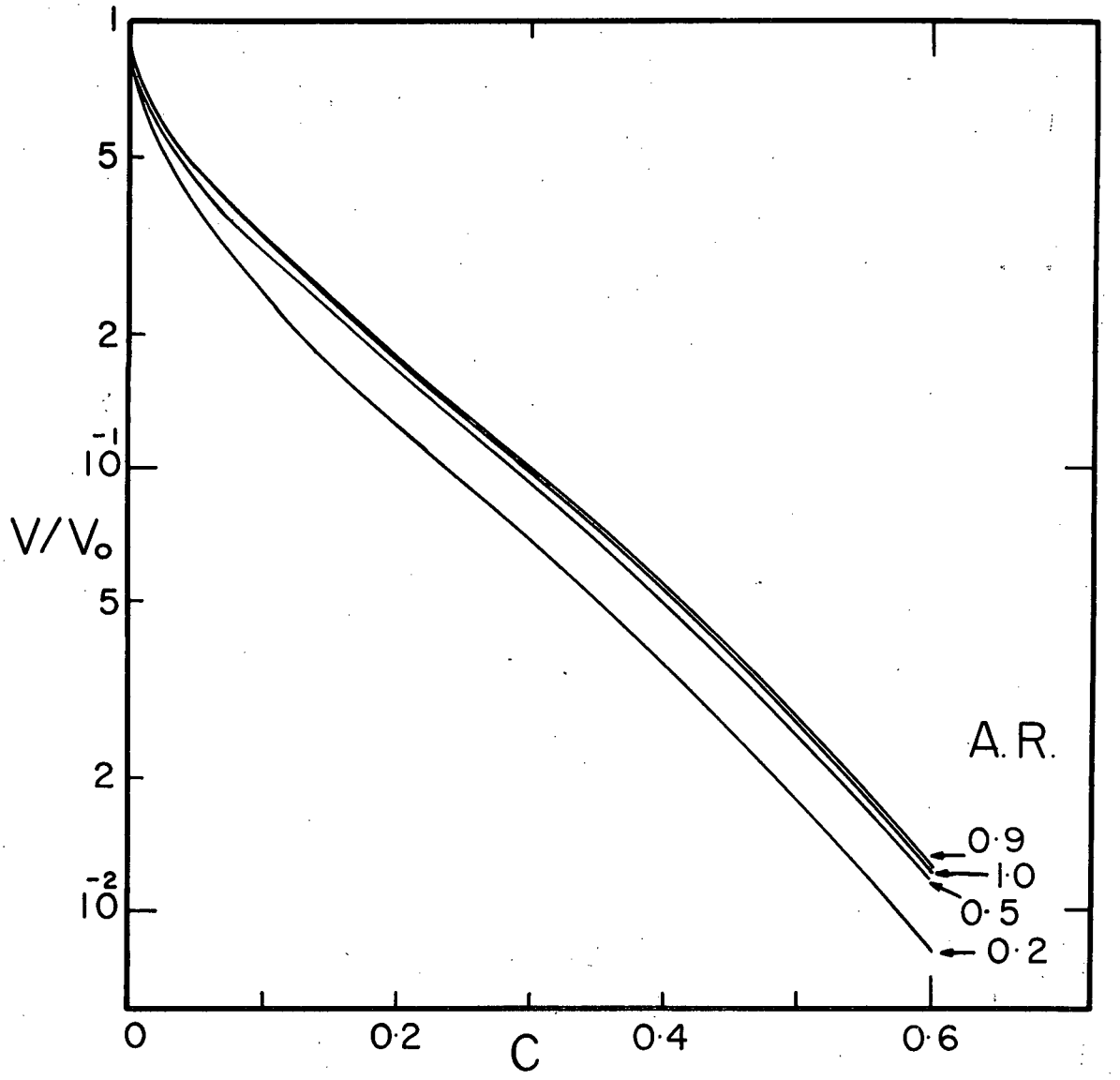


Figure 94. Variation of velocity ratio with concentration for prolate spheroids: Happel's model, Re=0.01.

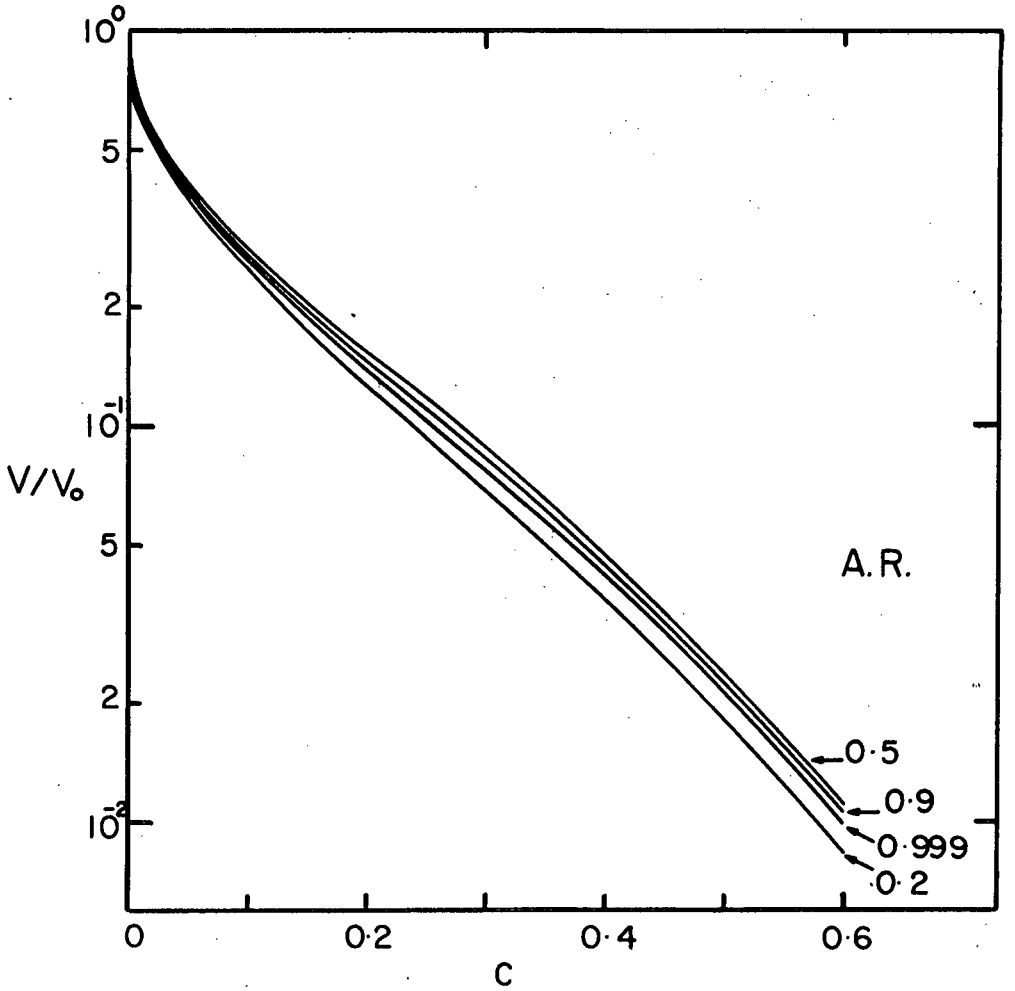


Figure 95. Variation of velocity ratio with concentration for prolate spheroids: Kuwabara's model, Re=0.01.

attributed to the fact that at this low aspect ratio the surface area is large for a given equatorial diameter, and consequently a high skin drag predominates.

For A.R. = 0.9, both oblate and prolate spheroids showed values of V/V_o very close to that of a perfect sphere, indicating that large variations in the experimental results for swarms of "spheres" recorded in the literature (126) cannot be attributed to the use of imperfectly spherical particles.

The variation of the Kozeny constant, k, with concentration, evaluated from the drag coefficients for oblate and prolate spheroids, is shown in figures 96 and 97, respectively. For oblate spheroids with A.R. = 0.2, minimum values of k are observed at c = 0.15 for the Happel model and 0.1 for the Kuwabara model. Thereafter k increases with concentration to values of 48 and 70 at c = 0.6, for the Happel and Kuwabara models, respectively. For A.R. = 0.5 - 0.999, k showed only a slight variation with concentration in the range c = 0.3 - 0.6.

For prolate spheroids (figure 97) no minimum in k was observed. The value of k at c = 0.6 for A.R. = 0.2 is 3.7, which compares favourably with the value of 3.44 for flow parallel to cylinders (133). This agreement is not surprising in view of the fact that the prolate spheroids with A.R. = 0.2 represent needle-like particles aligned with the flow.

The broken lines in figures 96 and 97 represent the Kozeny constant evaluated by the tortuosity method, where

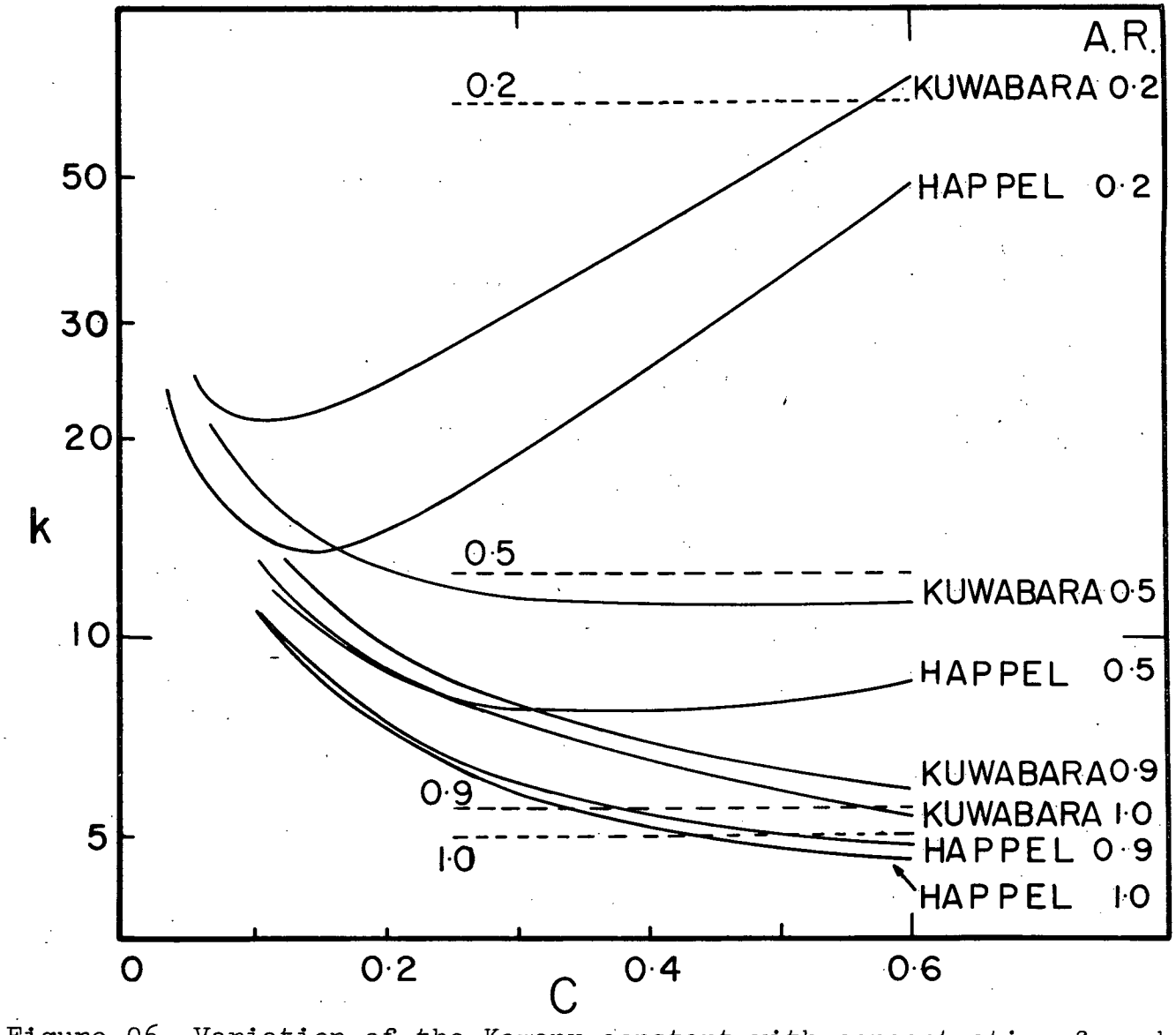


Figure 96. Variation of the Kozeny constant with concentration for oblate spheroids:---, tortuosity method.

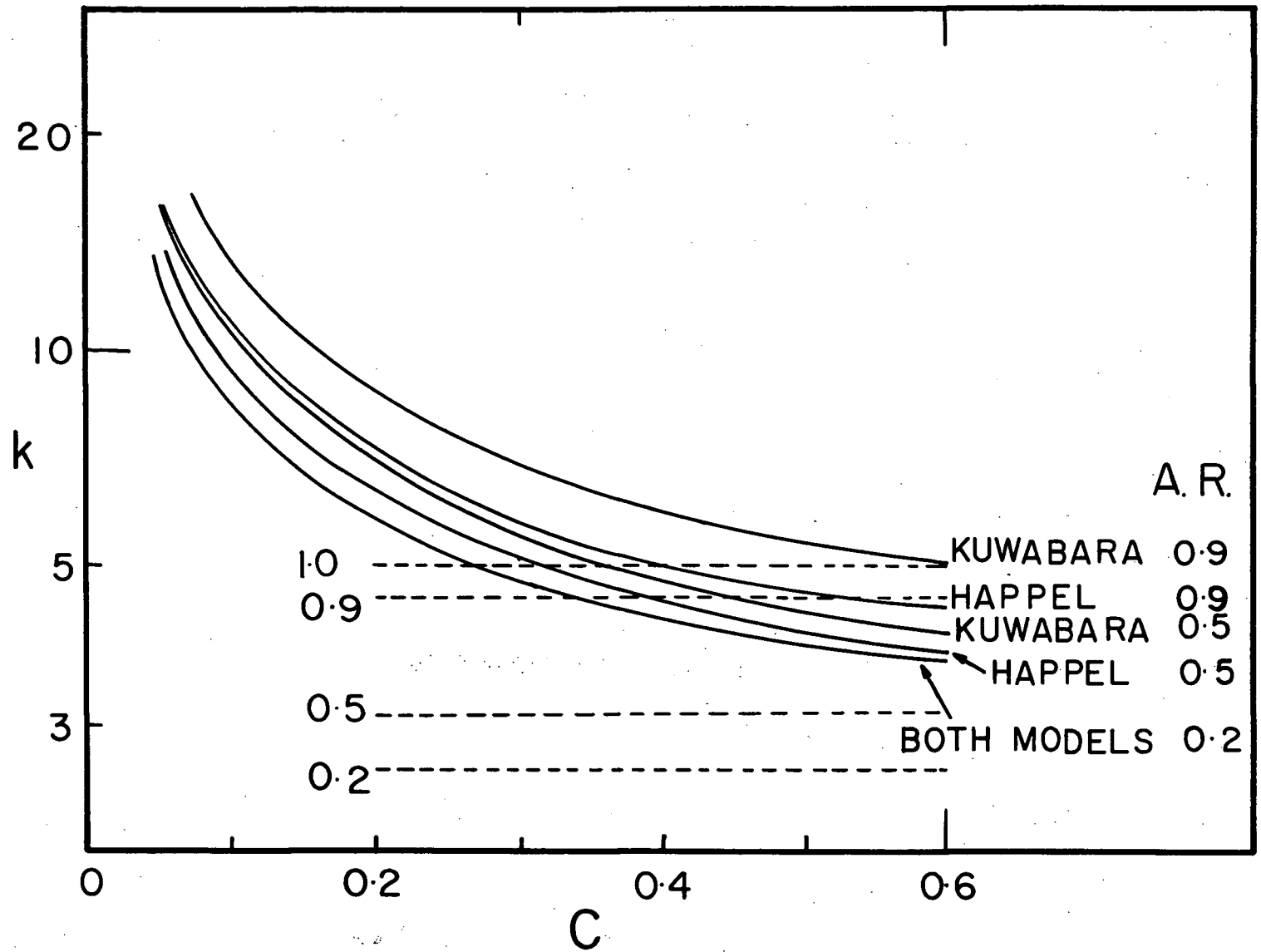


Figure 97. Variation of the Kozeny constant with concentration for prolate spheroids:---, tortuosity method.

only the shape of the particle is taken into account. Even though the method is very approximate, it apparently gives a good estimate of the order of the Kozeny constant as obtained from the computed drag coefficients, for the higher concentrations. The methods of evaluating k are given in Appendix III.

The large deviations from the commonly accepted value of 5 clearly indicate that this value is quite inapplicable to aligned particles which deviate significantly in shape from a sphere.

A comparison between the streamlines, equi-vorticity lines and equi-velocity lines for oblate spheroids with A.R. = 0.2 and c = 0.1832, of both models, is shown in figure 98. In all cases complete symmetry exists between upstream and downstream conditions, because of creeping flow. The streamlines and equi-velocity lines appear to be respectively very similar for the two models, but the equi-vorticity lines differ from each other. For Happel's model some of the equi-vorticity lines leaving the surface of the spheroid meet the outer cell envelope, whereas for Kuwabara's model none of the lines leaving the surface meet the outer envelope. The difference arises from the fact that for Happel's model the value of vorticity at the outer envelope is non-zero except at the axis of revolution of the cell, whereas for Kuwabara's it is always zero by definition.

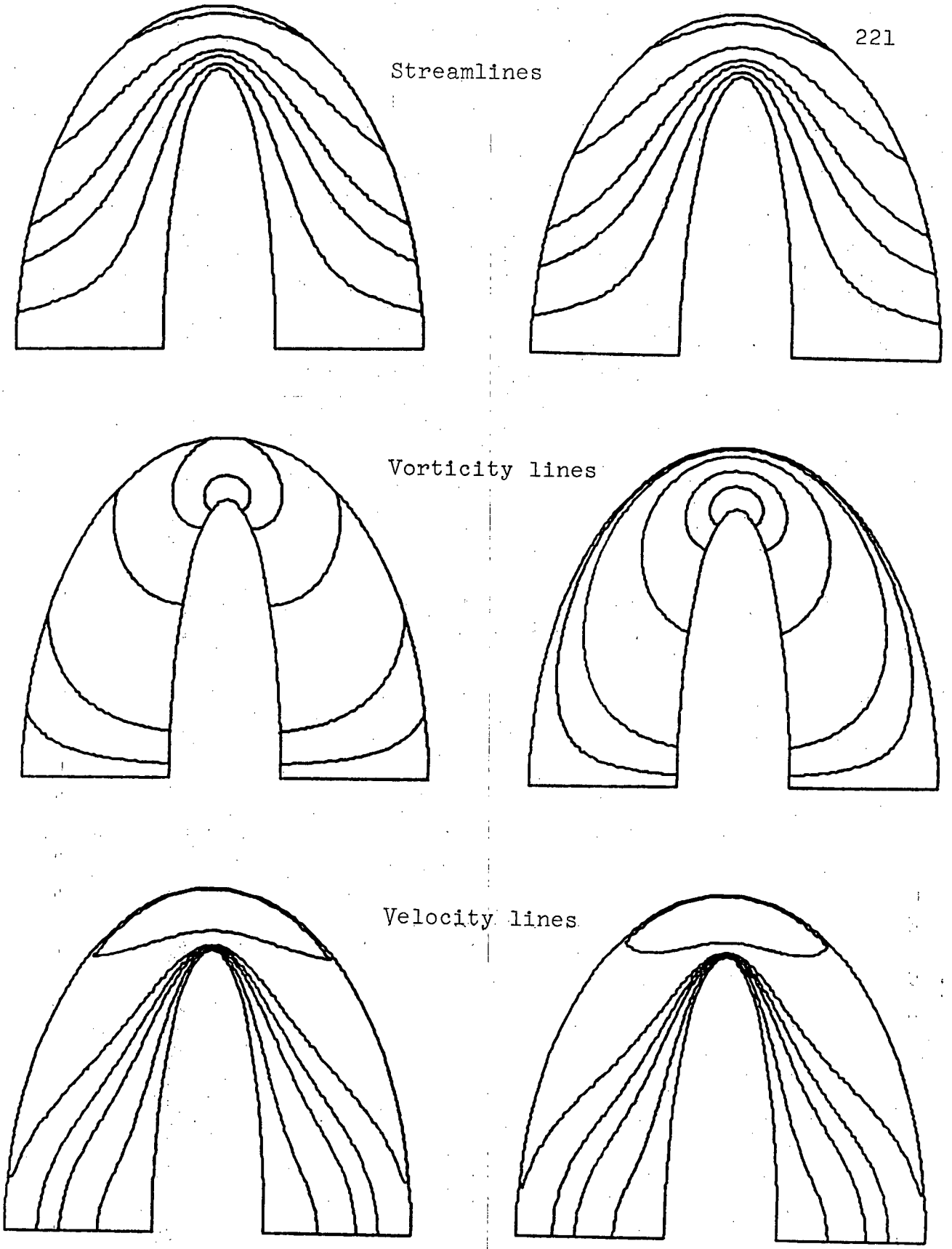


Figure 98. Flow patterns for an oblate spheroidal cell model, A.R. = 0.2, c = 0.1832.

B. Clusters of Elliptical Cylinders

The variation of the total drag coefficient with concentration for O.R. $\leqslant 1$ is given in figures 99 and 100 for the Happel and Kuwabara models, respectively. Both figures show that C_{DT} for O.R. = 0.2 is much higher than that for circular cylinders (O.R. = 1.0). For O.R. $\geqslant 1.0$, the variation of C_{DT} with concentration is given by figures 101 and 102, for the Happel and Kuwabara models, respectively. Unlike the curves for O.R. $\leqslant$ 1, curves of C_{DT} vs. c for $1.0 \leqslant$ O.R. $\leqslant 5.0$ are close to each other according to both models.

The variation of the Kozeny constant with c for O.R. < 1.0, shown in figure 103, is very similar to that of the oblate spheroids (figure 96) in that a minimum point is again exhibited for O.R. = 0.2. The results by both models are close to each other for both O.R. = 0.2 and O.R. = 0.5. However, for O.R. = 0.9 and 1.0, Happel's model gives higher values of k than Kuwabara's model. For O.R. > 1.0, the variation of k with c, given in figure 104, is similar to that of prolate spheroids (figure 97). Thus for elliptical cylinders the deviation from $k \simeq 5$ is again large for shapes that are significantly non-circular. The Kozeny constant as found by the tortuosity method once again gives a reasonable estimate of k for high concentrations.

The variation of non-dimensional pressure gradient with O.R. is given in figure 105 for Rew = 0.01, where Rew is the Reynolds number based on the axis, $2b_1$, parallel to

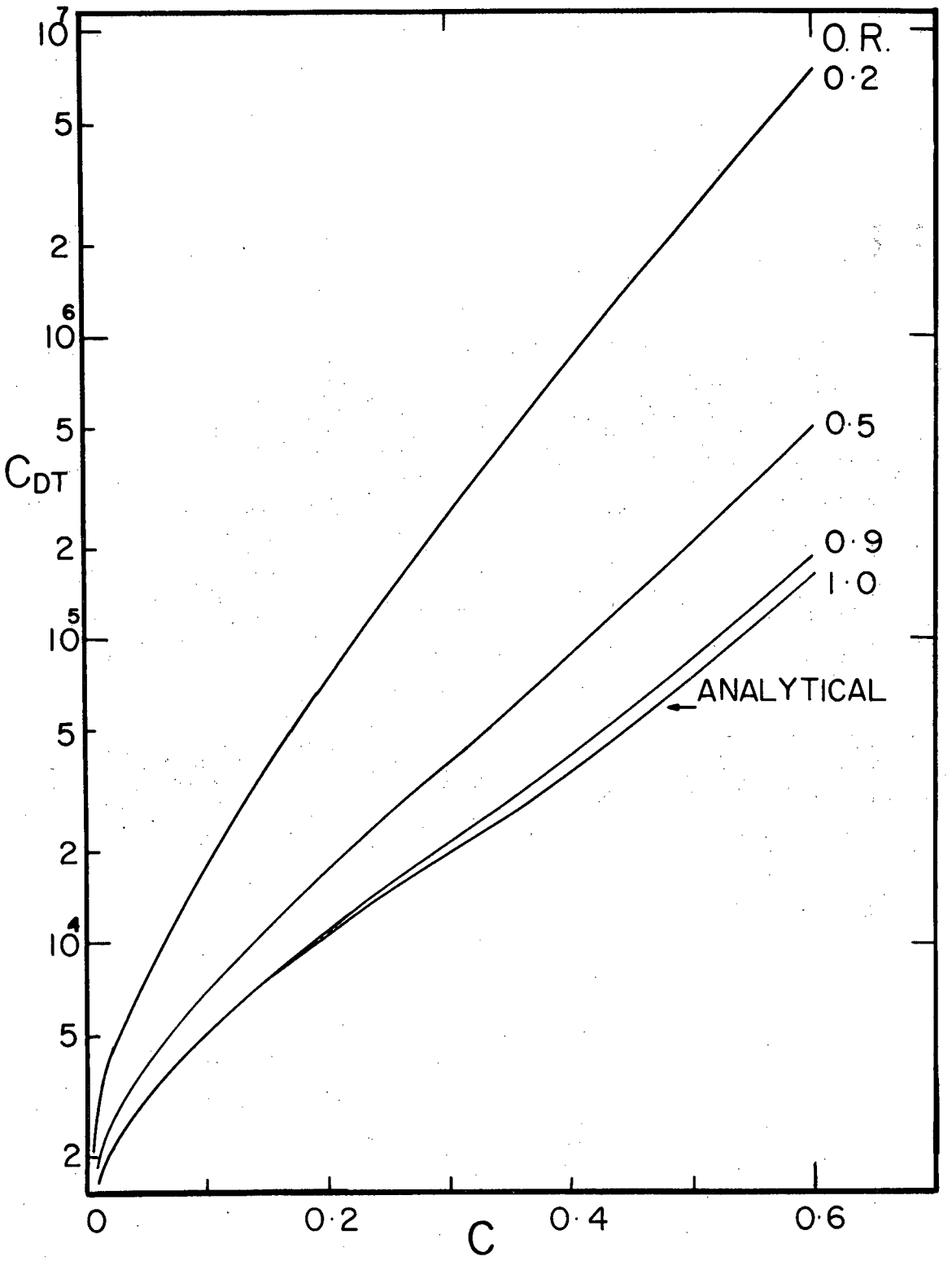


Figure 99. Variation of the total drag coefficient with concentration for elliptical cylinders with O.R. $\leq$ 1.0: Happel's model, Re=0.01.

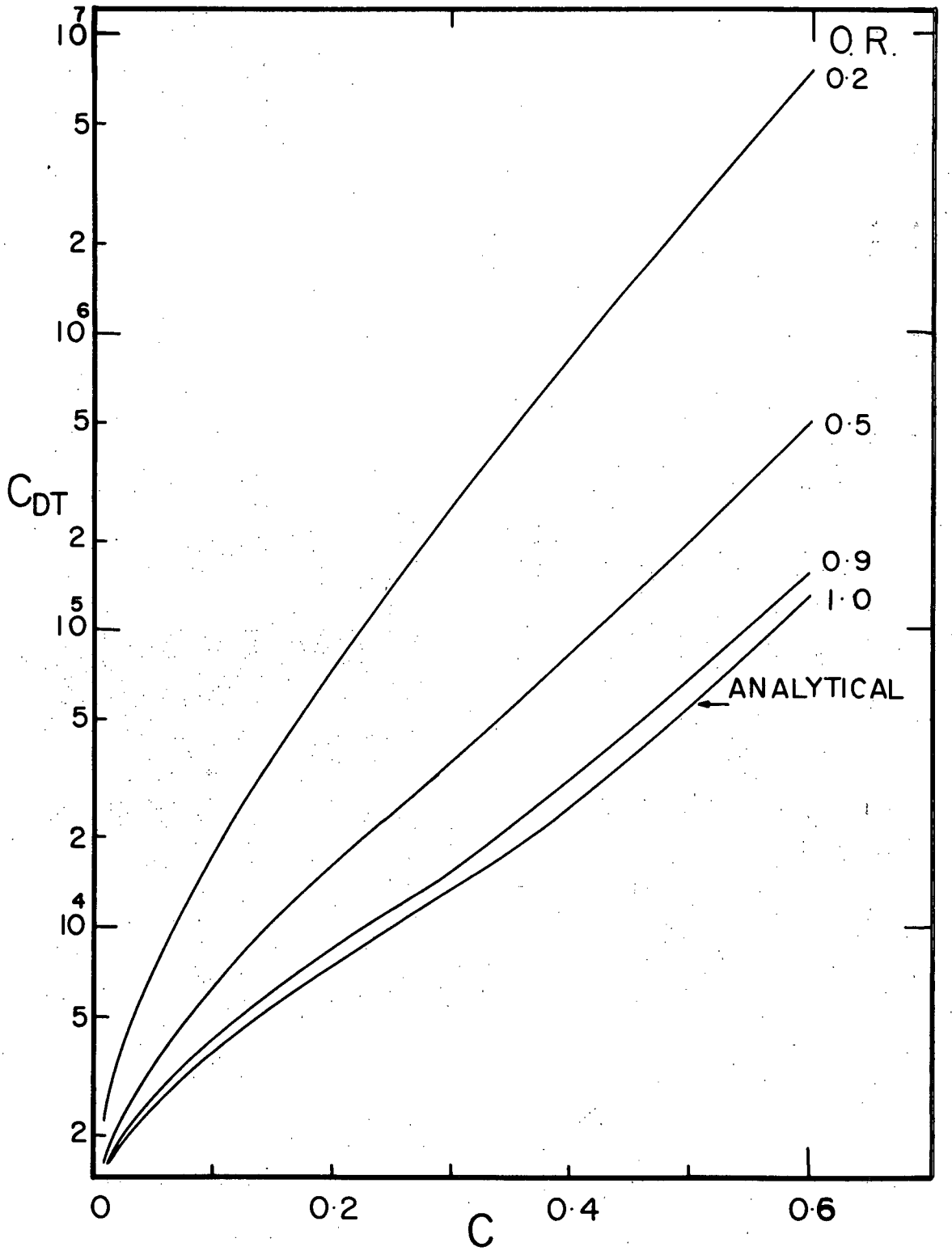


Figure 100. Variation of the total drag coefficient with concentration for elliptical cylinders with O.R. $\leq$ 1.0: Kuwabara's model, Re=0.01.

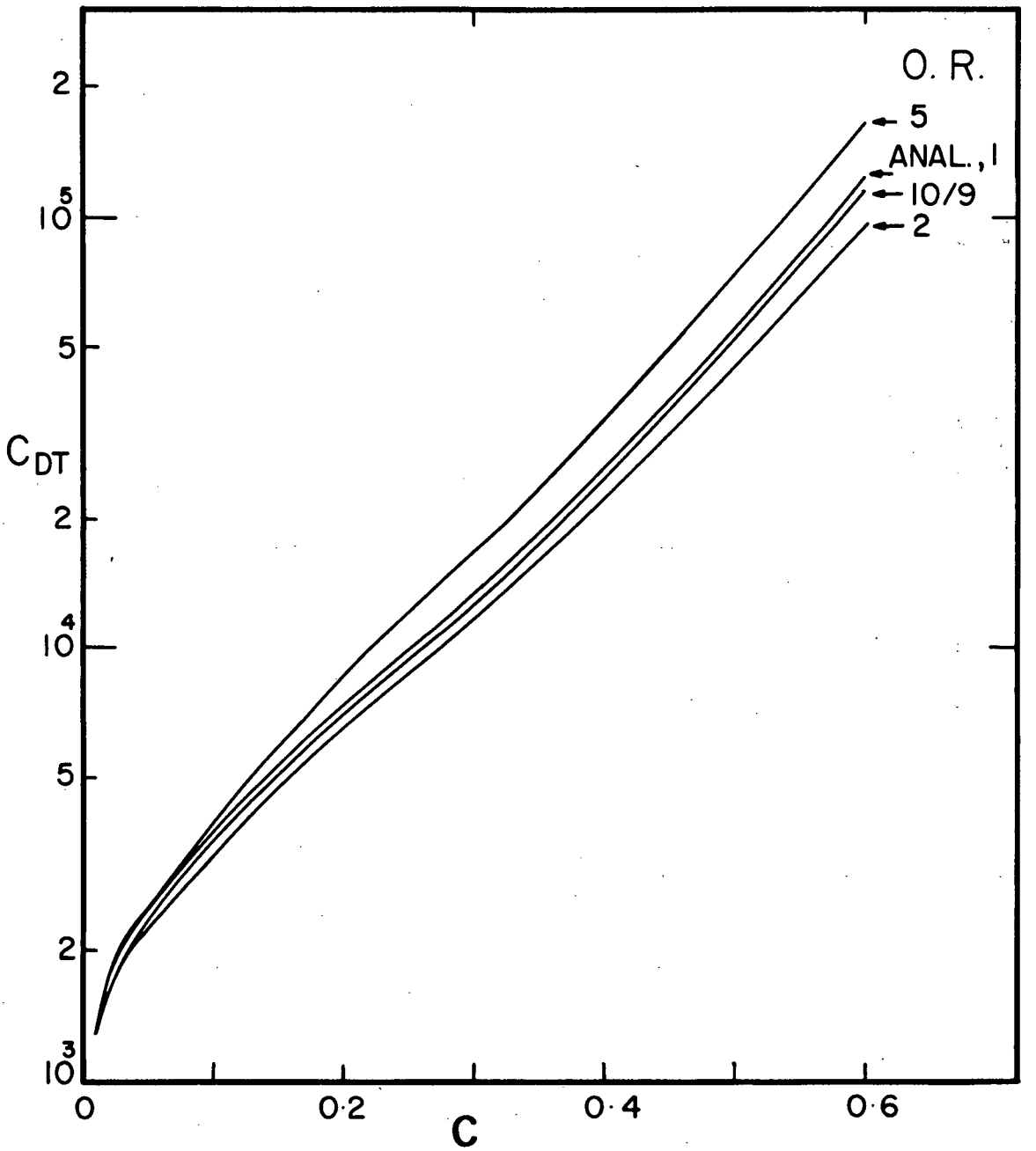


Figure 101. Variation of the total drag coefficient with concentration for elliptical cylinders with O.R. $\geq$ 1.0: Happel's model, Re=0.01.

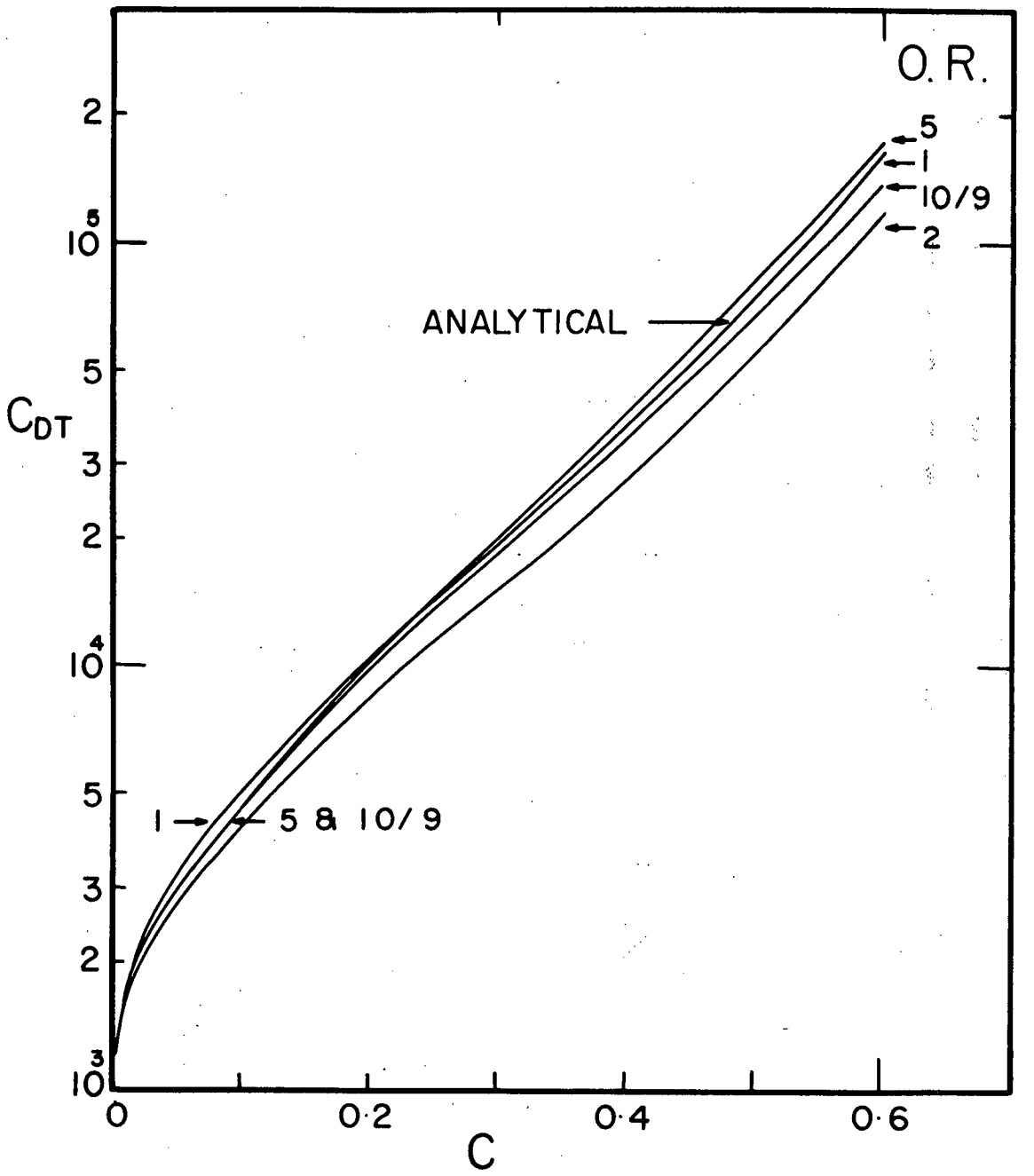


Figure 102. Variation of the total drag coefficient with concentration for elliptical cylinders with O.R. $\geq$ 1.0: Kuwabara's model, Re=0.01.

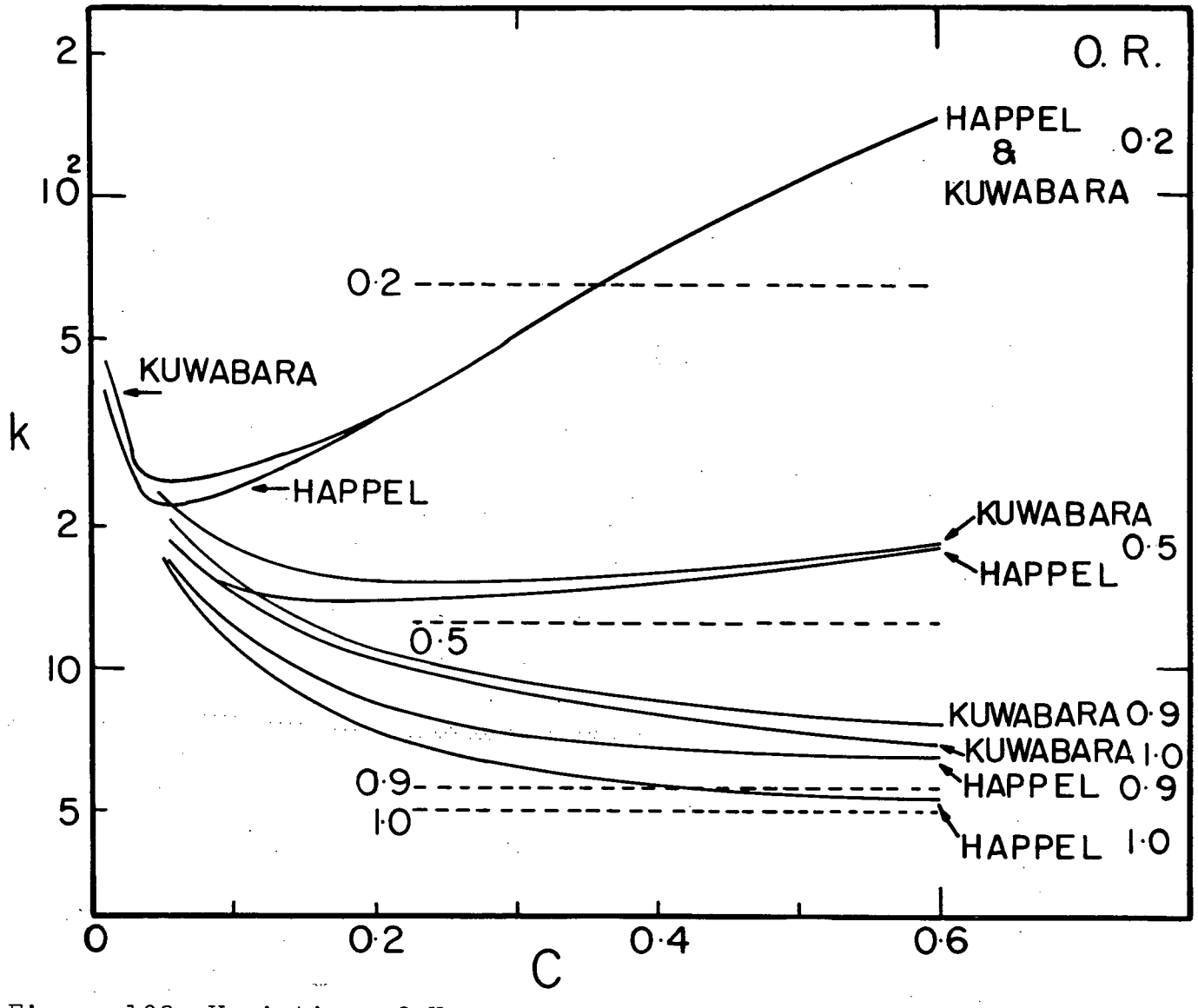


Figure 103. Variation of Kozeny constant for elliptical cylinders with O.R. ≤ 1.0 at Re=0.01: ___, tortuosity method.

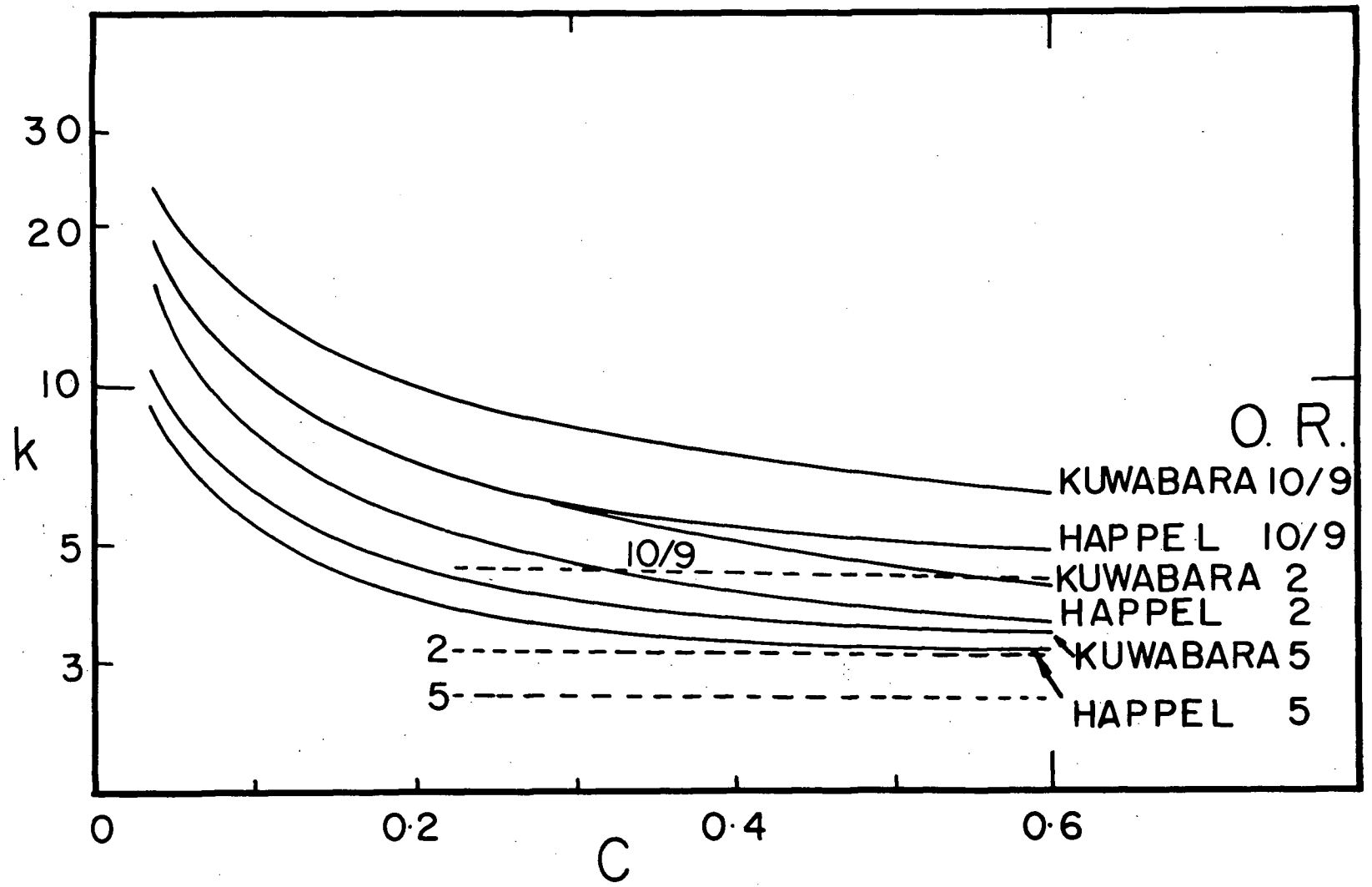


Figure 104. Variation of Kozeny constant with concentration for elliptical cylinders with O.R. > 1.0 at Re=0.01: ———, tortuosity method.

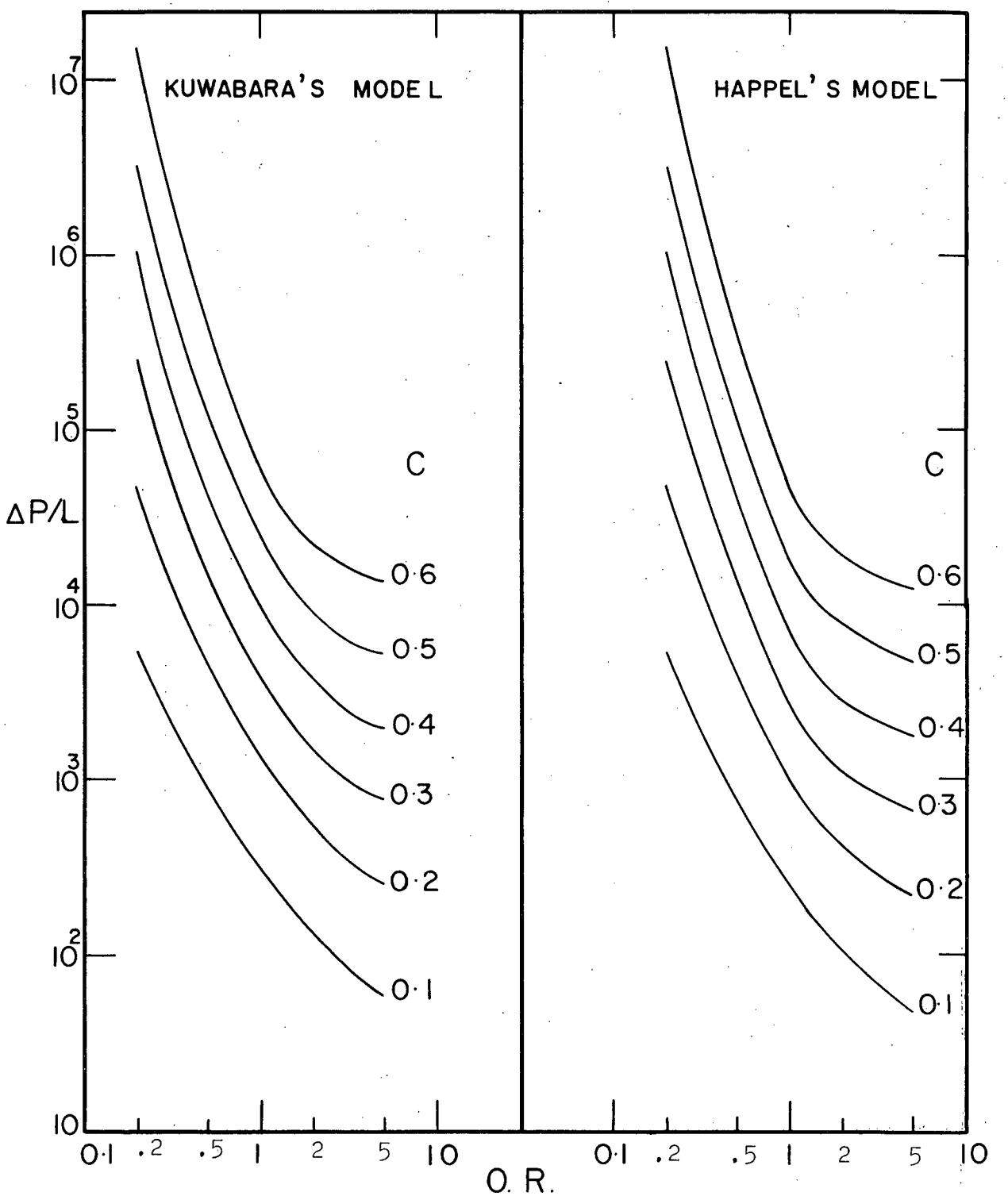


Figure 105. Variation of ΔP/L with orientation ratio for elliptical cylinders, Rew = 0.01.

the main flow direction. For a given fluid and a fixed length of the axis, $2b_1$, figure 105 shows that for A.R. = 0.2 at c = 0.6, $\Delta P/L$ for the flow perpendicular to the major axis (O.R. = 0.2) is as much as 1000 times that for the flow parallel to this axis (O.R. = 5.0). The derivation of the expression used for $\Delta P/L$ is given in Appendix III.

When the concentration of a bank of cylinders is very low (high clearance), then the pressure drop across several rows of cylinders can be taken as equal to the sum of pressure drops across isolated rows. Kuwabara (134) evaluated the total drag coefficient on a row of elliptical cylinders. Here the isolated row has been extended to a square cell model by assuming that other rows of cylinders are present in a square lattice, as shown in figure 106. The concentration is then the area of the elliptical cross-section divided by the area of the hatched square. A comparison between Kuwabara's zero vorticity cell model and the extended square cell model is shown in figure 107. Excellent agreement between these two models is obtained for low values of concentration. For $c > 0.05$ the two Kuwabara models diverge as the effect of concentration becomes more appreciable.

The contouring of equi-velocity and streamlines for O.R. = 5 and c = 0.200 shows similar flow patterns for both random cell models. However, as in the case of the spheroids, the equi-vorticity lines leaving the elliptical cylinder surface for Kuwabara's model do not end on the outer

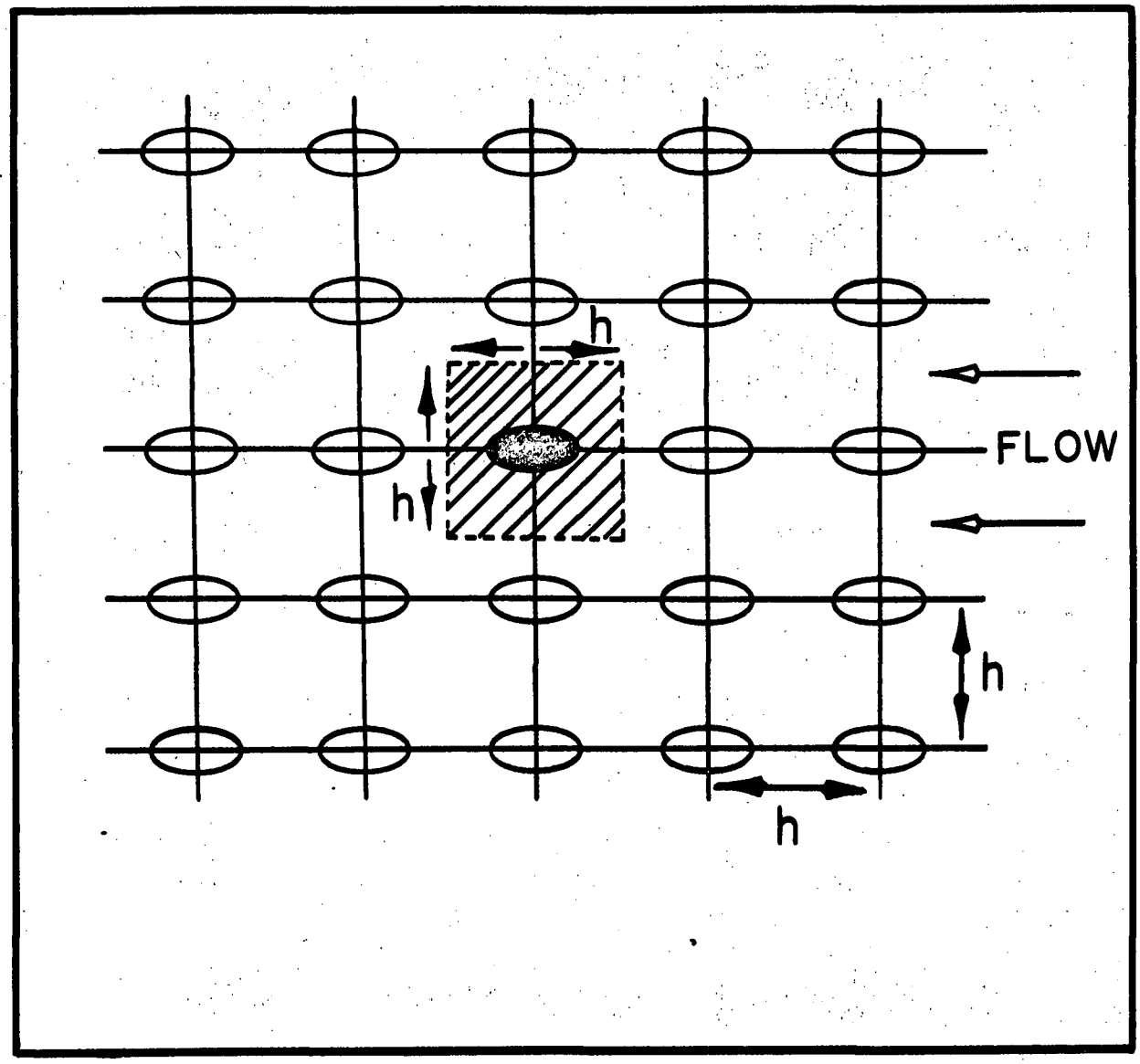


Figure 106. Square cell model for elliptical cylinders.

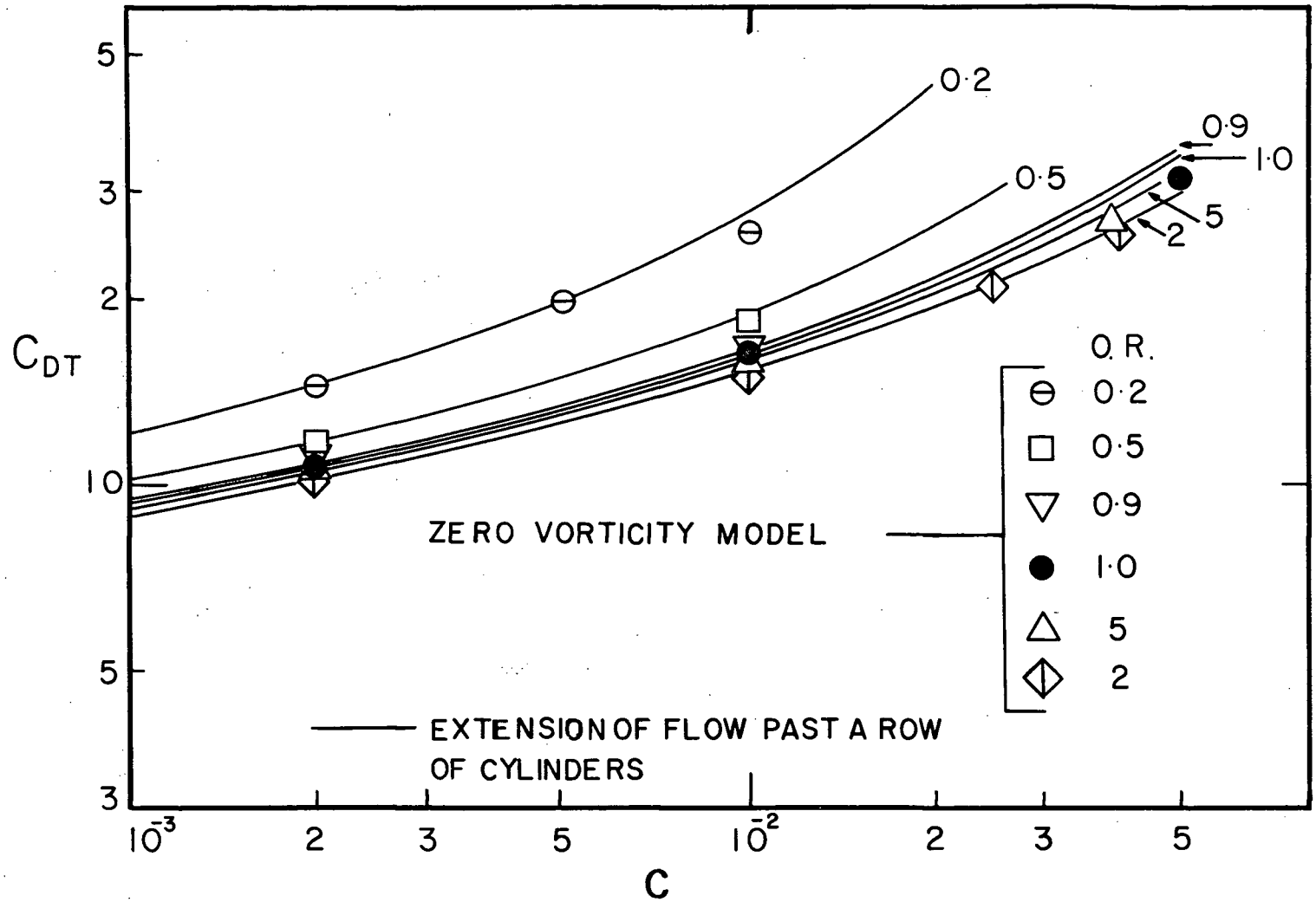
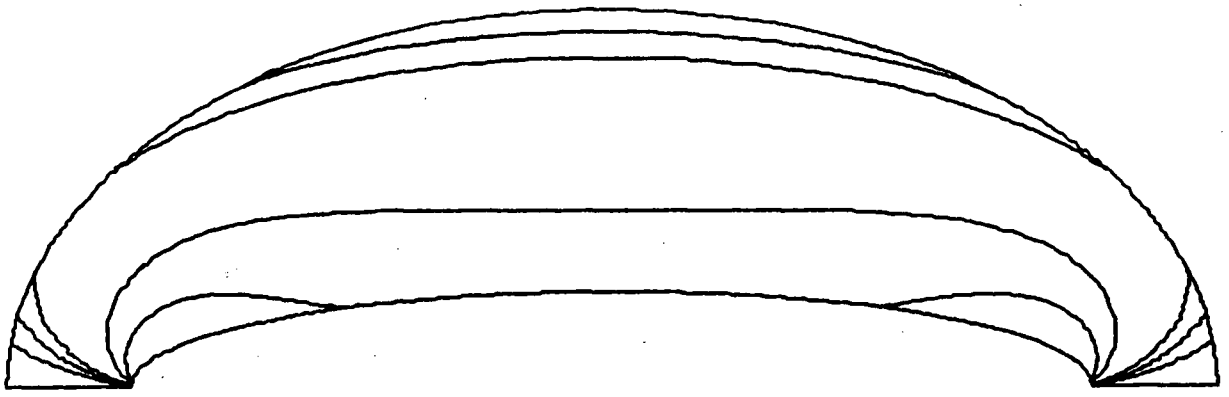


Figure 107. Comparison between the total drag coefficient obtained by Kuwabara's zero vorticity cell model and flow past a single row of elliptical cylinders, also by Kuwabara, extended to a square cell model: Re=0.01.

Happel's Model



Kuwabara's Model

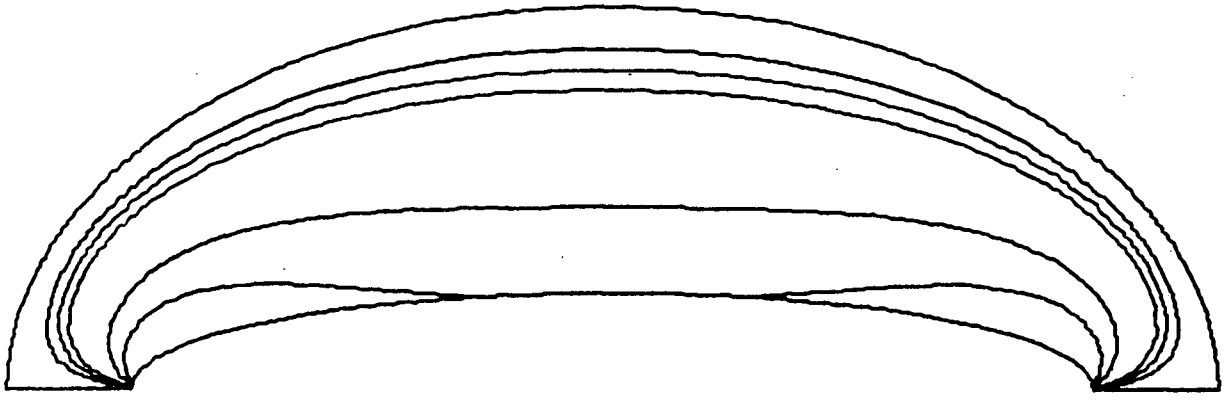


Figure 108. Equi-vorticity lines for elliptical cell models, O.R. = 5, c = 0.200.

envelope, whereas for Happel's model some of the equi-vorticity lines leaving the inner surface join the outer envelope, as shown in figure 108.

CHAPTER VI

Conclusions and Recommendations

Principal conclusions

1. The numerical solution of the Navier-Stokes equation has been successfully accomplished, using the relaxation technique of Jenson, for laminar flow past isolated spheroids and elliptical cylinders with aspect ratios from 0.2 to ~1 and Reynolds numbers up to 100.
2. The total drag coefficient experienced by an oblate spheroid with aspect ratio 0.999, as given by the numerical solution at the various Reynolds numbers, is in good agreement with the experimental data for a perfect sphere.
3. The variation of C_{DT} with Re for the spheroids of various aspect ratios and for the elliptical cylinders of various orientation ratios was not much different from that of a sphere and a circular cylinder, respectively.
4. The frontal stagnation pressure, P_o, was found to be a function of the shape of the body and of Re. The agreement of P_o computed numerically for the higher Re with those predicted by boundary layer theory is excellent.
5. The computed boundary layer thickness at $\eta = \pi/2$ was found to follow the relationship $\delta \propto Re^{-1/2}$, which

corresponds to that predicted by boundary layer theory.

6. For swarms of spheroids and clusters of elliptical cylinders the same numerical solutions were accomplished for creeping flow, using the cell models of both Happel and Kuwabara. Large deviations of the Kozeny constant from its commonly assumed value of 5 for packed beds were found for particles which deviate significantly in shape from a sphere or a circular cylinder, by both models.

7. Happel's free surface model generally predicted lower total drag coefficients than Kuwabara's zero vorticity model for both the swarms of spheroids and the clusters of elliptical cylinders.

Recommendations for Further Work

Flow visualization of a moving spheroid or an elliptical cylinder might be studied, together with the experimental determination of the total drag coefficient, for low and intermediate Reynolds numbers.

The existing computer programs as developed in this work could be used to extend both the Happel and the Kuwabara models for swarms of spheroids or clusters of elliptical cylinders to higher Reynolds numbers.

Heat and mass transfer from spheroids and elliptical cylinders could be studied by use of the stream functions found in this work.

LIST OF REFERENCES

1) Soo, S.L. 1967 "Fluid Dynamics of Multiphase Systems." Waltham, Mass: Blaisdell Publishing Company.

2) Longwell, P.A. 1966 "Mechanics of Fluid Flow.", New York: McGraw-Hill Book Co.

3) Stokes, G.G. 1851 Trans. Camb. Soc. 9, 8.

4) Rouse, H. and Ince, S. 1957 "History of Hydraulic." Iowa Inst. of Hydraulic Res., State University of Iowa.

5) Lamb, H. 1932 "Hydrodynamics." 6th ed. Cambridge: Cambridge Univ. Press.

6) Dryden, H.L. Murnaghan, F.D. Bateman, H. 1932 "Hydrodynamics." N.R.C. Bulletin No.84, Reprinted by Dover Pub. 1956.

7) Payne, L.E. and Pell, W.H. 1960 J. Fluid Mech. 7. 529.

8) Happel, J. and Brenner, H. 1965 "Low Reynolds Number Hydrodynamics." Englewood Cliffs, N.J: Prentice Hall.

9) Brenner, H. 1966 "Hydrodynamic Resistance of Particles at Small Reynolds Numbers." Advances in Chemical Engineering 6, New York: Academic Press.

10) Goldstein, S. 1938 "Modern Developments in Fluid Dynamics." Oxford: Clarendon Press.

11) Sampson, R. 1891 Phil. Trans. Roy. Soc. 182, 449.

12) Savic, P. 1953. Rept. No. MT-22, N.R.C. Canada.

13) Haberman, W.L., Sayre, R.M. and Taylor, D.W. 1958 Model Basin Report No.1143.

14) Ray, M. 1936 Phil Mag. (7), 21, 546.

15) Roscoe, R. 1949 Phil. Mag. (7), 40, 338.

16) Gupta, S.C. 1957 ZAMP 8, 257.

17) Oberbeck, A. 1876 J. reine angew. Math 81, 62.

18) Whitehead, A.N. 1889 Quart. J. Math. 23, 143.

19) Oseen, C.W. 1910 Ark. F. Mat. Astr. og. Fys. 6, No.29.

20) Oseen, C.W. 1913 Ark. F. Mat. Astr. og. Fys. 9, No.16.

21) Burgers, J.M. et al. 1916 Amer. J. Math. 38, 81.

22) Goldstein, S. 1929, Proc. Roy. Soc. A123, 216.

23) Goldstein, S. 1929, Proc. Roy. Soc. A123, 225.

24) Tomotika, S. and Aoi, I. 1950 Quart. J. Mech. and Appl. Math. 3, 140.

25a) Pearcey, T. and McHugh, B. 1955 Phil. Mag. (7), 46, 783.

25b) Stewartson, K. 1955 Phil. Mag. (7), 46, 345.

26) Oseen, C.W. 1927 "Hydrodynamik." Leipzig, 18.

27) Aoi, T. 1955 J. Physics Soc. Japan 10, 119.

28) Lagerstrom, P. and Cole, J. 1955 Rat. Mech. Anal. 4, 817.

29) Kaplun , S. 1957 J. Math. Mech. 6, 595.

30) Proudman, I. and Pearson, J.R.A. 1957 F. Fluid Mech. 2, 237.

31a) Breach, D.R. 1961 J. Fluid Mech. 10, 306.

31b) Breach, D.R. 1969 Canadian Congress of Applied Mechanics, Waterloo Univ. Canada,363.

32) Kaplun, S. and Lagerstrom, P. 1957 J. Math. Mech. 6, 585.

33) Synder, R.J., Spriggs, T.W. and Stewart, W.E. 1964, No.4, 535.

34) Flumerfelt, R.W. and Slattery, J.C. 1955 Chem. Eng. Sci 20, 157.

35) Kawaguti, M. 1948 Rept. Inst. Sci., Tokyo 2, 66.

36) Kawaguti, M. 1950 Rept. Inst. Sci., Tokyo 4, 154.

37) Hamielec, A.E. and Johnson, A.I. 1962 Can. J. Chem. Eng. 40, 41.

38) Hamielec, A.E., Storey, S.H. and Whitehead, J.M., 1963, 41, 246.

39) Slattery, J.C. Appl. 1961 Appl. Sci Res. (A), 10, 286.

40) Nakano, Y. and Tien, Y. 1967, Can. J. Chem. Eng. 45, 135.

41) Dennis S.C.R. and Dunwoody, J. 1966 J. Fluid Mech. 24, 577.

42) Thom, A. 1929 Aer. Res. Centre, R & M. No.1194.

43) Thom, A. 1931 Proc. Roy. Soc. A131, 30.

44) Thom, A. 1933 Proc. Roy. Soc. A141, 651.

45) Hu, H.S. and Sparrow, E.M. 1967, A.I.Ch.E.J. 13, 11.

46) Kawaguti, M. 1953, J. Phys. Soc. Japan 8, 747.

47) Fox, L. 1944 Quart. J. Appl. Math. 2, 251.

48) Fox, L. 1947. Proc. Roy. Soc. A190, 31.

49) Fox, L. 1948 Quart. J. Mech. 1, 253.

50) Southwell, R.V. et al 1945 Phil. Trans. A239, 419.

51) Lister, M. 1953 Ph.D. Thesis, Univ. of London.

52) Kawaguti, M. 1959 Quart. J. Mech. and Appl. Math. 12, 261.

53) Allen, D.N. de G. and Dennis, S.C.R. 1951 Quart. J. Mech. 4, (2), 199.

54) Allen, D.N. de G. and Southwell, R.V. 1955 Quart. J. Mech. 8, 129

55) Jenson, V.G. 1959 Proc. Roy. Soc. A249, 346.

56) Jenson, V.G., Horton, J.R. and Wearing, J.R. 1968 Trans. Inst. Chem. Engrs. 46, 177.

57) Rhodes, J.M. 1966 Ph.D. Thesis, University of Tennessee.

58) LeClair, B.P. and Hamielec, A.E. 1968 Ind. Eng. Chem. Fundamentals 7, 542.

59) Hamielec, A.E., Hoffman, T.W. and Ross, L.L. 1967 A.I.Ch.E.J. 13, 212.

60) Hamielec, A.E., Johnson, A.I. and Houghton, W.T. 1967, A.I.Ch.E.J. 13, 220.

61) Hamielec, A.E. and Raal, J.D. 1969 Phys. Fluids 12, 11.

62) Kawaguti, M. and Jain, P. 1966 J. Phys. Soc. Japan 21, 2055.

63) Payne, R.B. 1958 J. Fluid Mech. 4, 81.

64) Son, J.S. and Hanratty, T.J. 1969 J. Fluid Mech. 35, 369.

65) Stokes, G.G."Mathematical and Physical Papers" 3, 65.

66) Krakowski, M. and Charnes, A. 1953 Carnegie Inst. of Tech. Dept. of Mathematics, Tech. Rept. No.37.

67) Berry, A. and Swain, L.M. 1923, Proc. Roy. Soc. A102, 766.

68) Wilton,J. 1915 Phil. Mag. 30, 761.

69) Harrison, W.J. 1924 Camb. Trans. 23, 71.

70) Tomotika, S. and Aoi, I. 1951 Quart. J. Mech. and Appl. Math. 4, 401.

71) Bairstow, L., Cave, B.M. and Lang, E.D. 1923 Phil. Trans. Roy. Soc. A223, 383.

72) Piercy, N.A.V. and Winny, H.F. 1933 Proc. Roy Soc. A140, 543.

73) Tomotika, S. Aoi, I. 1953 Quart. J. Mech. and Appl. Math. 6, 290.

74) Davies, T.V. 1941 Phil. Mag. 31, 283.

75) Sidrak, S. 1950 Proc. Roy. Irish Acak A53, 65.

76) Imai, I. 1954, Proc. Roy. Soc. A224, 141.

77) Müller, W. 1932 "Einführung in die Theorie dar zähen Flüssigkeiten." Verlag. M.B.H., Leipzig.

78) Hocking, L.M. 1958 Mathematika 5,134.

79) Hocking, L.M. 1959 Quart. J. Mech. and Appl. Math. 12, 464.

80) Tamada, K. and Miyagi, T. 1962, J. Phys. Soc. Japan 17, 373.

81a) Miyagi, T. 1968 J. Phys. Soc. Japan 24, 204.

81b) Miyagi, T. 1969 Private Communication.

82) Kuo, Y.H. 1953 J. Math. Phys. 32, 83.

83) Blasius, H.Z. 1908 Math. U. Phys. 56:1.

84) Smoluchowski, M. 1911 Bull. Acad. Sci. Gracow 1a, 28.

85) Smoluchowski, M. 1912 Proc. Int. Congr. Math. 2, 192.

86) Smoluchowski, M. 1916 Phys. Z 17, 557, 585.

87) Burgers, J.M. 1941 Proc. Koningl. Akad. Wetensclap. (Amsterdam) 44, 104; 1942, 45, P2.

88) McNown, J.S. and Lin, L.N. 1952 Prog. 2nd Midwestern Conf. Fluid Mech. Reprints in English No.109, Iowa State University, U.S.A.

89) Lin, P.N. 1951 Ph.D. Thesis, Iowa State University, U.S.A.

90) Uchida, S. 1949 Dept. Inst. Sci Tech. Univ. Tokyo 3, 97 abstract Ind. Eng. Chem. 46, 1954, 1194.

91) Kawaguchi, M. 1958 J. Phys. Soc. Japan 13. 209.

92) Famularo, J. 1962. Sc.D. Thesis, New York University N.Y. U.S.A.

93) Hasimoto, H. 1959 J. Fluid Mech. 5, 317.

94) Darcy, H.P.G. 1856 "Les Fontaines Publiques de la Ville de Dijon." Paris: Victor Dalmont.

95) Emersleben, O. 1925 Phys. Z 26, 601.

96) Slichter, C.S. 1899 19th Annual Rep. U. S. Geol. Surv. Pt.2, 301 - 384.

97) Dupuit, A.J.E.J. 1865 "Traite theorique et practique de la conduite et de la distribution des eaux" Paris.

98) Blake, F.C. 1922, Trans. A.I.Ch.E. 14, 415.

99) Kozeny, J. 1927 Ber. Wien. Akad. 136a, 271.

100) Carman, P.C. 1937 Trans. Inst. Chem. Eng. 15, 150.

101) Davies,S. 1929 Engineering, 128, 69, 98.

102) Piercy, N.A.V. Hooper, M S. and Winny, H.F. 1933 Phil. Mag. (7) 647.

103) Fair, G.M. and Hatch, L.P. 1933 Trans. Amer. Wat. Works Asson. 25, 155.

104) Ratkowsky, D. and Epstein, N. 1968 Can. J. Chem. Eng. 46, 22.

105) Epstein, N. 1954 Ph.D. Thesis, New York University, U.S.A.

106) Brinkman, H.C. 1947 Appl. Sci. Res. A1, 27, 1948, A1, 81, 1949, A2, 190.

107) Spielman, L. and Goren, S.L. 1968 Environmental 2,279.

108) Richardson, J.F. and Zaki, W.N. 1954 Chem. Eng. Sci. 3, 65.

109) Hawksley, P.G.W. 1950 "Conference on some Aspect of Fluid Flow." P.114, Edward Arnold & Co., London.

110) Vand, V. 1948 J. Phys. Coll. Chem. 52, 277.

111) Hanratty, T.J. and Bandukwala, A. 1957 A.I.Ch.E.J. 3, 293.

112) Loeffler, A.L. and Ruth, B.F. 1959 A.I.Ch.E.J. 5, 310.

113) Witmore, R.L. 1955 British J. Appl. Phys. 6, 239.

114) Steinour, H.H. 1944 Ind. Eng. Chem. 36, 618.

115) Richardson, V.F. and Zaki, W.N. 1954 Trans. Inst. Chem. Eng. 32, 35.

116) Martin, J.J., McCabe, W.I., Monrad, C.C. 1951 C.E.P. 47 , 91.

117) Wilson, B.W. 1953 Aust. J. Appl. Sci. 4, 274.

118) Cunningham, E. 1910 Proc. Roy. Soc. A83, 357.

119) Sparrow, E.M. and Loeffer, A.L. Jr. 1959 A.I.Ch.E.J. 5, 325.

120) Epstein, P. 1903 Math. Ann. 60, 615; 1906, 63,205.

121) Miyagi, T. 1958 J. Phys. Soc. Japan 13, 493.

122) Tamada, K. and Fujikawa, H. 1957 Quart. J. Mech. Appl. Math. 10, 425.

123) Keller, J. 1964 J. Fluid Mech. 18, 94.

124) Kuwabara, S. 1959 J. Phys. Soc. Japan 14, 523.

125) Happel, J. and Ast, P.A. 1960 Chem. Eng. Sci. 11, 286.

126) Happel, J. 1958 A.I.Ch.E.J. 4, 197.

127) Adler, I.L. and Happel, J. 1962 Chem. Eng. Prog. Symp. Series 58, (No.38), 98.

128) Mertes, T.S. and Rhodes, H.B. 1955 Chem. Eng. Prog. 51, 429 and 517.

129) Verschoor, H. 1951 Appl. Sci. Res. A2, 155.

130) Happel, J. and Epstein, N. 1954 Ind. Eng. Chem. 46, 1187,

131) Smith, T.N. 1967 Trans. Inst. Chem. Engrs. 45, T311.

122) Smith, T.N. 1966 Trans. Inst. Chem. Engrs. 44, T153.

133) Happel, J. 1959 A.I.Ch.E.J. 5, 174.

134) Kuwabara, S. 1959, J. Phys. Soc. Japan 14, 527.

135) Kirsch, A.A. and Fuchs, N.A. 1967 Ann. Occup. Hyg.10, 23.

136) Bourot, J.M. 1968 C.R. Acad. Paris, t266, 1077.

137) Bourot, J.M. 1968 C.R. Acad. Paris, t266,1277.

138) Bourot, J.M. 1968 C.R. Acad. Paris, t266, 470.

139) Yu,H.S. and Sparrow,E.M. 1967 A.I.Ch.E.J. 13 ,10.

140) Oliver, D.R. 1961 Chem. Eng. Sci. 15, 230.

141) Snyder, L.J. and Stewart, W.E. 1966 A.I.Ch.E.J. 12. 167.

142) Galloway, L.R. and Epstein, N. 1965 A.I.Ch.E.- I. Chem. E. Symposium Series No.6. London: Inst. Chem. Engrs.

143) Galloway, L.R. 1963 Ph.D. Thesis University of British Columbia.

144) Gunn, D.J. and Darling, C.W.W. 1963 Trans. Inst. Chem. Engrs. 41, 163.

145) Jayaweera, K.O.L.F. and Mason, B.J. 1965 J. Fluid Mech. 22, 709.

146) Finn, R.K. 1953 J. Appl. Phys. 24, 771.

147) Wieselsberger, C. 1922 Phys. Z. 22, 321.

148) Lapple, C.E. in 1950 "Chemical Engineers Handbook." 3rd ed. New York: McGraw-Hill.

149) Groves, A.S.,Shair, F.H., Petersen, E.E., Acrivos, A. 1963 J. Fluid Mech. 19, 60.

150) Homann, F. 1936 Translation: Nat. Adv. Comm. Aero., Wash., Tech. Mem. No.1334 (1952)

151) Weinberg, L. 1951 J.F. Inst. 252, 42.

152) Forsythe, G.E. & Wasow, W.R. 1960 Finite Difference Methods for Partial Differential Equations, New York: John Wiley and Sons.

153) Burggraf, O.R. 1966 J. Fluid Mech. 24, 113.

154) Lapple, C.E. and Shepherd, C.B. 1940 Ind. Eng. Chem. 32, 605.

155) Schmiedel, J. 1928 Phys. Z. 29, 593.

156) Folsom, R.G. and Arbor, A. 1956 Trans. Am. Soc. Mech. Engrs. 78, 1447.

157) Nisi, H. and Porter, A.W. 1923 Phil. Mag. 46, 754.

158) Masliyah, J.H. and Epstein, N. 1969 submitted Phys. Fluids.

159) Van Dyke, M.D. 1964 "Perturbation Methods in Fluid Mechanics." Academic Press.

160) Taneda, S. 1956 Rept. Inst. Appl. Mech., Kyushu University 4, 99.

161) McNown, J.S., Lee, H.M., McPherson, M.B. and Enger, S.M. 1948 Proc. VII Int. Congr. Appl. Mech. 2, 17.

162) Schlichting, H. 1960 "Boundary Layer Theory". New York: McGraw-Hill Book Co.

163) LeClair, B.P., Hamielec, A.E. and Pruppacher, H.R. 1969 submitted to J. Atmospheric Sci.

164) Rimon, Y. and Lugt, H.J. 1969 Phys. Fluids 12, 2465.

NOMENCLATURE

a	sphere radius; cylinder radius; length of major semi-axis
a_1	length of the semi-axis of the particle perpendicular to the flow direction
a_2	length of the semi-axis of the outer envelope perpendicular to the flow direction.
a_e	equatorial radius of the spheroid
A	length of increment in the ξ-direction
A_n	coefficient appearing in equation 32 and table 1
A.R.	aspect ratio, ratio of minor to major axis
b	length of minor semi-axis
b_1	length of the semi-axis of the particle parallel to the flow direction
b_2	length of the semi-axis of the outer envelope parallel to the flow direction
B	length of increment in the η-direction
c	focal length of the coordinates system; volumetric concentration of the swarm or a cluster
C_{DF}	form drag coefficient
C_{DS}	skin drag coefficient
C_{DT}	total drag coefficient
C_{DTW}	total drag coefficient based on the axis of the elliptical cylinder parallel to the flow direction
d_m	mean diameter (total volume of the outer envelope divided by the volume of the inner particle, all raised to power 1/3)
E'^2	second order differential operator
F	total drag force
F_F	form drag force

F_S	skin drag force
G	dimensionless vorticity function given by equation 105 for spheroids and by ζ for cylinders
G_n	value of G after n iterations
G_n^*	unmodified value of G after n iternations
h	distance between the centres of two particles
h_1, h_2, h_3	metric coefficients of the coordinate system
H	bed height for the evaluation of k using the tortuosity method
H'	length of the semi-axis of the particle perpendicular to the flow direction, figures 34 and 74
H_e	effective bed length for the evaluation of k using the tortuosity method
i_1, i_2, i_3	unit vectors
I	denotes η-direction
I_n	Gegenbauer function of order n and degree -1/2
IM	maximum number of points in η-direction
J	denotes ξ-direction
JM	maximum number of points in ξ-direction
k	Kozeny constant
k_o	capillary constant
K	shape factor for spheroids (equations 20 and 21); permeability of a packed bed
L	dimensionless bed length, $L = L'/b_1$
L'	length of a packed bed
L_e'	length of the equivalent channel in a packed bed
m	hydraulic radius

O.R.	orientation ratio of elliptical cylinder $= b_1/a_1$
P	dimensionless dynamic pressure, $P=\frac{P' - P'_{st}}{\frac{1}{2} U^2 \rho}$
P'	dimensional dynamic pressure
P_o	dimensionless frontal stagnation pressure
P'_{st}	dimensional static pressure
$\Delta P'$	pressure drop per bed length L'
q_1, q_2, q_3	curvilinear coordinates
r	spherical radial coordinate; aspect ratio, appendix III
Re	Reynolds number
Rew	Reynolds number based on the axis parallel to the flow direction
S	particle surface area per unit volume of bed
S_v	specific surface of particles in a packed bed
U	superficial velocity; velocity of the undisturbed stream
v	dimensionless velocity $= v'/U$
v'	dimensional velocity
V	settling velocity of a swarm of particles
V_o	settling velocity of a single particle
W'_L	wake length, figures 34 and 74
x,y,z	Cartesian coordinates

Greek Letters

α_g	relaxation factor for the vorticity function
α_{gs}	relaxation factor for the vorticity function at the particle surface
α_s	relaxation factor for the stream function
γ	ratio of the inner particle radius to that of the outer envelope; Euler's constant = 0.5772
Γ	gamma function
δ	dimensionless boundary layer thickness, $\delta=\delta'/a_1$
δ'	dimensional boundary layer thickness
ε	porosity = 1-c
ζ	dimensionless vorticity function
ζ'	dimensional vorticity function
η	spheroidal and elliptical coordinates (ξ,η)
θ	spherical coordinates (r,θ)
μ	viscosity
ν	kinematic viscosity
ξ	spheroidal and elliptical coordinates (ξ,η)
ρ	density
τ	dimensionless shear stress
τ'	dimensional shear stress
ψ	dimensionless stream function
ψ'	dimensional stream function
ψ_n	value of ψ after n iterations
ψ_n^*	unmodified value of ψ after n iterations

Subscripts

a	inner surface
b	outer surface
η	η-direction
ξ	ξ-direction
ϕ	ϕ-direction

Superscripts

-	vector

APPENDIX I

Boundary Layer Theory and Potential Flow Development

Groves et al (149) obtained an expression for the dimensionless frontal stagnation pressure on a bluff body using boundary layer theory :

$$P_o = 1 - \frac{\mu}{1/2\rho U^2} \left.\frac{\partial u'}{\partial x'}\right|_{\substack{x'=\delta' \\ y'=0}} \qquad (I.1)$$

where δ' is the boundary layer thickness and the frontal stagnation point is at (0,0) . The above expression was also obtained by Homann (150) through different reasoning . Once the expression for the potential flow velocity u' (the velocity in the x-direction) is known for a given body , then the dimensionless stagnation pressure can be evaluated .

A. Spheroids

The solution of the harmonic equation

$$E'^2\psi' = 0 \qquad (I.2)$$

describing the flow of an ideal fluid past an oblate spheroid in terms of the stream function ψ' , for the boundary conditions of $\psi' = 0$ at the spheroid surface ($\xi=\xi_a$) and $\psi' = \frac{1}{2} Uc^2 \cosh^2\xi \sin^2\eta$ as $\xi\to\infty$, is given (8,151) by

$$\psi' = \frac{1}{2} U c^2 \sin^2\eta\{\tau^2+F(\lambda-\tau^2 \cot^{-1}\lambda)\} \qquad (I.3)$$

where

$$F = \frac{\tau_a^2}{\tau_a^2 \cot^{-1}\lambda_a - \lambda_a} \quad , \quad \tau = \cosh\xi \text{ and } \lambda = \sinh\xi \quad .$$

By definition , the velocities are given by

$$v'_\xi = - h_2 h_3 \frac{\partial \psi'}{\partial \eta} \tag{I.4}$$

and

$$v'_\eta = h_1 h_3 \frac{\partial \psi'}{\partial \xi} \tag{I.5}$$

and the metric coefficients h_1, h_2 and h_3 are given by equations 93 and 94 .

Using equations I.3 and I.4 yields

$$\left.\frac{\partial v'_\xi}{\partial \xi}\right|_{\substack{\eta=0 \\ \xi=\xi_a}} = \frac{- 2 U}{\tau_a(\lambda_a - \tau_a^2 \cot^{-1}\lambda_a)} \tag{I.6}$$

For an oblate spheroid equation I.1 takes the form

$$P_o = 1 + \frac{\mu}{\frac{1}{2}\rho U^2} \left(\frac{\partial v'_\xi}{\partial \xi} \quad \frac{\partial \xi}{\partial x'} \right) \Bigg|_{\substack{\eta=0 \\ \xi=\xi_a}} \tag{I.7}$$

where

$$x' = c \cos\eta \sinh\xi \tag{I.8}$$

and

$$\left.\frac{\partial x'}{\partial \xi}\right|_{\substack{\eta=0 \\ \xi=\xi_a}} = c \tau_a \tag{I.9}$$

Combining equations I.6, I.7 and I.9 yields

$$P_o = 1 + \frac{8}{Re} \cdot \left(\frac{\operatorname{sech}\xi_a}{\tau_a^2 \cot^{-1}\lambda_a - \lambda_a} \right) \tag{I.10}$$

For a prolate spheroid the dimensionless frontal stagnation pressure is given by

$$P_o = 1 + \frac{8}{Re} \cdot \frac{\operatorname{cosech}\xi_a}{\tau_a - \lambda_a^2 \coth^{-1}\tau_a} \qquad (I.11)$$

Re is based on the equatorial diameter of the spheroid . For $\xi_a \to \infty$, equations I.10 and I.11 each reduce to

$$P_o = 1 + \frac{12}{Re}$$

which is the case of a perfect sphere .

The surface pressure distribution for the oblate spheroid is obtained as follows :

$$v'_\eta\Big|_{\xi=\xi_a} = \frac{U\tau_a^2 \sin\eta}{(\cos^2\eta+\lambda_a^2)^{1/2}} \left\{\frac{\lambda_a}{\tau_a^2} - \frac{1-\lambda_a \coth^{-1}\lambda_a}{\lambda_a - \tau_a^2 \coth^{-1}\lambda_a}\right\} \qquad (I.12)$$

For the streamline $\psi'=0$, Bernoulli's equation gives

$$P'\Big|_{\substack{\xi=\infty\\ \eta=0}} + \frac{\rho}{2} v'^2_\eta\Big|_{\substack{\xi=0\\ \eta=0}} = P'\Big|_{\xi=\xi_a} + \frac{\rho}{2} v'^2_\eta\Big|_{\xi=\xi_a} \qquad (I.13)$$

Introducing the dimensionless surface pressure as given by equation 137a , and noting that

$$P\Big|_{\substack{\xi=\infty\\ \eta=0}} = 0 \text{ and } v'_\eta\Big|_{\substack{\xi=\infty\\ \eta=0}} = U ,$$

then equation I.13 applied at the surface yields

$$P = 1 - \left(v'_\eta/U \right)^2 \qquad (I.14)$$

The dimensionless surface pressure, P, for potential flow past the oblate spheroid is then given by

$$P = 1 - \sin^2\eta \frac{(\lambda_a^2+1)^2}{\lambda_a^2+\cos^2\eta} \left(\frac{\lambda_a}{\lambda_a^2+1} - \frac{1-\lambda_a \coth^{-1}\lambda_a}{\lambda_a-(\lambda_a^2+1)\coth^{-1}\lambda_a} \right)^2 \qquad (I.15)$$

On further reduction equation I.15 becomes

$$P = 1 - \frac{\sin^2\eta}{(\lambda_a^2+\cos^2\eta)(\lambda_a-(\lambda_a^2+1)\coth^{-1}\lambda_a)^2} \qquad (I.16)$$

The corresponding pressure distribution for the prolate spheroid is given by

$$P = 1 - \frac{\sin^2\eta}{(\tau_a^2 - \cos^2\eta)(\tau_a-(\tau_a^2 -1)\ \coth^{-1}\tau_a\ )^2} \qquad (I.17)$$

Both equations I.16 and I.17 reduce to

$$P = 1 - \frac{9}{4}\sin^2\eta \qquad (I.18)$$

for spheres as $\lambda_a \to \infty$ and $\tau_a \to \infty$.

B. Elliptical Cylinders

The solution of the harmonic equation I.2 when the main flow is parallel to the major axis of an elliptical cylinder , for the boundary conditions of $\psi' = 0$ at the surface of the cylinder ($\xi = \xi_a$) and $\psi' = U\ c\ \sinh\xi\ \sin\eta$ for $\xi \to \infty$, yields

$$\psi' = Uc\ \sin\eta\{-\lambda_a \left[\frac{\tau_a+\lambda_a}{\tau_a-\lambda_a}\right]^{1/2} e^{-\xi} + \sinh\xi\ \} \qquad (I.19)$$

The velocities for the two-dimensional flow are given by definition as

$$v'_\xi = -\ h_2\ \frac{\partial\psi'}{\partial\eta} \qquad (I.20)$$

and

$$v'_\eta = \quad h_1\frac{\partial\psi'}{\partial\xi} \qquad (I.21)$$

The metric coefficients are given by equation 134 .

Differentiating equation I.19 w.r.t. η and combining with equation I.20 yields

$$v'_\xi = \frac{U\ \cos\eta}{\sqrt{\lambda^2+\sin^2\eta}}\ \{-\lambda_a\sqrt{\frac{\tau_a\ +\ \lambda_a}{\tau_a\ -\ \lambda_a}}\ \ e^{-\xi} + \sinh\xi\ \} \qquad (I.22)$$

By differentiating equation I.22 w.r.t.ξ , we obtain , after

some reduction ,

$$\left.\frac{\partial v'_\xi}{\partial \xi}\right|_{\substack{\xi=\xi_a \\ \eta=0}} = \frac{U}{\sinh\xi_a}\left(\frac{1+\tanh\xi_a}{1-\tanh\xi_a}\right)^{1/2} \qquad (I.23)$$

For the main flow parallel to the major axis of the elliptical cylinder , equation I.1 has the form

$$P_o = 1 + \frac{\mu}{\frac{1}{2}\rho U^2}\left(\frac{\partial v'_\xi}{\partial \xi}\,\frac{\partial \xi}{\partial x'}\right)\Bigg|_{\substack{\xi=\xi_a \\ \eta=0}} \qquad (I.24)$$

where $x' = c\cosh\xi\cos\eta$ (I.25)

and

$$\left.\frac{\partial x'}{\partial \xi}\right|_{\substack{\xi=\xi_a \\ \eta=0}} = c\sinh\xi_a \qquad (I.26)$$

Combining equations I.23,I.24 and I.26 yields

$$P_o = 1 + \frac{4}{Re}\left(\frac{1+\tanh\xi_a}{1-\tanh\xi_a}\right)^{1/2}\frac{1}{\sinh\xi_a}$$

or

$$P_o = 1 + \frac{4}{Re}\left[\frac{1+\tanh\xi_a}{\tanh\xi_a}\right] \qquad (I.27)$$

The above equation gives the dimensionless frontal stagnation pressure for O.R.$\geq$1.0 . For O.R.$\leq$1.0 ,

$$P_o = 1 + \frac{4}{Re}\left[\frac{1+\coth\xi_a}{\coth\xi_a}\right] \qquad (I.28)$$

For a circular cylinder $\xi_a \to \infty$ and both $\tanh\xi_a$ and $\coth\xi_a$ tend to unity giving , from both equations I.27 and I.28 ,

$$P_o = 1 + \frac{8}{Re} \qquad (I.29)$$

The surface pressure distribution around the elliptical cylinder for O.R.$\geq$1.0 is obtained by using equation I.14 , where

$$v'_\eta \Big|_{\xi=\xi_a} = U \sin\eta \left(\frac{1 + \tanh\xi_a}{1 - \tanh\xi_a}\right)^{1/2} \frac{1}{[\lambda_a^2 + \sin^2\eta]^{1/2}} \qquad \text{(I.30)}$$

giving

$$P = 1 - \frac{\sin^2\eta}{\lambda_a^2 + \sin^2\eta} \left[\frac{1 + \tanh\xi_a}{1 - \tanh\xi_a} \right] \qquad \text{(I.31)}$$

For O.R.$\leqslant$1.0 the pressure distribution is given by

$$P = 1 - \frac{\sin^2\eta}{\tau_a^2 - \sin^2\eta} \left[\frac{\coth\xi_a + 1}{\coth\xi_a - 1} \right] \qquad \text{(I.32)}$$

For a circular cylinder $\xi_a \to \infty$ and equations I.31 and I.32 each reduce to

$$P = 1 - 4 \sin^2\eta$$

NOTATION FOR APPENDIX II

A	Interval length in the ξ-direction
A.R.	Aspect ratio, ratio of minor to major axis
B	Interval length in the η-direction
CDF	Form drag coefficient, C_{DF}
CDS	Skin drag coefficient, C_{DS}
CDT	Total drag coefficient, C_{DT}
DM	Mean diameter, d_m
IM	Number of points in the η-direction
JM	Number of points in the ξ-direction
MARK	Run number
X1	Value of ξ at the particle surface
X2	Value of ξ at the outer envelope

APPENDIX II

Data for Single Spheroids, Single Elliptical Cylinders, Swarms of Spheroids and Clusters of Elliptical Cylinders.

Single Oblate Spheroids

OBLATE SPHEROID MARK= 259

A.R.	PE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
1.00	1.00	0.4629649E-05	50.9996	3.0000	7.0952	0.0931	0.0982	33	45

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.2021E 00	0.3999E 00	0.5918E 00	0.7756E 00	0.9488E 00	0.1109E 01	0.1255E 01	0.1384E 01	0.1496E 01
0.1589E 01	0.1662E 01	0.1715E 01	0.1747E 01	0.1761E 01	0.1755E 01	0.1731E 01	0.1689E 01	0.1633E 01	0.1562E 01
0.1478E 01	0.1384E 01	0.1280E 01	0.1168E 01	0.1051E 01	0.9274E 00	0.8007E 00	0.6709E 00	0.5390E 00	0.4056E 00
0.2711E 00	0.1360E 00	0.1392E-12							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.18331E 02	0.90387E 01	0.27370E 02	0.20280E 01	0.49309E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.7910E 01	0.7722E 01	0.7175E 01	0.6307E 01	0.5178E 01	0.3863E 01	0.2444E 01	0.1004E 01	-0.3815E 00	-0.1650E 01
-0.2758E 01	-0.3681E 01	-0.4412E 01	-0.4957E 01	-0.5330E 01	-0.5544E 01	-0.5617E 01			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.18331E 02	0.92195E 01	0.27550E 02	0.19883E 01	0.50295E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.7907E 01	0.7715E 01	0.7156E 01	0.6270E 01	0.5117E 01	0.3774E 01	0.2324E 01	0.8543E 00	-0.5593E 00	-0.1853E 01
-0.2982E 01	-0.3922E 01	-0.4666E 01	-0.5219E 01	-0.5598E 01	-0.5816E 01	-0.5888E 01			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

OBLATE SPHEROID MARK= 37

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
1.00	1.00	0.20013835-03	17.0957	4.0000	6.8300	0.0499	0.0983	33	59

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.2076E 00	0.4107E 00	0.6078E 00	0.7963E 00	0.9737E 00	0.1138E 01	0.1287E 01	0.1419E 01	0.1533E 01
0.1627E 01	0.1702E 01	0.1756E 01	0.1790E 01	0.1805E 01	0.1800E 01	0.1776E 01	0.1736E 01	0.1679E 01	0.1608E 01
0.1525E 01	0.1429E 01	0.1324E 01	0.1211E 01	0.1091E 01	0.9647E 00	0.8340E 00	0.6998E 00	0.5629E 00	0.4243E 00
0.2836E 00	0.1423E 00	0.1508E-12							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.18927E 02	0.94788E 01	0.28404E 02	0.19967E 01	0.50083E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.8062E 01	0.7865E 01	0.7288E 01	0.6376E 01	0.5133E 01	0.3819E 01	0.2337E 01	0.8362E 00	-0.6085E 00	-0.1935E 01
-0.3099E 01	-0.4076E 01	-0.4957E 01	-0.5665E 01	-0.6060E 01	-0.6083E 01	-0.5716E 01			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.18927E 02	0.95344E 01	0.28441E 02	0.19851E 01	0.50376E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.8059E 01	0.7860E 01	0.7279E 01	0.6361E 01	0.5170E 01	0.3785E 01	0.2295E 01	0.7344E 00	-0.6691E 00	-0.2003E 01
-0.3174E 01	-0.4156E 01	-0.4939E 01	-0.5629E 01	-0.5936E 01	-0.6174E 01	-0.6251E 01			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

OBLATE SPHEROID MARK= 5

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
1.00	1.00	0.3718853E-06	29.9591	4.0000	7.4000	0.0500	0.0982	33	59

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.2039E 00	0.4033E 00	0.5967E 00	0.7816E 00	0.9557E 00	0.1117E 01	0.1263E 01	0.1392E 01	0.1503E 01
0.1595E 01	0.1667E 01	0.1720E 01	0.1753E 01	0.1765E 01	0.1759E 01	0.1735E 01	0.1695E 01	0.1639E 01	0.1569E 01
0.1486E 01	0.1392E 01	0.1289E 01	0.1178E 01	0.1060E 01	0.9371E 00	0.8098E 00	0.6791E 00	0.5460E 00	0.4111E 00
0.2749E 00	0.1379E 00	0.1436E-12							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.18492E 02	0.92049E 01	0.27697E 02	0.20089E 01	0.49777E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.7953E 01	0.7759E 01	0.7195E 01	0.6303E 01	0.5146E 01	0.3803E 01	0.2359E 01	0.8977E 00	-0.5936E 00	-0.1793E 01
-0.2920E 01	-0.3862E 01	-0.4613E 01	-0.5176E 01	-0.5564E 01	-0.5790E 01	-0.5864E 01			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.18492E 02	0.92671E 01	0.27754E 02	0.19965E 01	0.50087E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.7949E 01	0.7754E 01	0.7186E 01	0.6288E 01	0.5124E 01	0.3772E 01	0.2318E 01	0.8466E 00	-0.5966E 00	-0.1861E 01
-0.2994E 01	-0.3942E 01	-0.4697E 01	-0.5263E 01	-0.5652E 01	-0.5872E 01	-0.5953E 01			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

OBLATE SPHEROID MARK= 265

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
1.00	5.00	0.4629649E-05	59.9996	3.0000	7.0952	0.0931	0.0982	33	45

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.3466E 00	0.6783E 00	0.9972E 00	0.1297E 01	0.1573E 01	0.1819E 01	0.2032E 01	0.2208E 01	0.2346E 01
0.2442E 01	0.2498E 01	0.2516E 01	0.2496E 01	0.2441E 01	0.2356E 01	0.2244E 01	0.2110E 01	0.1958E 01	0.1795E 01
0.1624E 01	0.1450E 01	0.1277E 01	0.1109E 01	0.9480E 00	0.7963E 00	0.6550E 00	0.5246E 00	0.4046E 00	0.2941E 00
0.1912E 00	0.9387E-01	0.1392E-12							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.47528E 01	0.24281E 01	0.71809E 01	0.19574E 01	0.51088E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2633E 01	0.2536E 01	0.2274E 01	0.1875E 01	0.1380E 01	0.8415E 00	0.3110E 00	-0.1666E 00	-0.5596E 00	-0.8522E 00
-0.1044E 01	-0.1146E 01	-0.1180E 01	-0.1170E 01	-0.1141E 01	-0.1113E 01	-0.1102E 01			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.47528E 01	0.24804E 01	0.72332E 01	0.19161E 01	0.52188E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2633E 01	0.2531E 01	0.2265E 01	0.1860E 01	0.1356E 01	0.8063E 00	0.2640E 00	-0.2249E 00	-0.6277E 00	-0.9274E 00
-0.1123E 01	-0.1227E 01	-0.1261E 01	-0.1249E 01	-0.1218E 01	-0.1189E 01	-0.1178E 01			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

OBLATE SPHEROID MARK= 58

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
1.00	10.00	0.20013833E-03	17.0957	4.0000	6.8300	0.0489	0.0982	33	59

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.4700E 00	0.9249E 00	0.1359E 01	0.1743E 01	0.2128E 01	0.2449E 01	0.2718E 01	0.2932E 01	0.3087E 01
0.3183E 01	0.3221E 01	0.3202E 01	0.3131E 01	0.3012E 01	0.2856E 01	0.2663E 01	0.2446E 01	0.2213E 01	0.1970E 01
0.1726E 01	0.1487E 01	0.1259E 01	0.1046E 01	0.8524E 00	0.6798E 00	0.5292E 00	0.4003E 00	0.2918E 00	0.2012E 00
0.1250E 00	0.5914E-01	0.1508E-12							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.28439E 01	0.15340E 01	0.43779E 01	0.18540E 01	0.53929E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1897E 01	0.1807E 01	0.1579E 01	0.1236E 01	0.8220E 00	0.3883E 00	-0.1656E-01	-0.3566E 00	-0.6031E 00	-0.7565E 00
-0.8233E 00	-0.8222E 00	-0.7764E 00	-0.7097E 00	-0.6436E 00	-0.5959E 00	-0.5784E 00			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.28439E 01	0.15478E 01	0.43917E 01	0.18374E 01	0.54424E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1886E 01	0.1806E 01	0.1577E 01	0.1232E 01	0.8152E 00	0.3784E 00	-0.2991E-01	-0.3712E 00	-0.6224E 00	-0.7776E 00
-0.8654E 00	-0.8446E 00	-0.7981E 00	-0.7306E 00	-0.6639E 00	-0.6156E 00	-0.5979E 00			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

OBLATE SPHEROID MARK= 73

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
1.00	10.00	0.37198953E-04	29.9591	4.0000	7.4000	0.0500	0.0982	33	69

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.4691E 00	0.9231E 00	0.1356E 01	0.1739E 01	0.2124E 01	0.2443E 01	0.2712E 01	0.2925E 01	0.3079E 01
0.3175E 01	0.3211E 01	0.3192E 01	0.3120E 01	0.3002E 01	0.2843E 01	0.2652E 01	0.2435E 01	0.2202E 01	0.1960E 01
0.1716E 01	0.1477E 01	0.1250E 01	0.1037E 01	0.8443E 00	0.6723E 00	0.5224E 00	0.3944E 00	0.2869E 00	0.1973E 00
0.1223E 00	0.5777E-01	0.1436E-12							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.28326E 01	0.15244E 01	0.43571E 01	0.18580E 01	0.53822E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1885E 01	0.1805E 01	0.1579E 01	0.1236E 01	0.8238E 00	0.3917E 00	-0.1131E-01	-0.3475E 00	-0.5945E 00	-0.7445E 00
-0.8124E 00	-0.8106E 00	-0.7645E 00	-0.6976E 00	-0.6315E 00	-0.5837E 00	-0.5662E 00			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.28326E 01	0.15389E 01	0.43715E 01	0.18407E 01	0.54328E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1885E 01	0.1804E 01	0.1576E 01	0.1232E 01	0.8169E 00	0.3815E 00	-0.2509E-01	-0.3647E 00	-0.6144E 00	-0.7684E 00
-0.8352E 00	-0.8336E 00	-0.7870E 00	-0.7193E 00	-0.6525E 00	-0.6041E 00	-0.5866E 00			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

OBLATE SPHEROID MARK= 90

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
1.00	20.00	0.20013833E-03	17.0957	4.0000	6.8390	0.0489	0.0982	33	59

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.6652E 00	0.1307E 01	0.1917E 01	0.2480E 01	0.2985E 01	0.3419E 01	0.3775E 01	0.4044E 01	0.4224E 01
0.4313E 01	0.4313E 01	0.4229E 01	0.4068E 01	0.3839E 01	0.3556E 01	0.3231E 01	0.2877E 01	0.2511E 01	0.2143E 01
0.1787E 01	0.1453E 01	0.1147E 01	0.8758E 00	0.6423E 00	0.4481E 00	0.2928E 00	0.1750E 00	0.9168E-01	0.3855E-01
0.9943E-02	-0.9864E-03	0.1508E-12							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.17396E 01	0.10250E 01	0.27647E 01	0.16971E 01	0.58923E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1477E 01	0.1401E 01	0.1188E 01	0.8720E 00	0.4996E 00	0.1241E 00	-0.2063E 00	-0.4573E 00	-0.6136E 00	-0.6793E 00
-0.6727E 00	-0.6187E 00	-0.5418E 00	-0.4613E 00	-0.3918E 00	-0.3444E 00	-0.3274E 00			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.17396E 01	0.10404E 01	0.27800E 01	0.16721E 01	0.59807E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1476E 01	0.1401E 01	0.1188E 01	0.8707E 00	0.4965E 00	0.1183E 00	-0.2157E 00	-0.4705E 00	-0.6303E 00	-0.6983E 00
-0.6929E 00	-0.6393E 00	-0.5620E 00	-0.4810E 00	-0.4109E 00	-0.3631E 00	-0.3459E 00			

ANGLE AT WHICH SURFACE SHEAR STRESS BECOMES ZERO I.E. SEPARATION,IS 173.9 DEGREES

OBLATE SPHEROID MARK= 283

A.R.	RE	CONCENTRATION	OM	X1	X2	A	B	IM	JM
1.00	20.00	0.20011119E-03	17.0965	4.0000	6.8390	0.0444	0.0524	61	65

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 3.001 DEGREES INTERVAL

0.0	0.3493E 00	0.6950E 00	0.1036E 01	0.1369E 01	0.1693E 01	0.2006E 01	0.2305E 01	0.2588E 01	0.2854E 01
0.3100E 01	0.3326E 01	0.3530E 01	0.3711E 01	0.3867E 01	0.3999E 01	0.4105E 01	0.4185E 01	0.4241E 01	0.4270E 01
0.4274E 01	0.4253E 01	0.4210E 01	0.4143E 01	0.4056E 01	0.3949E 01	0.3824E 01	0.3683E 01	0.3528E 01	0.3361E 01
0.3184E 01	0.3000E 01	0.2810E 01	0.2616E 01	0.2421E 01	0.2227E 01	0.2035E 01	0.1846E 01	0.1663E 01	0.1487E 01
0.1319E 01	0.1160E 01	0.1010E 01	0.8711E 00	0.7425E 00	0.6248E 00	0.5183E 00	0.4229E 00	0.3386E 00	0.2651E 00
0.2021E 00	0.1491E 00	0.1057E 00	0.7119E-01	0.4472E-01	0.2546E-01	0.1241E-01	0.4501E-02	0.5590E-03	-0.6245E-03
0.0									

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.17155E 01	0.10182E 01	0.27337E 01	0.16848E 01	0.59353E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 6.001 DEGREES INTERVAL

0.1467E 01	0.1466E 01	0.1383E 01	0.1282E 01	0.1147E 01	0.9835E 00	0.7994E 00	0.6023E 00	0.4003E 00	0.2016E 00
0.1289E-01	-0.1589E 00	-0.3090E 00	-0.4339E 00	-0.5319E 00	-0.6028E 00	-0.6479E 00	-0.6697E 00	-0.6716E 00	-0.6572E 00
-0.6305E 00	-0.5953E 00	-0.5549E 00	-0.5123E 00	-0.4699E 00	-0.4300E 00	-0.3943E 00	-0.3646E 00	-0.3421E 00	-0.3281E 00
-0.3234E 00									

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.17155E 01	0.10321E 01	0.27476E 01	0.16621E 01	0.60164E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 6.001 DEGREES INTERVAL

0.1467E 01	0.1466E 01	0.1383E 01	0.1282E 01	0.1146E 01	0.9825E 00	0.7978E 00	0.5998E 00	0.3967E 00	0.1964E 00
0.6256E-02	-0.1673E 00	-0.3192E 00	-0.4459E 00	-0.5456E 00	-0.6179E 00	-0.6643E 00	-0.6871E 00	-0.6895E 00	-0.6756E 00
-0.6491E 00	-0.6139E 00	-0.5734E 00	-0.5307E 00	-0.4881E 00	-0.4480E 00	-0.4121E 00	-0.3821E 00	-0.3595E 00	-0.3456E 00
-0.3406E 00									

ANGLE AT WHICH SURFACE SHEAR STRESS BECOMES ZERO I.E. SEPARATION,IS 175.5 DEGREES

OBLATE SPHEROID MARK= 106

A.R.	RE	CONCENTRATION	OM	X1	X2	A	B	IM	JM
1.00	50.00	0.2001383E-03	17.0957	4.0000	6.8390	0.0499	0.0982	33	59

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1092E 01	0.2143E 01	0.3137E 01	0.4049E 01	0.4855E 01	0.5537E 01	0.6076E 01	0.6462E 01	0.6686E 01
0.6747E 01	0.6649E 01	0.6400E 01	0.6017E 01	0.5520E 01	0.4937E 01	0.4295E 01	0.3627E 01	0.2963E 01	0.2330E 01
0.1750E 01	0.1240E 01	0.8079E 00	0.4554E 00	0.1792E 00	-0.2708E-01	-0.1704E 00	-0.2564E 00	-0.2802E 00	-0.2725E 00
-0.2123E 00	-0.1184E 00	0.1508E-12							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.94927E 00	0.66237E 00	0.16116E 01	0.14331E 01	0.69778E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1207E 01	0.1130E 01	0.9133E 00	0.5968E 00	0.2350E 00	-0.1121E 00	-0.3024E 00	-0.5735E 00	-0.6486E 00	-0.6360E 00
-0.5687E 00	-0.4805E 00	-0.3953E 00	-0.3237E 00	-0.2678E 00	-0.2301E 00	-0.2161E 00			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.94927E 00	0.68059E 00	0.16299E 01	0.13948E 01	0.71697E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1207E 01	0.1131E 01	0.9189E 00	0.6072E 00	0.2488E 00	-0.9903E-01	-0.3817E 00	-0.5685E 00	-0.6499E 00	-0.6420E 00
-0.5771E 00	-0.4896E 00	-0.4042E 00	-0.3322E 00	-0.2760E 00	-0.2379E 00	-0.2239E 00			

ANGLE AT WHICH SURFACE SHEAR STRESS BECOMES ZERO I.E. SEPARATION,IS 139.9 DEGREES

OBLATE SPHEROID MARK= 150

A.R.	RE	CONCENTRATION	OM	X1	X2	A	B	IM	JM
1.00	50.00	0.20011119E-03	17.0965	4.0000	6.8390	0.0273	0.0524	61	105

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 3.00 DEGREES INTERVAL

0.0	0.5633E 00	0.1121E 01	0.1670E 01	0.2206E 01	0.2727E 01	0.3227E 01	0.3704E 01	0.4155E 01	0.4575E 01
0.4961E 01	0.5312E 01	0.5624E 01	0.5896E 01	0.6126E 01	0.6311E 01	0.6452E 01	0.6547E 01	0.6596E 01	0.6600E 01
0.6558E 01	0.6474E 01	0.6347E 01	0.6182E 01	0.5979E 01	0.5742E 01	0.5476E 01	0.5183E 01	0.4869E 01	0.4538E 01
0.4194E 01	0.3843E 01	0.3489E 01	0.3137E 01	0.2791E 01	0.2455E 01	0.2132E 01	0.1826E 01	0.1539E 01	0.1272E 01
0.1027E 01	0.8043E 00	0.6042E 00	0.4262E 00	0.2697E 00	0.1339E 00	-0.1784E-01	-0.7953E-01	-0.1591E 00	-0.2215E 00
-0.2676E 00	-0.2978E 00	-0.3127E 00	-0.3128E 00	-0.2989E 00	-0.2720E 00	-0.2334E 00	-0.1848E 00	-0.1282E 00	-0.6601E-01
0.0									

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.92468E 00	0.65562E 00	0.15803E 01	0.14104E 01	0.70902E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 6.00 DEGREES INTERVAL

0.1202E 01	0.1181E 01	0.1119E 01	0.1019E 01	0.8870E 00	0.7283E 00	0.5509E 00	0.3636E 00	0.1751E 00	-0.5997E-02
-0.1717E 00	-0.3156E 00	-0.4327E 00	-0.5202E 00	-0.5776E 00	-0.6066E 00	-0.6101E 00	-0.5933E 00	-0.5615E 00	-0.5201E 00
-0.4740E 00	-0.4271E 00	-0.3819E 00	-0.3401E 00	-0.3023E 00	-0.2686E 00	-0.2393E 00	-0.2148E 00	-0.1941E 00	-0.1862E 00
-0.1801E 00									

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.92468E 00	0.66631E 00	0.15910E 01	0.13878E 01	0.72059E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 6.00 DEGREES INTERVAL

0.1202E 01	0.1181E 01	0.1119E 01	0.1020E 01	0.8875E 00	0.7287E 00	0.5513E 00	0.3636E 00	0.1745E 00	-0.7443E-02
-0.1743E 00	-0.3195E 00	-0.4381E 00	-0.5271E 00	-0.5859E 00	-0.6160E 00	-0.6207E 00	-0.6046E 00	-0.5733E 00	-0.5323E 00
-0.4863E 00	-0.4394E 00	-0.3942E 00	-0.3524E 00	-0.3145E 00	-0.2808E 00	-0.2515E 00	-0.2269E 00	-0.2081E 00	-0.1942E 00
-0.1921E 00									

ANGLE AT WHICH SURFACE SHEAR STRESS BECOMES ZERO I.E. SEPARATION,IS 138.6 DEGREES

OBLATE SPHEROID MARK= 124

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
1.00	100.00	0.2001383E-03	17.0957	4.0000	6.8390	0.0489	0.0982	33	59

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1629E 01	0.3195E 01	0.4671E 01	0.6017E 01	0.7197E 01	0.8180E 01	0.8940E 01	0.9457E 01	0.9720E 01
0.9725E 01	0.9477E 01	0.8993E 01	0.8298E 01	0.7439E 01	0.6434E 01	0.5369E 01	0.4288E 01	0.3250E 01	0.2305E 01
0.1490E 01	0.8241E 00	0.3102E 00	-0.6464E-01	-0.3246E 00	-0.4091E 00	-0.4150E 00	-0.4834E 00	-0.6983E 00	-0.6422E 00
-0.5021E 00	-0.2833E 00	0.1504E-12							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.61706E 00	0.51616E 00	0.11332E 01	0.11955E 01	0.83649E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1109E 01	0.1024E 01	0.7889E 00	0.4486E 00	0.6815E-01	-0.2831E 00	-0.5468E 00	-0.6901E 00	-0.7146E 00	-0.6535E 00
-0.5548E 00	-0.4583E 00	-0.3938E 00	-0.3318E 00	-0.2922E 00	-0.2602E 00	-0.2463E 00			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.61706E 00	0.51472E 00	0.11131E 01	0.11988E 01	0.83415E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1110E 01	0.1031E 01	0.8126E 00	0.4941E 00	0.1352E 00	-0.2010E 00	-0.4596E 00	-0.6075E 00	-0.6416E 00	-0.5990E 00
-0.4946E 00	-0.3990E 00	-0.3242E 00	-0.2719E 00	-0.2321E 00	-0.1998E 00	-0.1857E 00			

ANGLE AT WHICH SURFACE SHEAR STRESS BECOMES ZERO I.E. SEPARATION,IS 129.4 DEGREES

OBLATE SPHEROID MARK= 216

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
1.00	100.00	0.2001110E-03	17.0965	4.0000	6.8390	0.0273	0.0524	61	105

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 3.00 DEGREES INTERVAL

0.0	0.8184E 00	0.1629E 01	0.2424E 01	0.3204E 01	0.3959E 01	0.4683E 01	0.5373E 01	0.6021E 01	0.6625E 01
0.7178E 01	0.7676E 01	0.8116E 01	0.8495E 01	0.8809E 01	0.9055E 01	0.9232E 01	0.9338E 01	0.9374E 01	0.9338E 01
0.9233E 01	0.9059E 01	0.8819E 01	0.8517E 01	0.8157E 01	0.7744E 01	0.7284E 01	0.6791E 01	0.6266E 01	0.5715E 01
0.5153E 01	0.4588E 01	0.4028E 01	0.3481E 01	0.2957E 01	0.2463E 01	0.2001E 01	0.1580E 01	0.1200E 01	0.8624E 00
0.5680E 00	0.3149E 00	0.1009E 00	-0.7737E-01	-0.2238E 00	-0.3626E 00	-0.4380E 00	-0.5138E 00	-0.5728E 00	-0.6169E 00
-0.6466E 00	-0.6615E 00	-0.6600E 00	-0.6406E 00	-0.6017E 00	-0.5426E 00	-0.4638E 00	-0.3667E 00	-0.2564E 00	-0.1309E 00
0.0									

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.59112E 00	0.50817E 00	0.10993E 01	0.11632E 01	0.85947E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 6.00 DEGREES INTERVAL

0.1106E 01	0.1084E 01	0.1020E 01	0.9171E 00	0.7808E 00	0.6181E 00	0.4375E 00	0.2483E 00	0.6027E-01	-0.1172E 00
-0.2756E 00	-0.4077E 00	-0.5085E 00	-0.5757E 00	-0.6098E 00	-0.6138E 00	-0.5935E 00	-0.5556E 00	-0.5074E 00	-0.4561E 00
-0.4060E 00	-0.3605E 00	-0.3213E 00	-0.2883E 00	-0.2607E 00	-0.2368E 00	-0.2155E 00	-0.1947E 00	-0.1811E 00	-0.1707E 00
-0.1669E 00									

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.59112E 00	0.52389E 00	0.11150E 01	0.11283E 01	0.88626E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 6.00 DEGREES INTERVAL

0.1106E 01	0.1084E 01	0.1021E 01	0.9189E 00	0.7838E 00	0.6232E 00	0.4425E 00	0.2537E 00	0.6555E-01	-0.1127E 00
-0.2725E 00	-0.4065E 00	-0.5090E 00	-0.5798E 00	-0.6165E 00	-0.6229E 00	-0.6044E 00	-0.5678E 00	-0.5206E 00	-0.4694E 00
-0.4193E 00	-0.3739E 00	-0.3345E 00	-0.3015E 00	-0.2737E 00	-0.2498E 00	-0.2284E 00	-0.2094E 00	-0.1938E 00	-0.1832E 00
-0.1795E 00									

ANGLE AT WHICH SURFACE SHEAR STRESS BECOMES ZERO I.E. SEPARATION,IS 127.7 DEGREES

OBLATE SPHEROID MARK= 249

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
1.00	100.00	0.2914830E-02	6.9089	4.0000	5.9459	0.0304	0.0785	41	65

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 4.50 DEGREES INTERVAL

0.0	0.1259E 01	0.2488E 01	0.3673E 01	0.4797E 01	0.5839E 01	0.6782E 01	0.7611E 01	0.8311E 01	0.8870E 01
0.9277E 01	0.9527E 01	0.9616E 01	0.9542E 01	0.9311E 01	0.8932E 01	0.8409E 01	0.7749E 01	0.7335E 01	0.6218E 01
0.5364E 01	0.4497E 01	0.3649E 01	0.2849E 01	0.2119E 01	0.1477E 01	0.9322E 00	0.4962E 00	0.1345E 00	-0.1334E 00
-0.3316E 00	-0.4755E 00	-0.5801E 00	-0.6542E 00	-0.6988E 00	-0.7074E 00	-0.6996E 00	-0.5765E 00	-0.4276E 00	-0.2316E 00
0.7173E-12									

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.61106E 00	0.53290E 00	0.11440E 01	0.11467E 01	0.87209E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 9.00 DEGREES INTERVAL

0.1108E 01	0.1057E 01	0.9128E 00	0.6910E 00	0.4179E 00	0.1249E 00	-0.1547E 00	-0.3004E 00	-0.3602E 00	-0.3527E 00
-0.6718E 00	-0.6342E 00	-0.5638E 00	-0.4844E 00	-0.4124E 00	-0.3583E 00	-0.3124E 00	-0.2700E 00	-0.2497E 00	-0.2345E 00
-0.2171E 00									

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.61106E 00	0.53093E 00	0.11420E 01	0.11091E 01	0.90160E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 9.00 DEGREES INTERVAL

0.1108E 01	0.1058E 01	0.9156E 00	0.6966E 00	0.4240E 00	0.1345E 00	-0.1454E 00	-0.3836E 00	-0.5673E 00	-0.6445E 00
-0.6782E 00	-0.6439E 00	-0.5756E 00	-0.4966E 00	-0.4247E 00	-0.3674E 00	-0.3246E 00	-0.2910E 00	-0.2716E 00	-0.2382E 00
-0.2287E 00									

ANGLE AT WHICH SURFACE SHEAR STRESS BECOMES ZERO I.E. SEPARATION,IS 128.3 DEGREES

OBLATE SPHEROID MARK= 38

A.R.	RE	CONCENTRATION	DM	XI	X2	A	B	IM	JM
0.90	1.00	0.2000668E-03	17.0978	1.4750	4.3300	0.0492	0.0982	33	59

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1851E 00	0.3677E 00	0.5485E 00	0.7249E 00	0.9017E 00	0.1071E 01	0.1234E 01	0.1388E 01	0.1529E 01
0.1656E 01	0.1764E 01	0.1850E 01	0.1912E 01	0.1947E 01	0.1953E 01	0.1932E 01	0.1883E 01	0.1809E 01	0.1714E 01
0.1602E 01	0.1476E 01	0.1342E 01	0.1203E 01	0.1061E 01	0.9197E 00	0.7803E 00	0.6436E 00	0.5101E 00	0.3797E 00
0.2519E 00	0.1258E 00	0.1514E-12							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.17772E 02	0.10106E 02	0.27879E 02	0.17585E 01	0.56865E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.7850E 01	0.7707E 01	0.7285E 01	0.6574E 01	0.5563E 01	0.4258E 01	0.2703E 01	0.9907E 00	-0.7361E 00	-0.2322E 01
-0.3644E 01	-0.4645E 01	-0.5337E 01	-0.5773E 01	-0.6024E 01	-0.6150E 01	-0.6190E 01			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.17772E 02	0.10152E 02	0.27924E 02	0.17507E 01	0.57121E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.7857E 01	0.7713E 01	0.7290E 01	0.6577E 01	0.5563E 01	0.4252E 01	0.2689E 01	0.9673E 00	-0.7696E 00	-0.2364E 01
-0.3692E 01	-0.4698E 01	-0.5387E 01	-0.5823E 01	-0.6072E 01	-0.6197E 01	-0.6237E 01			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

OBLATE SPHEROID MARK= 257

A.R.	RE	CONCENTRATION	DM	XI	X2	A	B	IM	JM
0.90	1.00	0.3843239E-04	20.4233	1.4750	4.8800	0.0501	0.0982	33	59

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1817E 00	0.3610E 00	0.5386E 00	0.7135E 00	0.8850E 00	0.1051E 01	0.1211E 01	0.1361E 01	0.1500E 01
0.1623E 01	0.1728E 01	0.1812E 01	0.1872E 01	0.1906E 01	0.1910E 01	0.1889E 01	0.1839E 01	0.1766E 01	0.1673E 01
0.1561E 01	0.1438E 01	0.1307E 01	0.1170E 01	0.1032E 01	0.8937E 00	0.7577E 00	0.6247E 00	0.4969E 00	0.3693E 00
0.2443E 00	0.1220E 00	0.1441E-12							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.17366E 02	0.97804E 01	0.27143E 02	0.17759E 01	0.56312E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.7746E 01	0.7606E 01	0.7195E 01	0.6503E 01	0.5518E 01	0.4248E 01	0.2734E 01	0.1071E 01	-0.4234E 00	-0.2138E 01
-0.3612E 01	-0.4373E 01	-0.4932E 01	-0.5444E 01	-0.5679E 01	-0.5795E 01	-0.5833E 01			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.17368E 02	0.98213E 01	0.27189E 02	0.17684E 01	0.56548E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.7753E 01	0.7612E 01	0.7201E 01	0.6507E 01	0.5519E 01	0.4244E 01	0.2724E 01	0.1052E 01	-0.4325E 00	-0.2175E 01
-0.3654E 01	-0.4417E 01	-0.5076E 01	-0.5488E 01	-0.5721E 01	-0.5836E 01	-0.5873E 01			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

OBLATE SPHEROID MARK= 240

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	1.00	0.4435923E-05	59.9726	1.4750	5.5850	0.0934	0.0982	33	45

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1808E 00	0.3592E 00	0.5358E 00	0.7099E 00	0.8804E 00	0.1046E 01	0.1206E 01	0.1353E 01	0.1481E 01
0.1613E 01	0.1717E 01	0.1800E 01	0.1858E 01	0.1891E 01	0.1895E 01	0.1873E 01	0.1824E 01	0.1751E 01	0.1657E 01
0.1547E 01	0.1424E 01	0.1294E 01	0.1158E 01	0.1021E 01	0.8841E 00	0.7494E 00	0.6177E 00	0.4893E 00	0.3660E 00
0.2414E 00	0.1205E 00	0.1393E-12							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.17231E 02	0.96116E 01	0.26942E 02	0.17927E 01	0.55782E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.7707E 01	0.7569E 01	0.7160E 01	0.6473E 01	0.5498E 01	0.4244E 01	0.2756E 01	0.1123E 01	-0.5173E 00	-0.2020E 01
-0.3270E 01	-0.4215E 01	-0.4865E 01	-0.5275E 01	-0.5510E 01	-0.5627E 01	-0.5663E 01			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.17231E 02	0.97622E 01	0.26993E 02	0.17650E 01	0.56656E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.7713E 01	0.7574E 01	0.7162E 01	0.6468E 01	0.5482E 01	0.4211E 01	0.2697E 01	0.1035E 01	-0.6379E 00	-0.2168E 01
-0.3638E 01	-0.4394E 01	-0.5048E 01	-0.5456E 01	-0.5688E 01	-0.5803E 01	-0.5839E 01			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

OBLATE SPHEROID MARK= 268

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	5.00	0.4435923E-05	59.9726	1.4750	5.5850	0.0934	0.0982	33	45

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.3108E 00	0.6151E 00	0.9127E 00	0.1201E 01	0.1475E 01	0.1733E 01	0.1968E 01	0.2177E 01	0.2355E 01
0.2496E 01	0.2597E 01	0.2653E 01	0.2662E 01	0.2626E 01	0.2545E 01	0.2424E 01	0.2269E 01	0.2088E 01	0.1890E 01
0.1683E 01	0.1475E 01	0.1273E 01	0.1081E 01	0.9034E 00	0.7422E 00	0.5978E 00	0.4696E 00	0.3562E 00	0.2553E 00
0.1644E 00	0.8026E-01	0.1393E-12							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.44648E 01	0.25796E 01	0.70445E 01	0.17308E 01	0.57777E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2568E 01	0.2496E 01	0.2278E 01	0.1933E 01	0.1477E 01	0.9429E 00	0.3767E 00	-0.1664E 00	-0.6308E 00	-0.9759E 00
-0.1188E 01	-0.1281E 01	-0.1287E 01	-0.1245E 01	-0.1189E 01	-0.1146E 01	-0.1130E 01			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.44648E 01	0.26243E 01	0.70891E 01	0.17013E 01	0.58777E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2570E 01	0.2495E 01	0.2277E 01	0.1928E 01	0.1467E 01	0.9248E 00	0.3479E 00	-0.2068E 00	-0.6816E 00	-0.1034E 01
-0.1250E 01	-0.1342E 01	-0.1346E 01	-0.1301E 01	-0.1243E 01	-0.1197E 01	-0.1180E 01			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

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    OBLATE  SPHEROID                                                                    MARK=  61
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 A.R.          RE          CONCENTRATION          DM          X1          X2          A          B          IM    JM
 0.90         10.00       0.2010668E-03        17.0078      1.4750      4.3300     0.0492     0.0982      33    50

 DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT   5.63  DEGREES INTERVAL

  0.0          0.4245E 00   0.8429E 00   0.1248E 01   0.1638E 01   0.1990E 01   0.2345E 01   0.2685E 01   0.2981E 01   0.3134E 01
  0.3280E 01   0.3373E 01   0.3401E 01   0.3363E 01   0.3265E 01   0.3107E 01   0.2944E 01   0.2737E 01   0.2564E 01   0.2443E 01
  0.1772E 01   0.1492E 01   0.1239E 01   0.9940E 00   0.7955E 00   0.6076E 00   0.4483E 00   0.3161E 00   0.2370E 00   0.1458E 00
  0.9707E-01   0.4523E-01   0.1514E-12

 THREE POINTS LAGRANGE DIFFERENTIATION FORMULA              SIMPSON'S RULE FOR INTEGRATION

          CDS          CDF          CDT        CDS/CDF      CDF/CDS
      0.2665E 01   0.1624E 01   0.4301E 01   0.1639E 01   0.6101E 00

 DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT   11.25  DEGREES INTERVAL

  0.1847E 01   0.1780E 01   0.1588E 01   0.1284E 01   0.8668E 00   0.4532E 00   0.2141E-01  -0.3457E 00  -0.6610E 00  -0.8621E 00
 -0.9127E 00  -0.8077E 00  -0.6294E 00  -0.7420E 00  -0.6431E 00  -0.6033E 00  -0.6847E 00

 FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA               SIMPSON'S RULE FOR INTEGRATION

          CDS          CDF          CDT        CDS/CDF      CDF/CDS
      0.2665E 01   0.1637E 01   0.4303E 01   0.1627E 01   0.6114E 00

 DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT   11.25  DEGREES INTERVAL

  0.1848E 01   0.1781E 01   0.1588E 01   0.1284E 01   0.8639E 00   0.4542E 00   0.1682E-01  -0.3743E 00  -0.6745E 00  -0.8676E 00
 -0.9287E 00  -0.8129E 00  -0.8644E 00  -0.7569E 00  -0.6743E 00  -0.6208E 00  -0.6012E 00

 SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE
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    OBLATE  SPHEROID                                                                    MARK=  81
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 A.R.          RE          CONCENTRATION          DM          X1          X2          A          B          IM    JM
 0.90         10.00       0.3943239E-04        20.6323      1.4750      4.8000     0.0501     0.1087      33    50

 DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT   5.63  DEGREES INTERVAL

  0.0          0.4253E 00   0.8405E 00   0.1246E 01   0.1633E 01   0.1989E 01   0.2338E 01   0.2681E 01   0.2983E 01   0.3137E 01
  0.3267E 01   0.3365E 01   0.3387E 01   0.3347E 01   0.3243E 01   0.3082E 01   0.2916E 01   0.2715E 01   0.2538E 01   0.2408E 01
  0.1767E 01   0.1478E 01   0.1217E 01   0.9813E 00   0.7740E 00   0.5946E 00   0.4481E 00   0.3271E 00   0.2502E 00   0.1532E 00
  0.9279E-01   0.4299E-01   0.1441E-12

 THREE POINTS LAGRANGE DIFFERENTIATION FORMULA              SIMPSON'S RULE FOR INTEGRATION

          CDS          CDF          CDT        CDS/CDF      CDF/CDS
      0.2649E 01   0.1638E 01   0.4277E 01   0.1617E 01   0.6184E 00

 DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT   11.25  DEGREES INTERVAL

  0.1848E 01   0.1778E 01   0.1588E 01   0.1284E 01   0.8648E 00   0.4613E 00   0.2400E-01  -0.3603E 00  -0.6568E 00  -0.8636E 00
 -0.9081E 00  -0.8049E 00  -0.8903E 00  -0.7648E 00  -0.6889E 00  -0.6154E 00  -0.5984E 00

 FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA               SIMPSON'S RULE FOR INTEGRATION

          CDS          CDF          CDT        CDS/CDF      CDF/CDS
      0.2649E 01   0.1646E 01   0.4300E 01   0.1615E 01   0.6191E 00

 DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT   11.25  DEGREES INTERVAL

  0.1848E 01   0.1779E 01   0.1587E 01   0.1284E 01   0.8649E 00   0.4623E 00   0.1837E-01  -0.3712E 00  -0.6689E 00  -0.8622E 00
 -0.9240E 00  -0.8115E 00  -0.8961E 00  -0.7614E 00  -0.6832E 00  -0.6221E 00  -0.6100E 00

 SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE
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    OBLATE  SPHEROID                                                                    MARK=  102
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 A.R.          RE          CONCENTRATION          DM          X1          X2          A          B          IM    JM
 0.90         20.00       0.2000668E-03        17.0078      1.4750      4.3300     0.0492     0.0982      33    50

 DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT   5.63  DEGREES INTERVAL

  0.0          0.6068E 00   0.1198E 01   0.1772E 01   0.2319E 01   0.2831E 01   0.3298E 01   0.3707E 01   0.4047E 01   0.4304E 01
  0.4478E 01   0.4550E 01   0.4571E 01   0.4392E 01   0.4169E 01   0.3865E 01   0.3497E 01   0.3086E 01   0.2553E 01   0.2221E 01
  0.1806E 01   0.1425E 01   0.1085E 01   0.7941E 00   0.5527E 00   0.3602E 00   0.2135E 00   0.1082E 00   0.3928E-01   0.6194E-03
 -0.1432E-01  -0.1264E-01   0.1514E-12

 THREE POINTS LAGRANGE DIFFERENTIATION FORMULA              SIMPSON'S RULE FOR INTEGRATION

          CDS          CDF          CDT        CDS/CDF      CDF/CDS
      0.1632E 01   0.1093E 01   0.2725E 01   0.1493E 01   0.6697E 00

 DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT   11.25  DEGREES INTERVAL

  0.1454E 01   0.1388E 01   0.1202E 01   0.9139E 00   0.5565E 00   0.1682E 00  -0.1941E 00  -0.4844E 00  -0.6714E 00  -0.7497E 00
 -0.7388E 00  -0.6715E 00  -0.5802E 00  -0.4892E 00  -0.4140E 00  -0.3666E 00  -0.3472E 00

 FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA               SIMPSON'S RULE FOR INTEGRATION

          CDS          CDF          CDT        CDS/CDF      CDF/CDS
      0.1632E 01   0.1106E 01   0.2739E 01   0.1474E 01   0.6780E 00

 DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT   11.25  DEGREES INTERVAL

  0.1454E 01   0.1389E 01   0.1203E 01   0.9149E 00   0.5568E 00   0.1664E 00  -0.1991E 00  -0.4932E 00  -0.6837E 00  -0.7643E 00
 -0.7545E 00  -0.6872E 00  -0.5954E 00  -0.5037E 00  -0.4280E 00  -0.3782E 00  -0.3607E 00

 ANGLE AT WHICH SURFACE SHEAR STRESS BECOMES ZERO  I.E. SEPARATION,IS   163.4 DEGREES
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OBLATE SPHEROID MARK= 112

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	50.00	0.2000648E-03	17.0978	1.4750	4.3300	0.0402	0.0082	33	59

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.9983E 00	0.1970E 01	0.2910E 01	0.3803E 01	0.4632E 01	0.5375E 01	0.6013E 01	0.6522E 01	0.6881E 01
0.7070E 01	0.7079E 01	0.6898E 01	0.6538E 01	0.6017E 01	0.5366E 01	0.4626E 01	0.3845E 01	0.3067E 01	0.2335E 01
0.1680E 01	0.1120E 01	0.6623E 00	0.3043E 00	0.3662E-01	-0.1528E 00	-0.2751E 00	-0.3389E 00	-0.3502E 00	-0.3146E 00
-0.2379E 00	-0.1304E 00	0.1514E-12							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.88996E 00	0.71108E 00	0.16010E 01	0.12516E 01	0.79900E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1196E 01	0.1128E 01	0.9340E 00	0.6380E 00	0.2900E 00	-0.8563E-01	-0.3091E 00	-0.6114E 00	-0.7028E 00	-0.6895E 00
-0.6120E 00	-0.5129E 00	-0.4202E 00	-0.3446E 00	-0.2869E 00	-0.2486E 00	-0.2346E 00			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.88996E 00	0.72756E 00	0.16175E 01	0.12232E 01	0.81753E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1196E 01	0.1130E 01	0.9396E 00	0.6484E 00	0.2981E 00	-0.7053E-01	-0.3866E 00	-0.6045E 00	-0.7022E 00	-0.6934E 00
-0.6182E 00	-0.5195E 00	-0.4265E 00	-0.3505E 00	-0.2926E 00	-0.2540E 00	-0.2399E 00			

ANGLE AT WHICH SURFACE SHEAR STRESS BECOMES ZERO I.E. SEPARATION,IS 136.1 DEGREES

OBLATE SPHEROID MARK= 141

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	50.00	0.2000841E-03	17.0973	1.4750	4.3300	0.0275	0.0524	61	105

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 3.00 DEGREES INTERVAL

0.0	0.5146E 00	0.1025E 01	0.1531E 01	0.2031E 01	0.2522E 01	0.3002E 01	0.3469E 01	0.3920E 01	0.4361E 01
0.4761E 01	0.5144E 01	0.5503E 01	0.5828E 01	0.6119E 01	0.6377E 01	0.6580E 01	0.6765E 01	0.6943E 01	0.6931E 01
0.6947E 01	0.6910E 01	0.6821E 01	0.6680E 01	0.6488E 01	0.6250E 01	0.5968E 01	0.5644E 01	0.5295E 01	0.4916E 01
0.4519E 01	0.4109E 01	0.3695E 01	0.3283E 01	0.2880E 01	0.2492E 01	0.2123E 01	0.1778E 01	0.1458E 01	0.1167E 01
0.9043E 00	0.6704E 00	0.4647E 00	0.2859E 00	0.1325E 00	0.2449E-02	-0.1052E 00	-0.1929E 00	-0.2619E 00	-0.3132E 00
-0.3481E 00	-0.3673E 00	-0.3715E 00	-0.3618E 00	-0.3387E 00	-0.3034E 00	-0.2573E 00	-0.2019E 00	-0.1392E 00	-0.7140E-01
0.0									

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.86758E 00	0.70359E 00	0.15711E 01	0.12332E 01	0.81091E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 6.00 DEGREES INTERVAL

0.1192E 01	0.1173E 01	0.1119E 01	0.1030E 01	0.9103E 00	0.7830E 00	0.6936E 00	0.4391E 00	0.2171E 00	0.2635E-01
-0.1540E 00	-0.3154E 00	-0.4503E 00	-0.5534E 00	-0.6223E 00	-0.6575E 00	-0.6627E 00	-0.6435E 00	-0.6068E 00	-0.5595E 00
-0.5077E 00	-0.4558E 00	-0.4069E 00	-0.3625E 00	-0.3230E 00	-0.2883E 00	-0.2584E 00	-0.2338E 00	-0.2150E 00	-0.2032E 00
-0.1991E 00									

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.86758E 00	0.71290E 00	0.15805E 01	0.12170E 01	0.82170E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 6.00 DEGREES INTERVAL

0.1192E 01	0.1174E 01	0.1119E 01	0.1031E 01	0.9110E 00	0.7838E 00	0.6946E 00	0.4100E 00	0.2177E 00	0.2641E-01
-0.1548E 00	-0.3173E 00	-0.4536E 00	-0.5582E 00	-0.6285E 00	-0.6653E 00	-0.6712E 00	-0.6529E 00	-0.6166E 00	-0.5686E 00
-0.5176E 00	-0.4657E 00	-0.4168E 00	-0.3723E 00	-0.3327E 00	-0.2980E 00	-0.2681E 00	-0.2432E 00	-0.2245E 00	-0.2127E 00
-0.2086E 00									

ANGLE AT WHICH SURFACE SHEAR STRESS BECOMES ZERO I.E. SEPARATION,IS 135.1 DEGREES

OBLATE SPHEROID MARK= 124

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	100.00	0.2000648E-03	17.0978	1.4750	4.3300	0.0402	0.0082	33	59

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1485E 01	0.2930E 01	0.4326E 01	0.5648E 01	0.6864E 01	0.7951E 01	0.8865E 01	0.9574E 01	0.1006E 02
0.1023E 02	0.1013E 02	0.9725E 01	0.9032E 01	0.8088E 01	0.6955E 01	0.5711E 01	0.4446E 01	0.3243E 01	0.2175E 01
0.1284E 01	0.5892E 00	0.8021E-01	-0.2696E 00	-0.4984E 00	-0.6457E 00	-0.7408E 00	-0.7928E 00	-0.7904E 00	-0.7337E 00
-0.5505E 00	-0.3077E 00	0.1514E-12							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.57573E 00	0.55830E 00	0.11340E 01	0.10312E 01	0.98972E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1103E 01	0.1038E 01	0.8163E 00	0.4959E 00	0.1159E 00	-0.2583E 00	-0.5665E 00	-0.7266E 00	-0.7594E 00	-0.6895E 00
-0.5798E 00	-0.4771E 00	-0.4012E 00	-0.3495E 00	-0.3089E 00	-0.2753E 00	-0.2506E 00			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.57573E 00	0.55745E 00	0.11332E 01	0.10328E 01	0.98824E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1104E 01	0.1035E 01	0.8365E 00	0.5364E 00	0.1749E 00	-0.1868E 00	-0.4776E 00	-0.6518E 00	-0.6937E 00	-0.6320E 00
-0.5270E 00	-0.4247E 00	-0.3485E 00	-0.2966E 00	-0.2558E 00	-0.2210E 00	-0.2070E 00			

ANGLE AT WHICH SURFACE SHEAR STRESS BECOMES ZERO I.E. SEPARATION,IS 125.1 DEGREES

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 OBLATE SPHEROID                                                    MARK = 317
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 A.R.          RE          CONCENTRATION          DM          X1          X2          A          B          IM    JM
 0.90        100.00      0.20009841E-03        17.0273      1.4750      4.3200      0.0275      0.0624      61    105

 DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT   3.00  DEGREES INTERVAL

  0.0          0.74746E 00   0.14005E 01   0.22256E 01   0.30515E 01   0.37445E 01   0.43403E 01   0.48237E 01   0.52390E 01   0.56146E 01
  0.60906E 01  0.74529E 01   0.72040E 01   0.84311E 01   0.88238E 01   0.91855E 01   0.94664E 01   0.96775E 01   0.98134E 01   0.98675E 01
  0.98440E 01  0.97288E 01   0.95431E 01   0.92952E 01   0.89932E 01   0.86459E 01   0.78568E 01   0.74005E 01   0.47075E 01   0.41405E 01
  0.55004E 01  0.68642E 01   0.61875E 01   0.35537E 01   0.22515E 01   0.13385E 01   0.11474E 01   0.11413E 01   0.10055E 01   0.65108E 00
  0.35614E 00  0.10056E 00  -0.10534E 00  -0.27145E 00  -0.40335E 00  -0.50735E 00  -0.58730E 00  -0.64430E 00  -0.68435E 00  -0.72085E 00
 -0.74746E 00 -0.75146E 00  -0.73915E 00  -0.70988E 00  -0.66505E 00  -0.60835E 00  -0.54000E 00  -0.39331E 00  -0.37156E 00  -0.13046E 00
  0.0

 THREE POINTS LAGRANGE DIFFERENTIATION FORMULA          SIMPSON'S RULE FOR INTEGRATION

          COS           COF           COT          COS/COF       COF/COS
      0.553556E 00  0.549646E 00  0.110205E 01  0.100837E 01  0.990082E 00

 DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT   6.00  DEGREES INTERVAL

  0.11005E 01  0.10815E 01  0.10245E 01  0.93185E 00  0.83715E 00  0.65465E 00  0.48005E 00  0.29135E 00  0.97075E-01 -0.92515E-01
 -0.26725E 00 -0.41735E 00 -0.53485E 00 -0.61485E 00 -0.65425E 00 -0.64225E 00 -0.58025E 00 -0.50415E 00 -0.54225E 00 -0.48525E 00
 -0.43105E 00 -0.38295E 00 -0.34225E 00 -0.30955E 00 -0.28035E 00 -0.25595E 00 -0.23395E 00 -0.21435E 00 -0.19825E 00 -0.18765E 00
 -0.18365E 00

 FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA           SIMPSON'S RULE FOR INTEGRATION

          COS           COF           COT          COS/COF       COF/COS
      0.553556E 00  0.554241E 00  0.111605E 01  0.998764E 00  0.101405E 01

 DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT   6.00  DEGREES INTERVAL

  0.11005E 01  0.10815E 01  0.10245E 01  0.93355E 00  0.83905E 00  0.65965E 00  0.48505E 00  0.29705E 00  0.10335E 00 -0.84705E-01
 -0.26245E 00 -0.41415E 00 -0.53195E 00 -0.61455E 00 -0.65595E 00 -0.64805E 00 -0.58785E 00 -0.50935E 00 -0.55245E 00 -0.49505E 00
 -0.44175E 00 -0.39765E 00 -0.35285E 00 -0.31905E 00 -0.29075E 00 -0.26635E 00 -0.24635E 00 -0.22455E 00 -0.20815E 00 -0.19745E 00
 -0.19355E 00

 ANGLE AT WHICH SURFACE SHEAR STRESS BECOMES ZERO   I.E. SEPARATION IS   134.5 DEGREES
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OBLATE SPHEROID MARK= 258

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	1.00	0.1999334E-03	17.1273	0.5499	2.4460	0.0499	0.9982	33	58

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1010E 00	0.2028E 00	0.3100E 00	0.4260E 00	0.5567E 00	0.7007E 00	0.8693E 00	0.1067E 01	0.1300E 01
0.1575E 01	0.1895E 01	0.2256E 01	0.2627E 01	0.2962E 01	0.3183E 01	0.3218E 01	0.3044E 01	0.2713E 01	0.2304E 01
0.1895E 01	0.1529E 01	0.1222E 01	0.9713E 00	0.7696E 00	0.6072E 00	0.4757E 00	0.3672E 00	0.2761E 00	0.1976E 00
0.1276E 00	0.6303E-01	0.1655E-12							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.12206E 02	0.13617E 02	0.25823E 02	0.89636E 00	0.11156E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.7073E 01	0.7095E 01	0.7187E 01	0.7333E 01	0.7414E 01	0.7225E 01	0.6189E 01	0.3401E 01	-0.1209E 01	-0.5414E 01
-0.7361E 01	-0.7613E 01	-0.7723E 01	-0.6734E 01	-0.6343E 01	-0.4105E 01	-0.6032E 01			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.12206E 02	0.13633E 02	0.25839E 02	0.89534E 00	0.11169E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.7104E 01	0.7127E 01	0.7221E 01	0.7360E 01	0.7440E 01	0.7237E 01	0.6272E 01	0.3487E 01	-0.1173E 01	-0.5420E 01
-0.7355E 01	-0.7583E 01	-0.7177E 01	-0.6681E 01	-0.6287E 01	-0.6048E 01	-0.5976E 01			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

OBLATE SPHEROID MARK= 256

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	1.00	0.3723297E-04	29.9471	0.5490	4.0050	0.0480	0.9982	33	73

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.9856E-01	0.1979E 00	0.3024E 00	0.4156E 00	0.5410E 00	0.6832E 00	0.8474E 00	0.1040E 01	0.1266E 01
0.1534E 01	0.1845E 01	0.2193E 01	0.2555E 01	0.2879E 01	0.3092E 01	0.3124E 01	0.2955E 01	0.2630E 01	0.2233E 01
0.1835E 01	0.1479E 01	0.1191E 01	0.9381E 00	0.7427E 00	0.5857E 00	0.4584E 00	0.3537E 00	0.2659E 00	0.1901E 00
0.1228E 00	0.6063E-01	0.1460E-12							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.11850E 02	0.13180E 02	0.25030E 02	0.89912E 00	0.11122E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.6987E 01	0.6959E 01	0.7069E 01	0.7181E 01	0.7270E 01	0.7086E 01	0.6079E 01	0.3368E 01	-0.1111E 01	-0.5186E 01
-0.7058E 01	-0.7286E 01	-0.6895E 01	-0.6413E 01	-0.6029E 01	-0.5796E 01	-0.5724E 01			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.11850E 02	0.13182E 02	0.25032E 02	0.89897E 00	0.11124E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.6968E 01	0.6990E 01	0.7081E 01	0.7217E 01	0.7315E 01	0.7146E 01	0.6160E 01	0.3452E 01	-0.1070E 01	-0.5180E 01
-0.7039E 01	-0.7243E 01	-0.6837E 01	-0.6348E 01	-0.5961E 01	-0.5726E 01	-0.5655E 01			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

OBLATE SPHEROID MARK= 261

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	1.00	0.4629253E-05	60.0013	0.5400	4.7000	0.0943	0.0982	33	45

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.9781E-01	0.1965E 00	0.3004E 00	0.4128E 00	0.5373E 00	0.6785E 00	0.8414E 00	0.1032E 01	0.1257E 01
0.1522E 01	0.1833E 01	0.2173E 01	0.2529E 01	0.2848E 01	0.3056E 01	0.3086E 01	0.2918E 01	0.2598E 01	0.2205E 01
0.1812E 01	0.1461E 01	0.1166E 01	0.9258E 00	0.7336E 00	0.5774E 00	0.4517E 00	0.3484E 00	0.2617E 00	0.1871E 00
0.1208E 00	0.5955E-01	0.1403E-12							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

COS	COF	COT	COS/COF	COF/COS
0.11718E 02	0.13024E 02	0.24742E 02	0.89975E 00	0.11114E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.6891E 01	0.6913E 01	0.6976E 01	0.7112E 01	0.7172E 01	0.5939E 01	0.5878E 01	0.3187E 01	-0.1122E 01	-0.5046E 01
-0.6922E 01	-0.7212E 01	-0.6848E 01	-0.6413E 01	-0.6343E 01	-0.5816E 01	-0.5745E 01			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

COS	COF	COT	COS/COF	COF/COS
0.11718E 02	0.13071E 02	0.24780E 02	0.89653E 00	0.11154E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.6921E 01	0.6964E 01	0.7033E 01	0.7164E 01	0.7253E 01	0.7069E 01	0.6062E 01	0.3362E 01	-0.1078E 01	-0.5111E 01
-0.6967E 01	-0.7190E 01	-0.6797E 01	-0.6317E 01	-0.5934E 01	-0.5702E 01	-0.5630E 01			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

OBLATE SPHEROID MARK= 267

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	5.00	0.4629253E-05	60.0013	0.5400	4.7000	0.0943	0.0982	33	45

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1835E 00	0.3653E 00	0.5548E 00	0.7557E 00	0.9726E 00	0.1210E 01	0.1475E 01	0.1772E 01	0.2107E 01
0.2482E 01	0.2892E 01	0.3319E 01	0.3719E 01	0.4016E 01	0.4122E 01	0.3962E 01	0.3556E 01	0.2988E 01	0.2338E 01
0.1834E 01	0.1377E 01	0.1018E 01	0.7451E 00	0.5416E 00	0.3907E 00	0.2795E 00	0.1975E 00	0.1366E 00	0.9075E-01
0.5521E-01	0.2605E-01	0.1403E-12							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

COS	COF	COT	COS/COF	COF/COS
0.30273E 01	0.34734E 01	0.65006E 01	0.87157E 00	0.11474E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2296E 01	0.2279E 01	0.2231E 01	0.2142E 01	0.1985E 01	0.1696E 01	0.1162E 01	0.1868E 00	-0.1034E 01	-0.1915E 01
-0.2152E 01	-0.2002E 01	-0.1751E 01	-0.1526E 01	-0.1363E 01	-0.1267E 01	-0.1235E 01			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

COS	COF	COT	COS/COF	COF/COS
0.30273E 01	0.34894E 01	0.65166E 01	0.86757E 00	0.11526E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2305E 01	0.2287E 01	0.2242E 01	0.2158E 01	0.2010E 01	0.1731E 01	0.1189E 01	0.2202E 00	-0.1038E 01	-0.1942E 01
-0.2166E 01	-0.1997E 01	-0.1734E 01	-0.1503E 01	-0.1338E 01	-0.1241E 01	-0.1209E 01			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

OBLATE SPHEROID MARK= 84

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	10.00	0.3723297E-04	29.9471	0.5400	4.0050	0.0480	0.0982	33	73

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.2621E 00	0.5238E 00	0.7945E 00	0.1080E 01	0.1385E 01	0.1716E 01	0.2078E 01	0.2476E 01	0.2914E 01
0.3388E 01	0.3887E 01	0.4378E 01	0.4798E 01	0.5052E 01	0.5031E 01	0.4677E 01	0.4032E 01	0.3237E 01	0.2447E 01
0.1765E 01	0.1275E 01	0.8231E 00	0.5338E 00	0.3314E 00	0.1932E 00	0.1020E 00	0.4449E-01	0.1121E-01	-0.5000E-02
-0.9598E-02	-0.6928E-02	0.1460E-12							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

COS	COF	COT	COS/COF	COF/COS
0.18015E 01	0.21688E 01	0.39703E 01	0.83069E 00	0.12039E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1682E 01	0.1657E 01	0.1586E 01	0.1462E 01	0.1267E 01	0.9635E 00	0.4867E 00	-0.2211E 00	-0.1010E 01	-0.1470E 01
-0.1481E 01	-0.1279E 01	-0.1055E 01	-0.8746E 00	-0.7492E 00	-0.6764E 00	-0.6527E 00			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

COS	COF	COT	COS/COF	COF/COS
0.18015E 01	0.21729E 01	0.39744E 01	0.82909E 00	0.12061E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1687E 01	0.1662E 01	0.1592E 01	0.1469E 01	0.1275E 01	0.9747E 00	0.5001E 00	-0.2105E 00	-0.1009E 01	-0.1473E 01
-0.1480E 01	-0.1275E 01	-0.1049E 01	-0.8678E 00	-0.7423E 00	-0.6695E 00	-0.6458E 00			

ANGLE AT WHICH SURFACE SHEAR STRESS BECOMES ZERO I.E. SEPARATION,IS 161.4 DEGREES

OBLATE SPHEROID MARK= 103

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	20.00	0.1990334E-03	17.1273	0.5490	3.4460	0.0499	0.0982	33	59

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.3875E 00	0.7751E 00	0.1176E 01	0.1598E 01	0.2048E 01	0.2534E 01	0.3059E 01	0.3629E 01	0.4239E 01
0.4877E 01	0.5514E 01	0.6090E 01	0.6511E 01	0.6649E 01	0.6370E 01	0.5670E 01	0.4631E 01	0.3479E 01	0.2417E 01
0.1557E 01	0.9186E 00	0.4734E 00	0.1774E 00	-0.1002E-01	-0.1203E 00	-0.1762E 00	-0.1936E 00	-0.1835E 00	-0.1539E 00
-0.1106E 00	-0.5851E-01	0.1555E-12							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.11150E 01	0.14826E 01	0.25976E 01	0.75209E 00	0.13296E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1359E 01	0.1328E 01	0.1238E 01	0.1081E 01	0.8643E 00	0.5076E 00	0.4969E-01	-0.5151E 00	-0.1027E 01	-0.1230E 01
-0.1129E 01	-0.9261E 00	-0.7409E 00	-0.6025E 00	-0.5089E 00	-0.4545E 00	-0.4365E 00			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.11150E 01	0.14881E 01	0.26031E 01	0.74930E 00	0.13346E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1362E 01	0.1331E 01	0.1242E 01	0.1087E 01	0.8520E 00	0.5179E 00	0.6129E-01	-0.5071E 00	-0.1027E 01	-0.1233E 01
-0.1130E 01	-0.9241E 00	-0.7380E 00	-0.5994E 00	-0.5058E 00	-0.4515E 00	-0.4334E 00			

ANGLE AT WHICH SURFACE SHEAR STRESS BECOMES ZERO I.E. SEPARATION,IS 134.7 DEGREES

OBLATE SPHEROID MARK= 111

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	50.00	0.1990334E-03	17.1273	0.5490	3.4460	0.0499	0.0982	33	59

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.6450E 00	0.1293E 01	0.1966E 01	0.2676E 01	0.3438E 01	0.4260E 01	0.5148E 01	0.6109E 01	0.7097E 01
0.8098E 01	0.9010E 01	0.9730E 01	0.1005E 02	0.9774E 01	0.9207E 01	0.7138E 01	0.5256E 01	0.3385E 01	0.1850E 01
0.7650E 00	0.5333E-01	-0.3739E 00	-0.6104E 00	-0.7260E 00	-0.7654E 00	-0.7532E 00	-0.7015E 00	-0.6151E 00	-0.4976E 00
-0.3520E 00	-0.1853E 00	0.1555E-12							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.60059E 00	0.99964E 00	0.16002E 01	0.60081E 00	0.16446E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1151E 01	0.1115E 01	0.1006E 01	0.8163E 00	0.5339E 00	0.1525E 00	-0.3088E 00	-0.7539E 00	-0.1025E 01	-0.1015E 01
-0.8431E 00	-0.6692E 00	-0.5424E 00	-0.4651E 00	-0.3929E 00	-0.3525E 00	-0.3379E 00			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.60059E 00	0.10044E 01	0.16049E 01	0.59679E 00	0.16756E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1153E 01	0.1117E 01	0.1011E 01	0.8248E 00	0.5471E 00	0.1708E 00	-0.2954E 00	-0.7382E 00	-0.1018E 01	-0.1011E 01
-0.8386E 00	-0.6635E 00	-0.5367E 00	-0.4491E 00	-0.3875E 00	-0.3645E 00	-0.3318E 00			

ANGLE AT WHICH SURFACE SHEAR STRESS BECOMES ZERO I.E. SEPARATION,IS 118.8 DEGREES

OBLATE SPHEROID MARK= 144

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	50.00	0.1990631E-03	17.1265	0.5490	3.4460	0.0279	0.0524	61	105

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 3.00 DEGREES INTERVAL

0.0	0.3319E 00	0.6640E 00	0.9997E 00	0.1341E 01	0.1693E 01	0.2049E 01	0.2410E 01	0.2782E 01	0.3201E 01
0.3615E 01	0.4048E 01	0.4499E 01	0.4970E 01	0.5450E 01	0.5963E 01	0.6481E 01	0.7007E 01	0.7534E 01	0.8051E 01
0.8543E 01	0.8992E 01	0.9374E 01	0.9662E 01	0.9827E 01	0.9835E 01	0.9662E 01	0.9288E 01	0.8711E 01	0.7948E 01
0.7036E 01	0.6031E 01	0.4996E 01	0.3988E 01	0.3056E 01	0.2332E 01	0.1529E 01	0.9497E 00	0.4943E 00	0.1104E 00
-0.1405E 00	-0.3707E 00	-0.5251E 00	-0.6355E 00	-0.7113E 00	-0.7601E 00	-0.7875E 00	-0.7975E 00	-0.7931E 00	-0.7769E 00
-0.7477E 00	-0.7089E 00	-0.6603E 00	-0.6022E 00	-0.5353E 00	-0.4603E 00	-0.3781E 00	-0.2897E 00	-0.1965E 00	-0.9870E-01
0.0									

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.58577E 00	0.98089E 00	0.15667E 01	0.59718E 00	0.16745E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 6.00 DEGREES INTERVAL

0.1149E 01	0.1140E 01	0.1111E 01	0.1063E 01	0.9930E 00	0.9010E 00	0.7847E 00	0.6623E 00	0.4724E 00	0.2751E 00
0.5272E-01	-0.1882E 00	-0.4351E 00	-0.6666E 00	-0.8539E 00	-0.9643E 00	-0.9968E 00	-0.9576E 00	-0.8641E 00	-0.7448E 00
-0.6730E 00	-0.5923E 00	-0.5255E 00	-0.4706E 00	-0.4249E 00	-0.3865E 00	-0.3542E 00	-0.3280E 00	-0.3082E 00	-0.2958E 00
-0.2916E 00									

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.58577E 00	0.98616E 00	0.15699E 01	0.59510E 00	0.16401E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 6.00 DEGREES INTERVAL

0.1150E 01	0.1140E 01	0.1111E 01	0.1063E 01	0.9960E 00	0.9025E 00	0.7867E 00	0.6650E 00	0.4760E 00	0.2785E 00
0.5781E-01	-0.1829E 00	-0.4301E 00	-0.6629E 00	-0.8521E 00	-0.9643E 00	-0.9977E 00	-0.9537E 00	-0.8570E 00	-0.7435E 00
-0.6733E 00	-0.5925E 00	-0.5257E 00	-0.4708E 00	-0.4251E 00	-0.3867E 00	-0.3544E 00	-0.3281E 00	-0.3084E 00	-0.2960E 00
-0.2917E 00									

ANGLE AT WHICH SURFACE SHEAR STRESS BECOMES ZERO I.E. SEPARATION,IS 118.3 DEGREES

OBLATE SPHEROID MARK= 178

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	100.00	0.1990334E-03	17.1273	0.5490	3.4460	0.0499	0.0992	33	59

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.9430E 00	0.1893E 01	0.2882E 01	0.3930E 01	0.5056E 01	0.6274E 01	0.7592E 01	0.8998E 01	0.1045E 02
0.1187E 02	0.1309E 02	0.1386E 02	0.1389E 02	0.1291E 02	0.1095E 02	0.9036E 01	0.5074E 01	0.2552E 01	0.7626E 00
-0.3100E 00	-0.8765E 00	-0.1116E 01	-0.1205E 01	-0.1261E 01	-0.1299E 01	-0.1344E 01	-0.1352E 01	-0.1283E 01	-0.1107E 01
-0.8238E 00	-0.4485E 00	0.1555E-12							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.37466E 00	0.81196E 00	0.11866E 01	0.46143E 00	0.21672E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1077E 01	0.1038E 01	0.9172E 00	0.7057E 00	0.3918E 00	-0.2229E-01	-0.4852E 00	-0.8600E 00	-0.9847E 00	-0.8697E 00
-0.6930E 00	-0.5697E 00	-0.5013E 00	-0.4539E 00	-0.4040E 00	-0.3576E 00	-0.3371E 00			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.37466E 00	0.80920E 00	0.11839E 01	0.46299E 00	0.21599E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1078E 01	0.1041E 01	0.9261E 00	0.7242E 00	0.4224E 00	0.2069E-01	-0.4344E 00	-0.8125E 00	-0.9484E 00	-0.8380E 00
-0.6615E 00	-0.5373E 00	-0.4690E 00	-0.4215E 00	-0.3713E 00	-0.3246E 00	-0.3041E 00			

ANGLE AT WHICH SURFACE SHEAR STRESS BECOMES ZERO I.E. SEPARATION,IS 110.9 DEGREES

OBLATE SPHEROID MARK= 224

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	100.00	0.1990631E-03	17.1265	0.5490	3.4460	0.0279	0.0524	61	105

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 3.00 DEGREES INTERVAL

0.0	0.4784E 00	0.9576E 00	0.1442E 01	0.1936E 01	0.2442E 01	0.2963E 01	0.3501E 01	0.4061E 01	0.4643E 01
0.5252E 01	0.5887E 01	0.6552E 01	0.7244E 01	0.7963E 01	0.8704E 01	0.9461E 01	0.1022E 02	0.1098E 02	0.1170E 02
0.1236E 02	0.1292E 02	0.1336E 02	0.1360E 02	0.1362E 02	0.1336E 02	0.1280E 02	0.1193E 02	0.1077E 02	0.9378E 01
0.7840E 01	0.6259E 01	0.4734E 01	0.3348E 01	0.2153E 01	0.1173E 01	0.4049E 00	-0.1716E 00	-0.5862E 00	-0.8716E 00
-0.1059E 01	-0.1177E 01	-0.1247E 01	-0.1288E 01	-0.1313E 01	-0.1329E 01	-0.1339E 01	-0.1346E 01	-0.1346E 01	-0.1337E 01
-0.1314E 01	-0.1275E 01	-0.1215E 01	-0.1133E 01	-0.1028E 01	-0.8992E 00	-0.7493E 00	-0.5806E 00	-0.3969E 00	-0.2025E 00
0.0									

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.36271E 00	0.76899E 00	0.11317E 01	0.47167E 00	0.21201E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 6.00 DEGREES INTERVAL

0.1076E 01	0.1066E 01	0.1035E 01	0.9829E 00	0.9080E 00	0.8085E 00	0.6825E 00	0.5281E 00	0.3449E 00	0.1346E 00
-0.9638E-01	-0.3353E 00	-0.5611E 00	-0.7462E 00	-0.8633E 00	-0.8980E 00	-0.8587E 00	-0.7742E 00	-0.6769E 00	-0.5884E 00
-0.5176E 00	-0.4644E 00	-0.4246E 00	-0.3928E 00	-0.3644E 00	-0.3368E 00	-0.3095E 00	-0.2839E 00	-0.2626E 00	-0.2484E 00
-0.2433E 00									

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.36271E 00	0.77398E 00	0.11367E 01	0.46862E 00	0.21339E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 6.00 DEGREES INTERVAL

0.1076E 01	0.1066E 01	0.1036E 01	0.9839E 00	0.9097E 00	0.8112E 00	0.6864E 00	0.5335E 00	0.3521E 00	0.1436E 00
-0.8604E-01	-0.3243E 00	-0.5509E 00	-0.7381E 00	-0.8581E 00	-0.8954E 00	-0.8576E 00	-0.7735E 00	-0.6760E 00	-0.5874E 00
-0.5165E 00	-0.4633E 00	-0.4236E 00	-0.3919E 00	-0.3636E 00	-0.3360E 00	-0.3086E 00	-0.2829E 00	-0.2616E 00	-0.2473E 00
-0.2422E 00									

ANGLE AT WHICH SURFACE SHEAR STRESS BECOMES ZERO I.E. SEPARATION,IS 110.1 DEGREES

OBLATE SPHEROID MARK= 72

A.R.	RF	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	1.00	0.3761967E-04	20.3997	0.2029	3.5750	0.0496	0.2082	33	49

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.4404E-01	0.8833E-01	0.1357E 00	0.1883E 00	0.2409E 00	0.2918E 00	0.3412E 00	0.3888E 00	0.4344E 00
0.4780E 00	0.5193E 00	0.5580E 00	0.5939E 00	0.6268E 00	0.6566E 00	0.6832E 00	0.7065E 00	0.7265E 00	0.7431E 00
0.7564E 00	0.7665E 00	0.7734E 00	0.7772E 00	0.7780E 00	0.7759E 00	0.7710E 00	0.7634E 00	0.7532E 00	0.7405E 00
0.7254E 00	0.7080E 00	0.6884E 00	0.6667E 00	0.6430E 00	0.6174E 00	0.5900E 00	0.5609E 00	0.5302E 00	0.4980E 00
0.4644E 00	0.4294E 00	0.3931E 00	0.3556E 00	0.3169E 00	0.2771E 00	0.2363E 00	0.1946E 00	0.1520E 00	0.1087E 00
0.6450E-01	0.2010E-01								

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.59852E 01	0.17935E 02	0.23910E 02	0.33371E 00	0.29944E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.6453E 01	0.6539E 01	0.6837E 01	0.7408E 01	0.8275E 01	0.9441E 01	0.1123E 02	0.1244E 02	-0.1973E 01	-0.1543E 02
-0.1279E 02	-0.9753E 01	-0.7844E 01	-0.7584E 01	-0.5998E 01	-0.5638E 01	-0.5517E 01			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.59852E 01	0.17935E 02	0.23891E 02	0.33429E 00	0.29915E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.6448E 01	0.6533E 01	0.6830E 01	0.7438E 01	0.8403E 01	0.9389E 01	0.1245E 02	0.1378E 02	-0.1939E 01	-0.1568E 02
-0.1271E 02	-0.9625E 01	-0.7724E 01	-0.6560E 01	-0.5991E 01	-0.5814E 01	-0.5436E 01			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

OBLATE SPHEROID MARK= 243

A.R.	RF	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	1.00	0.4619325E-05	60.0486	0.2029	4.2725	0.0925	0.2082	33	45

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.4347E-01	0.8729E-01	0.1341E 00	0.1861E 00	0.2462E 00	0.3181E 00	0.4077E 00	0.5237E 00	0.6895E 00
0.9029E 00	0.1235E 01	0.1762E 01	0.2634E 01	0.4002E 01	0.6111E 01	0.7179E 01	0.5687E 01	0.3533E 01	0.2110E 01
0.1308E 01	0.8513E 00	0.5786E 00	0.4047E 00	0.2930E 00	0.2146E 00	0.1584E 00	0.1167E 00	0.8473E-01	0.5910E-01
0.3759E-01	0.1846E-01	0.1423E-12							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.58740E 01	0.17619E 02	0.23493E 02	0.33340E 00	0.29904E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.6377E 01	0.6443E 01	0.6758E 01	0.7323E 01	0.8175E 01	0.9814E 01	0.1202E 02	0.1240E 02	-0.1943E 01	-0.1451E 02
-0.1260E 02	-0.9742E 01	-0.7874E 01	-0.6727E 01	-0.6042E 01	-0.5679E 01	-0.5568E 01			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.58740E 01	0.17598E 02	0.23472E 02	0.33380E 00	0.29958E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.6411E 01	0.6496E 01	0.6787E 01	0.7347E 01	0.8208E 01	0.9867E 01	0.1226E 02	0.1323E 02	-0.1994E 01	-0.1504E 02
-0.1293E 02	-0.9498E 01	-0.7614E 01	-0.6476E 01	-0.5798E 01	-0.5439E 01	-0.5330E 01			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

OBLATE SPHEROID MARK= 270

A.R.	RF	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	1.00	0.9490076E-06	101.7594	0.2029	4.8000	0.1045	0.2082	33	45

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.4340E-01	0.8721E-01	0.1340E 00	0.1860E 00	0.2459E 00	0.3178E 00	0.4073E 00	0.5233E 00	0.6891E 00
0.9026E 00	0.1235E 01	0.1761E 01	0.2634E 01	0.4003E 01	0.6089E 01	0.7148E 01	0.5657E 01	0.3523E 01	0.2108E 01
0.1307E 01	0.8503E 00	0.5775E 00	0.4057E 00	0.2932E 00	0.2139E 00	0.1578E 00	0.1163E 00	0.8439E-01	0.5886E-01
0.3743E-01	0.1837E-01	0.1392E-12							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.58576E 01	0.17565E 02	0.23423E 02	0.33348E 00	0.29987E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.6365E 01	0.6452E 01	0.6747E 01	0.7311E 01	0.8161E 01	0.9785E 01	0.1192E 02	0.1211E 02	-0.1942E 01	-0.1427E 02
-0.1257E 02	-0.9767E 01	-0.7909E 01	-0.6763E 01	-0.6077E 01	-0.5714E 01	-0.5602E 01			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.58576E 01	0.17547E 02	0.23405E 02	0.33382E 00	0.29957E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.6399E 01	0.6484E 01	0.6775E 01	0.7335E 01	0.8187E 01	0.9857E 01	0.1224E 02	0.1306E 02	-0.1883E 01	-0.1490E 02
-0.1251E 02	-0.9492E 01	-0.7606E 01	-0.6467E 01	-0.5790E 01	-0.5431E 01	-0.5322E 01			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

OBLATE SPHEROID MARK= 264

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	5.00	0.4418325E-05	60.0486	0.2029	4.2725	0.0925	0.0982	33	45

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.9832E-01	0.1967E 00	0.3000E 00	0.4119E 00	0.5367E 00	0.6803E 00	0.8511E 00	0.1062E 01	0.1332E 01
0.1696E 01	0.2212E 01	0.2987E 01	0.4205E 01	0.6101E 01	0.8442E 01	0.9160E 01	0.6404E 01	0.3680E 01	0.1926E 01
0.1013E 01	0.5363E 00	0.2774E 00	0.1325E 00	0.5008E-01	0.3857E-02	-0.2041E-01	-0.3092E-01	-0.3260E-01	-0.2856E-01
-0.2088E-01	-0.1107E-01	0.1423E-12							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.15139E 01	-0.46740E 01	0.61879E 01	0.32390E 00	0.30874E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2094E 01	0.2101E 01	0.2133E 01	0.2202E 01	0.2332E 01	0.2554E 01	0.2840E 01	0.2411E 01	-0.1793E 01	-0.4438E 01
-0.3486E 01	-0.2558E 01	-0.1985E 01	-0.1637E 01	-0.1438E 01	-0.1315E 01	-0.1281E 01			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.15139E 01	0.46697E 01	0.61837E 01	0.32420E 00	0.30845E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2103E 01	0.2110E 01	0.2142E 01	0.2211E 01	0.2342E 01	0.2578E 01	0.2921E 01	0.2628E 01	-0.1831E 01	-0.4567E 01
-0.3450E 01	-0.2488E 01	-0.1915E 01	-0.1571E 01	-0.1365E 01	-0.1255E 01	-0.1220E 01			

ANGLE AT WHICH SURFACE SHEAR STRESS BECOMES ZERO I.E. SEPARATION,IS 141.5 DEGREES

OBLATE SPHEROID MARK= 97

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	10.00	0.1999067E-03	17.1052	0.2029	3.0140	0.0495	0.0982	33	59

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1566E 00	0.3132E 00	0.4775E 00	0.6548E 00	0.8513E 00	0.1075E 01	0.1337E 01	0.1653E 01	0.2067E 01
0.2562E 01	0.3266E 01	0.4283E 01	0.5823E 01	0.8129E 01	0.1077E 02	0.1099E 02	0.7328E 01	0.3644E 01	0.1611E 01
0.6371E 00	0.1706E 00	-0.6584E-01	-0.1630E 00	-0.2075E 00	-0.2173E 00	-0.2070E 00	-0.1845E 00	-0.1544E 00	-0.1195E 00
-0.8157E-01	-0.4174E-01	0.1642E-12							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.91859E 00	0.29853E 01	0.39039E 01	0.30770E 00	0.32499E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1559E 01	0.1553E 01	0.1541E 01	0.1528E 01	0.1523E 01	0.1540E 01	0.1561E 01	0.1109E 01	-0.1846E 01	-0.3173E 01
-0.2280E 01	-0.1625E 01	-0.1243E 01	-0.1012E 01	-0.8736E 00	-0.7983E 00	-0.7741E 00			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.91859E 00	0.29816E 01	0.39002E 01	0.30809E 00	0.32458E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1564E 01	0.1558E 01	0.1546E 01	0.1534E 01	0.1529E 01	0.1548E 01	0.1580E 01	0.1147E 01	-0.1862E 01	-0.3191E 01
-0.2259E 01	-0.1602E 01	-0.1222E 01	-0.9931E 00	-0.8550E 00	-0.7800E 00	-0.7559E 00			

ANGLE AT WHICH SURFACE SHEAR STRESS BECOMES ZERO I.E. SEPARATION,IS 122.4 DEGREES

OBLATE SPHEROID MARK= 96

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	10.00	0.3741067E-04	29.8997	0.2029	3.5750	0.0496	0.0982	33	60

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1547E 00	0.3094E 00	0.4717E 00	0.4468E 00	0.8407E 00	0.1061E 01	0.1320E 01	0.1631E 01	0.2021E 01
0.2528E 01	0.3222E 01	0.4226E 01	0.5745E 01	0.8018E 01	0.1063E 02	0.1084E 02	0.7231E 01	0.3598E 01	0.1584E 01
0.6243E 00	0.1669E 00	-0.6780E-01	-0.1631E 00	-0.2066E 00	-0.2160E 00	-0.2055E 00	-0.1831E 00	-0.1532E 00	-0.1186E 00
-0.8094E-01	-0.4142E-01	0.1504E-12							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.90994E 00	0.29405E 01	0.38460E 01	0.30798E 00	0.32472E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1554E 01	0.1548E 01	0.1537E 01	0.1525E 01	0.1520E 01	0.1538E 01	0.1560E 01	0.1113E 01	-0.1787E 01	-0.3104E 01
-0.2229E 01	-0.1580E 01	-0.1204E 01	-0.9769E 00	-0.8403E 00	-0.7661E 00	-0.7423E 00			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.90994E 00	0.29364E 01	0.38419E 01	0.30839E 00	0.32427E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1560E 01	0.1554E 01	0.1542E 01	0.1530E 01	0.1526E 01	0.1546E 01	0.1580E 01	0.1172E 01	-0.1814E 01	-0.3123E 01
-0.2204E 01	-0.1557E 01	-0.1182E 01	-0.9569E 00	-0.8210E 00	-0.7472E 00	-0.7235E 00			

ANGLE AT WHICH SURFACE SHEAR STRESS BECOMES ZERO I.E. SEPARATION,IS 122.3 DEGREES

OBLATE SPHEROID MARK= 91

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	20.00	0.1998067E-03	17.1052	0.2029	3.0160	0.0485	0.0982	33	59

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.2435E 00	0.4883E 00	0.7464E 00	0.1026E 01	0.1378E 01	0.1693E 01	0.2108E 01	0.2604E 01	0.3212E 01
0.3981E 01	0.4992E 01	0.6380E 01	0.8362E 01	0.1111E 02	0.1383E 02	0.1301E 02	0.7713E 01	0.3137E 01	0.8675E 00
-0.9744E-01	-0.4878E 00	-0.6283E 00	-0.6558E 00	-0.6298E 00	-0.5771E 00	-0.5101E 00	-0.4349E 00	-0.3543E 00	-0.2698E 00
-0.1825E 00	-0.9303E-01	0.1642E-12							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.56180E 00	0.20229E 01	0.25847E 01	0.27772E 00	0.36008E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1285E 01	0.1271E 01	0.1233E 01	0.1169E 01	0.1076E 01	0.9468E 00	0.7583E 00	0.1975E 00	-0.1782E 01	-0.2284E 01
-0.1570E 01	-0.1116E 01	-0.8597E 00	-0.7050E 00	-0.6095E 00	-0.5568E 00	-0.5383E 00			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.56180E 00	0.20193E 01	0.25811E 01	0.27821E 00	0.35944E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1288E 01	0.1274E 01	0.1236E 01	0.1173E 01	0.1080E 01	0.9553E 00	0.7760E 00	0.2377E 00	-0.1796E 01	-0.2289E 01
-0.1552E 01	-0.1099E 01	-0.8445E 00	-0.6902E 00	-0.5953E 00	-0.5420E 00	-0.5243E 00			

ANGLE AT WHICH SURFACE SHEAR STRESS BECOMES ZERO I.E. SEPARATION,IS 112.0 DEGREES

OBLATE SPHEROID MARK= 113

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	50.00	0.1998067E-03	17.1052	0.2029	3.0160	0.0485	0.0982	33	59

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.4099E 00	0.8253E 00	0.1267E 01	0.1752E 01	0.2300E 01	0.2933E 01	0.3681E 01	0.4582E 01	0.5685E 01
0.7055E 01	0.8774E 01	0.1094E 02	0.1374E 02	0.1697E 02	0.1898E 02	0.1528E 02	0.6885E 01	0.1198E 01	-0.1026E 01
-0.1674E 01	-0.1762E 01	-0.1672E 01	-0.1538E 01	-0.1401E 01	-0.1268E 01	-0.1135E 01	-0.9921E 00	-0.8326E 00	-0.6527E 00
-0.4574E 00	-0.2352E 00	0.1642E-12							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.29285E 00	0.13779E 01	0.16707E 01	0.21254E 00	0.47050E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1116E 01	0.1097E 01	0.1041E 01	0.9389E 00	0.7755E 00	0.5276E 00	0.1585E 00	-0.4719E 00	-0.1601E 01	-0.1523E 01
-0.1030E 01	-0.7794E 00	-0.6474E 00	-0.5606E 00	-0.4958E 00	-0.4529E 00	-0.4356E 00			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.29285E 00	0.13714E 01	0.16643E 01	0.21353E 00	0.46831E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1117E 01	0.1099E 01	0.1044E 01	0.9433E 00	0.7816E 00	0.5415E 00	0.1822E 00	-0.4380E 00	-0.1604E 01	-0.1513E 01
-0.1009E 01	-0.7599E 00	-0.6300E 00	-0.5427E 00	-0.4780E 00	-0.4361E 00	-0.4177E 00			

ANGLE AT WHICH SURFACE SHEAR STRESS BECOMES ZERO I.E. SEPARATION,IS 104.3 DEGREES

OBLATE SPHEROID MARK= 165

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	50.00	0.1998299E-03	17.1045	0.2029	3.0160	0.0270	0.0524	61	105

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 3.00 DEGREES INTERVAL

0.0	0.2110E 00	0.4226E 00	0.6379E 00	0.8590E 00	0.1088E 01	0.1328E 01	0.1580E 01	0.1849E 01	0.2136E 01
0.2445E 01	0.2780E 01	0.3146E 01	0.3547E 01	0.3989E 01	0.4479E 01	0.5024E 01	0.5633E 01	0.6316E 01	0.7084E 01
0.7956E 01	0.8943E 01	0.1007E 02	0.1135E 02	0.1282E 02	0.1446E 02	0.1621E 02	0.1784E 02	0.1877E 02	0.1808E 02
0.1511E 02	0.1059E 02	0.6046E 01	0.2704E 01	0.5671E 00	-0.6696E 00	-0.1330E 01	-0.1654E 01	-0.1789E 01	-0.1817E 01
-0.1788E 01	-0.1730E 01	-0.1658E 01	-0.1581E 01	-0.1504E 01	-0.1429E 01	-0.1354E 01	-0.1280E 01	-0.1206E 01	-0.1131E 01
-0.1052E 01	-0.9701E 00	-0.8829E 00	-0.7902E 00	-0.6917E 00	-0.5874E 00	-0.4778E 00	-0.3634E 00	-0.2451E 00	-0.1240E 00
0.0									

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.28546E 00	0.13680E 01	0.16534E 01	0.20867E 00	0.47923E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 4.00 DEGREES INTERVAL

0.1115E 01	0.1110E 01	0.1095E 01	0.1070E 01	0.1036E 01	0.9866E 00	0.9205E 00	0.8390E 00	0.7392E 00	0.6187E 00
0.4557E 00	0.2652E 00	0.2323E-01	-0.3278E 00	-0.8092E 00	-0.1577E 01	-0.1731E 01	-0.1446E 01	-0.1156E 01	-0.9499E 00
-0.8117E 00	-0.7195E 00	-0.6503E 00	-0.5956E 00	-0.5502E 00	-0.5110E 00	-0.4772E 00	-0.4492E 00	-0.4279E 00	-0.4145E 00
-0.4098E 00									

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.28546E 00	0.13457E 01	0.16511E 01	0.20002E 00	0.47842E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 4.00 DEGREES INTERVAL

0.1114E 01	0.1110E 01	0.1094E 01	0.1071E 01	0.1035E 01	0.9855E 00	0.9218E 00	0.8408E 00	0.7398E 00	0.6163E 00
0.4607E 00	0.2720E 00	0.3140E-01	-0.3149E 00	-0.8072E 00	-0.1580E 01	-0.1736E 01	-0.1441E 01	-0.1147E 01	-0.9430E 00
-0.8073E 00	-0.7134E 00	-0.6443E 00	-0.5899E 00	-0.5446E 00	-0.5056E 00	-0.4717E 00	-0.4436E 00	-0.4223E 00	-0.4088E 00
-0.4041E 00									

ANGLE AT WHICH SURFACE SHEAR STRESS BECOMES ZERO I.E. SEPARATION,IS 103.6 DEGREES

OBLATE SPHEROID MARK= 137

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	100.00	0.1998067E-03	17.1052	0.2029	3.0160	0.0485	0.0982	33	59

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.5801E 00	0.1170E 01	0.1801E 01	0.2496E 01	0.3284E 01	0.4203E 01	0.5298E 01	0.6621E 01	0.8249E 01
0.1026E 02	0.1274E 02	0.1573E 02	0.1911E 02	0.2213E 02	0.2333E 02	0.1517E 02	0.4606E 01	-0.9770E 00	-0.2442E 01
-0.2460E 01	-0.2173E 01	-0.1938E 01	-0.1831E 01	-0.1824E 01	-0.1851E 01	-0.1852E 01	-0.1779E 01	-0.1606E 01	-0.1327E 01
-0.9530E 00	-0.5070E 00	0.1642E-12							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.17547E 00	0.11574E 01	0.13328E 01	0.15161E 00	0.65957E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1057E 01	0.1037E 01	0.9750E 00	0.8599E 00	0.6719E 00	0.3795E 00	-0.5444E-01	-0.6623E 00	-0.1313E 01	-0.1073E 01
-0.7729E 00	-0.6639E 00	-0.6135E 00	-0.5618E 00	-0.5004E 00	-0.4458E 00	-0.4246E 00			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.17547E 00	0.11459E 01	0.13214E 01	0.15312E 00	0.65306E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1058E 01	0.1039E 01	0.9783E 00	0.8669E 00	0.6850E 00	0.4019E 00	-0.2012E-01	-0.6234E 00	-0.1302E 01	-0.1049E 01
-0.7437E 00	-0.6357E 00	-0.5858E 00	-0.5338E 00	-0.4720E 00	-0.4185E 00	-0.3963E 00			

ANGLE AT WHICH SURFACE SHEAR STRESS BECOMES ZERO I.E. SEPARATION,IS 100.3 DEGREES

OBLATE SPHEROID MARK= 234

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	100.00	0.1998299E-03	17.1045	0.2029	3.0160	0.0270	0.0524	61	105

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 3.00 DEGREES INTERVAL

0.0	0.2938E 00	0.5887E 00	0.8800E 00	0.1198E 01	0.1519E 01	0.1855E 01	0.2210E 01	0.2588E 01	0.2993E 01
0.3432E 01	0.3900E 01	0.4430E 01	0.5004E 01	0.5639E 01	0.6334E 01	0.7128E 01	0.8006E 01	0.8983E 01	0.1008E 02
0.1130E 02	0.1266E 02	0.1416E 02	0.1577E 02	0.1750E 02	0.1925E 02	0.2085E 02	0.2191E 02	0.2179E 02	0.1910E 02
0.1463E 02	0.8765E 01	0.3495E 01	0.1961E 00	-0.1373E 01	-0.2164E 01	-0.2423E 01	-0.2426E 01	-0.2318E 01	-0.2197E 01
-0.2070E 01	-0.1985E 01	-0.1936E 01	-0.1910E 01	-0.1902E 01	-0.1905E 01	-0.1907E 01	-0.1898E 01	-0.2005E 01	-0.1990E 01
-0.1960E 01	-0.1879E 01	-0.1776E 01	-0.1641E 01	-0.1475E 01	-0.1270E 01	-0.1058E 01	-0.8147E 00	-0.5546E 00	-0.2834E 00
0.0									

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.16458E 00	0.11226E 01	0.12892E 01	0.14834E 00	0.67393E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 6.00 DEGREES INTERVAL

0.1056E 01	0.1051E 01	0.1036E 01	0.1009E 01	0.9693E 00	0.9158E 00	0.8454E 00	0.7549E 00	0.6402E 00	0.4964E 00
0.3185E 00	0.1017E 00	-0.1591E 00	-0.4743E 00	-0.8403E 00	-0.1200E 01	-0.1161E 01	-0.9334E 00	-0.7613E 00	-0.6442E 00
-0.6122E 00	-0.5819E 00	-0.5585E 00	-0.5339E 00	-0.5048E 00	-0.4711E 00	-0.4352E 00	-0.4007E 00	-0.3720E 00	-0.3528E 00
-0.3440E 00									

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.16458E 00	0.11184E 01	0.12850E 01	0.14705E 00	0.67137E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 6.00 DEGREES INTERVAL

0.1057E 01	0.1051E 01	0.1036E 01	0.1009E 01	0.9701E 00	0.9149E 00	0.8472E 00	0.7577E 00	0.6442E 00	0.5022E 00
0.3365E 00	0.1121E 00	-0.1461E 00	-0.4618E 00	-0.8570E 00	-0.1197E 01	-0.1156E 01	-0.9341E 00	-0.7513E 00	-0.6545E 00
-0.6029E 00	-0.5728E 00	-0.5496E 00	-0.5250E 00	-0.4958E 00	-0.4620E 00	-0.4259E 00	-0.3914E 00	-0.3634E 00	-0.3436E 00
-0.3366E 00									

ANGLE AT WHICH SURFACE SHEAR STRESS BECOMES ZERO I.E. SEPARATION,IS 99.7 DEGREES

OBLATE SPHEROID MARK= 266

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	100.00	0.2916674E-02	6.9990	0.2029	2.1185	0.0299	0.0785	41	65

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 4.50 DEGREES INTERVAL

0.0	0.4900E 00	0.9850E 00	0.1504E 01	0.2059E 01	0.2664E 01	0.3338E 01	0.4101E 01	0.4978E 01	0.6000E 01
0.7206E 01	0.8640E 01	0.1036E 02	0.1241E 02	0.1485E 02	0.1771E 02	0.2091E 02	0.2412E 02	0.2434E 02	0.2490E 02
0.1743E 02	0.7052E 01	0.1484E 00	-0.2678E 01	-0.3403E 01	-0.3331E 01	-0.3028E 01	-0.2715E 01	-0.2471E 01	-0.2316E 01
-0.2234E 01	-0.2197E 01	-0.2169E 01	-0.2116E 01	-0.2013E 01	-0.1841E 01	-0.1595E 01	-0.1275E 01	-0.8939E 00	-0.4661E 00
0.9139E-12									

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.19467E 00	0.11551E 01	0.13498E 01	0.16853E 00	0.59935E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 9.00 DEGREES INTERVAL

0.1060E 01	0.1047E 01	0.1005E 01	0.9313E 00	0.8158E 00	0.6447E 00	0.3976E 00	0.4950E-01	-0.4219E 00	-0.1042E 01
-0.1640E 01	-0.1407E 01	-0.1013E 01	-0.8127E 00	-0.7116E 00	-0.6454E 00	-0.5933E 00	-0.5168E 00	-0.4521E 00	-0.4034E 00
-0.3848E 00									

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.19447E 00	0.11452E 01	0.13399E 01	0.16999E 00	0.58827E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 9.00 DEGREES INTERVAL

0.1061E 01	0.1047E 01	0.1004E 01	0.9331E 00	0.8191E 00	0.6505E 00	0.4075E 00	0.6560E-01	-0.3988E 00	-0.1017E 01
-0.1630E 01	-0.1391E 01	-0.9993E 00	-0.7917E 00	-0.6934E 00	-0.6273E 00	-0.5650E 00	-0.4980E 00	-0.4329E 00	-0.3841E 00
-0.3654E 00									

ANGLE AT WHICH SURFACE SHEAR STRESS BECOMES ZERO I.E. SEPARATION,IS 99.3 DEGREES

Single Prolate Spheroids

PROLATE SPHEROID MARK= 591

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	1.00	0.1775408E-03	17.7923	1.4750	4.3350	0.0477	0.2982	33	61

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.2331E 00	0.4586E 00	0.6718E 00	0.8480E 00	0.1044E 01	0.1197E 01	0.1328E 01	0.1436E 01	0.1519E 01
0.1583E 01	0.1628E 01	0.1655E 01	0.1668E 01	0.1667E 01	0.1654E 01	0.1630E 01	0.1597E 01	0.1556E 01	0.1507E 01
0.1441E 01	0.1372E 01	0.1294E 01	0.1206E 01	0.1110E 01	0.1001E 01	0.8833E 00	0.7555E 00	0.6181E 00	0.4721E 00
0.3191E 00	0.1609E 00	0.3706E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.20096E 02	0.89203E 01	0.29016E 02	0.22528E 01	0.44389E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.8275E 01	0.8005E 01	0.7239E 01	0.6109E 01	0.4770E 01	0.3360E 01	0.1972E 01	0.6602E 00	-0.5549E 00	-0.1471E 01
-0.2694E 01	-0.3629E 01	-0.4449E 01	-0.5195E 01	-0.5748E 01	-0.6139E 01	-0.6365E 01			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.20096E 02	0.89960E 01	0.29092E 02	0.22338E 01	0.44766E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.8258E 01	0.7983E 01	0.7207E 01	0.6044E 01	0.4711E 01	0.3287E 01	0.1887E 01	0.5650E 00	-0.6599E 00	-0.1785E 01
-0.2815E 01	-0.3757E 01	-0.4605E 01	-0.5336E 01	-0.5915E 01	-0.6290E 01	-0.6416E 01			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

PROLATE SPHEROID MARK= 520

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	1.00	0.3739906E-04	28.9268	1.4750	4.8550	0.0528	0.2982	33	65

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.2299E 00	0.4524E 00	0.6628E 00	0.8365E 00	0.1030E 01	0.1181E 01	0.1310E 01	0.1416E 01	0.1498E 01
0.1561E 01	0.1604E 01	0.1631E 01	0.1643E 01	0.1641E 01	0.1628E 01	0.1604E 01	0.1570E 01	0.1527E 01	0.1475E 01
0.1415E 01	0.1346E 01	0.1269E 01	0.1182E 01	0.1086E 01	0.9807E 00	0.8651E 00	0.7397E 00	0.6058E 00	0.4632E 00
0.3122E 00	0.1576E 00	0.3551E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.19766E 02	0.86418E 01	0.28400E 02	0.22873E 01	0.43720E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.8193E 01	0.7935E 01	0.7192E 01	0.6092E 01	0.4785E 01	0.3408E 01	0.2057E 01	0.7839E 00	-0.3918E 00	-0.1670E 01
-0.2657E 01	-0.3556E 01	-0.4165E 01	-0.4965E 01	-0.5416E 01	-0.5773E 01	-0.5903E 01			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.19766E 02	0.87121E 01	0.28479E 02	0.22688E 01	0.44076E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.8175E 01	0.7915E 01	0.7165E 01	0.6053E 01	0.4732E 01	0.3339E 01	0.1976E 01	0.6941E 00	-0.4896E 00	-0.1676E 01
-0.2569E 01	-0.3475E 01	-0.4290E 01	-0.4996E 01	-0.5553E 01	-0.5913E 01	-0.6035E 01			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

PROLATE SPHEROID MARK= 521

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	1.00	0.5387777E-05	57.0420	1.4750	5.5000	0.0629	0.2982	33	65

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.2286E 00	0.4499E 00	0.6591E 00	0.8517E 00	0.1024E 01	0.1175E 01	0.1302E 01	0.1406E 01	0.1489E 01
0.1551E 01	0.1594E 01	0.1620E 01	0.1632E 01	0.1630E 01	0.1616E 01	0.1592E 01	0.1558E 01	0.1515E 01	0.1463E 01
0.1403E 01	0.1335E 01	0.1258E 01	0.1171E 01	0.1076E 01	0.9712E 00	0.8566E 00	0.7323E 00	0.5989E 00	0.4573E 00
0.3090E 00	0.1559E 00	0.3450E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.19618E 02	0.85136E 01	0.28132E 02	0.23044E 01	0.43396E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.8162E 01	0.7905E 01	0.7171E 01	0.6085E 01	0.4796E 01	0.3439E 01	0.2106E 01	0.8489E 00	-0.3112E 00	-0.1373E 01
-0.2344E 01	-0.3228E 01	-0.4022E 01	-0.4707E 01	-0.5247E 01	-0.5595E 01	-0.5714E 01			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.19618E 02	0.86171E 01	0.28236E 02	0.22767E 01	0.43923E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.8145E 01	0.7884E 01	0.7139E 01	0.6036E 01	0.4728E 01	0.3352E 01	0.2002E 01	0.7308E 00	-0.4422E 00	-0.1516E 01
-0.2497E 01	-0.3391E 01	-0.4195E 01	-0.4889E 01	-0.5436E 01	-0.5791E 01	-0.5910E 01			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

PROLATE SPHEROID MARK= 527

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	5.00	0.3730906E-04	29.9268	1.4750	4.8550	0.0528	0.0982	33	65

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.3819E 00	0.7487E 00	0.1091E 01	0.1401E 01	0.1671E 01	0.1896E 01	0.2077E 01	0.2212E 01	0.2304E 01
0.2356E 01	0.2373E 01	0.2357E 01	0.2315E 01	0.2249E 01	0.2164E 01	0.2062E 01	0.1948E 01	0.1824E 01	0.1692E 01
0.1555E 01	0.1414E 01	0.1272E 01	0.1130E 01	0.9900E 00	0.8524E 00	0.7184E 00	0.5887E 00	0.4634E 00	0.3426E 00
0.2258E 00	0.1116E 00	0.3551E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.50742E 01	0.22975E 01	0.73717E 01	0.22086E 01	0.45278E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2708E 01	0.2593E 01	0.2271E 01	0.1803E 01	0.1265E 01	0.7268E 00	0.2350E 00	-0.1822E 00	-0.5143E 00	-0.7624E 00
-0.9345E 00	-0.1043E 01	-0.1101E 01	-0.1123E 01	-0.1124E 01	-0.1117E 01	-0.1113E 01			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.50742E 01	0.23216E 01	0.73958E 01	0.21857E 01	0.45752E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2703E 01	0.2587E 01	0.2269E 01	0.1787E 01	0.1244E 01	0.6991E 00	0.2021E 00	-0.2194E 00	-0.5549E 00	-0.8056E 00
-0.9795E 00	-0.1089E 01	-0.1147E 01	-0.1169E 01	-0.1170E 01	-0.1163E 01	-0.1158E 01			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

PROLATE SPHEROID MARK= 534

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	10.00	0.2913149E-03	15.0850	1.4750	4.1700	0.0421	0.0982	33	65

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.5171E 00	0.1012E 01	0.1472E 01	0.1883E 01	0.2238E 01	0.2529E 01	0.2754E 01	0.2915E 01	0.3015E 01
0.3059E 01	0.3053E 01	0.3003E 01	0.2916E 01	0.2797E 01	0.2655E 01	0.2492E 01	0.2316E 01	0.2130E 01	0.1938E 01
0.1745E 01	0.1553E 01	0.1364E 01	0.1183E 01	0.1010E 01	0.8447E 00	0.6950E 00	0.5551E 00	0.4266E 00	0.3088E 00
0.1999E 00	0.9755E-01	0.3779E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.30847E 01	0.16740E 01	0.47587E 01	0.18427E 01	0.54269E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1923E 01	0.1825E 01	0.1551E 01	0.1156E 01	0.7074E 00	0.2648E 00	-0.1291E 00	-0.4507E 00	-0.6922E 00	-0.8567E 00
-0.9544E 00	-0.9989E 00	-0.1005E 01	-0.9847E 00	-0.9595E 00	-0.9363E 00	-0.9269E 00			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.30847E 01	0.16851E 01	0.47698E 01	0.18306E 01	0.54628E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1920E 01	0.1821E 01	0.1545E 01	0.1147E 01	0.6956E 00	0.2493E 00	-0.1479E 00	-0.4722E 00	-0.7156E 00	-0.8811E 00
-0.9792E 00	-0.1023E 01	-0.1028E 01	-0.1009E 01	-0.9809E 00	-0.9569E 00	-0.9473E 00			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

PROLATE SPHEROID MARK= 531

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	10.00	0.3730906E-04	29.9268	1.4750	4.8550	0.0528	0.0982	33	65

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.5194E 00	0.1017E 01	0.1479E 01	0.1892E 01	0.2247E 01	0.2539E 01	0.2764E 01	0.2923E 01	0.3021E 01
0.3061E 01	0.3050E 01	0.2994E 01	0.2900E 01	0.2774E 01	0.2623E 01	0.2451E 01	0.2265E 01	0.2068E 01	0.1867E 01
0.1663E 01	0.1462E 01	0.1267E 01	0.1080E 01	0.9050E 00	0.7428E 00	0.5954E 00	0.4636E 00	0.3471E 00	0.2451E 00
0.1552E 00	0.7433E-01	0.3551E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.30230E 01	0.14470E 01	0.44700E 01	0.20892E 01	0.47865E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1929E 01	0.1833E 01	0.1566E 01	0.1182E 01	0.7500E 00	0.3285E 00	-0.3977E-01	-0.3319E 00	-0.5610E 00	-0.6715E 00
-0.7349E 00	-0.7463E 00	-0.7217E 00	-0.6774E 00	-0.6293E 00	-0.5924E 00	-0.5782E 00			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.30230E 01	0.14655E 01	0.44886E 01	0.20627E 01	0.48479E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1926E 01	0.1829E 01	0.1559E 01	0.1172E 01	0.7357E 00	0.3095E 00	-0.6300E-01	-0.3590E 00	-0.5712E 00	-0.7039E 00
-0.7685E 00	-0.7804E 00	-0.7556E 00	-0.7106E 00	-0.6618E 00	-0.6242E 00	-0.6097E 00			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

PROLATE SPHEROID MARK= 542

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	20.00	0.2913149E-03	15.0850	1.4750	4.1700	0.0421	0.0982	33	65

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.7304E 00	0.1427E 01	0.2072E 01	0.2644E 01	0.3129E 01	0.3520E 01	0.3811E 01	0.4005E 01	0.4107E 01
0.4124E 01	0.4065E 01	0.3941E 01	0.3762E 01	0.3537E 01	0.3277E 01	0.2991E 01	0.2688E 01	0.2378E 01	0.2067E 01
0.1763E 01	0.1473E 01	0.1202E 01	0.9538E 00	0.7329E 00	0.5416E 00	0.3814E 00	0.2531E 00	0.1556E 00	0.8653E-01
0.4158E-01	0.1454E-01	0.3779E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.18551E 01	0.96419E 00	0.28193E 01	0.19240E 01	0.51975E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1502E 01	0.1414E 01	0.1172E 01	0.8785E 00	0.4482E 00	0.8886E-01	-0.2094E 00	-0.4264E 00	-0.5586E 00	-0.6152E 00
-0.6125E 00	-0.5702E 00	-0.5063E 00	-0.4364E 00	-0.3732E 00	-0.3286E 00	-0.3122E 00			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.18551E 01	0.97813E 00	0.28332E 01	0.18966E 01	0.52727E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1500E 01	0.1412E 01	0.1169E 01	0.8740E 00	0.4413E 00	0.7896E-01	-0.2226E 00	-0.4427E 00	-0.5776E 00	-0.6360E 00
-0.6344E 00	-0.5924E 00	-0.5284E 00	-0.4581E 00	-0.3944E 00	-0.3494E 00	-0.3327E 00			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

PROLATE SPHEROID MARK= 550

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	50.00	0.2913149E-03	15.0850	1.4750	4.1700	0.0421	0.0982	33	65

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1186E 01	0.2312E 01	0.3348E 01	0.4258E 01	0.5017E 01	0.5612E 01	0.6035E 01	0.6290E 01	0.6386E 01
0.6336E 01	0.6155E 01	0.5862E 01	0.5476E 01	0.5012E 01	0.4494E 01	0.3941E 01	0.3373E 01	0.2809E 01	0.2266E 01
0.1760E 01	0.1303E 01	0.9046E 00	0.5676E 00	0.2977E 00	0.7734E-01	-0.8146E-01	-0.1861E 00	-0.2379E 00	-0.2385E 00
-0.1926E 00	-0.1098E 00	0.3779E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.99919E 00	0.60697E 00	0.16062E 01	0.16462E 01	0.60746E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1218E 01	0.1132E 01	0.8948E 00	0.5645E 00	0.2090E 00	-0.1115E 00	-0.3570E 00	-0.5094E 00	-0.5710E 00	-0.5597E 00
-0.5018E 00	-0.4240E 00	-0.3467E 00	-0.2797E 00	-0.2260E 00	-0.1887E 00	-0.1747E 00			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.99919E 00	0.62634E 00	0.16255E 01	0.15953E 01	0.62684E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1217E 01	0.1132E 01	0.8973E 00	0.5691E 00	0.2142E 00	-0.1085E 00	-0.3582E 00	-0.5159E 00	-0.5826E 00	-0.5750E 00
-0.5190E 00	-0.4419E 00	-0.3645E 00	-0.2973E 00	-0.2433E 00	-0.2057E 00	-0.1916E 00			

ANGLE AT WHICH SURFACE SHEAR STRESS BECOMES ZERO I.E. SEPARATION,IS 143.4 DEGREES

PROLATE SPHEROID MARK= 558

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	100.00	0.2913149E-03	15.0850	1.4750	4.1700	0.0421	0.0982	33	65

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1760E 01	0.3428E 01	0.4956E 01	0.6289E 01	0.7390E 01	0.8237E 01	0.8821E 01	0.9147E 01	0.9229E 01
0.9086E 01	0.8744E 01	0.8227E 01	0.7566E 01	0.6790E 01	0.5932E 01	0.5028E 01	0.4113E 01	0.3224E 01	0.2397E 01
0.1660E 01	0.1033E 01	0.5253E 00	0.1330E 00	-0.1565E 00	-0.3623E 00	-0.5027E 00	-0.5871E 00	-0.6121E 00	-0.5567E 00
-0.4434E 00	-0.2495E 00	0.3779E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.65536E 00	0.47298E 00	0.11283E 01	0.13856E 01	0.72172E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1115E 01	0.1023E 01	0.7708E 00	0.4237E 00	0.5786E-01	-0.2609E 00	-0.4807E 00	-0.6117E 00	-0.6343E 00	-0.5860E 00
-0.4976E 00	-0.4084E 00	-0.3355E 00	-0.2821E 00	-0.2413E 00	-0.2098E 00	-0.1966E 00			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.65536E 00	0.48679E 00	0.11422E 01	0.13443E 01	0.74279E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1115E 01	0.1027E 01	0.7870E 00	0.4545E 00	0.1009E 00	-0.2120E 00	-0.4423E 00	-0.5711E 00	-0.6022E 00	-0.5588E 00
-0.4759E 00	-0.3876E 00	-0.3146E 00	-0.2611E 00	-0.2201E 00	-0.1883E 00	-0.1749E 00			

ANGLE AT WHICH SURFACE SHEAR STRESS BECOMES ZERO I.E. SEPARATION,IS 132.0 DEGREES

PROLATE SPHEROID MARK= 566

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	100.00	0.2913384E-03	15.0846	1.4750	4.1700	0.0287	0.0491	65	95

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 2.81 DEGREES INTERVAL

0.0	0.8451E 00	0.1679E 01	0.2496E 01	0.3287E 01	0.4045E 01	0.4763E 01	0.5435E 01	0.6056E 01	0.6621E 01
0.7128E 01	0.7574E 01	0.7957E 01	0.8278E 01	0.8534E 01	0.8729E 01	0.8862E 01	0.8935E 01	0.8950E 01	0.8911E 01
0.8818E 01	0.8676E 01	0.8487E 01	0.8254E 01	0.7982E 01	0.7672E 01	0.7329E 01	0.6958E 01	0.6561E 01	0.6143E 01
0.5709E 01	0.5263E 01	0.4810E 01	0.4355E 01	0.3903E 01	0.3457E 01	0.3024E 01	0.2607E 01	0.2211E 01	0.1837E 01
0.1489E 01	0.1170E 01	0.8786E 00	0.6169E 00	0.3841E 00	0.1791E 00	0.5199E-03	-0.1537E 00	-0.2857E 00	-0.3979E 00
-0.4975E 00	-0.5711E 00	-0.6348E 00	-0.6840E 00	-0.7180E 00	-0.7354E 00	-0.7344E 00	-0.7131E 00	-0.6698E 00	-0.6040E 00
-0.5160E 00	-0.4079E 00	-0.2829E 00	-0.1456E 00	0.0					

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.62634E 00	0.44740E 00	0.10737E 01	0.14000E 01	0.71431E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.1112E 01	0.1090E 01	0.1026E 01	0.9238E 00	0.7904E 00	0.6330E 00	0.4633E 00	0.2876E 00	0.1152E 00	-0.4650E-01
-0.1914E 00	-0.3149E 00	-0.4140E 00	-0.4869E 00	-0.5337E 00	-0.5558E 00	-0.5558E 00	-0.5376E 00	-0.5058E 00	-0.4652E 00
-0.4204E 00	-0.3754E 00	-0.3330E 00	-0.2949E 00	-0.2617E 00	-0.2331E 00	-0.2080E 00	-0.1852E 00	-0.1639E 00	-0.1443E 00
-0.1279E 00	-0.1168E 00	-0.1129E 00							

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.62634E 00	0.46628E 00	0.10926E 01	0.13433E 01	0.74445E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.1112E 01	0.1090E 01	0.1027E 01	0.9260E 00	0.7940E 00	0.6380E 00	0.4694E 00	0.2943E 00	0.1219E 00	-0.4052E-01
-0.1868E 00	-0.3123E 00	-0.4137E 00	-0.4893E 00	-0.5388E 00	-0.5635E 00	-0.5659E 00	-0.5497E 00	-0.5193E 00	-0.4797E 00
-0.4355E 00	-0.3908E 00	-0.3486E 00	-0.3106E 00	-0.2775E 00	-0.2489E 00	-0.2239E 00	-0.2011E 00	-0.1797E 00	-0.1601E 00
-0.1436E 00	-0.1325E 00	-0.1285E 00							

ANGLE AT WHICH SURFACE SHEAR STRESS BECOMES ZERO I.E. SEPARATION,IS 120.4 DEGREES

PROLATE SPHEROID MARK= 593

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	1.00	0.9868366E-04	21.6543	0.5400	3.4500	0.0315	0.2082	33	93

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.4617E 00	0.8548E 00	0.1132E 01	0.1296E 01	0.1373E 01	0.1392E 01	0.1376E 01	0.1343E 01	0.1301E 01
0.1257E 01	0.1215E 01	0.1176E 01	0.1141E 01	0.1111E 01	0.1086E 01	0.1066E 01	0.1052E 01	0.1042E 01	0.1036E 01
0.1034E 01	0.1039E 01	0.1046E 01	0.1053E 01	0.1061E 01	0.1043E 01	0.1054E 01	0.1032E 01	0.9811E 00	0.8211E 00
0.6147E 00	0.3298E 00	0.3581E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.28152E 02	0.59030E 01	0.34056E 02	0.47684E 01	0.20971E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1018E 02	0.9129E 01	0.6738E 01	0.4667E 01	0.3130E 01	0.2044E 01	0.1305E 01	0.7411E 00	0.2780E 00	-0.1407E 00
-0.5647E 00	-0.1066E 01	-0.1736E 01	-0.2492E 01	-0.4039E 01	-0.5811E 01	-0.6179E 01			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.28152E 02	0.60250E 01	0.34177E 02	0.46726E 01	0.21402E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.9979E 01	0.8998E 01	0.6623E 01	0.4351E 01	0.2789E 01	0.1733E 01	0.9262E 00	0.3476E 00	-0.1390E 00	-0.5605E 00
-0.9938E 00	-0.1504E 01	-0.2183E 01	-0.3151E 01	-0.4504E 01	-0.5917E 01	-0.6590E 01			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

PROLATE SPHEROID MARK= 522

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	1.00	0.5360320E-05	57.1392	0.5490	4.4200	0.0605	0.0982	33	65

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.4612E 00	0.8535E 00	0.1130E 01	0.1294E 01	0.1371E 01	0.1390E 01	0.1374E 01	0.1339E 01	0.1297E 01
0.1252E 01	0.1209E 01	0.1169E 01	0.1134E 01	0.1103E 01	0.1077E 01	0.1056E 01	0.1040E 01	0.1029E 01	0.1022E 01
0.1020E 01	0.1022E 01	0.1026E 01	0.1033E 01	0.1038E 01	0.1039E 01	0.1029E 01	0.9958E 00	0.9252E 00	0.7976E 00
0.5963E 00	0.3198E 00	0.3431E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.27866E 02	0.54973E 01	0.33363E 02	0.50690E 01	0.19728E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1019E 02	0.9197E 01	0.7004E 01	0.4985E 01	0.3528E 01	0.2532E 01	0.1836E 01	0.1321E 01	0.9066E 00	0.5308E 00
0.1390E 00	-0.3328E 00	-0.9708E 00	-0.1887E 01	-0.3158E 01	-0.4544E 01	-0.5168E 01			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.27866E 02	0.58240E 01	0.33692E 02	0.47830E 01	0.20907E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.9991E 01	0.8939E 01	0.6617E 01	0.4497E 01	0.2973E 01	0.1928E 01	0.1192E 01	0.6425E 00	0.1963E 00	-0.2091E 00
-0.6305E 00	-0.1133E 01	-0.1808E 01	-0.2771E 01	-0.4111E 01	-0.5582E 01	-0.6243E 01			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

PROLATE SPHEROID MARK= 524

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	5.00	0.3826323E-04	29.6759	0.5490	3.7650	0.0502	0.0982	33	65

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.7347E 00	0.1356E 01	0.1785E 01	0.2032E 01	0.2137E 01	0.2147E 01	0.2102E 01	0.2027E 01	0.1938E 01
0.1844E 01	0.1756E 01	0.1670E 01	0.1590E 01	0.1516E 01	0.1448E 01	0.1386E 01	0.1330E 01	0.1278E 01	0.1231E 01
0.1188E 01	0.1149E 01	0.1111E 01	0.1074E 01	0.1038E 01	0.9986E 00	0.9509E 00	0.8879E 00	0.7984E 00	0.6698E 00
0.4898E 00	0.2580E 00	0.3514E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.72481E 01	0.15189E 01	0.87669E 01	0.47721E 01	0.20955E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.3309E 01	0.2949E 01	0.2157E 01	0.1430E 01	0.8819E 00	0.5141E 00	0.2629E 00	0.8760E-01	-0.3838E-01	-0.1331E 00
-0.2105E 00	-0.2833E 00	-0.3671E 00	-0.4814E 00	-0.6421E 00	-0.8212E 00	-0.8998E 00			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.72481E 01	0.15967E 01	0.88347E 01	0.45681E 01	0.21991E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.3251E 01	0.2876E 01	0.2052E 01	0.1290E 01	0.7355E 00	0.3540E 00	0.9374E-01	-0.8995E-01	-0.3332E 00	-0.3242E 00
-0.4048E 00	-0.4846E 00	-0.5732E 00	-0.6929E 00	-0.8508E 00	-0.1049E 01	-0.1131E 01			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

PROLATE SPHEROID MARK= 537

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	10.00	0.2991846E-03	14.9515	0.5490	3.0800	0.0395	0.0982	33	65

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.9683E 00	0.1780E 01	0.2338E 01	0.2651E 01	0.2775E 01	0.2775E 01	0.2701E 01	0.2589E 01	0.2451E 01
0.2328E 01	0.2198E 01	0.2074E 01	0.1958E 01	0.1850E 01	0.1749E 01	0.1654E 01	0.1565E 01	0.1484E 01	0.1409E 01
0.1331E 01	0.1259E 01	0.1190E 01	0.1121E 01	0.1053E 01	0.9819E 00	0.9054E 00	0.8184E 00	0.7136E 00	0.5819E 00
0.4157E 00	0.2146E 00	0.3698E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.43160E 01	0.98876E 00	0.53027E 01	0.43740E 01	0.22963E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2285E 01	0.2016E 01	0.1427E 01	0.8770E 00	0.4733E 00	0.1076E 00	0.1140E-01	-0.1138E 00	-0.1976E 00	-0.2520E 00
-0.2892E 00	-0.3137E 00	-0.3344E 00	-0.3606E 00	-0.4010E 00	-0.4501E 00	-0.4705E 00			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.43160E 01	0.10185E 01	0.53344E 01	0.42378E 01	0.23597E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2249E 01	0.1976E 01	0.1371E 01	0.8090E 00	0.3966E 00	0.1139E 00	-0.2778E-01	-0.2075E 00	-0.3050E 00	-0.3532E 00
-0.3917E 00	-0.4179E 00	-0.4400E 00	-0.4675E 00	-0.5094E 00	-0.5603E 00	-0.5813E 00			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

PROLATE SPHEROID MARK= 530

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	10.00	0.3826323E-04	20.6759	0.5490	3.7650	0.0502	0.0982	33	65

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.9699E 00	0.1782E 01	0.2341E 01	0.2644E 01	0.2778E 01	0.2777E 01	0.2702E 01	0.2588E 01	0.2450E 01
0.2325E 01	0.2194E 01	0.2069E 01	0.1952E 01	0.1843E 01	0.1741E 01	0.1645E 01	0.1556E 01	0.1472E 01	0.1393E 01
0.1317E 01	0.1244E 01	0.1173E 01	0.1103E 01	0.1033E 01	0.9605E 00	0.8831E 00	0.7985E 00	0.6917E 00	0.5624E 00
0.4005E 00	0.2063E 00	0.3514E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.42920E 01	0.95372E 00	0.52457E 01	0.45003E 01	0.22221E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2284E 01	0.2019E 01	0.1436E 01	0.8919E 00	0.4932E 00	0.2222E 00	0.4107E-01	-0.7944E-01	-0.1580E 00	-0.2103E 00
-0.2477E 00	-0.2639E 00	-0.2816E 00	-0.3052E 00	-0.3428E 00	-0.3885E 00	-0.4077E 00			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.42920E 01	0.10009E 01	0.52929E 01	0.42882E 01	0.23320E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2248E 01	0.1973E 01	0.1371E 01	0.8105E 00	0.3098E 00	0.1192E 00	-0.5989E-01	-0.1971E 00	-0.2820E 00	-0.3378E 00
-0.3740E 00	-0.3982E 00	-0.4184E 00	-0.4443E 00	-0.4845E 00	-0.5333E 00	-0.5533E 00			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

PROLATE SPHEROID MARK= 543

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	20.00	0.2991846E-03	14.9515	0.5490	1.0800	0.0395	0.0982	33	65

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1327E 01	0.2428E 01	0.3175E 01	0.3581E 01	0.3726E 01	0.3701E 01	0.3578E 01	0.3405E 01	0.3212E 01
0.3015E 01	0.2822E 01	0.2639E 01	0.2466E 01	0.2304E 01	0.2151E 01	0.2007E 01	0.1869E 01	0.1737E 01	0.1609E 01
0.1485E 01	0.1363E 01	0.1242E 01	0.1123E 01	0.1005E 01	0.8870E 00	0.7686E 00	0.6487E 00	0.5261E 00	0.3989E 00
0.2661E 00	0.1290E 00	0.3698E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.26156E 01	0.63031E 00	0.32459E 01	0.41497E 01	0.24008E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1709E 01	0.1490E 01	0.1017E 01	0.5747E 00	0.2520E 00	0.3582E-01	-0.1039E 00	-0.1907E 00	-0.2605E 00	-0.2633E 00
-0.2667E 00	-0.2564E 00	-0.2382E 00	-0.2182E 00	-0.2017E 00	-0.1914E 00	-0.1860E 00			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.26156E 01	0.65866E 00	0.32743E 01	0.39711E 01	0.25192E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1687E 01	0.1465E 01	0.9827E 00	0.5318E 00	0.2018E 00	-0.2094E-01	-0.1664E 00	-0.2579E 00	-0.3113E 00	-0.3369E 00
-0.3422E 00	-0.3333E 00	-0.3160E 00	-0.2966E 00	-0.2805E 00	-0.2705E 00	-0.2650E 00			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

PROLATE SPHEROID MARK= 549

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	50.00	0.2991846E-03	14.9515	0.5490	1.0800	0.0395	0.0982	33	65

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.2125E 01	0.3857E 01	0.5003E 01	0.5590E 01	0.5758E 01	0.5660E 01	0.5414E 01	0.5098E 01	0.4757E 01
0.4415E 01	0.4086E 01	0.3773E 01	0.3478E 01	0.3199E 01	0.2934E 01	0.2680E 01	0.2435E 01	0.2197E 01	0.1965E 01
0.1736E 01	0.1512E 01	0.1293E 01	0.1081E 01	0.8766E 00	0.6834E 00	0.5043E 00	0.3419E 00	0.2013E 00	0.9960E-01
0.1803E-01	-0.1185E-01	0.3698E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.14083E 01	0.37357E 00	0.17818E 01	0.37698E 01	0.26527E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1317E 01	0.1122E 01	0.7091E 00	0.3284E 00	0.5949E-01	-0.1140E 00	-0.2170E 00	-0.2716E 00	-0.2917E 00	-0.2867E 00
-0.2619E 00	-0.2253E 00	-0.1833E 00	-0.1421E 00	-0.1058E 00	-0.7725E-01	-0.6456E-01			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.14083E 01	0.40439E 00	0.18127E 01	0.34825E 01	0.28715E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1307E 01	0.1112E 01	0.7009E 00	0.3205E 00	0.4675E-01	-0.1326E 00	-0.2432E 00	-0.3047E 00	-0.3303E 00	-0.3287E 00
-0.3069E 00	-0.2718E 00	-0.2303E 00	-0.1893E 00	-0.1529E 00	-0.1239E 00	-0.1109E 00			

ANGLE AT WHICH SURFACE SHEAR STRESS BECOMES ZERO I.E. SEPARATION,IS 172.2 DEGREES

PROLATE SPHEROID MARK= 555

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	100.00	0.2991846E-03	14.9515	0.5490	3.0800	0.0395	0.0982	33	65

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.3183E 01	0.5736E 01	0.7386E 01	0.8183E 01	0.8355E 01	0.8141E 01	0.7722E 01	0.7213E 01	0.6678E 01
0.6151E 01	0.5649E 01	0.5175E 01	0.4729E 01	0.4309E 01	0.3908E 01	0.3523E 01	0.3149E 01	0.2784E 01	0.2425E 01
0.2071E 01	0.1726E 01	0.1392E 01	0.1076E 01	0.7823E 00	0.5183E 00	0.2881E 00	0.9491E-01	-0.5410E-01	-0.1532E 00
-0.1792E 00	-0.1253E 00	0.3698E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.93486E 00	0.27789E 00	0.12127E 01	0.33642E 01	0.29725E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1172E 01	0.9670E 00	0.5431E 00	0.1621E 00	-0.9791E-01	-0.2554E 00	-0.3419E 00	-0.3805E 00	-0.3855E 00	-0.3656E 00
-0.3278E 00	-0.2797E 00	-0.2298E 00	-0.1857E 00	-0.1504E 00	-0.1235E 00	-0.1115E 00			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.93486E 00	0.29353E 00	0.12284E 01	0.31849E 01	0.31398E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1167E 01	0.9742E 00	0.5802E 00	0.2299E 00	-0.1281E-01	-0.1673E 00	-0.2598E 00	-0.3076E 00	-0.3211E 00	-0.3076E 00
-0.2739E 00	-0.2279E 00	-0.1788E 00	-0.1347E 00	-0.9912E-01	-0.7183E-01	-0.5963E-01			

ANGLE AT WHICH SURFACE SHEAR STRESS BECOMES ZERO I.E. SEPARATION,IS 155.4 DEGREES

PROLATE SPHEROID MARK= 590

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	100.00	0.2991948E-03	14.9513	0.5490	3.0800	0.0243	0.0491	65	105

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 2.81 DEGREES INTERVAL

0.0	0.1534E 01	0.2990E 01	0.4297E 01	0.5410E 01	0.6306E 01	0.6984E 01	0.7460E 01	0.7761E 01	0.7914E 01
0.7950E 01	0.7896E 01	0.7774E 01	0.7603E 01	0.7399E 01	0.7172E 01	0.6932E 01	0.6686E 01	0.6437E 01	0.6189E 01
0.5944E 01	0.5705E 01	0.5470E 01	0.5241E 01	0.5018E 01	0.4801E 01	0.4589E 01	0.4382E 01	0.4180E 01	0.3981E 01
0.3786E 01	0.3593E 01	0.3403E 01	0.3215E 01	0.3029E 01	0.2844E 01	0.2661E 01	0.2479E 01	0.2299E 01	0.2120E 01
0.1944E 01	0.1770E 01	0.1599E 01	0.1432E 01	0.1269E 01	0.1111E 01	0.9583E 00	0.8119E 00	0.6722E 00	0.5395E 00
0.4144E 00	0.2972E 00	0.1883E 00	0.8834E-01	-0.2057E-02	-0.8167E-01	-0.1488E 00	-0.2010E 00	-0.2355E 00	-0.2494E 00
-0.2403E 00	-0.2078E 00	-0.1536E 00	-0.8227E-01	0.0					

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.89519E 00	0.27874E 00	0.11739E 01	0.32115E 01	0.31138E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.1162E 01	0.1112E 01	0.9746E 00	0.7872E 00	0.5864E 00	0.3973E 00	0.2321E 00	0.9406E-01	-0.1793E-01	-0.1069E 00
-0.1764E 00	-0.2294E 00	-0.2685E 00	-0.2958E 00	-0.3131E 00	-0.3215E 00	-0.3222E 00	-0.3161E 00	-0.3041E 00	-0.2872E 00
-0.2662E 00	-0.2425E 00	-0.2172E 00	-0.1916E 00	-0.1668E 00	-0.1436E 00	-0.1225E 00	-0.1034E 00	-0.8606E-01	-0.7026E-01
-0.5660E-01	-0.4684E-01	-0.4324E-01							

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.89519E 00	0.30332E 00	0.11985E 01	0.29513E 01	0.33883E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.1160E 01	0.1110E 01	0.9742E 00	0.7879E 00	0.5877E 00	0.3981E 00	0.2313E 00	0.9085E-01	-0.2426E-01	-0.1167E 00
-0.1897E 00	-0.2461E 00	-0.2884E 00	-0.3186E 00	-0.3383E 00	-0.3488E 00	-0.3512E 00	-0.3465E 00	-0.3356E 00	-0.3195E 00
-0.2992E 00	-0.2758E 00	-0.2509E 00	-0.2252E 00	-0.2004E 00	-0.1771E 00	-0.1558E 00	-0.1366E 00	-0.1190E 00	-0.1030E 00
-0.8904E-01	-0.7907E-01	-0.7540E-01							

ANGLE AT WHICH SURFACE SHEAR STRESS BECOMES ZERO I.E. SEPARATION,IS 151.8 DEGREES

PROLATE SPHEROID MARK= 565

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	1.00	0.37386888E-04	29.9060	0.2022	3.0400	0.0302	0.0982	33	95

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1382E 01	0.1876E 01	0.1796E 01	0.1588E 01	0.1391E 01	0.1228E 01	0.1093E 01	0.9853E 00	0.9131E 00
0.8474E 00	0.7947E 00	0.7525E 00	0.7189E 00	0.6928E 00	0.6731E 00	0.6593E 00	0.6509E 00	0.6480E 00	0.6507E 00
0.6593E 00	0.6744E 00	0.6972E 00	0.7293E 00	0.7737E 00	0.8306E 00	0.9069E 00	0.1006E 01	0.1129E 01	0.1256E 01
0.1297E 01	0.9463E 00	0.3467E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.49282E 02	0.29493E 01	0.51331E 02	0.34048E 02	0.41584E-01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1700E 02	0.1207E 02	0.7909E 01	0.6442E 01	0.5872E 01	0.5619E 01	0.5496E 01	0.5432E 01	0.5394E 01	0.5373E 01
0.5344E 01	0.5284E 01	0.5151E 01	0.4832E 01	0.3995E 01	0.1176E 01	-0.2085E 01			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.49282E 02	0.27399E 01	0.52021E 02	0.17987E 02	0.55596E-01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1734E 02	0.1202E 02	0.7928E 01	0.5889E 01	0.5194E 01	0.4843E 01	0.4636E 01	0.4496E 01	0.4390E 01	0.4309E 01
0.4205E 01	0.4076E 01	0.3867E 01	0.3450E 01	0.2415E 01	-0.5341E 00	-0.4056E 01			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

PROLATE SPHEROID MARK= 562

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	1.00	0.5472362E-05	56.7466	0.2029	3.6400	0.0370	0.0982	33	95

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1375E 01	0.1867E 01	0.1787E 01	0.1581E 01	0.1384E 01	0.1222E 01	0.1092E 01	0.9895E 00	0.9076E 00
0.8419E 00	0.7892E 00	0.7469E 00	0.7133E 00	0.6870E 00	0.6671E 00	0.6531E 00	0.6445E 00	0.6413E 00	0.6435E 00
0.6516E 00	0.6662E 00	0.6885E 00	0.7198E 00	0.7623E 00	0.8191E 00	0.8938E 00	0.9907E 00	0.1111E 01	0.1236E 01
0.1275E 01	0.9297E 00	0.3409E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.48825E 02	0.17763E 01	0.50602E 02	0.27487E 02	0.36381E-01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES/INTERVAL

0.1693E 02	0.1218E 02	0.8180E 01	0.6792E 01	0.6276E 01	0.6065E 01	0.5978E 01	0.5946E 01	0.5939E 01	0.5939E 01
0.5932E 01	0.5897E 01	0.5786E 01	0.5483E 01	0.4612E 01	0.2004E 01	-0.1092E 01			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.48825E 02	0.27022E 01	0.51528E 02	0.18069E 02	0.55343E-01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1727E 02	0.1200E 02	0.7550E 01	0.5931E 01	0.5251E 01	0.4909E 01	0.4710E 01	0.4578E 01	0.4477E 01	0.4387E 01
0.4291E 01	0.4163E 01	0.3950E 01	0.3526E 01	0.2493E 01	-0.6154E 00	-0.3854E 01			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

PROLATE SPHEROID MARK= 595

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	1.00	0.1551757E-05	86.3753	0.2029	4.1000	0.0424	0.0982	33	93

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1377E 01	0.1867E 01	0.1788E 01	0.1582E 01	0.1384E 01	0.1222E 01	0.1092E 01	0.9893E 00	0.9073E 00
0.8416E 00	0.7887E 00	0.7464E 00	0.7126E 00	0.6863E 00	0.6663E 00	0.6522E 00	0.6435E 00	0.6402E 00	0.6424E 00
0.6504E 00	0.6649E 00	0.6869E 00	0.7181E 00	0.7604E 00	0.8170E 00	0.8914E 00	0.9879E 00	0.1107E 01	0.1232E 01
0.1271E 01	0.9260E 00	0.3386E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.48764E 02	0.15442E 01	0.50309E 02	0.31579E 02	0.31667E-01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1693E 02	0.1229E 02	0.8396E 01	0.7065E 01	0.6588E 01	0.6409E 01	0.6349E 01	0.6344E 01	0.6361E 01	0.6384E 01
0.6399E 01	0.6386E 01	0.6301E 01	0.6029E 01	0.5200E 01	0.2677E 01	-0.3142E 00			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.48764E 02	0.26569E 01	0.51421E 02	0.18354E 02	0.54484E-01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1727E 02	0.1199E 02	0.7558E 01	0.5948E 01	0.5273E 01	0.4936E 01	0.4741E 01	0.4616E 01	0.4521E 01	0.4436E 01
0.4344E 01	0.4218E 01	0.4011E 01	0.3596E 01	0.2574E 01	-0.3136E 00	-0.3713E 01			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

PROLATE SPHEROID MARK= 617

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	5.00	0.3738688E-04	29.9060	0.2029	3.0400	0.0302	0.0982	33	95

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.2093E 01	0.2817E 01	0.2679E 01	0.2354E 01	0.2046E 01	0.1792E 01	0.1590E 01	0.1429E 01	0.1299E 01
0.1195E 01	0.1110E 01	0.1040E 01	0.9829E 00	0.9359E 00	0.8974E 00	0.8663E 00	0.8418E 00	0.8231E 00	0.8100E 00
0.8023E 00	0.8001E 00	0.8038E 00	0.8143E 00	0.8330E 00	0.8620E 00	0.9045E 00	0.9636E 00	0.1040E 01	0.1119E 01
0.1123E 01	0.7991E 00	0.3467E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.12742E 02	0.58892E 00	0.13331E 02	0.21637E 02	0.46218E-01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.5206E 01	0.3631E 01	0.2294E 01	0.1806E 01	0.1607E 01	0.1514E 01	0.1466E 01	0.1439E 01	0.1422E 01	0.1410E 01
0.1399E 01	0.1384E 01	0.1360E 01	0.1308E 01	0.1163E 01	0.7262E 00	0.2090E 00			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.12742E 02	0.77634E 00	0.13519E 02	0.16413E 02	0.60926E-01

DIMENSIONLESS SURFACE PRESSURF DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.5316E 01	0.3622E 01	0.2184E 01	0.1642E 01	0.1405E 01	0.1281E 01	0.1208E 01	0.1159E 01	0.1122E 01	0.1092E 01
0.1064E 01	0.1033E 01	0.9913E 00	0.9202E 00	0.7531E 00	0.2764E 00	-0.2838E 00			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

PROLATE SPHEROID MARK= 569

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	10.00	0.3001853E-03	14.9349	0.2029	2.3480	0.0228	0.0982	33	95

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.2660E 01	0.3548E 01	0.3352E 01	0.2927E 01	0.2539E 01	0.2205E 01	0.1947E 01	0.1742E 01	0.1578E 01
0.1444E 01	0.1336E 01	0.1246E 01	0.1171E 01	0.1109E 01	0.1057E 01	0.1014E 01	0.9781E 00	0.9495E 00	0.9266E 00
0.9098E 00	0.8987E 00	0.8933E 00	0.8940E 00	0.9014E 00	0.9164E 00	0.9408E 00	0.9767E 00	0.1024E 01	0.1071E 01
0.1046E 01	0.7265E 00	0.3600E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.74478E 01	0.48377E 00	0.79315E 01	0.15395E 02	0.64955E-01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.3384E 01	0.2283E 01	0.1350E 01	0.9955E 00	0.8425E 00	0.7647E 00	0.7193E 00	0.6891E 00	0.6663E 00	0.6663E 00
0.6262E 00	0.6037E 00	0.5757E 00	0.5353E 00	0.4580E 00	0.2556E 00	0.2533E-01			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.74478E 01	0.56185E 00	0.80096E 01	0.13256E 02	0.75438E-01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.3456E 01	0.2305E 01	0.1329E 01	0.9498E 00	0.7793E 00	0.6878E 00	0.6313E 00	0.5915E 00	0.5605E 00	0.5331E 00
0.5062E 00	0.4772E 00	0.4429E 00	0.3958E 00	0.3110E 00	0.9675E-01	-0.1460E 00			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

PROLATE SPHEROID MARK= 572

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	10.00	0.3001853E-03	14.9349	0.2029	2.3480	0.0228	0.0982	33	95

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.2665E 01	0.3555E 01	0.3358E 01	0.2932E 01	0.2535E 01	0.2210E 01	0.1951E 01	0.1746E 01	0.1582E 01
0.1449E 01	0.1341E 01	0.1252E 01	0.1178E 01	0.1116E 01	0.1065E 01	0.1023E 01	0.9880E 00	0.9596E 00	0.9371E 00
0.9201E 00	0.9082E 00	0.9015E 00	0.9003E 00	0.9051E 00	0.9174E 00	0.9389E 00	0.9720E 00	0.1017E 01	0.1061E 01
0.1035E 01	0.7180E 00	0.3600E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.74900E 01	0.43046E 00	0.79205E 01	0.17400E 02	0.57471E-01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.3389E 01	0.2288E 01	0.1357E 01	0.1006E 01	0.8559E 00	0.7815E 00	0.7395E 00	0.7135E 00	0.6954E 00	0.6815E 00
0.6692E 00	0.6565E 00	0.6405E 00	0.6140E 00	0.5511E 00	0.3626E 00	0.1411E 00			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.74900E 01	0.50727E 00	0.79973E 01	0.14765E 02	0.67726E-01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.3461E 01	0.2310E 01	0.1336E 01	0.9610E 00	0.7933E 00	0.7053E 00	0.6521E 00	0.6166E 00	0.5905E 00	0.5693E 00
0.5504E 00	0.5314E 00	0.5094E 00	0.4768E 00	0.4068E 00	0.2072E 00	-0.2617E-01			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

PROLATE SPHEROID MARK= 574

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	20.00	0.3001853E-03	14.9369	0.2029	2.3480	0.0228	0.0982	33	95

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.3541E 01	0.4654E 01	0.4350E 01	0.3764E 01	0.3229E 01	0.2796E 01	0.2456E 01	0.2187E 01	0.1973E 01
0.1799E 01	0.1658E 01	0.1541E 01	0.1443E 01	0.1361E 01	0.1293E 01	0.1234E 01	0.1184E 01	0.1142E 01	0.1105E 01
0.1075E 01	0.1048E 01	0.1026E 01	0.1006E 01	0.9890E 00	0.9763E 00	0.9659E 00	0.9581E 00	0.9556E 00	0.9451E 00
0.8749E 00	0.5758E 00	0.3600E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.45012E 01	0.27094E 00	0.47721E 01	0.16613E 02	0.60194E-01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2353E 01	0.1534E 01	0.8559E 00	0.5996E 00	0.4918E 00	0.4397E 00	0.4114E 00	0.3946E 00	0.3837E 00	0.3760E 00
0.3705E 00	0.3667E 00	0.3636E 00	0.3594E 00	0.3444E 00	0.2844E 00	0.2118E 00			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.45012E 01	0.32463E 00	0.48258E 01	0.13866E 02	0.72121E-01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2402E 01	0.1552E 01	0.8421E 00	0.5571E 00	0.4454E 00	0.3826E 00	0.3457E 00	0.3219E 00	0.3053E 00	0.2928E 00
0.2831E 00	0.2755E 00	0.2689E 00	0.2615E 00	0.2433E 00	0.1747E 00	0.1019E 00			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

PROLATE SPHEROID MARK= 579

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	50.00	0.3001853E-03	14.9369	0.2029	2.3480	0.0228	0.0982	33	95

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.5496E 01	0.7012E 01	0.6618E 01	0.5663E 01	0.4629E 01	0.3771E 01	0.3160E 01	0.2751E 01	0.2465E 01
0.2248E 01	0.2081E 01	0.1907E 01	0.1962E 01	0.1830E 01	0.1734E 01	0.1643E 01	0.1563E 01	0.1493E 01	0.1430E 01
0.1373E 01	0.1320E 01	0.1268E 01	0.1217E 01	0.1165E 01	0.1110E 01	0.1048E 01	0.9812E 00	0.9069E 00	0.8121E 00
0.6718E 00	0.3871E 00	0.3600E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.24006E 01	0.15985E 00	0.25605E 01	0.15018E 02	0.66587E-01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1630E 01	0.9815E 00	0.4714E 00	0.2976E 00	0.2153E 00	0.1729E 00	0.1568E 00	0.1530E 00	0.1500E 00	0.1487E 00
0.1484E 00	0.1527E 00	0.1580E 00	0.1561E 00	0.1441E 00	0.1613E-03				

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.24006E 01	0.20547E 00	0.26041E 01	0.11684E 02	0.85589E-01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1661E 01	0.9971E 00	0.4706E 00	0.2703E 00	0.1836E 00	0.1399E 00	0.1151E 00	0.9970E-01	0.8376E-01	0.7301E-01
0.7882E-01	0.7724E-01	0.7871E-01	0.8337E-01	0.8935E-01	0.9021E-01	0.8279E-01			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

PROLATE SPHEROID MARK= 613

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	50.00	0.3001974E-03	14.9347	0.2029	2.3480	0.0206	0.0491	65	105

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 2.81 DEGREES INTERVAL

0.0	0.3194E 01	0.5529E 01	0.6689E 01	0.6982E 01	0.6793E 01	0.6390E 01	0.5920E 01	0.5454E 01	0.5020E 01
0.4630E 01	0.4283E 01	0.3976E 01	0.3705E 01	0.3466E 01	0.3254E 01	0.3065E 01	0.2897E 01	0.2746E 01	0.2611E 01
0.2488E 01	0.2377E 01	0.2276E 01	0.2184E 01	0.2100E 01	0.2023E 01	0.1951E 01	0.1885E 01	0.1824E 01	0.1767E 01
0.1714E 01	0.1665E 01	0.1619E 01	0.1576E 01	0.1535E 01	0.1496E 01	0.1457E 01	0.1422E 01	0.1388E 01	0.1355E 01
0.1323E 01	0.1292E 01	0.1261E 01	0.1231E 01	0.1202E 01	0.1172E 01	0.1142E 01	0.1112E 01	0.1081E 01	0.1050E 01
0.1018E 01	0.9853E 00	0.9514E 00	0.9148E 00	0.8813E 00	0.8447E 00	0.8072E 00	0.7635E 00	0.7274E 00	0.6806E 00
0.6210E 00	0.5382E 00	0.4046E 00	0.2160E 00	0.0					

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.23607E 01	0.15079E 00	0.25115E 01	0.15656E 02	0.63873E-01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.1599E 01	0.1357E 01	0.9220E 00	0.5964E 00	0.3973E 00	0.2758E 00	0.1994E 00	0.1498E 00	0.1165E 00	0.9356E-01
0.7751E-01	0.6613E-01	0.5803E-01	0.5232E-01	0.4941E-01	0.4591E-01	0.4458E-01	0.4427E-01	0.4491E-01	0.4665E-01
0.4890E-01	0.5233E-01	0.5542E-01	0.6194E-01	0.6817E-01	0.7517E-01	0.8264E-01	0.9035E-01	0.9648E-01	0.1002E 00
0.9818E-01	0.9914E-01	0.9397E-01							

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.23607E 01	0.18983E 00	0.25509E 01	0.12436E 02	0.80413E-01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.1573E 01	0.1323E 01	0.8743E 00	0.5423E 00	0.3350E 00	0.2056E 00	0.1219E 00	0.6550E-01	0.2625E-01	-0.1870E-02
-0.2248E-01	-0.3783E-01	-0.4935E-01	-0.5803E-01	-0.6432E-01	-0.6925E-01	-0.7249E-01	-0.7445E-01	-0.7525E-01	-0.7494E-01
-0.7357E-01	-0.7114E-01	-0.6766E-01	-0.6307E-01	-0.5751E-01	-0.5111E-01	-0.4420E-01	-0.3731E-01	-0.3138E-01	-0.2818E-01
-0.3079E-01	-0.4065E-01	-0.4630E-01							

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

PROLATE SPHEROID MARK= 590

A.R.	RE	CONCENTRATION	OM	X1	X2	A	B	IM	JM
0.20	100.00	0.3001953E-03	14.9349	0.2029	2.3480	0.0228	0.2982	33	95

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.8029E 01	0.9964E 01	0.8942E 01	0.7505E 01	0.6296E 01	0.5362E 01	0.4646E 01	0.4090E 01	0.3651E 01
0.3296E 01	0.3006E 01	0.2764E 01	0.2560E 01	0.2386E 01	0.2236E 01	0.2106E 01	0.1990E 01	0.1887E 01	0.1793E 01
0.1707E 01	0.1624E 01	0.1543E 01	0.1462E 01	0.1377E 01	0.1287E 01	0.1189E 01	0.1083E 01	0.9627E 00	0.8195E 00
0.6292E 00	0.3271E 00	0.3600E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.15511E 01	0.12430E 00	0.16753E 01	0.12478E 02	0.80138E-01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1350E 01	0.7258E 00	0.2695E 00	0.1180E 00	0.6441E-01	0.4352E-01	0.3491E-01	0.3113E-01	0.2912E-01	0.2760E-01
0.2621E-01	0.2524E-01	0.2541E-01	0.2734E-01	0.3052E-01	0.3150E-01	0.3163E-01			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.15511E 01	0.17508E 00	0.17261E 01	0.88590E 01	0.11288E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1372E 01	0.7580E 00	0.3126E 00	0.1521E 00	0.8331E-01	0.4812E-01	0.2794E-01	0.1512E-01	0.4549E-02	0.3185E-03
-0.4427E-02	-0.7816E-02	-0.9412E-02	-0.8713E-02	-0.6339E-02	-0.5808E-02	-0.5907E-02			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

PROLATE SPHEROID MARK= 588

A.R.	RE	CONCENTRATION	OM	X1	X2	A	B	IM	JM
0.20	100.00	0.3001974E-03	14.9347	0.2029	2.3480	0.0206	0.2991	65	105

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 2.81 DEGREES INTERVAL

0.0	0.4601E 01	0.7888E 01	0.9468E 01	0.9799E 01	0.9455E 01	0.8828E 01	0.8125E 01	0.7441E 01	0.6815E 01
0.6256E 01	0.5764E 01	0.5332E 01	0.4953E 01	0.4619E 01	0.4324E 01	0.4062E 01	0.3828E 01	0.3618E 01	0.3429E 01
0.3259E 01	0.3103E 01	0.2962E 01	0.2832E 01	0.2713E 01	0.2603E 01	0.2500E 01	0.2405E 01	0.2316E 01	0.2233E 01
0.2155E 01	0.2080E 01	0.2010E 01	0.1943E 01	0.1879E 01	0.1818E 01	0.1759E 01	0.1702E 01	0.1647E 01	0.1593E 01
0.1540E 01	0.1489E 01	0.1438E 01	0.1389E 01	0.1340E 01	0.1292E 01	0.1244E 01	0.1197E 01	0.1150E 01	0.1104E 01
0.1057E 01	0.1011E 01	0.9644E 00	0.9174E 00	0.8691E 00	0.8190E 00	0.7667E 00	0.7114E 00	0.6524E 00	0.5877E 00
0.5137E 00	0.4231E 00	0.3060E 00	0.1567E 00	0.0					

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.14812E 01	0.10408E 00	0.15853E 01	0.14232E 02	0.70267E-01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.1332E 01	0.1110E 01	0.7192E 00	0.4318E 00	0.2577E 00	0.1542E 00	0.9126E-01	0.5177E-01	0.2642E-01	0.9876E-02
-0.9413E-03	-0.7918E-02	-0.1223E-01	-0.1462E-01	-0.1558E-01	-0.1543E-01	-0.1438E-01	-0.1256E-01	-0.1006E-01	-0.6964E-02
-0.3328E-02	0.7772E-03	0.5272E-02	0.1006E-01	0.1503E-01	0.2001E-01	0.2478E-01	0.2901E-01	0.3224E-01	0.3391E-01
0.3374E-01	0.3027E-01	0.2879E-01							

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.14812E 01	0.15035E 00	0.16315E 01	0.98519E 01	0.10150E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.1316E 01	0.1094E 01	0.7040E 00	0.4183E 00	0.2417E 00	0.1324E 00	0.6197E-01	0.1472E-01	-0.1810E-01	-0.4152E-01
-0.5852E-01	-0.7096E-01	-0.8003E-01	-0.8654E-01	-0.9103E-01	-0.9387E-01	-0.9534E-01	-0.9564E-01	-0.9492E-01	-0.9330E-01
-0.9087E-01	-0.8775E-01	-0.8405E-01	-0.7990E-01	-0.7542E-01	-0.7083E-01	-0.6637E-01	-0.6241E-01	-0.5943E-01	-0.5805E-01
-0.5903E-01	-0.6237E-01	-0.6399E-01							

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

Single Elliptical Cylinders with O.R.> 1

FLOW ALONG MAJOR AXIS ELL. CYLINDER MARK= 1045

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
1.00	1.00	0.1511351E-04	257.2273	3.0000	8.5500	0.0603	0.0982	33	93

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1196E 00	0.2369E 00	0.3498E 00	0.4561E 00	0.5540E 00	0.6418E 00	0.7184E 00	0.7825E 00	0.8337E 00
0.8716E 00	0.8961E 00	0.9077E 00	0.9068E 00	0.8945E 00	0.8716E 00	0.8396E 00	0.7995E 00	0.7530E 00	0.7013E 00
0.6459E 00	0.5880E 00	0.5288E 00	0.4694E 00	0.4106E 00	0.3531E 00	0.2974E 00	0.2436E 00	0.1919E 00	0.1420E 00
0.9375E-01	0.4658E-01	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.53144E 01	0.54606E 01	0.10775E 02	0.97322E 00	0.10275E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.4001E 01	0.3869E 01	0.3483E 01	0.2885E 01	0.2130E 01	0.1286E 01	0.4228E 00	-0.3078E 00	-0.1127E 01	-0.1734E 01
-0.2204E 01	-0.2541E 01	-0.2761E 01	-0.2890E 01	-0.2954E 01	-0.2991E 01	-0.2988E 01			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.53144E 01	0.54645E 01	0.10779E 02	0.97254E 00	0.10282E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.3989E 01	0.3855E 01	0.3470E 01	0.2870E 01	0.2113E 01	0.1268E 01	0.4028E 00	-0.4189E 00	-0.1149E 01	-0.1756E 01
-0.2226E 01	-0.2562E 01	-0.2781E 01	-0.2908E 01	-0.2972E 01	-0.2999E 01	-0.3005E 01			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MAJOR AXIS ELL. CYLINDER MARK= 1066

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
1.00	5.00	0.6773190E-04	121.5076	3.0000	7.8000	0.0522	0.0982	33	93

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.2912E 00	0.5753E 00	0.8449E 00	0.1094E 01	0.1315E 01	0.1506E 01	0.1661E 01	0.1779E 01	0.1859E 01
0.1898E 01	0.1902E 01	0.1870E 01	0.1807E 01	0.1717E 01	0.1605E 01	0.1475E 01	0.1333E 01	0.1183E 01	0.1031E 01
0.8812E 00	0.7370E 00	0.6022E 00	0.4794E 00	0.3705E 00	0.2771E 00	0.1994E 00	0.1374E 00	0.8991E-01	0.5523E-01
0.3083E-01	0.1360E-01	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.18911E 01	0.21580E 01	0.40491E 01	0.87630E 00	0.11412E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1860E 01	0.1766E 01	0.1498E 01	0.1094E 01	0.6084E 00	0.1033E 00	-0.3656E 00	-0.7562E 00	-0.1044E 01	-0.1224E 01
-0.1305E 01	-0.1305E 01	-0.1251E 01	-0.1170E 01	-0.1087E 01	-0.1027E 01	-0.1005E 01			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.18911E 01	0.21606E 01	0.40517E 01	0.87524E 00	0.11425E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1856E 01	0.1762E 01	0.1494E 01	0.1090E 01	0.6037E 00	0.9779E-01	-0.3721E 00	-0.7638E 00	-0.1053E 01	-0.1233E 01
-0.1313E 01	-0.1314E 01	-0.1259E 01	-0.1177E 01	-0.1094E 01	-0.1033E 01	-0.1011E 01			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MAJOR AXIS ELL. CYLINDER MARK= 1039

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	1.00	0.5585625E-04	133.8025	1.4750	6.3700	0.0532	0.0982	33	93

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1337E 00	0.2633E 00	0.3849E 00	0.4954E 00	0.5923E 00	0.6742E 00	0.7406E 00	0.7915E 00	0.8276E 00
0.8501E 00	0.8602E 00	0.8594E 00	0.8492E 00	0.8339E 00	0.8057E 00	0.7748E 00	0.7392E 00	0.6998E 00	0.6573E 00
0.6122E 00	0.5652E 00	0.5167E 00	0.4670E 00	0.4164E 00	0.3652E 00	0.3135E 00	0.2616E 00	0.2094E 00	0.1571E 00
0.1048E 00	0.5239E-01	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.56834E 01	0.52262E 01	0.10910E 02	0.10875E 01	0.91956E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.4114E 01	0.3940E 01	0.3454E 01	0.2744E 01	0.1916E 01	0.1067E 01	0.2654E 00	-0.4494E 00	-0.1060E 01	-0.1566E 01
-0.1972E 01	-0.2290E 01	-0.2530E 01	-0.2704E 01	-0.2820E 01	-0.2887E 01	-0.2909E 01			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.56834E 01	0.52276E 01	0.10911E 02	0.10872E 01	0.91979E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.4095E 01	0.3921E 01	0.3433E 01	0.2721E 01	0.1891E 01	0.1041E 01	0.2365E 00	-0.4763E 00	-0.1087E 01	-0.1592E 01
-0.1998E 01	-0.2315E 01	-0.2554E 01	-0.2728E 01	-0.2844E 01	-0.2910E 01	-0.2932E 01			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MAJOR AXIS ELL. CYLINDER MARK= 1064

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	5.00	0.5585625E-04	133.8025	1.4750	6.3700	0.0532	0.0982	33	93

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.3140E 00	0.6164E 00	0.8964E 00	0.1145E 01	0.1357E 01	0.1526E 01	0.1653E 01	0.1738E 01	0.1783E 01
0.1791E 01	0.1768E 01	0.1717E 01	0.1642E 01	0.1550E 01	0.1443E 01	0.1326E 01	0.1202E 01	0.1074E 01	0.9451E 00
0.8180E 00	0.6948E 00	0.5779E 00	0.4690E 00	0.3701E 00	0.2826E 00	0.2076E 00	0.1457E 00	0.9697E-01	0.6030E-01
0.3384E-01	0.1485E-01	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.19653E 01	0.20752E 01	0.40404E 01	0.94704E 00	0.10559E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1883E 01	0.1772E 01	0.1463E 01	0.1019E 01	0.5194E 00	0.3303E-01	-0.3914E 00	-0.7280E 00	-0.9701E 00	-0.1123E 01
-0.1200E 01	-0.1215E 01	-0.1185E 01	-0.1127E 01	-0.1062E 01	-0.1011E 01	-0.9917E 00			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.19653E 01	0.20811E 01	0.40463E 01	0.94436E 00	0.10589E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1876E 01	0.1765E 01	0.1455E 01	0.1011E 01	0.5102E 00	0.2289E-01	-0.4024E 00	-0.7399E 00	-0.9828E 00	-0.1137E 01
-0.1214E 01	-0.1229E 01	-0.1199E 01	-0.1142E 01	-0.1076E 01	-0.1025E 01	-0.1006E 01			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MAJOR AXIS ELL. CYLINDER MARK= 1123

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	15.00	0.5585625E-04	133.8025	1.4750	6.3700	0.0532	0.0982	33	93

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.6092E 00	0.1193E 01	0.1729E 01	0.2197E 01	0.2586E 01	0.2882E 01	0.3088E 01	0.3205E 01	0.3237E 01
0.3193E 01	0.3084E 01	0.2920E 01	0.2713E 01	0.2474E 01	0.2213E 01	0.1939E 01	0.1663E 01	0.1392E 01	0.1132E 01
0.8882E 00	0.6649E 00	0.4651E 00	0.2909E 00	0.1438E 00	0.2558E-01	-0.6247E-01	-0.1192E 00	-0.1446E 00	-0.1401E 00
-0.1097E 00	-0.6011E-01	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.10014E 01	0.12397E 01	0.22411E 01	0.80775E 00	0.12380E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1358E 01	0.1253E 01	0.9663E 00	0.5636E 00	0.1270E 00	-0.2721E 00	-0.5871E 00	-0.7984E 00	-0.9093E 00	-0.9380E 00
-0.9092E 00	-0.8464E 00	-0.7676E 00	-0.6850E 00	-0.6092E 00	-0.5538E 00	-0.5331E 00			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.10014E 01	0.12454E 01	0.22468E 01	0.80406E 00	0.12437E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1353E 01	0.1249E 01	0.9630E 00	0.5617E 00	0.1258E 00	-0.2735E 00	-0.5897E 00	-0.8028E 00	-0.9156E 00	-0.9456E 00
-0.9176E 00	-0.8552E 00	-0.7766E 00	-0.6940E 00	-0.6180E 00	-0.5624E 00	-0.5417E 00			

ANGLE AT WHICH SURFACE SHEAR STRESS BECOMES ZERO I.E. SEPARATION.IS 142.3 DEGREES

FLOW ALONG MAJOR AXIS FLL. CYLINDER MARK= 1266

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	40.00	0.5586259E-04	133.7949	1.4750	6.3700	0.0471	0.0491	65	105

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 2.81 DEGREES INTERVAL

0.0	0.5539E 00	0.1102E 01	0.1637E 01	0.2154E 01	0.2647E 01	0.3111E 01	0.3543E 01	0.3938E 01	0.4293E 01
0.4606E 01	0.4875E 01	0.5100E 01	0.5281E 01	0.5416E 01	0.5509E 01	0.5558E 01	0.5568E 01	0.5538E 01	0.5472E 01
0.5373E 01	0.5242E 01	0.5083E 01	0.4899E 01	0.4692E 01	0.4457E 01	0.4226E 01	0.3971E 01	0.3708E 01	0.3437E 01
0.3163E 01	0.2884E 01	0.2615E 01	0.2347E 01	0.2086E 01	0.1833E 01	0.1591E 01	0.1362E 01	0.1146E 01	0.9450E 00
0.7591E 00	0.5888E 00	0.4342E 00	0.2951E 00	0.1712E 00	0.6184E-01	-0.3377E-01	-0.1164E 00	-0.1870E 00	-0.2462E 00
-0.2947E 00	-0.3330E 00	-0.3614E 00	-0.3802E 00	-0.3892E 00	-0.3885E 00	-0.3780E 00	-0.3577E 00	-0.3280E 00	-0.2893E 00
-0.2424E 00	-0.1884E 00	-0.1289E 00	-0.6540E-01	0.0					

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.5587E 00	0.8699E 00	0.1419E 01	0.6489E 00	0.1540E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.1151E 01	0.1123E 01	0.1041E 01	0.9115E 00	0.7427E 00	0.5457E 00	0.3326E 00	0.1152E 00	-0.9548E-01	-0.2903E 00
-0.4620E 00	-0.6057E 00	-0.7187E 00	-0.8004E 00	-0.8522E 00	-0.8768E 00	-0.8783E 00	-0.8612E 00	-0.9303E 00	-0.7901E 00
-0.7448E 00	-0.6976E 00	-0.6510E 00	-0.6046E 00	-0.5654E 00	-0.5274E 00	-0.4928E 00	-0.4614E 00	-0.4335E 00	-0.4098E 00
-0.3916E 00	-0.3799E 00	-0.3753E 00							

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.5587E 00	0.8612E 00	0.1420E 01	0.6487E 00	0.1541E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.1151E 01	0.1123E 01	0.1043E 01	0.9155E 00	0.7496E 00	0.5558E 00	0.3457E 00	0.1310E 00	-0.7762E-01	-0.2712E 00
-0.4425E 00	-0.5867E 00	-0.7008E 00	-0.7842E 00	-0.8378E 00	-0.8643E 00	-0.8674E 00	-0.8516E 00	-0.8215E 00	-0.7819E 00
-0.7367E 00	-0.6896E 00	-0.6425E 00	-0.5979E 00	-0.5562E 00	-0.5180E 00	-0.4830E 00	-0.4513E 00	-0.4231E 00	-0.3992E 00
-0.3806E 00	-0.3689E 00	-0.3648E 00							

ANGLE AT WHICH SURFACE SHEAR STRESS BECOMES ZERO I.E. SEPARATION IS 128.4 DEGREES

FLOW ALONG MAJOR AXIS FLL. CYLINDER MARK= 1251

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	90.00	0.5586259E-04	133.7949	1.4750	6.3700	0.0471	0.0491	65	105

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 2.81 DEGREES INTERVAL

0.0	0.8572E 00	0.1704E 01	0.2529E 01	0.3323E 01	0.4077E 01	0.4782E 01	0.5431E 01	0.6019E 01	0.6539E 01
0.6988E 01	0.7365E 01	0.7667E 01	0.7894E 01	0.8047E 01	0.8129E 01	0.8139E 01	0.8084E 01	0.7967E 01	0.7792E 01
0.7564E 01	0.7289E 01	0.6972E 01	0.6618E 01	0.6235E 01	0.5828E 01	0.5404E 01	0.4968E 01	0.4526E 01	0.4085E 01
0.3649E 01	0.3223E 01	0.2812E 01	0.2419E 01	0.2048E 01	0.1700E 01	0.1377E 01	0.1081E 01	0.8123E 00	0.5698E 00
0.3535E 00	0.1625E 00	-0.4473E-02	-0.1489E 00	-0.2724E 00	-0.3769E 00	-0.4642E 00	-0.5361E 00	-0.5942E 00	-0.6400E 00
-0.6745E 00	-0.6988E 00	-0.7120E 00	-0.7151E 00	-0.7073E 00	-0.6879E 00	-0.6563E 00	-0.6122E 00	-0.5552E 00	-0.4857E 00
-0.4046E 00	-0.3133E 00	-0.2137E 00	-0.1083E 00	0.0					

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.3156E 00	0.8014E 00	0.1117E 01	0.3938E 00	0.2590E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.1070E 01	0.1040E 01	0.9543E 00	0.8184E 00	0.6628E 00	0.4397E 00	0.2228E 00	0.4978E-02	-0.2018E 00	-0.3879E 00
-0.5464E 00	-0.6731E 00	-0.7667E 00	-0.8283E 00	-0.8611E 00	-0.8697E 00	-0.8595E 00	-0.8358E 00	-0.8035E 00	-0.7664E 00
-0.7277E 00	-0.6892E 00	-0.6522E 00	-0.6175E 00	-0.5852E 00	-0.5553E 00	-0.5274E 00	-0.5017E 00	-0.4782E 00	-0.4580E 00
-0.4421E 00	-0.4318E 00	-0.4283E 00							

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.3156E 00	0.8017E 00	0.1117E 01	0.3937E 00	0.2539E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.1067E 01	0.1039E 01	0.9553E 00	0.8233E 00	0.6526E 00	0.4553E 00	0.2441E 00	0.3178E-01	-0.1705E 00	-0.3535E 00
-0.5106E 00	-0.6375E 00	-0.7327E 00	-0.7969E 00	-0.8328E 00	-0.8443E 00	-0.8365E 00	-0.8146E 00	-0.7833E 00	-0.7470E 00
-0.7087E 00	-0.6706E 00	-0.6340E 00	-0.5997E 00	-0.5679E 00	-0.5384E 00	-0.5109E 00	-0.4854E 00	-0.4622E 00	-0.4420E 00
-0.4261E 00	-0.4159E 00	-0.4123E 00							

ANGLE AT WHICH SURFACE SHEAR STRESS BECOMES ZERO I.E. SEPARATION IS 118.1 DEGREES

FLOW ALONG MAJOR AXIS ELL. CYLINDER MARK= 1078

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	0.50	0.8109224E-04	111.0479	0.5490	5.2000	0.0506	0.0982	33	93

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1809E 00	0.3318E 00	0.4377E 00	0.4997E 00	0.5276E 00	0.5329E 00	0.5247E 00	0.5092E 00	0.4904E 00
0.4706E 00	0.4511E 00	0.4328E 00	0.4159E 00	0.4008E 00	0.3873E 00	0.3757E 00	0.3658E 00	0.3575E 00	0.3509E 00
0.3459E 00	0.3422E 00	0.3397E 00	0.3379E 00	0.3361E 00	0.3331E 00	0.3268E 00	0.3140E 00	0.2900E 00	0.2492E 00
0.1862E 00	0.1007E 00	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.12544E 02	0.62882E 01	0.18832E 02	0.19949E 01	0.50128E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.7096E 01	0.6185E 01	0.4347E 01	0.2692E 01	0.1505E 01	0.6901E 00	0.1166E 00	-0.3069E 00	-0.6408E 00	-0.9293E 00
-0.1213E 01	-0.1537E 01	-0.1960E 01	-0.2556E 01	-0.3383E 01	-0.4301E 01	-0.4754E 01			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.12544E 02	0.62752E 01	0.18820E 02	0.19990E 01	0.50024E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.6945E 01	0.6013E 01	0.4154E 01	0.2497E 01	0.1317E 01	0.5070E 00	-0.6351E-01	-0.4851E 00	-0.8172E 00	-0.1103E 01
-0.1384E 01	-0.1705E 01	-0.2124E 01	-0.2718E 01	-0.3547E 01	-0.4475E 01	-0.4936E 01			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MAJOR AXIS ELL. CYLINDER MARK= 1047

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	1.00	0.8109224E-04	111.0479	0.5490	5.2000	0.0506	0.0982	33	93

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.2410E 00	0.4423E 00	0.5830E 00	0.6644E 00	0.7000E 00	0.7050E 00	0.6916E 00	0.6683E 00	0.6402E 00
0.6107E 00	0.5815E 00	0.5535E 00	0.5274E 00	0.5033E 00	0.4813E 00	0.4615E 00	0.4436E 00	0.4277E 00	0.4137E 00
0.4014E 00	0.3907E 00	0.3814E 00	0.3729E 00	0.3647E 00	0.3555E 00	0.3434E 00	0.3253E 00	0.2968E 00	0.2524E 00
0.1873E 00	0.1007E 00	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.76772E 01	0.40072E 01	0.11684E 02	0.19159E 01	0.52195E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.4646E 01	0.4034E 01	0.2775E 01	0.1625E 01	0.7866E 00	0.2051E 00	-0.2039E 00	-0.5017E 00	-0.7292E 00	-0.9156E 00
-0.1085E 01	-0.1260E 01	-0.1473E 01	-0.1760E 01	-0.2152E 01	-0.2586E 01	-0.2799E 01			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.76772E 01	0.40149E 01	0.11692E 02	0.19122E 01	0.52297E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.4549E 01	0.3929E 01	0.2659E 01	0.1506E 01	0.6679E 00	0.8629E-01	-0.3232E 00	-0.6213E 00	-0.8487E 00	-0.1039E 01
-0.1204E 01	-0.1380E 01	-0.1592E 01	-0.1879E 01	-0.2272E 01	-0.2711E 01	-0.2928E 01			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MAJOR AXIS ELL. CYLINDER MARK= 1069

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	5.00	0.8109224E-04	111.0479	0.5490	5.2000	0.0506	0.0982	33	93

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.5354E 00	0.9798E 00	0.1286E 01	0.1458E 01	0.1525E 01	0.1522E 01	0.1477E 01	0.1409E 01	0.1331E 01
0.1249E 01	0.1167E 01	0.1088E 01	0.1012E 01	0.9403E 00	0.8726E 00	0.8087E 00	0.7486E 00	0.6912E 00	0.6370E 00
0.5853E 00	0.5358E 00	0.4884E 00	0.4428E 00	0.3985E 00	0.3551E 00	0.3121E 00	0.2684E 00	0.2229E 00	0.1739E 00
0.1203E 00	0.6171E-01	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.26885E 01	0.16036E 01	0.42921E 01	0.16766E 01	0.59645E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2110E 01	0.1800E 01	0.1155E 01	0.5485E 00	0.9498E-01	-0.2218E 00	-0.4388E 00	-0.5850E 00	-0.6810E 00	-0.7412E 00
-0.7767E 00	-0.7961E 00	-0.8071E 00	-0.8168E 00	-0.8308E 00	-0.8482E 00	-0.8572E 00			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.26885E 01	0.16093E 01	0.42978E 01	0.16707E 01	0.59857E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2074E 01	0.1760E 01	0.1109E 01	0.5008E 00	0.4726E-01	-0.2696E 00	-0.4869E 00	-0.6134E 00	-0.7001E 00	-0.7907E 00
-0.8265E 00	-0.8462E 00	-0.8574E 00	-0.8673E 00	-0.8815E 00	-0.8994E 00	-0.9086E 00			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MAJOR AXIS ELL. CYLINDER MARK= 1094

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	15.00	0.8109224E-04	111.0479	0.5490	5.2000	0.0506	0.0982	33	93

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1012E 01	0.1846E 01	0.2411E 01	0.2714E 01	0.2815E 01	0.2782E 01	0.2670E 01	0.2518E 01	0.2347E 01
0.2172E 01	0.1999E 01	0.1833E 01	0.1675E 01	0.1525E 01	0.1383E 01	0.1248E 01	0.1119E 01	0.9965E 00	0.8797E 00
0.7671E 00	0.6596E 00	0.5566E 00	0.4580E 00	0.3639E 00	0.2748E 00	0.1919E 00	0.1175E 00	0.5555E-01	0.1092E-01
-0.1191E-01	-0.1284E-01	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.14142E 01	0.95670E 00	0.23709E 01	0.14782E 01	0.67649E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1476E 01	0.1232E 01	0.7169E 00	0.2245E 00	-0.1437E 00	-0.3934E 00	-0.5523E 00	-0.6444E 00	-0.6879E 00	-0.6957E 00
-0.6782E 00	-0.6439E 00	-0.5990E 00	-0.5477E 00	-0.4933E 00	-0.4444E 00	-0.4229E 00			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.14142E 01	0.96478E 00	0.23790E 01	0.14658E 01	0.68220E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1455E 01	0.1210E 01	0.6935E 00	0.2018E 00	-0.1442E 00	-0.4170E 00	-0.5776E 00	-0.6717E 00	-0.7167E 00	-0.7259E 00
-0.7092E 00	-0.6753E 00	-0.6305E 00	-0.5793E 00	-0.5246E 00	-0.4751E 00	-0.4532E 00			

ANGLE AT WHICH SURFACE SHEAR STRESS BECOMES ZERO I.E. SEPARATION,IS 165.8 DEGREES

FLOW ALONG MAJOR AXIS ELL. CYLINDER MARK= 1096

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	50.00	0.8109224E-04	111.0479	0.5490	5.2000	0.0506	0.0982	33	93

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.2112E 01	0.3827E 01	0.4947E 01	0.5497E 01	0.5618E 01	0.5466E 01	0.5161E 01	0.4783E 01	0.4380E 01
0.3977E 01	0.3588E 01	0.3216E 01	0.2865E 01	0.2533E 01	0.2220E 01	0.1924E 01	0.1647E 01	0.1387E 01	0.1145E 01
0.9242E 00	0.7237E 00	0.5457E 00	0.3912E 00	0.2600E 00	0.1500E 00	0.5812E-01	-0.1782E-01	-0.7683E-01	-0.1086E 00
-0.1065E 00	-0.6616E-01	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.71630E 00	0.74416E 00	0.14605E 01	0.96256E 00	0.10389E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1185E 01	0.9682E 00	0.4467E 00	-0.2546E-01	-0.3645E 00	-0.5777E 00	-0.6962E 00	-0.7473E 00	-0.7519E 00	-0.7268E 00
-0.6855E 00	-0.6391E 00	-0.5951E 00	-0.5575E 00	-0.5266E 00	-0.5016E 00	-0.4907E 00			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.71630E 00	0.75236E 00	0.14687E 01	0.95207E 00	0.10503E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1183E 01	0.9497E 00	0.4605E 00	0.1816E-02	-0.3303E 00	-0.5443E 00	-0.6680E 00	-0.7258E 00	-0.7365E 00	-0.7157E 00
-0.6768E 00	-0.6310E 00	-0.5865E 00	-0.5480E 00	-0.5159E 00	-0.4899E 00	-0.4785E 00			

ANGLE AT WHICH SURFACE SHEAR STRESS BECOMES ZERO I.E. SEPARATION,IS 150.6 DEGREES

FLOW ALONG MAJOR AXIS ELL. CYLINDER MARK= 1070

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	0.20	0.1257301E-03	89.1826	0.2029	4.4000	0.0500	0.0982	33	85

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.3159E 00	0.4127E 00	0.3911E 00	0.3446E 00	0.3011E 00	0.2654E 00	0.2370E 00	0.2144E 00	0.1963E 00
0.1818E 00	0.1700E 00	0.1604E 00	0.1528E 00	0.1467E 00	0.1420E 00	0.1385E 00	0.1363E 00	0.1352E 00	0.1354E 00
0.1368E 00	0.1397E 00	0.1443E 00	0.1509E 00	0.1599E 00	0.1721F 00	0.1883E 00	0.2093E 00	0.2356F 00	0.2639E 00
0.2758E 00	0.2099E 00	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.36007E 02	0.72040E 01	0.43211E 02	0.49982E 01	0.20007E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1698E 02	0.9996E 01	0.4840E 01	0.2985E 01	0.2200E 01	0.1789E 01	0.1534E 01	0.1351F 01	0.1203E 01	0.1070E 01
0.9303E 00	0.7565E 00	0.4908E 00	-0.1628F-01	-0.1225E 01	-0.4611E 01	-0.9201E 01			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.36007E 02	0.71962E 01	0.43203E 02	0.50036E 01	0.19986E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1687E 02	0.9559E 01	0.4394E 01	0.2581E 01	0.1813E 01	0.1412E 01	0.1160E 01	0.9783F 00	0.8294E 00	0.6941E 00
0.5523E 00	0.3774E 00	-0.1134E 00	-0.3862E 00	-0.1576E 01	-0.4972E 01	-0.9785E 01			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MAJOR AXIS ELL. CYLINDER MARK= 1074

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	0.20	0.8649593E-04	133.0428	0.2029	4.8000	0.0500	0.0982	33	93

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.3075E 00	0.4017E 00	0.3806E 00	0.3353E 00	0.2929E 00	0.2582E 00	0.2305E 00	0.2085E 00	0.1909E 00
0.1767E 00	0.1652E 00	0.1559E 00	0.1484E 00	0.1425E 00	0.1379E 00	0.1345E 00	0.1323E 00	0.1313E 00	0.1314E 00
0.1328E 00	0.1356E 00	0.1401E 00	0.1464E 00	0.1552E 00	0.1670E 00	0.1827E 00	0.2030E 00	0.2285E 00	0.2559E 00
0.2674E 00	0.2035E 00	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.34979E 02	0.70995E 01	0.42079E 02	0.49270E 01	0.20296E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1654E 02	0.9685E 01	0.4605E 01	0.2763E 01	0.1975E 01	0.1561E 01	0.1303E 01	0.1120E 01	0.9723E 00	0.8401E 00
0.7042E 00	0.5347F 00	0.2727E 00	-0.2251E 00	-0.1403E 01	-0.4689E 01	-0.9139E 01			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.34979E 02	0.71306E 01	0.42110E 02	0.49055E 01	0.20385E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1644E 02	0.9224E 01	0.4103E 01	0.2284E 01	0.1505E 01	0.1093E 01	0.8356E 00	0.6501F 00	0.5001E 00	0.3654E 00
0.2282E 00	0.5873E-01	-0.2019E 00	-0.6936E 00	-0.1852E 01	-0.5150E 01	-0.9817E 01			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MAJOR AXIS ELL. CYLINDER MARK= 1021

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	1.00	0.2798012E-03	59.7827	0.2029	4.0000	0.0558	0.0982	33	69

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.5885E 00	0.7691E 00	0.7289E 00	0.6414E 00	0.5591E 00	0.4910E 00	0.4363F 00	0.3922E 00	0.3564E 00
0.3269E 00	0.3024E 00	0.2819E 00	0.2647E 00	0.2500E 00	0.2377E 00	0.2272E 00	0.2184E 00	0.2115E 00	0.2061E 00
0.2022E 00	0.2001E 00	0.2000E 00	0.2021E 00	0.2071E 00	0.2156E 00	0.2286E 00	0.2471E 00	0.2714E 00	0.2981E 00
0.3071E 00	0.2317E 00	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.11577E 02	0.24363E 01	0.14013E 02	0.47517E 01	0.21045E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.6264E 01	0.3669E 01	0.1693E 01	0.9403E 00	0.5950E 00	0.3998E 00	0.2729E 00	0.1827E 00	0.1146E 00	0.6094E-01
0.1585E-01	-0.2781E-01	-0.9371E-01	-0.1857E 00	-0.4336E 00	-0.1159E 01	-0.2137E 01			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.11577E 02	0.24375E 01	0.14014E 02	0.47495E 01	0.21055E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.6239E 01	0.3498E 01	0.1512E 01	0.7743E 00	0.4341E 00	0.2403E 00	0.1134E 00	0.2349E-01	-0.4471E-01	-0.9845E-01
-0.1434E 00	-0.1847E 00	-0.2417E 00	-0.3613E 00	-0.5866E 00	-0.1312E 01	-0.2346E 01			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MAJOR AXIS ELL. CYLINDER MARK= 1033

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	1.00	0.1257301E-03	89.1826	0.2029	4.4000	0.0500	0.0982	33	85

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.5761E 00	0.7523E 00	0.7125E 00	0.6267E 00	0.5460E 00	0.4794E 00	0.4258E 00	0.3826E 00	0.3475E 00
0.3186E 00	0.2945E 00	0.2744E 00	0.2574E 00	0.2430E 00	0.2308E 00	0.2205E 00	0.2119E 00	0.2049E 00	0.1994E 00
0.1956E 00	0.1934E 00	0.1932E 00	0.1951E 00	0.1999E 00	0.2080E 00	0.2204E 00	0.2389E 00	0.2613E 00	0.2864E 00
0.2954E 00	0.2227E 00	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.11247E 02	0.24080E 01	0.13655E 02	0.46708E 01	0.21409E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.6150E 01	0.3574E 01	0.1638E 01	0.9051E 00	0.5678E 00	0.3754E 00	0.2699E 00	0.1601E 00	0.9179E-01	0.3688E-01
-0.1039E-01	-0.5719E-01	-0.1170E 00	-0.2223E 00	-0.4718E 00	-0.1176E 01	-0.2132E 01			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.11247E 02	0.24177E 01	0.13665E 02	0.46520E 01	0.21496E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.6124E 01	0.3424E 01	0.1481E 01	0.7593E 00	0.4255E 00	0.2337E 00	0.1075E 00	0.1711E-01	-0.5197E-01	-0.1078E 00
-0.1559E 00	-0.2035E 00	-0.2637E 00	-0.3685E 00	-0.6146E 00	-0.1322E 01	-0.2326E 01			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MAJOR AXIS ELL. CYLINDER MARK= 1038

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	1.00	0.5649593E-04	133.0428	0.2029	4.8000	0.0500	0.0982	33	93

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.5719E 00	0.7471E 00	0.7077E 00	0.6227E 00	0.5427E 00	0.4766E 00	0.4234E 00	0.3806E 00	0.3458E 00
0.3172E 00	0.2934E 00	0.2735E 00	0.2567E 00	0.2425E 00	0.2305E 00	0.2204E 00	0.2119E 00	0.2051E 00	0.1999E 00
0.1962E 00	0.1942E 00	0.1941E 00	0.1963E 00	0.2012E 00	0.2095E 00	0.2222E 00	0.2402E 00	0.2640E 00	0.2901E 00
0.2990E 00	0.2257E 00	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.11236E 02	0.23696E 01	0.13606E 02	0.47418E 01	0.21089E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.6118E 01	0.3566E 01	0.1647E 01	0.9208E 00	0.5872E 00	0.3981E 00	0.2747E 00	0.1870E 00	0.1210E 00	0.6881E-01
0.2453E-01	-0.1884E-01	-0.7426E-01	-0.1742E 00	-0.4185E 00	-0.1123E 01	-0.2089E 01			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.11236E 02	0.23700E 01	0.13607E 02	0.47411E 01	0.21092E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.6092E 01	0.3418E 01	0.1494E 01	0.7795E 00	0.4497E 00	0.2616E 00	0.1384E 00	0.5069E-01	-0.1536E-01	-0.8748E-01
-0.1117E 00	-0.1548E 00	-0.2095E 00	-0.3076E 00	-0.5668E 00	-0.1253E 01	-0.2266E 01			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MAJOR AXIS ELL. CYLINDER MARK= 1067

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	5.00	0.5649593E-04	133.0428	0.2029	4.8000	0.0500	0.0982	33	93

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1224E 01	0.1598E 01	0.1510E 01	0.1322E 01	0.1144E 01	0.9960E 00	0.8762E 00	0.7792E 00	0.6999E 00
0.6342E 00	0.5793E 00	0.5328E 00	0.4930E 00	0.4586E 00	0.4285E 00	0.4020E 00	0.3784E 00	0.3572E 00	0.3380E 00
0.3205E 00	0.3045E 00	0.2898E 00	0.2767E 00	0.2653E 00	0.2563E 00	0.2504E 00	0.2488E 00	0.2519E 00	0.2574E 00
0.2507E 00	0.1827E 00	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.40465E 01	0.96449E 00	0.50110E 01	0.41955E 01	0.23835E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2724E 01	0.1577E 01	0.6622E 00	0.2787E 00	0.8759E-01	-0.2321E-01	-0.9286E-01	-0.1382E 00	-0.1676E 00	-0.1859E 00
-0.1960E 00	-0.1998E 00	-0.1997E 00	-0.2012E 00	-0.2216E 00	-0.3135E 00	-0.4533E 00			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.40465E 01	0.97209E 00	0.50186E 01	0.41627E 01	0.24023E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2729E 01	0.1530E 01	0.6144E 00	0.2348E 00	0.4367E-01	-0.6835E-01	-0.1393E 00	-0.1856E 00	-0.2159E 00	-0.2348E 00
-0.2452E 00	-0.2493E 00	-0.2494E 00	-0.2508E 00	-0.2704E 00	-0.3678E 00	-0.5098E 00			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MAJOR AXIS ELL. CYLINDER MARK= 1297

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	10.00	0.5649593E-04	133.0428	0.2029	4.8000	0.0500	0.0982	33	93

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1771E 01	0.2306E 01	0.2171E 01	0.1889E 01	0.1621E 01	0.1403E 01	0.1226E 01	0.1083E 01	0.9671E 00
0.8715E 00	0.7917E 00	0.7244E 00	0.6669E 00	0.6172E 00	0.5737E 00	0.5352E 00	0.5007E 00	0.4695E 00	0.4409E 00
0.4144E 00	0.3895E 00	0.3661E 00	0.3440E 00	0.3230E 00	0.3036E 00	0.2862E 00	0.2719E 00	0.2613E 00	0.2528E 00
0.2345E 00	0.1654E 00	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.27229E 01	0.75334E 00	0.34762E 01	0.36144E 01	0.27667E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2060E 01	0.1173E 01	0.4331E 00	0.1067E 00	-0.5864E-01	-0.1535E 00	-0.2117E 00	-0.2483E 00	-0.2708E 00	-0.2833E 00
-0.2885E 00	-0.2886E 00	-0.2836E 00	-0.2774E 00	-0.2767E 00	-0.3052E 00	-0.3588E 00			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.27229E 01	0.76658E 00	0.34895E 01	0.35520E 01	0.28153E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2065E 01	0.1142E 01	0.4031E 00	0.7856E-01	-0.8907E-01	-0.1870E 00	-0.2480E 00	-0.2867E 00	-0.3108E 00	-0.3245E 00
-0.3303E 00	-0.3303E 00	-0.3260E 00	-0.3198E 00	-0.3185E 00	-0.3467E 00	-0.4031E 00			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MAJOR AXIS ELL. CYLINDER MARK= 1094

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	20.00	0.5649593E-04	133.0428	0.2029	4.8000	0.0500	0.0982	33	93

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.2643E 01	0.3420E 01	0.3185E 01	0.2741E 01	0.2330E 01	0.1994E 01	0.1727E 01	0.1513E 01	0.1341E 01
0.1201E 01	0.1084E 01	0.9863E 00	0.9025E 00	0.8299E 00	0.7663E 00	0.7093E 00	0.6579E 00	0.6104E 00	0.5667E 00
0.5252E 00	0.4855E 00	0.4473E 00	0.4100E 00	0.3736E 00	0.3377E 00	0.3026E 00	0.2687E 00	0.2365E 00	0.2059E 00
0.1712E 00	0.1110E 00	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.18338E 01	0.56757E 00	0.24013E 01	0.32309E 01	0.30951E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1649E 01	0.9056E 00	0.2611E 00	-0.2631E-01	-0.1668E 00	-0.2427E 00	-0.2856E 00	-0.3102E 00	-0.3203E 00	-0.3235E 00
-0.3181E 00	-0.3086E 00	-0.2956E 00	-0.2805E 00	-0.2659E 00	-0.2599E 00	-0.2678E 00			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.18338E 01	0.58988E 00	0.24237E 01	0.31087E 01	0.32168E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1670E 01	0.9064E 00	0.2708E 00	-0.1428E-01	-0.1597E 00	-0.2419E 00	-0.2904E 00	-0.3184E 00	-0.3297E 00	-0.3332E 00
-0.3343E 00	-0.3257E 00	-0.3130E 00	-0.2979E 00	-0.2829E 00	-0.2764E 00	-0.2847E 00			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MAJOR AXIS ELL. CYLINDER MARK= 1319

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	40.00	0.5649065E-04	133.0491	0.2029	4.8000	0.0442	0.0491	65	105

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 2.81 DEGREES INTERVAL

0.0	0.2231E 01	0.3876E 01	0.4025E 01	0.4028E 01	0.4692E 01	0.4401E 01	0.4058E 01	0.3713E 01	0.3390E 01
0.3096E 01	0.2834E 01	0.2600E 01	0.2393E 01	0.2210E 01	0.2047E 01	0.1902E 01	0.1773E 01	0.1657E 01	0.1553E 01
0.1459E 01	0.1374E 01	0.1297E 01	0.1226E 01	0.1162E 01	0.1103E 01	0.1049E 01	0.9986E 00	0.9522E 00	0.9091E 00
0.8689E 00	0.8313E 00	0.7961E 00	0.7630E 00	0.7317E 00	0.7021E 00	0.6740E 00	0.6473E 00	0.6217E 00	0.5971E 00
0.5735E 00	0.5507E 00	0.5286E 00	0.5070E 00	0.4860E 00	0.4653E 00	0.4450E 00	0.4248E 00	0.4048E 00	0.3848E 00
0.3647E 00	0.3445E 00	0.3242E 00	0.3037E 00	0.2831E 00	0.2624E 00	0.2418E 00	0.2213E 00	0.2006E 00	0.1793E 00
0.1562E 00	0.1292E 00	0.9504E-01	0.5133E-01	0.0					

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.11146E 01	0.62821E 00	0.17428E 01	0.17743E 01	0.56360E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.1344E 01	0.1106E 01	0.6756E 00	0.3253E 00	0.8542E-01	-0.7659E-01	-0.1886E 00	-0.2682E 00	-0.3263E 00	-0.3696E 00
-0.4023E 00	-0.4274E 00	-0.4469E 00	-0.4620E 00	-0.4737E 00	-0.4829E 00	-0.4901E 00	-0.4958E 00	-0.5002E 00	-0.5036E 00
-0.5064E 00	-0.5087E 00	-0.5108E 00	-0.5129E 00	-0.5152E 00	-0.5177E 00	-0.5207E 00	-0.5242E 00	-0.5284E 00	-0.5335E 00
-0.5398E 00	-0.5466E 00	-0.5500E 00							

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.11146E 01	0.65587E 00	0.17705E 01	0.16995E 01	0.58842E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.1326E 01	0.1080E 01	0.6471E 00	0.3044E 00	0.7144E-01	-0.8841E-01	-0.2019E 00	-0.2850E 00	-0.3474E 00	-0.3951E 00
-0.4321E 00	-0.4610E 00	-0.4837E 00	-0.5015E 00	-0.5156E 00	-0.5266E 00	-0.5352E 00	-0.5419E 00	-0.5472E 00	-0.5514E 00
-0.5547E 00	-0.5574E 00	-0.5599E 00	-0.5623E 00	-0.5648E 00	-0.5676E 00	-0.5709E 00	-0.5748E 00	-0.5794E 00	-0.5849E 00
-0.5917E 00	-0.5991E 00	-0.6030E 00							

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

Single Elliptical Cylinders with O.R.< 1

FLOW ALONG MINOR AXIS ELL. CYLINDER MARK= 1524

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
1.00	0.01	0.1511351E-04	257.2273	3.0000	8.5500	0.0603	0.0982	33	93

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.4178E-01	0.8311E-01	0.1236E 00	0.1627E 00	0.2002E 00	0.2356E 00	0.2686E 00	0.2989E 00	0.3261E 00
0.3501E 00	0.3706E 00	0.3876E 00	0.4007E 00	0.4100E 00	0.4154E 00	0.4169E 00	0.4144E 00	0.4080E 00	0.3978E 00
0.3839E 00	0.3663E 00	0.3453E 00	0.3210E 00	0.2936E 00	0.2635E 00	0.2308E 00	0.1959E 00	0.1591E 00	0.1207E 00
0.8112E-01	0.4076E-01	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.26390E 03	0.26146E 03	0.525366E 03	0.10093E 01	0.99074E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1678E 03	0.1645E 03	0.1546E 03	0.1386E 03	0.1173E 03	0.9156E 02	0.6247E 02	0.3117E 02	-0.1159E 01	-0.3332E 02
-0.6416E 02	-0.9257E 02	-0.1175E 03	-0.1380E 03	-0.1533E 03	-0.1627E 03	-0.1659E 03			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.26390E 03	0.26166E 03	0.525556E 03	0.10086E 01	0.99151E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1673E 03	0.1639E 03	0.1540E 03	0.1381E 03	0.1167E 03	0.9094E 02	0.6182E 02	0.3050E 02	-0.1852E 01	-0.3403E 02
-0.6488E 02	-0.9333E 02	-0.1183E 03	-0.1388E 03	-0.1541E 03	-0.1635E 03	-0.1667E 03			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MINOR AXIS ELL. CYLINDER MARK= 1320

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
1.00	0.01	0.1523033E-07	8102.9883	3.0000	12.0000	0.0865	0.0785	41	105

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 4.50 DEGREES INTERVAL

0.0	0.2513E-01	0.5021E-01	0.7494E-01	0.9921E-01	0.1229E 00	0.1458E 00	0.1678E 00	0.1888E 00	0.2086E 00
0.2271E 00	0.2442E 00	0.2598E 00	0.2737E 00	0.2859E 00	0.2963E 00	0.3049E 00	0.3115E 00	0.3161E 00	0.3188E 00
0.3194E 00	0.3180E 00	0.3146E 00	0.3093E 00	0.3021E 00	0.2930E 00	0.2821E 00	0.2695E 00	0.2553E 00	0.2395E 00
0.2224E 00	0.2039E 00	0.1843E 00	0.1636E 00	0.1420E 00	0.1195E 00	0.9644E-01	0.7280E-01	0.4876E-01	0.2445E-01
0.0									

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.19920E 03	0.20151E 03	0.40071E 03	0.98850E 00	0.10116E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 9.00 DEGREES INTERVAL

0.1252E 03	0.1236E 03	0.1188E 03	0.1110E 03	0.1004E 03	0.8716E 02	0.7163E 02	0.5421E 02	0.3535E 02	0.1553E 02
-0.4723E 01	-0.2488E 02	-0.4443E 02	-0.6287E 02	-0.7976E 02	-0.9470E 02	-0.1074E 03	-0.1175E 03	-0.1248E 03	-0.1293E 03
-0.1308E 03									

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.19920E 03	0.20193E 03	0.40113E 03	0.98645E 00	0.10137E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 9.00 DEGREES INTERVAL

0.1249E 03	0.1233E 03	0.1186E 03	0.1108E 03	0.1001E 03	0.8683E 02	0.7127E 02	0.5381E 02	0.3491E 02	0.1505E 02
-0.5251E 01	-0.2545E 02	-0.4504E 02	-0.6352E 02	-0.8044E 02	-0.9541E 02	-0.1081E 03	-0.1182E 03	-0.1256E 03	-0.1301E 03
-0.1316E 03									

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MINOR AXIS ELL. CYLINDER MARK= 1112

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	1.00	0.5649593E-04	133.0428	0.2029	4.8000	0.0500	0.0982	33	93

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.3465E-01	0.7036E-01	0.1082E 00	0.1496E 00	0.1962E 00	0.2506E 00	0.3162E 00	0.3987E 00	0.5067E 00
0.6551E 00	0.8699E 00	0.1129E 01	0.1730E 01	0.2586E 01	0.3709E 01	0.4148E 01	0.3097E 01	0.1795E 01	0.9021E 00
0.5654E 00	0.3352E 00	0.2047E 00	0.1272E 00	0.7955E-01	0.4950E-01	0.3032E-01	0.1909E-01	0.1038E-01	0.5647E-02
0.2823E-02	0.1145E-02	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.17795E 01	0.90376E 01	0.10817E 02	0.19690E 00	0.50787E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.3642E 01	0.3690E 01	0.3841E 01	0.4126E 01	0.4602E 01	0.5382E 01	0.6493E 01	0.6459E 01	-0.3089E 01	-0.9858E 01
-0.7708E 01	-0.5890E 01	-0.4748E 01	-0.4066E 01	-0.3662E 01	-0.3447E 01	-0.3380E 01			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.17795E 01	0.90302E 01	0.10810E 02	0.19706E 00	0.50745E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.3658E 01	0.3706E 01	0.3858E 01	0.4144E 01	0.4624E 01	0.5400E 01	0.6537E 01	0.6543E 01	-0.3124E 01	-0.9976E 01
-0.7765E 01	-0.5842E 01	-0.4702E 01	-0.4023E 01	-0.3621E 01	-0.3407E 01	-0.3339E 01			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MINOR AXIS ELL. CYLINDER MARK= 1119

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	5.00	0.5649593E-04	133.0428	0.2029	4.8000	0.0500	0.0982	33	93

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1086E 00	0.2195E 00	0.3352E 00	0.4584E 00	0.5927E 00	0.7431E 00	0.9163E 00	0.1123E 01	0.1378E 01
0.1710E 01	0.2163E 01	0.2817E 01	0.3803E 01	0.5262E 01	0.6888E 01	0.6900E 01	0.4470E 01	0.2122E 01	0.9598E 00
0.2723E 00	0.1560E-02	-0.1223E 00	-0.1745E 00	-0.1900E 00	-0.1856E 00	-0.1699E 00	-0.1476E 00	-0.1214E 00	-0.9268E-01
-0.6247E-01	-0.3141E-01	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.60961E 00	0.33358E 01	0.39454E 01	0.18275E 00	0.54720E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1620E 01	0.1618E 01	0.1613E 01	0.1613E 01	0.1635E 01	0.1703E 01	0.1780E 01	0.1208E 01	-0.2594E 01	-0.4179E 01
-0.3016E 01	-0.2203E 01	-0.1743E 01	-0.1472E 01	-0.1312E 01	-0.1226E 01	-0.1199E 01			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.60961E 00	0.33326E 01	0.39423E 01	0.18292E 00	0.54668E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1626E 01	0.1624E 01	0.1618E 01	0.1619E 01	0.1642E 01	0.1710E 01	0.1801E 01	0.1274E 01	-0.2631E 01	-0.4213E 01
-0.2999E 01	-0.2185E 01	-0.1726E 01	-0.1456E 01	-0.1297E 01	-0.1211E 01	-0.1184E 01			

ANGLE AT WHICH SURFACE SHEAR STRESS BECOMES ZERO I.E. SEPARATION,IS 118.2 DEGREES

FLOW ALONG MINOR AXIS ELL. CYLINDER MARK= 1143

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	15.00	0.5649593E-04	133.0428	0.2029	4.8000	0.0500	0.0282	33	93

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.2380E 00	0.4813E 00	0.7354E 00	0.1026E 01	0.1301E 01	0.1629E 01	0.2000E 01	0.2430E 01	0.2942E 01
0.3572E 01	0.4379E 01	0.5466E 01	0.6981E 01	0.9007E 01	0.1080E 02	0.9649E 01	0.5249E 01	0.1300E 01	0.2027E 00
-0.4114E 00	-0.6185E 00	-0.6609E 00	-0.6357E 00	-0.5824E 00	-0.5177E 00	-0.4481E 00	-0.3764E 00	-0.3033E 00	-0.2289E 00
-0.1533E 00	-0.7688E-01	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.30966E 00	0.22835E 01	0.25931E 01	0.13561E 00	0.73742E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1220E 01	0.1200E 01	0.1140E 01	0.1030E 01	0.8078E 00	0.7164E 00	0.4636E 00	-0.2160E 00	-0.2326E 01	-0.2711E 01
-0.1970E 01	-0.1546E 01	-0.1325E 01	-0.1201E 01	-0.1128E 01	-0.1087E 01	-0.1074E 01			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.30966E 00	0.22763E 01	0.25859E 01	0.13604E 00	0.73509E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1222E 01	0.1202E 01	0.1143E 01	0.1043E 01	0.9034E 00	0.7250E 00	0.4812E 00	-0.1770E 00	-0.2347E 01	-0.2717E 01
-0.1953E 01	-0.1529E 01	-0.1310E 01	-0.1186E 01	-0.1113E 01	-0.1073E 01	-0.1060E 01			

ANGLE AT WHICH SURFACE SHEAR STRESS BECOMES ZERO I.E. SEPARATION,IS 108.8 DEGREES

FLOW ALONG MINOR AXIS ELL. CYLINDER MARK= 1254

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	40.00	0.5649065E-04	133.0491	0.2029	4.8000	0.0442	0.0491	65	105

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 2.81 DEGREES INTERVAL

0.0	0.2098E 00	0.4208E 00	0.6347E 00	0.8528E 00	0.1077E 01	0.1308E 01	0.1548E 01	0.1799E 01	0.2063E 01
0.2342E 01	0.2637E 01	0.2953E 01	0.3290E 01	0.3653E 01	0.4045E 01	0.4470E 01	0.4931E 01	0.5435E 01	0.5985E 01
0.6590E 01	0.7257E 01	0.7996E 01	0.8817E 01	0.9733E 01	0.1076E 02	0.1190E 02	0.1313E 02	0.1439E 02	0.1543E 02
0.1581E 02	0.1491E 02	0.1239E 02	0.8779E 01	0.5225E 01	0.2502E 01	0.7242E 00	-0.3251E 00	-0.8981E 00	-0.1183E 01
-0.1300E 01	-0.1322E 01	-0.1293E 01	-0.1236E 01	-0.1166E 01	-0.1092E 01	-0.1018E 01	-0.9465E 00	-0.8782E 00	-0.8133E 00
-0.7518E 00	-0.6930E 00	-0.6366E 00	-0.5819E 00	-0.5284E 00	-0.4758E 00	-0.4235E 00	-0.3714E 00	-0.3191E 00	-0.2666E 00
-0.2138E 00	-0.1607E 00	-0.1073E 00	-0.5368E-01	0.0					

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

COS	COF	COT	COS/COF	COF/COS
0.17251E 00	0.16565E 01	0.18290E 01	0.10414E 00	0.96021E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.1086E 01	0.1079E 01	0.1059E 01	0.1024E 01	0.9751E 00	0.9100E 00	0.8276E 00	0.7263E 00	0.6043E 00	0.4596E 00
0.2901E 00	0.9344E-01	-0.1364E 00	-0.4188E 00	-0.8098E 00	-0.1395E 01	-0.2016E 01	-0.2148E 01	-0.1869E 01	-0.1561E 01
-0.1336E 01	-0.1184E 01	-0.1081E 01	-0.1009E 01	-0.9567E 00	-0.9177E 00	-0.8877E 00	-0.8642E 00	-0.8459E 00	-0.8320E 00
-0.8222E 00	-0.8163E 00	-0.8143E 00							

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

COS	COF	COT	COS/COF	COF/COS
0.17251E 00	0.16419E 01	0.18145E 01	0.10506E 00	0.95180E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.1086E 01	0.1079E 01	0.1059E 01	0.1025E 01	0.9770E 00	0.9129E 00	0.8318E 00	0.7321E 00	0.6120E 00	0.4696E 00
0.3030E 00	0.1096E 00	-0.1159E 00	-0.3928E 00	-0.7793E 00	-0.1373E 01	-0.2021E 01	-0.2150E 01	-0.1854E 01	-0.1538E 01
-0.1313E 01	-0.1162E 01	-0.1059E 01	-0.9873E 00	-0.9354E 00	-0.8966E 00	-0.8667E 00	-0.8433E 00	-0.8251E 00	-0.8112E 00
-0.8014E 00	-0.7956E 00	-0.7936E 00							

ANGLE AT WHICH SURFACE SHEAR STRESS BECOMES ZERO I.E. SEPARATION,IS 103.2 DEGREES

Swarms of Oblate Spheroids, Happel's Model

OBLATE SPHEROID HAPPEL'S MODEL MARK= 5152

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
1.00	0.01	0.2010083E-02	7.9237	4.0000	6.0700	0.0517	0.0982	33	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

-0.0	0.1838E 00	0.3666E 00	0.5417E 00	0.7134E 00	0.8782E 00	0.1035E 01	0.1181E 01	0.1314E 01	0.1438E 01
0.1546E 01	0.1640E 01	0.1718E 01	0.1777E 01	0.1823E 01	0.1849E 01	0.1858E 01	0.1849E 01	0.1822E 01	0.1777E 01
0.1716E 01	0.1637E 01	0.1544E 01	0.1436E 01	0.1313E 01	0.1178E 01	0.1032E 01	0.8757E 00	0.7113E 00	0.5400E 00
0.3634E 00	0.1832E 00	0.4126E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.19808E 04	0.98185E 03	0.29626E 04	0.20174E 01	0.49569E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.7409E 03	0.7266E 03	0.6944E 03	0.6161E 03	0.5242E 03	0.4121E 03	0.2845E 03	0.1462E 03	0.2485E 01	-0.1412E 03
-0.2790E 03	-0.4060E 03	-0.5171E 03	-0.6082E 03	-0.6799E 03	-0.7174E 03	-0.7317E 03			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.19808E 04	0.98845E 03	0.29693E 04	0.20039E 01	0.49902E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.7404E 03	0.7260E 03	0.6935E 03	0.6147E 03	0.5221E 03	0.4092E 03	0.2805E 03	0.1413E 03	-0.3330E 01	-0.1479E 03
-0.2867E 03	-0.4145E 03	-0.5262E 03	-0.6178E 03	-0.6840E 03	-0.7270E 03	-0.7421E 03			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

OBLATE SPHEROID HAPPEL'S MODEL MARK= 5156

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
1.00	0.01	0.1015613E-01	4.6177	4.0000	5.5300	0.0478	0.0982	33	33

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

-0.0	0.2199E 00	0.4362E 00	0.6482E 00	0.8538E 00	0.1051E 01	0.1238E 01	0.1413E 01	0.1575E 01	0.1722E 01
0.1852E 01	0.1964E 01	0.2057E 01	0.2131E 01	0.2184E 01	0.2215E 01	0.2226E 01	0.2215E 01	0.2183E 01	0.2129E 01
0.2055E 01	0.1962E 01	0.1849E 01	0.1719E 01	0.1573E 01	0.1411E 01	0.1236E 01	0.1049E 01	0.8530E 00	0.6468E 00
0.4353E 00	0.2194E 00	0.4948E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.23726E 04	0.11813E 04	0.35536E 04	0.20089E 01	0.49778E 00	0.70714E 02	0.50034E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.8541E 03	0.8371E 03	0.7967E 03	0.7048E 03	0.5946E 03	0.4602E 03	0.3068E 03	0.1402E 03	-0.3289E 02	-0.2058E 03
-0.3717E 03	-0.5243E 03	-0.6579E 03	-0.7675E 03	-0.8490E 03	-0.8992E 03	-0.9162E 03			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.23726E 04	0.11875E 04	0.35601E 04	0.19980E 01	0.50050E 00	0.70842E 02	0.50034E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.8534E 03	0.8363E 03	0.7957E 03	0.7034E 03	0.5926E 03	0.4575E 03	0.3031E 03	0.1355E 03	-0.3857E 02	-0.2125E 03
-0.3792E 03	-0.5324E 03	-0.6667E 03	-0.7749E 03	-0.8548E 03	-0.9093E 03	-0.9264E 03			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

PROLATE SPHEROID HAPPEL'S MODEL MARK= 618

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
1.00	0.01	0.1014963E-01	4.6187	4.0000	5.5300	0.0382	0.0982	33	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

-0.0	0.2201E 00	0.4367E 00	0.6487E 00	0.8543E 00	0.1052E 01	0.1238E 01	0.1413E 01	0.1575E 01	0.1721E 01
0.1850E 01	0.1962E 01	0.2055E 01	0.2128E 01	0.2180E 01	0.2212E 01	0.2222E 01	0.2211E 01	0.2179E 01	0.2126E 01
0.2053E 01	0.1960E 01	0.1848E 01	0.1718E 01	0.1572E 01	0.1411E 01	0.1236E 01	0.1050E 01	0.8527E 00	0.6475E 00
0.4358E 00	0.2197E 00	0.4947E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.23733E 04	0.11812E 04	0.35545E 04	0.20092E 01	0.49772E 00	0.70746E 02	0.49966E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.8542E 03	0.8369E 03	0.7861E 03	0.7038E 03	0.5932E 03	0.4586E 03	0.3053E 03	0.1389E 03	-0.3391E 02	-0.2065E 03
-0.3724E 03	-0.5253E 03	-0.6592E 03	-0.7692E 03	-0.8510E 03	-0.9015E 03	-0.9186E 03			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.23733E 04	0.11854E 04	0.35586E 04	0.20022E 01	0.49945E 00	0.70828E 02	0.49966E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.8534E 03	0.8361E 03	0.7850E 03	0.7024E 03	0.5914E 03	0.4564E 03	0.3025E 03	0.1356E 03	-0.3795E 02	-0.2111E 03
-0.3775E 03	-0.5310E 03	-0.6653E 03	-0.7757E 03	-0.8578E 03	-0.9084E 03	-0.9256E 03			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

OBLATE SPHEROID HAPPEL'S MODEL MARK= 5051

A.R.	RF	CONCENTRATION	DM	X1	X2	A	B	IM	JM
1.00	0.01	0.4980144E-01	2.7180	4.0000	5.0000	0.0312	0.0982	33	33

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

-0.0	0.3229E 00	0.4408E 00	0.9521E 00	0.1254E 01	0.1544E 01	0.1820E 01	0.2078E 01	0.2316E 01	0.2531E 01
0.2723E 01	0.2888E 01	0.3025E 01	0.3134E 01	0.3212E 01	0.3259E 01	0.3274E 01	0.3258E 01	0.3211E 01	0.3132E 01
0.3024E 01	0.2886E 01	0.2721E 01	0.2529E 01	0.2314E 01	0.2076E 01	0.1818E 01	0.1543E 01	0.1253E 01	0.9511E 00
0.6400E 00	0.3226E 00	0.7292E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.348908E 04	0.179856 04	0.528836 04	0.19405E 01	0.51534E 00	0.18984E 02	0.50034E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1106E 04	0.1080E 04	0.1003E 04	0.8789E 03	0.7111E 03	0.5064E 03	0.2729E 03	0.1974E 02	-0.2437E 03	-0.5068E 03
-0.7594E 03	-0.9927E 03	-0.1197E 04	-0.1364E 04	-0.1487E 04	-0.1564E 04	-0.1589E 04			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.348988E 04	0.180235 04	0.529216 04	0.19363E 01	0.51644E 00	0.18997E 02	0.50034E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1105E 04	0.1079E 04	0.1002E 04	0.8772E 03	0.7090E 03	0.5037E 03	0.2697E 03	0.1603E 02	-0.2480E 03	-0.5115E 03
-0.7645E 03	-0.9985E 03	-0.1203E 04	-0.1370E 04	-0.1494E 04	-0.1570E 04	-0.1596E 04			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

OBLATE SPHEROID HAPPEL'S MODEL MARK= 5150

A.R.	RF	CONCENTRATION	DM	X1	X2	A	B	IM	JM
1.00	0.01	0.4066458E 00	1.3498	4.0000	4.3000	0.0094	0.0982	33	33

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

-0.0	0.1968E 01	0.3910E 01	0.5816E 01	0.7666E 01	0.9444E 01	0.1113E 02	0.1271E 02	0.1417E 02	0.1549E 02
0.1666E 02	0.1768E 02	0.1852E 02	0.1919E 02	0.1966E 02	0.1995E 02	0.2005E 02	0.1995E 02	0.1966E 02	0.1918E 02
0.1852E 02	0.1768E 02	0.1666E 02	0.1549E 02	0.1417E 02	0.1271E 02	0.1113E 02	0.9443E 01	0.7666E 01	0.5816E 01
0.3910E 01	0.1968E 01	0.4472E-08							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.21367E 05	0.26051E 05	0.47418E 05	0.82022E 00	0.12192E 01	0.50761E 01	0.50034E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2683E 04	0.2310E 04	0.1202E 04	-0.6001E 03	-0.3037E 04	-0.5990E 04	-0.9365E 04	-0.1304E 05	-0.1685E 05	-0.2066E 05
-0.2433E 05	-0.2769E 05	-0.3066E 05	-0.3309E 05	-0.3489E 05	-0.3600E 05	-0.3637E 05			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.21367F 05	0.26058E 05	0.47425E 05	0.81999E 00	0.12195E 01	0.50769E 01	0.50034E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2680F 04	0.2307E 04	0.1199E 04	-0.6037E 03	-0.3045E 04	-0.5998E 04	-0.9373E 04	-0.1306E 05	-0.1686F 05	-0.2068F 05
-0.2434F 05	-0.2770E 05	-0.3067E 05	-0.3311E 05	-0.3491E 05	-0.3602E 05	-0.3639E 05			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

OBLATE SPHEROID HAPPEL'S MODEL MARK= 5153

A.R.	RF	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	0.01	0.2014202E-02	7.9183	1.4750	3.5600	0.0521	0.0982	33	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

-0.0	0.1638E 00	0.3262E 00	0.4887E 00	0.6511E 00	0.8133E 00	0.9744E 00	0.1133E 01	0.1288E 01	0.1437E 01
0.1576E 01	0.1703E 01	0.1814E 01	0.1905E 01	0.1973E 01	0.2014E 01	0.2028E 01	0.2013E 01	0.1971E 01	0.1903E 01
0.1811E 01	0.1700E 01	0.1573E 01	0.1434E 01	0.1285E 01	0.1130E 01	0.9716E 00	0.8108E 00	0.6491E 00	0.4871E 00
0.3251E 00	0.1632E 00	0.4160E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.18665E 04	0.10509E 04	0.29174E 04	0.17761E 01	0.56304E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.7257E 03	0.7162E 03	0.6880E 03	0.6381E 03	0.5627E 03	0.4586E 03	0.3253E 03	0.1672E 03	-0.5460E 01	-0.1779E 03
-0.3355E 03	-0.4679E 03	-0.5710E 03	-0.6456E 03	-0.6949E 03	-0.7228E 03	-0.7321E 03			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.18665E 04	0.10566E 04	0.29231E 04	0.17666E 01	0.56606E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.7262E 03	0.7166E 03	0.6883E 03	0.6383E 03	0.5626E 03	0.4579E 03	0.3239E 03	0.1649E 03	-0.8889E 01	-0.1825E 03
-0.3408E 03	-0.4738E 03	-0.5773E 03	-0.6521E 03	-0.7015E 03	-0.7294E 03	-0.7388E 03			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

OBLATE SPHEROID HAPPEL'S MODEL MARK= 5157

A.R.	RF	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	0.01	0.9862337E-02	4.6631	1.4750	3.0300	0.0486	0.0982	33	33

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

-0.0	0.1957E 00	0.3898E 00	0.5839E 00	0.7780E 00	0.9718E 00	0.1164E 01	0.1354E 01	0.1539E 01	0.1717E 01
0.1884E 01	0.2036E 01	0.2168E 01	0.2277E 01	0.2358E 01	0.2408E 01	0.2425E 01	0.2408E 01	0.2357E 01	0.2275E 01
0.2166E 01	0.2033E 01	0.1881E 01	0.1714E 01	0.1537E 01	0.1352E 01	0.1162E 01	0.9697E 00	0.7762E 00	0.5825E 00
0.3888E 00	0.1952E 00	0.5004E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.22315E 04	0.12614E 04	0.34929E 04	0.17691E 01	0.56527E 00	0.73875E 02	0.55828E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.8340E 03	0.8226E 03	0.7886E 03	0.7290E 03	0.6391E 03	0.5147E 03	0.3548E 03	0.1649E 03	-0.4235E 02	-0.2496E 03
-0.4390E 03	-0.5981E 03	-0.7219E 03	-0.8113E 03	-0.8704E 03	-0.9039E 03	-0.9152E 03			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.22315E 04	0.12478E 04	0.34993E 04	0.17602E 01	0.56813E 00	0.74010E 02	0.55828E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.8344E 03	0.8229E 03	0.7889E 03	0.7293E 03	0.6391E 03	0.5142E 03	0.3535E 03	0.1626E 03	-0.4593E 02	-0.2546E 03
-0.4450E 03	-0.6047E 03	-0.7289E 03	-0.8195E 03	-0.8777E 03	-0.9112E 03	-0.9225E 03			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

OBLATE SPHEROID HAPPEL'S MODEL MARK= 5104

A.R.	RF	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	0.01	0.5186682E-01	2.6811	1.4750	2.4750	0.0250	0.0788	41	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 4.50 DEGREES INTERVAL

0.0	0.2356E 00	0.4701E 00	0.7044E 00	0.9381E 00	0.1171E 01	0.1402E 01	0.1641E 01	0.1872E 01	0.2099E 01
0.2322E 01	0.2537E 01	0.2742E 01	0.2935E 01	0.3111E 01	0.3268E 01	0.3402E 01	0.3510E 01	0.3590E 01	0.3638E 01
0.3654E 01	0.3638E 01	0.3589E 01	0.3509E 01	0.3401E 01	0.3266E 01	0.3109E 01	0.2933E 01	0.2740E 01	0.2535E 01
0.2320E 01	0.2097E 01	0.1870E 01	0.1639E 01	0.1406E 01	0.1172E 01	0.9379E 00	0.7036E 00	0.4694E 00	0.2352E 00
0.1299E-11									

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.33645E 04	0.19643E 04	0.53288E 04	0.17129E 01	0.58381E 00	0.19800E 02	0.55828E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 9.00 DEGREES INTERVAL

0.1088E 04	0.1077E 04	0.1043E 04	0.9847E 03	0.8986E 03	0.7813E 03	0.6299E 03	0.4433E 03	0.2241E 03	-0.1998E 02
-0.2786E 03	-0.5371E 03	-0.7814E 03	-0.1000E 04	-0.1186E 04	-0.1337E 04	-0.1454E 04	-0.1539E 04	-0.1598E 04	-0.1631E 04
-0.1643E 04									

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.33645E 04	0.19644E 04	0.53310E 04	0.17110E 01	0.58446E 00	0.19816E 02	0.55828E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 9.00 DEGREES INTERVAL

0.1089E 04	0.1077E 04	0.1043E 04	0.9848E 03	0.8987E 03	0.7814E 03	0.6299E 03	0.4433E 03	0.2241E 03	-0.2048E 02
-0.2796E 03	-0.5386E 03	-0.7832E 03	-0.1002E 04	-0.1188E 04	-0.1339E 04	-0.1456E 04	-0.1542E 04	-0.1600E 04	-0.1634E 04
-0.1645E 04									

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

OBLATE SPHEROID HAPPEL'S MODEL MARK= 5103

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	0.01	0.2134231E 00	1.6733	1.4750	2.0000	0.0131	0.0785	41	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 4.50 DEGREES INTERVAL

0.0	0.5826E 00	0.1162E 01	0.1742E 01	0.2321E 01	0.2898E 01	0.3474E 01	0.4045E 01	0.4610E 01	0.5166E 01
0.5706E 01	0.6228E 01	0.6724E 01	0.7188E 01	0.7612E 01	0.7989E 01	0.8310E 01	0.8569E 01	0.8759E 01	0.8876E 01
0.8913E 01	0.8874E 01	0.8758E 01	0.8568E 01	0.8309E 01	0.7988E 01	0.7611E 01	0.7184E 01	0.6723E 01	0.6239E 01
0.5705E 01	0.5164E 01	0.4609E 01	0.4044E 01	0.3473E 01	0.2897E 01	0.2320E 01	0.1741E 01	0.1163E 01	0.5821E 00
0.3088E-11									

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.82318E 04	0.64148E 04	0.14647E 05	0.12832E 01	0.77928E 00	0.71747E 01	0.55893E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 9.00 DEGREES INTERVAL

0.1718E 04	0.1674E 04	0.1543E 04	0.1321E 04	0.1004E 04	0.5989E 03	0.6734E 02	-0.5533E 03	-0.1343E 04	-0.2069E 04
-0.2855E 04	-0.3670E 04	-0.4448E 04	-0.5157E 04	-0.5775E 04	-0.6295E 04	-0.6711E 04	-0.7027E 04	-0.7248E 04	-0.7379E 04
-0.7423E 04									

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.82318E 04	0.64148E 04	0.14649E 05	0.12829E 01	0.77952E 00	0.71776E 01	0.55893E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 9.00 DEGREES INTERVAL

0.1719E 04	0.1675E 04	0.1543E 04	0.1321E 04	0.1004E 04	0.5987E 03	0.6708E 02	-0.5529E 03	-0.1342E 04	-0.2069E 04
-0.2856E 04	-0.3671E 04	-0.4449E 04	-0.5158E 04	-0.5778E 04	-0.6297E 04	-0.6713E 04	-0.7030E 04	-0.7251E 04	-0.7382E 04
-0.7426E 04									

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

OBLATE SPHEROID HAPPEL'S MODEL MARK= 5126

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	1.00	0.3856186E 00	1.3739	1.4750	1.8000	0.0135	0.0785	41	25

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 4.50 DEGREES INTERVAL

0.0	0.1342E 01	0.2678E 01	0.4013E 01	0.5346E 01	0.6675E 01	0.7997E 01	0.9308E 01	0.1060E 02	0.1187E 02
0.1310E 02	0.1428E 02	0.1540E 02	0.1645E 02	0.1740E 02	0.1824E 02	0.1895E 02	0.1951E 02	0.1992E 02	0.2016E 02
0.2023E 02	0.2012E 02	0.1985E 02	0.1940E 02	0.1881E 02	0.1807E 02	0.1721E 02	0.1625E 02	0.1520E 02	0.1408E 02
0.1290E 02	0.1168E 02	0.1042E 02	0.9146E 01	0.7854E 01	0.6553E 01	0.5247E 01	0.3937E 01	0.2627E 01	0.1316E 01
0.7125E-11									

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.18711E 03	0.23184E 03	0.41895E 03	0.80706E 00	0.12391E 01	0.54141E 01	0.55828E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 9.00 DEGREES INTERVAL

0.2567E 02	0.2382E 02	0.1830E 02	0.9079E 01	-0.3849E 01	-0.2045E 02	-0.4058E 02	-0.6392E 02	-0.8995E 02	-0.1179E 03
-0.1466E 03	-0.1752E 03	-0.2024E 03	-0.2273E 03	-0.2494E 03	-0.2682E 03	-0.2836E 03	-0.2955E 03	-0.3040E 03	-0.3090E 03
-0.3107E 03									

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.18711E 03	0.23189E 03	0.41900E 03	0.80689E 00	0.12393E 01	0.54147E 01	0.55828E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 9.00 DEGREES INTERVAL

0.2569E 02	0.2384E 02	0.1832E 02	0.9099E 01	-0.3829E 01	-0.2043E 02	-0.4056E 02	-0.6391E 02	-0.8994E 02	-0.1179E 03
-0.1466E 03	-0.1752E 03	-0.2024E 03	-0.2273E 03	-0.2494E 03	-0.2682E 03	-0.2836E 03	-0.2955E 03	-0.3040E 03	-0.3091E 03
-0.3107E 03									

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

OBLATE SPHEROID HAPPEL'S MODEL MARK= 5118

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	0.01	0.5995795E 00	1.1859	1.4750	1.4500	0.0073	0.0785	41	25

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 4.50 DEGREES INTERVAL

0.0	0.4198E 01	0.8388E 01	0.1258E 02	0.1677E 02	0.2095E 02	0.2511E 02	0.2924E 02	0.3332E 02	0.3733E 02
0.4123E 02	0.4499E 02	0.4856E 02	0.5190E 02	0.5495E 02	0.5765E 02	0.5996E 02	0.6181E 02	0.6317E 02	0.6400E 02
0.6428E 02	0.6400E 02	0.6317E 02	0.6181E 02	0.5995E 02	0.5765E 02	0.5494E 02	0.5190E 02	0.4856E 02	0.4498E 02
0.4122E 02	0.3732E 02	0.3332E 02	0.2923E 02	0.2510E 02	0.2094E 02	0.1676E 02	0.1258E 02	0.8384E 01	0.4196E 01
0.2287E-10									

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.59411E 05	0.15079E 06	0.21020E 06	0.39409E 00	0.25381E 01	0.48366E 01	0.55828E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 9.00 DEGREES INTERVAL

0.4101E 04	0.2898E 04	-0.7081E 03	-0.6713E 04	-0.1500E 05	-0.2570E 05	-0.3868E 05	-0.5357E 05	-0.7010E 05	-0.8785E 05
-0.1062E 06	-0.1246E 06	-0.1423E 06	-0.1589E 06	-0.1737E 06	-0.1866E 06	-0.1973E 06	-0.2057E 06	-0.2117E 06	-0.2153E 06
-0.2165E 06									

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.59411E 05	0.15080E 06	0.21021E 06	0.39398E 00	0.25392E 01	0.48384E 01	0.55828E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 9.00 DEGREES INTERVAL

0.4106E 04	0.2902E 04	-0.7041E 03	-0.6709E 04	-0.1509E 05	-0.2572E 05	-0.3868E 05	-0.5356E 05	-0.7010E 05	-0.8785E 05
-0.1062E 06	-0.1246E 06	-0.1423E 06	-0.1589E 06	-0.1738E 06	-0.1866E 06	-0.1973E 06	-0.2057E 06	-0.2117E 06	-0.2153E 06
-0.2165E 06									

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

OBLATE SPHEROID HAPPEL'S MODEL MARK= 5154

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	0.01	0.2033916E-02	7.892A	0.5490	2.6700	0.0530	0.0982	33	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

-0.0	0.8832E-01	0.1780E 00	0.2734E 00	0.3782E 00	0.4967E 00	0.6338E 00	0.7957E 00	0.9897E 00	0.1224E 01
0.1508E 01	0.1847E 01	0.2237E 01	0.2659E 01	0.3059E 01	0.3357E 01	0.3469E 01	0.3356E 01	0.3057E 01	0.2656E 01
0.2234E 01	0.1843E 01	0.1505E 01	0.1221E 01	0.9870E 00	0.7933E 00	0.6317E 00	0.4950E 00	0.3769E 00	0.2724E 00
0.1773E 00	0.8891E-01	0.4393E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.13153E 04	0.14626E 04	0.27779E 04	0.89929E 00	0.11120E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.6759E 03	0.6813E 03	0.6995E 03	0.7285E 03	0.7606E 03	0.7714E 03	0.7016E 03	0.4464E 03	-0.2751E 02	-0.5016E 03
-0.7557E 03	-0.8245E 03	-0.8126E 03	-0.7803E 03	-0.7510E 03	-0.7326E 03	-0.7272E 03			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.13153E 04	0.14637E 04	0.27789E 04	0.89863E 00	0.11128E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.6787E 03	0.6840E 03	0.7024E 03	0.7318E 03	0.7646E 03	0.7755E 03	0.7103E 03	0.4560E 03	-0.2300E 02	-0.5020E 03
-0.7555E 03	-0.8214E 03	-0.8077E 03	-0.7743E 03	-0.7446E 03	-0.7260E 03	-0.7206E 03			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

OBLATE SPHEROID HAPPEL'S MODEL MARK= 5158

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	0.01	0.9596489E-02	4.7057	0.5490	2.1500	0.0500	0.0982	33	33

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

-0.0	0.1070E 00	0.2175E 00	0.3340E 00	0.4620E 00	0.6067E 00	0.7740E 00	0.9715E 00	0.1208E 01	0.1494E 01
0.1840E 01	0.2253E 01	0.2729E 01	0.3243E 01	0.3732E 01	0.4096E 01	0.4231E 01	0.4094E 01	0.3730E 01	0.3241E 01
0.2726E 01	0.2250E 01	0.1837E 01	0.1491E 01	0.1206E 01	0.9693E 00	0.7721E 00	0.6051E 00	0.4608E 00	0.3331E 00
0.2168E 00	0.1076E 00	0.5535E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.16049E 04	0.17886E 04	0.33935E 04	0.89729E 00	0.11145E 01	0.75136E 02	0.12509E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.7799E 03	0.7864E 03	0.8084E 03	0.8435E 03	0.8821E 03	0.8959E 03	0.8111E 03	0.4998E 03	-0.8006E 02	-0.6598E 03
-0.9709E 03	-0.1055E 04	-0.1041E 04	-0.1002E 04	-0.9663E 03	-0.9441E 03	-0.9377E 03			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.16049E 04	0.17898E 04	0.33946E 04	0.89670E 00	0.11152E 01	0.75162E 02	0.12509E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.7832E 03	0.7896E 03	0.8119E 03	0.8474E 03	0.8871E 03	0.9028E 03	0.8214E 03	0.5112E 03	-0.7442E 02	-0.6600E 03
-0.9702E 03	-0.1051E 04	-0.1035E 04	-0.9947E 03	-0.9588E 03	-0.9365E 03	-0.9301E 03			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

OBLATE SPHEROID HAPPEL'S MODEL MARK= 5107

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	0.01	0.6527466E-01	2.4836	0.5490	1.5000	0.0238	0.0785	41	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 4.50 DEGREES INTERVAL

0.0	0.1594E 00	0.3202E 00	0.4868E 00	0.6631E 00	0.8530E 00	0.1061E 01	0.1293E 01	0.1555E 01	0.1854E 01
0.2198E 01	0.2597E 01	0.3062E 01	0.3508E 01	0.4211E 01	0.4894E 01	0.5620E 01	0.6337E 01	0.6956E 01	0.7398E 01
0.7555E 01	0.7397E 01	0.6962E 01	0.6335E 01	0.5617E 01	0.4891E 01	0.4208E 01	0.3595E 01	0.3059E 01	0.2595E 01
0.2196E 01	0.1851E 01	0.1553E 01	0.1291E 01	0.1060E 01	0.8518E 00	0.6621E 00	0.4860E 00	0.3196E 00	0.1591E 00
0.1781E-11									

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.28791E 04	0.33186E 04	0.61976E 04	0.86756E 00	0.11527E 01	0.16960E 02	0.12509E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 9.00 DEGREES INTERVAL

0.1078E 04	0.1084E 04	0.1103E 04	0.1136E 04	0.1179E 04	0.1220E 04	0.1235E 04	0.1144E 04	0.9001E 03	0.3177E 03
-0.5610E 03	-0.1439E 04	-0.2021E 04	-0.2284E 04	-0.2354E 04	-0.2339E 04	-0.2297E 04	-0.2254E 04	-0.2221E 04	-0.2201E 04
-0.2196E 04									

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.28791E 04	0.33196E 04	0.61987E 04	0.86729E 00	0.11530E 01	0.16962E 02	0.12509E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 9.00 DEGREES INTERVAL

0.1082E 04	0.1087E 04	0.1107E 04	0.1140E 04	0.1182E 04	0.1224E 04	0.1239E 04	0.1170E 04	0.9066E 03	0.3240E 03
-0.5572E 03	-0.1438E 04	-0.2020E 04	-0.2282E 04	-0.2351E 04	-0.2335E 04	-0.2293E 04	-0.2250E 04	-0.2217E 04	-0.2197E 04
-0.2191E 04									

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

OBLATE SPHEROID HAPPEL'S MODEL MARK= 5109

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	0.01	0.1554163E 00	1.8599	0.5490	1.2000	0.0163	0.0785	41	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 4.50 DEGREES INTERVAL

0.0	0.3087E 00	0.6189E 00	0.9391E 00	0.1276E 01	0.1635E 01	0.2025E 01	0.2455E 01	0.2936E 01	0.3476E 01
0.4095E 01	0.4807E 01	0.5628E 01	0.6573E 01	0.7647E 01	0.8838E 01	0.1010E 02	0.1135E 02	0.1266E 02	0.1319E 02
0.1347E 02	0.1319E 02	0.1244E 02	0.1135E 02	0.1010E 02	0.8834E 01	0.7643E 01	0.6569E 01	0.5625E 01	0.4804E 01
0.4093E 01	0.3474E 01	0.2932E 01	0.2453E 01	0.2024E 01	0.1634E 01	0.1275E 01	0.9384E 00	0.6184E 00	0.3083E 00
0.3569E-11									

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.51963E 04	0.67011E 04	0.11897E 05	0.77543E 00	0.12896E 01	0.10087E 02	0.12509E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 9.00 DEGREES INTERVAL

0.1384E 04	0.1383E 04	0.1387E 04	0.1394E 04	0.1401E 04	0.1391E 04	0.1325E 04	0.1104E 04	0.5448E 03	-0.5477E 03
-0.2195E 04	-0.3822E 04	-0.4933E 04	-0.5491E 04	-0.5710E 04	-0.5776E 04	-0.5785E 04	-0.5778E 04	-0.5770E 04	-0.5767E 04
-0.5767E 04									

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.51963E 04	0.67015E 04	0.11898E 05	0.77540E 00	0.12897E 01	0.100875 02	0.12509E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 9.00 DEGREES INTERVAL

0.1390E 04	0.1389E 04	0.1393E 04	0.1400E 04	0.1407E 04	0.1397E 04	0.1331E 04	0.1111E 04	0.5531E 03	-0.5505E 03
-0.2189E 04	-0.3818E 04	-0.4929E 04	-0.5485E 04	-0.5706E 04	-0.5769E 04	-0.5778E 04	-0.5771E 04	-0.5763E 04	-0.5760E 04
-0.5761E 04									

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

OBLATE SPHEROID HAPPEL'S MODEL MARK= 5111

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	0.01	0.36481188E 00	1.3095	0.5490	0.9000	0.0110	0.0785	41	33

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 4.50 DEGREES INTERVAL

0.0	0.1026E 01	0.2059E 01	0.3127E 01	0.4250E 01	0.5448E 01	0.6743E 01	0.8163E 01	0.9736E 01	0.1150E 02
0.1348E 02	0.1574E 02	0.1831E 02	0.2122E 02	0.2448E 02	0.2807E 02	0.3184E 02	0.3557E 02	0.3876E 02	0.4095E 02
0.4175E 02	0.4095E 02	0.3873E 02	0.3553E 02	0.3183E 02	0.2806E 02	0.2448E 02	0.2121E 02	0.1830E 02	0.1574E 02
0.1348E 02	0.1149E 02	0.9733E 01	0.8160E 01	0.6741E 01	0.5444E 01	0.4249E 01	0.3127E 01	0.2059E 01	0.1025E 01
0.1303E-10									

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.16432E 05	0.33813E 05	0.50245E 05	0.48594E 00	0.20578E 01	0.771095 01	0.12509E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 9.00 DEGREES INTERVAL

-0.2165E 04	-0.2059E 04	-0.1754E 04	-0.1276E 04	-0.4705E 03	-0.5664E 03	-0.2014E 04	-0.4113E 04	-0.7337E 04	-0.1224E 05
-0.1867E 05	-0.2510E 05	-0.3001E 05	-0.3323E 05	-0.3532E 05	-0.3677E 05	-0.3781E 05	-0.3857E 05	-0.3909E 05	-0.3939E 05
-0.3949E 05									

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.16432E 05	0.33814E 05	0.50248E 05	0.48592E 00	0.20580E 01	0.771045 01	0.12509E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 9.00 DEGREES INTERVAL

-0.2178E 04	-0.2072E 04	-0.1767E 04	-0.1249E 04	-0.4920E 03	-0.5637E 03	-0.2001E 04	-0.4099E 04	-0.7322E 04	-0.1223E 05
-0.1866E 05	-0.2509E 05	-0.3000E 05	-0.3322E 05	-0.3531E 05	-0.3676E 05	-0.3780E 05	-0.3856E 05	-0.3907E 05	-0.3938E 05
-0.3948E 05									

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

OBLATE SPHEROID HAPPEL'S MODEL MARK= 5129

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	0.01	0.60777110E 00	1.1805	0.5490	0.7200	0.0071	0.0785	41	25

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 4.50 DEGREES INTERVAL

0.0	0.4202E 01	0.8468E 01	0.1290E 02	0.1758E 02	0.2262E 02	0.2811E 02	0.3419E 02	0.4098E 02	0.4864E 02
0.5734E 02	0.6724E 02	0.7856E 02	0.9134E 02	0.1056E 03	0.1212E 03	0.1374E 03	0.1532E 03	0.1668E 03	0.1741E 03
0.1794E 03	0.1741E 03	0.1667E 03	0.1532E 03	0.1374E 03	0.1212E 03	0.1056E 03	0.9135E 02	0.7856E 02	0.6724E 02
0.5734E 02	0.4863E 02	0.4097E 02	0.3418E 02	0.2811E 02	0.2262E 02	0.1758E 02	0.1290E 02	0.8466E 01	0.4201E 01
0.6155E-10									

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.70651E 05	0.32478E 06	0.39543E 06	0.21753E 00	0.45970E 01	0.858685 01	0.12509E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 9.00 DEGREES INTERVAL

0.3931E 04	0.2647E 04	-0.1247E 04	-0.8013E 04	-0.1811E 05	-0.3224E 05	-0.5163E 05	-0.7715E 05	-0.1113E 06	-0.1544E 06
-0.2073E 06	-0.2592E 06	-0.3033E 06	-0.3375E 06	-0.3632E 06	-0.3824E 06	-0.3965E 06	-0.4066E 06	-0.4133E 06	-0.4172E 06
-0.4185E 06									

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.70651E 05	0.32478E 06	0.39543E 06	0.21753E 00	0.45970E 01	0.858685 01	0.12509E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 9.00 DEGREES INTERVAL

0.3959E 04	0.2676E 04	-0.1217E 04	-0.7983E 04	-0.1809E 05	-0.3221E 05	-0.5160E 05	-0.7713E 05	-0.1113E 06	-0.1556E 06
-0.2073E 06	-0.2592E 06	-0.3033E 06	-0.3374E 06	-0.3631E 06	-0.3823E 06	-0.3964E 06	-0.4065E 06	-0.4133E 06	-0.4172E 06
-0.4185E 06									

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

OBLATE SPHEROID HAPPEL'S MODEL MARK= 5155

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	0.01	0.1971919E-02	7.9745	0.2029	2.2500	0.0512	0.0982	33	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63. DEGREES INTERVAL

-0.0	0.3746E-01	0.7543E-01	0.1147E 00	0.1636E 00	0.2192E 00	0.2878E 00	0.3759E 00	0.4935E 00	0.6570E 00
0.8951E 00	0.1260E 01	0.1852E 01	0.2866E 01	0.4622E 01	0.7185E 01	0.8757E 01	0.7181E 01	0.4617E 01	0.2861E 01
0.1848E 01	0.1257E 01	0.8021E 00	0.6545E 00	0.4913E 00	0.3741E 00	0.2863E 00	0.2179E 00	0.1626E 00	0.1159E 00
0.7494E-01	0.3722E-01	0.4907E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.71293E 03	0.21331E 04	0.28461E 04	0.33422E 00	0.29921E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.6731E 03	0.6849E 03	0.7247E 03	0.8004E 03	0.9277E 03	0.1136E 04	0.1461E 04	0.1677E 04	-0.3971E 02	-0.1755E 04
-0.1438E 04	-0.1212E 04	-0.1003E 04	-0.8753E 03	-0.7994E 03	-0.7593E 03	-0.7474E 03			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.71293E 03	0.21296E 04	0.28425E 04	0.33478E 00	0.29870E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.6744E 03	0.6881E 03	0.7277E 03	0.8029E 03	0.9298E 03	0.1138E 04	0.1469E 04	0.1719E 04	-0.3120E 02	-0.1779E 04
-0.1528E 04	-0.1197E 04	-0.9878E 03	-0.8604E 03	-0.7850E 03	-0.7452E 03	-0.7334E 03			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

OBLATE SPHEROID HAPPEL'S MODEL MARK= 5159

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	0.01	0.1005657E-01	4.6329	0.2029	1.7000	0.0468	0.0982	33	33

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

-0.0	0.5115E-01	0.1029E 00	0.1590E 00	0.2226E 00	0.2979E 00	0.3906E 00	0.5092E 00	0.6672E 00	0.8867E 00
0.1206E 01	0.1695E 01	0.2487E 01	0.3844E 01	0.6196E 01	0.9632E 01	0.1174E 02	0.9628E 01	0.6191E 01	0.3839E 01
0.2483E 01	0.1691E 01	0.1203E 01	0.8940E 00	0.6650E 00	0.5074E 00	0.3891E 00	0.2967E 00	0.2217E 00	0.1583E 00
0.1024E 00	0.5091E-01	0.7140E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.95672E 03	0.28730E 04	0.38297E 04	0.33301E 00	0.30030E 01	0.51516E 02	0.64900E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.8056E 03	0.8212E 03	0.8739E 03	0.9743E 03	0.1143E 04	0.1421E 04	0.1856E 04	0.2152E 04	-0.1589E 03	-0.2468E 04
-0.2171E 04	-0.1735E 04	-0.1457E 04	-0.1287E 04	-0.1187E 04	-0.1134E 04	-0.1118E 04			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.95672E 03	0.28698E 04	0.38266E 04	0.33337E 00	0.29996E 01	0.51473E 02	0.64900E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.8100E 03	0.8254E 03	0.8780E 03	0.9779E 03	0.1147E 04	0.1424E 04	0.1865E 04	0.2200E 04	-0.1486E 03	-0.2496E 04
-0.2159E 04	-0.1718E 04	-0.1440E 04	-0.1271E 04	-0.1171E 04	-0.1118E 04	-0.1103E 04			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

OBLATE SPHEROID HAPPEL'S MODEL MARK= 5115

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	0.01	0.1832548E 00	1.7605	0.2029	0.6900	0.0152	0.0785	41	33

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 4.50 DEGREES INTERVAL

0.0	0.4655E 00	0.9327E 00	0.1417E 01	0.1929E 01	0.2479E 01	0.3083E 01	0.3756E 01	0.4522E 01	0.5410E 01
0.6469E 01	0.7767E 01	0.9417E 01	0.1160E 02	0.1463E 02	0.1804E 02	0.2575E 02	0.3622E 02	0.5195E 02	0.7081E 02
0.8060E 02	0.7080E 02	0.5193E 02	0.3620E 02	0.2574E 02	0.1903E 02	0.1462E 02	0.1159E 02	0.9410E 01	0.7761E 01
0.6464E 01	0.5407E 01	0.4519E 01	0.3754E 01	0.3081E 01	0.2478E 01	0.1928E 01	0.1416E 01	0.9323E 00	0.4652E 00
0.1494E-10									

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.69209E 04	0.27285E 05	0.34206E 05	0.25365E 00	0.39425E 01	0.14181E 02	0.64900E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 9.00 DEGREES INTERVAL

0.1579E 04	0.1567E 04	0.1546E 04	0.1539E 04	0.1591E 04	0.1793E 04	0.2315E 04	0.3416E 04	0.5159E 04	0.4624E 04
-0.1124E 05	-0.2709E 05	-0.2762E 05	-0.2585E 05	-0.2476E 05	-0.2474E 05	-0.2404E 05	-0.2398E 05	-0.2399E 05	-0.2401E 05
-0.2402E 05									

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.69209E 04	0.27285E 05	0.34206E 05	0.25365E 00	0.39424E 01	0.14181E 02	0.64900E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 9.00 DEGREES INTERVAL

0.1591E 04	0.1578E 04	0.1558E 04	0.1550E 04	0.1602E 04	0.1803E 04	0.2324E 04	0.3425E 04	0.5176E 04	0.4685E 04
-0.1123E 05	-0.2713E 05	-0.2761E 05	-0.2585E 05	-0.2474E 05	-0.2472E 05	-0.2402E 05	-0.2397E 05	-0.2397E 05	-0.2399E 05
-0.2401E 05									

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

OBLATE SPHEROID HAPPEL'S MODEL MARK= 5138

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	1.00	0.4011483E 00	1.3559	0.2029	0.4300	0.0071	0.0785	41	33

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 4.50 DEGREES INTERVAL

0.0	0.2318E 01	0.4680E 01	0.7170E 01	0.9861E 01	0.1284E 02	0.1620E 02	0.2009E 02	0.2467E 02	0.3017E 02
0.3691E 02	0.4531E 02	0.5600E 02	0.6991E 02	0.8854E 02	0.1143E 03	0.1516E 03	0.2070E 03	0.2875E 03	0.3819E 03
0.4286E 03	0.3766E 03	0.2802E 03	0.2002E 03	0.1462E 03	0.1105E 03	0.8583E 02	0.6803E 02	0.5469E 02	0.4439E 02
0.3626E 02	0.2970E 02	0.2433E 02	0.1984E 02	0.1602E 02	0.1270E 02	0.9762E 01	0.7102E 01	0.4637E 01	0.2297E 01
0.1159E-09									

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.38332E 03	0.29739E 04	0.33572E 04	0.12890E 00	0.77582E 01	0.25062E 02	0.64900E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 9.00 DEGREES INTERVAL

0.2987E 02	0.2464E 02	0.8902E 01	-0.1863E 02	-0.6017E 02	-0.1188E 03	-0.1980E 03	-0.2994E 03	-0.4284E 03	-0.7134E 03
-0.1759E 04	-0.2747E 04	-0.2954E 04	-0.3039E 04	-0.3118E 04	-0.3186E 04	-0.3240E 04	-0.3278E 04	-0.3304E 04	-0.3319E 04
-0.3324E 04									

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.38332E 03	0.29742E 04	0.33575E 04	0.12888E 00	0.77590E 01	0.25065E 02	0.64900E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 9.00 DEGREES INTERVAL

0.3014E 02	0.2490E 02	0.9155E 01	-0.1840E 02	-0.6997E 02	-0.1187E 03	-0.1980E 03	-0.2996E 03	-0.4290E 03	-0.7141E 03
-0.1761E 04	-0.2749E 04	-0.2955E 04	-0.3039E 04	-0.3118E 04	-0.3187E 04	-0.3240E 04	-0.3278E 04	-0.3304E 04	-0.3319E 04
-0.3324E 04									

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

OBLATE SPHEROID HAPPEL'S MODEL MARK= 5117

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	0.01	0.4011483E 00	1.3559	0.2029	0.4300	0.0071	0.0524	61	33

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 3.00 DEGREES INTERVAL

0.0	0.1531E 01	0.3074E 01	0.4653E 01	0.6288E 01	0.7998E 01	0.9808E 01	0.1174E 02	0.1383E 02	0.1611E 02
0.1861E 02	0.2139E 02	0.2450E 02	0.2801E 02	0.3201E 02	0.3659E 02	0.4189E 02	0.4809E 02	0.5537E 02	0.6403E 02
0.7447E 02	0.8720E 02	0.1030E 03	0.1230E 03	0.1487E 03	0.1825E 03	0.2269E 03	0.2874E 03	0.3683E 03	0.4060E 03
0.4301E 03	0.4059E 03	0.3492E 03	0.2833E 03	0.2268E 03	0.1824E 03	0.1487E 03	0.1229E 03	0.1030E 03	0.8717E 02
0.7444E 02	0.6401E 02	0.5535E 02	0.4807E 02	0.4188E 02	0.3659E 02	0.3200E 02	0.2801E 02	0.2450E 02	0.2139E 02
0.1861E 02	0.1611E 02	0.1383E 02	0.1174E 02	0.9807E 01	0.7997E 01	0.6287E 01	0.4653E 01	0.3074E 01	0.1530E 01
0.2778E-09									

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.38337E 05	0.29718E 06	0.33552E 06	0.12900E 00	0.77517E 01	0.25047E 02	0.64900E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 4.00 DEGREES INTERVAL

0.2907E 04	0.2681E 04	0.2000E 04	0.8687E 03	-0.7793E 03	-0.2986E 04	-0.5821E 04	-0.9343E 04	-0.1360E 05	-0.1883E 05
-0.2474E 05	-0.3125E 05	-0.3857E 05	-0.4503E 05	-0.4939E 05	-0.5157E 05	-0.5260E 05	-0.5294E 05	-0.5313E 05	-0.5296E 05
-0.5051E 06	-0.5110E 06	-0.5161E 06	-0.5205E 06	-0.5240E 06	-0.5268E 06	-0.5290E 06	-0.5307E 06	-0.5318E 06	-0.5325E 06
-0.5327E 06									

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.38337E 05	0.29720E 06	0.33553E 06	0.12900E 00	0.77521E 01	0.25048E 02	0.64900E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 4.00 DEGREES INTERVAL

0.2917E 04	0.2692E 04	0.2010E 04	0.8784E 03	-0.7688E 03	-0.2977E 04	-0.5812E 04	-0.9354E 04	-0.1360E 05	-0.1883E 05
-0.2473E 05	-0.3125E 05	-0.3857E 05	-0.4503E 05	-0.4939E 05	-0.5159E 05	-0.5261E 05	-0.5296E 05	-0.5314E 05	-0.5298E 05
-0.5051E 06	-0.5110E 06	-0.5161E 06	-0.5205E 06	-0.5240E 06	-0.5268E 06	-0.5290E 06	-0.5307E 06	-0.5318E 06	-0.5325E 06
-0.5327E 06									

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

OBLATE SPHEROID HAPPEL'S MODEL MARK= 5110

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	0.01	0.5912186E 00	1.1015	0.2029	0.3200	0.0049	0.0785	41	25

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 4.50 DEGREES INTERVAL

0.0	0.8700E 01	0.1742E 02	0.2706E 02	0.3731E 02	0.4873E 02	0.6176E 02	0.7607E 02	0.9314E 02	0.1137E 03
0.1450E 03	0.1803E 03	0.2264E 03	0.2881E 03	0.3727E 03	0.4918E 03	0.6634E 03	0.9146E 03	0.1271E 04	0.1682E 04
0.1803E 04	0.1482E 04	0.1270E 04	0.9144E 03	0.6633E 03	0.4917E 03	0.3727E 03	0.2881E 03	0.2264E 03	0.1803E 03
0.1450E 03	0.1137E 03	0.9513E 02	0.7694E 02	0.6176E 02	0.4873E 02	0.3731E 02	0.2706E 02	0.1742E 02	0.8697E 01
0.6091E-09									

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.16852E 06	0.27729E 07	0.29415E 07	0.60771E-01	0.16456E 02	0.47389E 02	0.64900E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 9.00 DEGREES INTERVAL

0.5299E 04	0.9437E 03	-0.1261E 05	-0.3652E 05	-0.7415E 05	-0.1304E 06	-0.2140E 06	-0.3405E 06	-0.5370E 06	-0.8747E 06
-0.1597E 07	-0.2316E 07	-0.2657E 07	-0.2853E 07	-0.2980E 07	-0.3063E 07	-0.3120E 07	-0.3157E 07	-0.3181E 07	-0.3195E 07
-0.3199E 07									

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.16852E 06	0.27730E 07	0.29415E 07	0.60769E-01	0.16456E 02	0.47391E 02	0.64900E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 9.00 DEGREES INTERVAL

0.5351E 04	0.9958E 03	-0.1246E 05	-0.3652E 05	-0.7410E 05	-0.1303E 06	-0.2137E 06	-0.3404E 06	-0.5369E 06	-0.8745E 06
-0.1597E 07	-0.2316E 07	-0.2657E 07	-0.2853E 07	-0.2980E 07	-0.3063E 07	-0.3120E 07	-0.3157E 07	-0.3181E 07	-0.3195E 07
-0.3199E 07									

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

Swarms of Oblate Spheroids, Kuwabara's Model

OBLATE SPHEROID KUWABARA'S MODEL MARK= 277

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
1.00	0.01	0.2010083E-02	7.9237	4.0000	6.0700	0.0517	0.0982	33	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1911E 00	0.3793E 00	0.5637E 00	0.7475E 00	0.9140E 00	0.1077E 01	0.1229E 01	0.1369E 01	0.1497E 01
0.1610E 01	0.1707E 01	0.1788E 01	0.1852E 01	0.1898E 01	0.1925E 01	0.1934E 01	0.1924E 01	0.1896E 01	0.1850E 01
0.1786F 01	0.1704F 01	0.1607E 01	0.1494F 01	0.1366E 01	0.1226E 01	0.1074E 01	0.9115F 00	0.7404F 00	0.5621E 00
0.3783E 00	0.1907F 00	0.4309E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.20618E 04	0.10259E 04	0.30877E 04	0.20098E 01	0.49756E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.7539E 03	0.7393E 03	0.6954E 03	0.6241E 03	0.5283E 03	0.4116E 03	0.2781E 03	0.1331E 03	-0.1725E 02	-0.1671E 03
-0.3111F 03	-0.4437F 03	-0.5596E 03	-0.6547F 03	-0.7255E 03	-0.7691E 03	-0.7839E 03			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.20618E 04	0.10320E 04	0.30938F 04	0.19979E 01	0.50053E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.7536E 03	0.7391E 03	0.6950E 03	0.6232E 03	0.5269F 03	0.4095F 03	0.2751E 03	0.1289E 03	-0.7235E 02	-0.1730F 03
-0.3178F 03	-0.4511F 03	-0.5676E 03	-0.6631F 03	-0.7344F 03	-0.7783F 03	-0.7932E 03			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

PROLATE SPHEROID KUWABARA'S MODEL MARK= 5518

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
1.00	0.01	0.1014963E-01	4.6187	4.0000	5.5300	0.0382	0.0982	33	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.2369E 00	0.4700E 00	0.6983E 00	0.9197E 00	0.1132E 01	0.1333E 01	0.1522E 01	0.1695E 01	0.1853E 01
0.1992E 01	0.2112E 01	0.2212E 01	0.2291E 01	0.2347E 01	0.2381E 01	0.2393E 01	0.2381E 01	0.2346E 01	0.2289E 01
0.2210E 01	0.2110E 01	0.1990E 01	0.1850E 01	0.1693E 01	0.1519E 01	0.1331E 01	0.1130E 01	0.9178E 00	0.6969E 00
0.4691E 00	0.2364E 00	0.5336E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.25551E 04	0.13076E 04	0.38627E 04	0.19540E 01	0.51177E 00	0.76880E 02	0.49966E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.8652E 03	0.8463E 03	0.7902E 03	0.6991E 03	0.5768E 03	0.4278E 03	0.2580E 03	0.7394F 02	-0.1172E 03	-0.3085E 03
-0.4923E 03	-0.6615E 03	-0.8098E 03	-0.9314E 03	-0.1022E 04	-0.1078E 04	-0.1097E 04			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.25551E 04	0.13127E 04	0.38678E 04	0.19465E 01	0.51375E 00	0.76981E 02	0.49966E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.8649E 03	0.8459E 03	0.7896E 03	0.6982E 03	0.5755E 03	0.4259E 03	0.2555E 03	0.7065E 02	-0.1212E 03	-0.3133E 03
-0.4978E 03	-0.6678E 03	-0.8166E 03	-0.9386E 03	-0.1029E 04	-0.1085E 04	-0.1104E 04			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

OBLATE SPHEROID KUWABARA'S MODEL MARK= 273

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
1.00	0.01	0.1015613E-01	4.6177	4.0000	5.5300	0.0478	0.0982	33	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.2366E 00	0.4695E 00	0.6975E 00	0.9187E 00	0.1131E 01	0.1332E 01	0.1521E 01	0.1695E 01	0.1852E 01
0.1992E 01	0.2113E 01	0.2214E 01	0.2293E 01	0.2350E 01	0.2384E 01	0.2395E 01	0.2383E 01	0.2349E 01	0.2291E 01
0.2211E 01	0.2111E 01	0.1990E 01	0.1850E 01	0.1692E 01	0.1518E 01	0.1330E 01	0.1128E 01	0.9166E 00	0.6958E 00
0.4683E 00	0.2360E 00	0.5338E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.25529E 04	0.13063E 04	0.38592E 04	0.19543E 01	0.51170E 00	0.76794E 02	0.50034E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.8649E 03	0.8457E 03	0.7892E 03	0.6982E 03	0.5759E 03	0.4282E 03	0.2583E 03	0.7371E 02	-0.1178E 03	-0.3085E 03
-0.4918E 03	-0.6608E 03	-0.8088E 03	-0.9302E 03	-0.1020E 04	-0.1076E 04	-0.1094E 04			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.25529E 04	0.13139E 04	0.38668E 04	0.19432E 01	0.51463E 00	0.76942E 02	0.50034E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.8644E 03	0.8451E 03	0.7881E 03	0.6963E 03	0.5740E 03	0.4259E 03	0.2569E 03	0.6793E 02	-0.1248E 03	-0.3163E 03
-0.5004E 03	-0.6703E 03	-0.8194E 03	-0.9413E 03	-0.1032E 04	-0.1087E 04	-0.1106E 04			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

OBLATE SPHEROID KUWABARA'S MODEL MARK= 272

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
1.00	0.01	0.4980144E-01	2.7180	4.0000	5.0000	0.0312	0.0982	33	33

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.3633E 00	0.7208E 00	0.1071E 01	0.1411E 01	0.1737E 01	0.2047E 01	0.2338E 01	0.2605E 01	0.2848E 01
0.3064E 01	0.3249E 01	0.3404E 01	0.3526E 01	0.3614E 01	0.3667E 01	0.3684E 01	0.3666E 01	0.3613E 01	0.3525E 01
0.3403E 01	0.3248E 01	0.3062E 01	0.2846E 01	0.2603E 01	0.2335E 01	0.2045E 01	0.1736E 01	0.1410E 01	0.1070E 01
0.7200E 00	0.3628E 00	0.8214E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.39269E 04	0.22640E 04	0.61918E 04	0.17338E 01	0.57677E 00	0.22227E 02	0.50034E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1091E 04	0.1058E 04	0.9618E 03	0.8053E 03	0.5936E 03	0.3365E 03	0.4315E 02	-0.2766E 03	-0.6082E 03	-0.9395E 03
-0.1259E 04	-0.1562E 04	-0.1909E 04	-0.2018E 04	-0.2175E 04	-0.2271E 04	-0.2303E 04			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.39269E 04	0.22701E 04	0.61970E 04	0.17298E 01	0.57809E 00	0.22245E 02	0.50034E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1091E 04	0.1058E 04	0.9612E 03	0.8044E 03	0.5919E 03	0.3343E 03	0.4054E 02	-0.2803E 03	-0.6126E 03	-0.9446E 03
-0.1264E 04	-0.1559E 04	-0.1916E 04	-0.2025E 04	-0.2183E 04	-0.2279E 04	-0.2311E 04			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

OBLATE SPHEROID KUWABARA'S MODEL MARK= 271

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
1.00	0.01	0.4066458E 00	1.3498	4.0000	4.3000	0.0094	0.0982	33	33

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.2183E 01	0.4339E 01	0.6455E 01	0.8508E 01	0.1048E 02	0.1235E 02	0.1411E 02	0.1573E 02	0.1719E 02
0.1850E 02	0.1962E 02	0.2056E 02	0.2129E 02	0.2183E 02	0.2215E 02	0.2225E 02	0.2215E 02	0.2183E 02	0.2129E 02
0.2056E 02	0.1962E 02	0.1849E 02	0.1719E 02	0.1572E 02	0.1411E 02	0.1235E 02	0.1048E 02	0.8508E 01	0.6454E 01
0.4339E 01	0.2183E 01	0.4963E-08							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.23715E 05	0.36250E 05	0.59965E 05	0.65421E 00	0.15286E 01	0.64193E 01	0.50034E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2520E 04	0.2001E 04	0.4563E 03	-0.2052E 04	-0.5428E 04	-0.9543E 04	-0.1425E 05	-0.1935E 05	-0.2466E 05	-0.2997E 05
-0.3507E 05	-0.3976E 05	-0.4387E 05	-0.4725E 05	-0.4975E 05	-0.5130E 05	-0.5182E 05			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.23715E 05	0.36252E 05	0.59967E 05	0.65417E 00	0.15287E 01	0.64195E 01	0.50034E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2519E 04	0.1999E 04	0.4537E 03	-0.2056E 04	-0.5431E 04	-0.9545E 04	-0.1425E 05	-0.1936E 05	-0.2467E 05	-0.2997E 05
-0.3507E 05	-0.3977E 05	-0.4387E 05	-0.4725E 05	-0.4976E 05	-0.5130E 05	-0.5182E 05			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

OBLATE SPHEROID KUWABARA'S MODEL MARK= 278

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	0.01	0.20142025-02	7.0183	1.4750	2.5400	0.0521	0.0983	33	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1706E 00	0.3430E 00	0.5093E 00	0.6798E 00	0.8478E 00	0.1015E 01	0.1181E 01	0.1342E 01	0.1497E 01
0.1642E 01	0.1774E 01	0.1890E 01	0.1984E 01	0.2055E 01	0.2093E 01	0.2113E 01	0.2098E 01	0.2054E 01	0.1983E 01
0.1887E 01	0.1771E 01	0.1633E 01	0.1484E 01	0.1330E 01	0.1174E 01	0.1012E 01	0.8450E 00	0.6764E 00	0.5076E 00
0.3389E 00	0.1701E 00	0.4152E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.19446E 04	0.10999E 04	0.30445E 04	0.17680E 01	0.56561E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.7378E 03	0.7278E 03	0.6982E 03	0.6459E 03	0.5672E 03	0.4584E 03	0.3190E 03	0.1536E 03	-0.2720E 02	-0.2077E 03
-0.3727E 03	-0.5114E 03	-0.6195E 03	-0.6874E 03	-0.7091E 03	-0.7784E 03	-0.7883E 03			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.19445E 04	0.11055E 04	0.30501E 04	0.17590E 01	0.56843E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.7385E 03	0.7286E 03	0.6989E 03	0.6465E 03	0.5675E 03	0.4583E 03	0.3182E 03	0.1519E 03	-0.3002E 02	-0.2116E 03
-0.3776E 03	-0.5169E 03	-0.6253E 03	-0.7034E 03	-0.7551E 03	-0.7944E 03	-0.7943E 03			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

OBLATE SPHEROID KUWABARA'S MODEL MARK= 274

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	0.01	0.99623375-02	4.6631	1.4750	2.0300	0.0484	0.0982	33	33

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.2110E 00	0.4204E 00	0.6297E 00	0.8390E 00	0.1048E 01	0.1255E 01	0.1460E 01	0.1659E 01	0.1850E 01
0.2029E 01	0.2192E 01	0.2335E 01	0.2452E 01	0.2539E 01	0.2592E 01	0.2610E 01	0.2592E 01	0.2537E 01	0.2450E 01
0.2332E 01	0.2190E 01	0.2026E 01	0.1847E 01	0.1656E 01	0.1457E 01	0.1253E 01	0.1046E 01	0.8371E 00	0.6283E 00
0.4194E 00	0.2105E 00	0.5408E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.24032E 04	0.13914E 04	0.37946E 04	0.17272E 01	0.57898E 00	0.80255E 02	0.55828E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.8425E 03	0.8297E 03	0.7916E 03	0.7249E 03	0.6246E 03	0.4866E 03	0.3103E 03	0.1014E 03	-0.1265E 03	-0.3541E 03
-0.5626E 03	-0.7384E 03	-0.8758E 03	-0.9755E 03	-0.1042E 04	-0.1080E 04	-0.1092E 04			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.24032E 04	0.13973E 04	0.38005E 04	0.17198E 01	0.58146E 00	0.80381E 02	0.55828E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.8434E 03	0.8306E 03	0.7925E 03	0.7257E 03	0.6252E 03	0.4869E 03	0.3099E 03	0.9999E 02	-0.1291E 03	-0.3580E 03
-0.5675E 03	-0.7440E 03	-0.8817E 03	-0.9816E 03	-0.1048E 04	-0.1086E 04	-0.1098E 04			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

OBLATE SPHEROID KUWABARA'S MODEL MARK= 11

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	0.01	0.52666906E-01	2.6678	1.4750	2.4700	0.0249	0.0785	41	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 4.50 DEGREES INTERVAL

0.0	0.2695E 00	0.5376E 00	0.8055E 00	0.1073E 01	0.1341E 01	0.1608E 01	0.1874E 01	0.2136E 01	0.2395E 01
0.2648E 01	0.2892E 01	0.3124E 01	0.3342E 01	0.3542E 01	0.3719E 01	0.3871E 01	0.3993E 01	0.4082E 01	0.4137E 01
0.4155E 01	0.4136E 01	0.4081E 01	0.3991E 01	0.3869E 01	0.3717E 01	0.3540E 01	0.3340E 01	0.3122E 01	0.2889E 01
0.2645E 01	0.2393E 01	0.2134E 01	0.1871E 01	0.1606E 01	0.1339E 01	0.1072E 01	0.8045E 00	0.5368E 00	0.2691E 00
0.1398E-11									

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.38300E 04	0.25114E 04	0.63414E 04	0.15251E 01	0.65571E 00	0.21997E 02	0.55828E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 9.00 DEGREES INTERVAL

0.1070E 04	0.1054E 04	0.1007E 04	0.9276E 03	0.8118E 03	0.6564E 03	0.4588E 03	0.2186E 03	-0.6051E 02	-0.3699E 03
-0.6959E 03	-0.1022E 04	-0.1331E 04	-0.1609E 04	-0.1849E 04	-0.2046E 04	-0.2201E 04	-0.2316E 04	-0.2396E 04	-0.2443E 04
-0.2458E 04									

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.38300E 04	0.25140E 04	0.63440E 04	0.15235E 01	0.65640E 00	0.22006E 02	0.55828E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 9.00 DEGREES INTERVAL

0.1071E 04	0.1055E 04	0.1008E 04	0.9285E 03	0.8126E 03	0.6572E 03	0.4594E 03	0.2190E 03	-0.6040E 02	-0.3702E 03
-0.6966E 03	-0.1023E 04	-0.1332E 04	-0.1611E 04	-0.1851E 04	-0.2048E 04	-0.2203E 04	-0.2319E 04	-0.2398E 04	-0.2444E 04
-0.2460E 04									

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

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     OBLATE  SPHEROID     KUWABARA'S MODEL                                                    MARK=   15
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  A.R.          RF          CONCENTRATION          DM          X1          X2          A          B          IM      JM
  0.90          0.01        0.2134231E 00          1.4733      1.4750      2.0000      0.0131     0.0785     41      41

 DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT   4.50  DEGREES INTERVAL

  0.0           0.6694E 00    0.1335E 01    0.2001E 01    0.2666E 01    0.3330E 01    0.3992E 01    0.4649E 01    0.5298E 01    0.5936E 01
  0.6558E 01    0.7158E 01    0.7729E 01    0.8262E 01    0.8750E 01    0.9183E 01    0.9552E 01    0.9849E 01    0.1007E 02    0.1020E 02
  0.1024E 02    0.1020E 02    0.1007E 02    0.9848E 01    0.9550E 01    0.9181E 01    0.8748E 01    0.8260E 01    0.7726E 01    0.7156E 01
  0.6556E 01    0.5934E 01    0.5296E 01    0.4647E 01    0.3990E 01    0.3329E 01    0.2665E 01    0.2000E 01    0.1335E 01    0.6689E 00
  0.3518E-11

 THREE POINTS LAGRANGE DIFFERENTIATION FORMULA              SIMPSON'S RULE FOR INTEGRATION

        CDS             CDF             CDT          CDS/CDF          CDF/CDS          K1              K2
    0.94610E 04     0.95244E 04     0.18985E 05     0.99334E 00     0.10067E 01     0.93026E 01     0.55828E 01

 DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT   9.00  DEGREES INTERVAL

  0.1619E 04    0.1550E 04    0.1345E 04    0.1001E 04    0.5127E 03   -0.1233E 03   -0.9081E 03   -0.1834E 04   -0.2885E 04   -0.4034E 04
 -0.5278E 04   -0.6420E 04   -0.7564E 04   -0.8614E 04   -0.9540E 04   -0.1032E 05   -0.1096E 05   -0.1145E 05   -0.1179E 05   -0.1199E 05
 -0.1206E 05

 FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA               SIMPSON'S RULE FOR INTEGRATION

        CDS             CDF             CDT          CDS/CDF          CDF/CDS          K1              K2
    0.94610E 04     0.95266E 04     0.18988E 05     0.99311E 00     0.10069E 01     0.93037E 01     0.55828E 01

 DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT   9.00  DEGREES INTERVAL

  0.1620E 04    0.1552E 04    0.1347E 04    0.1003E 04    0.5145E 03   -0.1215E 03   -0.9066E 03   -0.1833E 04   -0.2884E 04   -0.4032E 04
 -0.5274E 04   -0.6420E 04   -0.7564E 04   -0.8615E 04   -0.9540E 04   -0.1032E 05   -0.1096E 05   -0.1145E 05   -0.1179E 05   -0.1200E 05
 -0.1206E 05

 SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE
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     OBLATE  SPHEROID     KUWABARA'S MODEL                                                    MARK=   13
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  A.R.          RF          CONCENTRATION          DM          X1          X2          A          B          IM      JM
  0.90          0.01        0.38563409E 00          1.3730      1.4750      1.8000      0.0081     0.0785     41      41

 DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT   4.50  DEGREES INTERVAL

  0.0           0.1481E 01    0.2957E 01    0.4433E 01    0.5909E 01    0.7383E 01    0.8851E 01    0.1031E 02    0.1175E 02    0.1317E 02
  0.1455E 02    0.1588E 02    0.1715E 02    0.1833E 02    0.1942E 02    0.2039E 02    0.2125E 02    0.2198E 02    0.2256E 02    0.2299E 02
  0.2324E 02    0.2332E 02    0.2324E 02    0.2299E 02    0.2256E 02    0.2198E 02    0.2125E 02    0.2039E 02    0.1942E 02    0.1833E 02
  0.1715E 02    0.1588E 02    0.1455E 02    0.1317E 02    0.1175E 02    0.1031E 02    0.8849E 01    0.7383E 01    0.5907E 01    0.4432E 01
  0.2956E 01    0.1481E 01    0.7909E-11

 THREE POINTS LAGRANGE DIFFERENTIATION FORMULA              SIMPSON'S RULE FOR INTEGRATION

        CDS             CDF             CDT          CDS/CDF          CDF/CDS          K1              K2
    0.20996E 05     0.33269E 05     0.54265E 05     0.63111E 00     0.15845E 01     0.70117E 01     0.55828E 01

 DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT   9.00  DEGREES INTERVAL

  0.2321E 04    0.2067E 04    0.1308E 04    0.3811E 02   -0.1747E 04   -0.4047E 04   -0.6846E 04   -0.1011E 05   -0.1377E 05   -0.1773E 05
 -0.2183E 05   -0.2593E 05   -0.2989E 05   -0.3356E 05   -0.3680E 05   -0.3960E 05   -0.4189E 05   -0.4368E 05   -0.4495E 05   -0.4571E 05
 -0.4596E 05

 FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA               SIMPSON'S RULE FOR INTEGRATION

        CDS             CDF             CDT          CDS/CDF          CDF/CDS          K1              K2
    0.20996E 05     0.33271E 05     0.54268E 05     0.63106E 00     0.15846E 01     0.70120E 01     0.55828E 01

 DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT   9.00  DEGREES INTERVAL

  0.2325E 04    0.2070E 04    0.1311E 04    0.4010E 02   -0.1746E 04   -0.4046E 04   -0.6847E 04   -0.1011E 05   -0.1377E 05   -0.1772E 05
 -0.2183E 05   -0.2593E 05   -0.2988E 05   -0.3356E 05   -0.3680E 05   -0.3960E 05   -0.4190E 05   -0.4368E 05   -0.4495E 05   -0.4571E 05
 -0.4596E 05

 SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE
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     OBLATE  SPHEROID     KUWABARA'S MODEL                                                    MARK=   31
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  A.R.          RF          CONCENTRATION          DM          X1          X2          A          B          IM      JM
  0.90          0.01        0.58223445E 00          1.1976      1.4750      1.4600      0.0077     0.0785     41      25

 DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT   4.50  DEGREES INTERVAL

  0.0           0.4056E 01    0.8106E 01    0.1216E 02    0.1621E 02    0.2024E 02    0.2430E 02    0.2831E 02    0.3229E 02    0.3618E 02
  0.4000E 02    0.4368E 02    0.4719E 02    0.5046E 02    0.5346E 02    0.5613E 02    0.5842E 02    0.6023E 02    0.6153E 02    0.6230E 02
  0.6267E 02    0.6239E 02    0.6157E 02    0.6023E 02    0.5839E 02    0.5613E 02    0.5346E 02    0.5044E 02    0.4718E 02    0.4368E 02
  0.4000E 02    0.3619E 02    0.3229E 02    0.2831E 02    0.2429E 02    0.2024E 02    0.1621E 02    0.1216E 02    0.8106E 01    0.4056E 01
  0.2203E-10

 THREE POINTS LAGRANGE DIFFERENTIATION FORMULA              SIMPSON'S RULE FOR INTEGRATION

        CDS             CDF             CDT          CDS/CDF          CDF/CDS          K1              K2
    0.57814E 05     0.16323E 06     0.22105E 06     0.35430E 00     0.28233E 01     0.59489E 01     0.55828E 01

 DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT   9.00  DEGREES INTERVAL

  0.3713E 04    0.2440E 04   -0.1383E 04   -0.7763E 04   -0.1670E 05   -0.2815E 05   -0.4201E 05   -0.5808E 05   -0.7601E 05   -0.9638E 05
 -0.1153E 06   -0.1353E 06   -0.1546E 06   -0.1725E 06   -0.1885E 06   -0.2024E 06   -0.2139E 06   -0.2228E 06   -0.2292E 06   -0.2330E 06
 -0.2343E 06

 FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA               SIMPSON'S RULE FOR INTEGRATION

        CDS             CDF             CDT          CDS/CDF          CDF/CDS          K1              K2
    0.57814E 05     0.16323E 06     0.22105E 06     0.35419E 00     0.28234E 01     0.59489E 01     0.55828E 01

 DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT   9.00  DEGREES INTERVAL

  0.3717E 04    0.2443E 04   -0.1379E 04   -0.7758E 04   -0.1669E 05   -0.2815E 05   -0.4201E 05   -0.5808E 05   -0.7600E 05   -0.9638E 05
 -0.1153E 06   -0.1353E 06   -0.1546E 06   -0.1725E 06   -0.1885E 06   -0.2024E 06   -0.2139E 06   -0.2228E 06   -0.2292E 06   -0.2330E 06
 -0.2343E 06

 SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE
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OBLATE SPHEROID KUWABARA'S MODEL MARK= 279

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	0.01	0.2033916E-02	7.8926	0.5490	2.6700	0.0530	0.0982	33	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.9304E-01	0.1874E 00	0.2878E 00	0.3981E 00	0.5276E 00	0.6666E 00	0.8364E 00	0.1040E 01	0.1286E 01
0.1583E 01	0.1937E 01	0.2347E 01	0.2788E 01	0.3207E 01	0.3519E 01	0.3635E 01	0.3518E 01	0.3204E 01	0.2784E 01
0.2343E 01	0.1934E 01	0.1579E 01	0.1282E 01	0.1037E 01	0.8338E 00	0.6643E 00	0.5207E 00	0.3966E 00	0.2868E 00
0.1867E 00	0.9270E-01	0.4643E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.13794E 04	0.15445E 04	0.29239E 04	0.89308E 00	0.11197E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.6831E 03	0.6885E 03	0.7071E 03	0.7366E 03	0.7688E 03	0.7791E 03	0.7042E 03	0.4347E 03	-0.6395E 02	-0.5621E 03
-0.8300E 03	-0.9032E 03	-0.8920E 03	-0.8591E 03	-0.8292E 03	-0.8105E 03	-0.8050E 03			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.13794E 04	0.15471E 04	0.29265E 04	0.89160E 00	0.11216E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.6843E 03	0.6917E 03	0.7105E 03	0.7404E 03	0.7735E 03	0.7857E 03	0.7133E 03	0.4443E 03	-0.6007E 02	-0.5640E 03
-0.8310E 03	-0.9012E 03	-0.8880E 03	-0.8541E 03	-0.8237E 03	-0.8048E 03	-0.7996E 03			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

OBLATE SPHEROID KUWABARA'S MODEL MARK= 275

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	0.01	0.9596489E-02	4.7057	0.5490	2.1500	0.0500	0.0982	33	33

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1198E 00	0.2411E 00	0.3700E 00	0.5111E 00	0.6700E 00	0.8533E 00	0.1069E 01	0.1327E 01	0.1637E 01
0.2012E 01	0.2459E 01	0.2974E 01	0.3530E 01	0.4057E 01	0.4450E 01	0.4597E 01	0.4449E 01	0.4055E 01	0.3527E 01
0.2971E 01	0.2456E 01	0.2009E 01	0.1634E 01	0.1324E 01	0.1066E 01	0.8512E 00	0.6683E 00	0.5097E 00	0.3689E 00
0.2404E 00	0.1194E 00	0.6068E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.17498E 04	0.19978E 04	0.37464E 04	0.87525E 00	0.11425E 01	0.82950E 02	0.12509E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.7743E 03	0.7802E 03	0.8012E 03	0.8345E 03	0.8701E 03	0.8773E 03	0.7770E 03	0.4308E 03	-0.2091E 03	-0.8401E 03
-0.1185E 04	-0.1285E 04	-0.1277E 04	-0.1241E 04	-0.1207E 04	-0.1186E 04	-0.1180E 04			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.17498E 04	0.20007E 04	0.37493E 04	0.87398E 00	0.11442E 01	0.83015E 02	0.12509E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.7784E 03	0.7843E 03	0.8054E 03	0.8393E 03	0.8760E 03	0.8855E 03	0.7886E 03	0.4428E 03	-0.1998E 03	-0.8413E 03
-0.1186E 04	-0.1282E 04	-0.1272E 04	-0.1235E 04	-0.1200E 04	-0.1179E 04	-0.1173E 04			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

OBLATE SPHEROID KUWABARA'S MODEL MARK= 18

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	0.01	0.6527466E-01	2.4936	0.5490	1.5000	0.0238	0.0785	41	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 4.50 DEGREES INTERVAL

0.0	0.1042E 00	0.2038E 00	0.3048E 00	0.4114E 00	0.5262E 00	0.6582E 00	0.8169E 00	0.1009E 01	0.2231E 01
0.2634E 01	0.3009E 01	0.3434E 01	0.3856E 01	0.4253E 01	0.4531E 01	0.4557E 01	0.4337E 01	0.3981E 01	0.3473E 01
0.2940E 01	0.2377E 01	0.2012E 01	0.1744E 01	0.1463E 01	0.1220E 01	0.1040E 01	0.8103E 00	0.5059E 00	0.3926E 00
0.2431E 01	0.2229E 01	0.1877E 01	0.1547E 01	0.1290E 01	0.1040E 01	0.8103E 00	0.5059E 00	0.3926E 00	0.1957E 00
0.2039E-11									

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.33478E 04	0.44439E 04	0.78117E 04	0.75785E 00	0.13195E 01	0.21376E 02	0.12509E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 9.00 DEGREES INTERVAL

0.1013E 04	0.1014E 04	0.1019E 04	0.1029E 04	0.1038E 04	0.1035E 04	0.9912E 03	0.8417E 03	0.4666E 03	-0.2726E 03
-0.1348E 04	-0.2426E 04	-0.3142E 04	-0.3576E 04	-0.3805E 04	-0.3729E 04	-0.3730E 04	-0.3721E 04	-0.3711E 04	-0.3705E 04
-0.3704E 04									

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.33478E 04	0.44450E 04	0.78127E 04	0.75766E 00	0.13198E 01	0.21379E 02	0.12509E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 9.00 DEGREES INTERVAL

0.1017E 04	0.1018E 04	0.1024E 04	0.1033E 04	0.1043E 04	0.1042E 04	0.9969E 03	0.8496E 03	0.4767E 03	-0.2647E 03
-0.1344E 04	-0.2422E 04	-0.3140E 04	-0.3573E 04	-0.3802E 04	-0.3726E 04	-0.3725E 04	-0.3715E 04	-0.3705E 04	-0.3699E 04
-0.3699E 04									

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

OBLATE SPHEROID KUWABARA'S MODEL MARK= 17

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	0.01	0.15541635E 00	1.8599	0.5490	1.2000	0.0163	0.0785	41	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 4.50 DEGREES INTERVAL

0.0	0.3751E 00	0.7522E 00	0.1142E 01	0.1552E 01	0.1980E 01	0.2465E 01	0.2987E 01	0.3569E 01	0.4225E 01
0.4971E 01	0.5824E 01	0.6803E 01	0.7922E 01	0.9187E 01	0.1058E 02	0.1206E 02	0.1351E 02	0.1477E 02	0.1565E 02
0.1596E 02	0.1565E 02	0.1477E 02	0.1351E 02	0.1206E 02	0.1058E 02	0.9183E 01	0.7918E 01	0.6799E 01	0.5820E 01
0.4968E 01	0.4222E 01	0.3567E 01	0.2985E 01	0.2463E 01	0.1988E 01	0.1551E 01	0.1141E 01	0.7516E 00	0.3748E 00
0.4052E-11									

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.62091E 04	0.10265E 05	0.16474E 05	0.60489E 00	0.16532E 01	0.13967E 02	0.12509E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 9.00 DEGREES INTERVAL

0.1280E 04	0.1264E 04	0.1223E 04	0.1154E 04	0.1047E 04	0.9801E 03	0.8020E 03	0.5913E 03	-0.8381E 03	-0.2423E 04
-0.4624E 04	-0.6825E 04	-0.8419E 04	-0.9346E 04	-0.9845E 04	-0.1012E 05	-0.1029E 05	-0.1040E 05	-0.1046E 05	-0.1050E 05
-0.1052E 05									

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.62091E 04	0.10265E 05	0.16474E 05	0.60489E 00	0.16532E 01	0.13967E 02	0.12509E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 9.00 DEGREES INTERVAL

0.1286E 04	0.1270E 04	0.1230E 04	0.1161E 04	0.1054E 04	0.9872E 03	0.8096E 03	0.6000E 03	-0.8183E 03	-0.2417E 04
-0.4616E 04	-0.6819E 04	-0.8413E 04	-0.9340E 04	-0.9838E 04	-0.1011E 05	-0.1028E 05	-0.1039E 05	-0.1046E 05	-0.1050E 05
-0.1051E 05									

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

OBLATE SPHEROID KUWABARA'S MODEL MARK= 24

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	0.01	0.36491188E 00	1.3995	0.5490	0.9000	0.0088	0.0785	41	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 4.50 DEGREES INTERVAL

0.0	0.1143E 01	0.2299E 01	0.3497E 01	0.4763E 01	0.6122E 01	0.7606E 01	0.9239E 01	0.1107E 02	0.1313E 02
0.1547E 02	0.1815E 02	0.2121E 02	0.2469E 02	0.2860E 02	0.3288E 02	0.3739E 02	0.4178E 02	0.4559E 02	0.4832E 02
0.4916E 02	0.4832E 02	0.4559E 02	0.4178E 02	0.3738E 02	0.3288E 02	0.2859E 02	0.2468E 02	0.2120E 02	0.1815E 02
0.1547E 02	0.1313E 02	0.1106E 02	0.9237E 01	0.7601E 01	0.6121E 01	0.4762E 01	0.3496E 01	0.2298E 01	0.1143E 01
0.1416E-10									

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.19229E 05	0.53851E 05	0.73080E 05	0.35707E 00	0.28006E 01	0.11223E 02	0.12509E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 9.00 DEGREES INTERVAL

0.2025E 04	0.1864E 04	0.1387E 04	0.5567E 03	-0.6948E 03	-0.2484E 04	-0.5026E 04	-0.8584E 04	-0.1404E 05	-0.2177E 05
-0.3147E 05	-0.4117E 05	-0.4887E 05	-0.5424E 05	-0.5789E 05	-0.6043E 05	-0.6222E 05	-0.6347E 05	-0.6430E 05	-0.6478E 05
-0.6494E 05									

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.19229E 05	0.53852E 05	0.73081E 05	0.35706E 00	0.28006E 01	0.11223E 02	0.12509E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 9.00 DEGREES INTERVAL

0.2037E 04	0.1874E 04	0.1399E 04	0.5695E 03	-0.6818E 03	-0.2477E 04	-0.5012E 04	-0.8559E 04	-0.1404E 05	-0.2176E 05
-0.3145E 05	-0.4116E 05	-0.4886E 05	-0.5423E 05	-0.5788E 05	-0.6042E 05	-0.6221E 05	-0.6346E 05	-0.6428E 05	-0.6476E 05
-0.6492E 05									

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

OBLATE SPHEROID KUWABARA'S MODEL MARK= 33

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	0.01	0.60777107E 00	1.1806	0.5490	0.7200	0.0071	0.0785	41	75

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 4.50 DEGREES INTERVAL

0.0	0.4412E 01	0.8898E 01	0.1357E 02	0.1852E 02	0.2387E 02	0.2973E 02	0.3626E 02	0.4360E 02	0.5196E 02
0.6152E 02	0.7253E 02	0.8518E 02	0.9965E 02	0.1160E 03	0.1339E 03	0.1527E 03	0.1710E 03	0.1860E 03	0.1970E 03
0.2017E 03	0.1979E 03	0.1860E 03	0.1710E 03	0.1526E 03	0.1338E 03	0.1159E 03	0.9944E 02	0.8017E 02	0.7253E 02
0.6152E 02	0.5195E 02	0.4360E 02	0.3625E 02	0.2973E 02	0.2387E 02	0.1852E 02	0.1357E 02	0.8898E 01	0.4411E 01
0.6425E-10									

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.78246E 05	0.44585E 06	0.52410E 06	0.17550E 00	0.56981E 01	0.11381E 02	0.12509E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 9.00 DEGREES INTERVAL

0.3778E 04	0.2275E 04	-0.2319E 04	-0.1039E 05	-0.2244E 05	-0.4032E 05	-0.6479E 05	-0.9805E 05	-0.1458E 06	-0.2076E 06
-0.2810E 06	-0.3544E 06	-0.4161E 06	-0.4630E 06	-0.4971E 06	-0.5217E 06	-0.5393E 06	-0.5515E 06	-0.5596E 06	-0.5642E 06
-0.5657E 06									

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.78246E 05	0.44585E 06	0.52410E 06	0.17550E 00	0.56981E 01	0.11381E 02	0.12509E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 9.00 DEGREES INTERVAL

0.3806E 04	0.2302E 04	-0.2291E 04	-0.1034E 05	-0.2241E 05	-0.4026E 05	-0.6476E 05	-0.9801E 05	-0.1458E 06	-0.2076E 06
-0.2810E 06	-0.3543E 06	-0.4161E 06	-0.4630E 06	-0.4971E 06	-0.5217E 06	-0.5393E 06	-0.5515E 06	-0.5596E 06	-0.5642E 06
-0.5657E 06									

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

OBLATE SPHEROID KUWABARA'S MODEL MARK= 280

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	0.01	0.1971919E-02	7.9745	0.2029	2.2500	0.0512	0.0982	33	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.4104E-01	0.8260E-01	0.1276E 00	0.1786E 00	0.2388E 00	0.3128E 00	0.4074E 00	0.5332E 00	0.7078E 00
0.9615E 00	0.1350E 01	0.1979E 01	0.3057E 01	0.4923E 01	0.7647E 01	0.9318E 01	0.7644E 01	0.4919E 01	0.3052E 01
0.1975E 01	0.1346E 01	0.9582E 00	0.7049E 00	0.5308E 00	0.4053E 00	0.3111E 00	0.2374E 00	0.1775E 00	0.1268E 00
0.8206E-01	0.4078E-01	0.5287E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.76026E 03	0.22864E 04	0.30467E 04	0.33251E 00	0.30074E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.6708E 03	0.6830E 03	0.7243E 03	0.8030E 03	0.9361E 03	0.1155E 04	0.1498E 04	0.1726E 04	-0.1004E 03	-0.1926E 04
-0.1699E 04	-0.1356E 04	-0.1136E 04	-0.1002E 04	-0.9234E 03	-0.8819E 03	-0.8696E 03			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.76026E 03	0.22808E 04	0.30411E 04	0.33332E 00	0.30001E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.6747E 03	0.6869E 03	0.7279E 03	0.8062E 03	0.9387E 03	0.1158E 04	0.1507E 04	0.1772E 04	-0.8908E 02	-0.1950E 04
-0.1686E 04	-0.1337E 04	-0.1117E 04	-0.9845E 03	-0.9058E 03	-0.8645E 03	-0.8523E 03			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

OBLATE SPHEROID KUWABARA'S MODEL MARK= 276

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	0.01	0.1005657E-01	4.6329	0.2029	1.7000	0.0468	0.0982	33	33

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.6403E-01	0.1285E 00	0.1976E 00	0.2750E 00	0.3650E 00	0.4740E 00	0.6115E 00	0.7923E 00	0.1041E 01
0.1399E 01	0.1945E 01	0.2828E 01	0.4336E 01	0.6947E 01	0.1076E 02	0.1310E 02	0.1076E 02	0.6961E 01	0.4331E 01
0.2823E 01	0.1941E 01	0.1390E 01	0.1038E 01	0.7899E 00	0.6095E 00	0.4723E 00	0.3636E 00	0.2739E 00	0.1968E 00
0.1280E 00	0.6377E-01	0.8030E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.10772E 04	0.33422E 04	0.44194E 04	0.32232E 00	0.31025E 01	0.59448E 02	0.64900E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.7657E 03	0.7808E 03	0.8329E 03	0.9337E 03	0.1107E 04	0.1398E 04	0.1860E 04	0.2167E 04	-0.4202E 03	-0.3005E 04
-0.2696E 04	-0.2233E 04	-0.1942E 04	-0.1768E 04	-0.1667E 04	-0.1615E 04	-0.1600E 04			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.10772E 04	0.33394E 04	0.44166E 04	0.32259E 00	0.30999E 01	0.59411E 02	0.64900E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.7712E 03	0.7861E 03	0.8380E 03	0.9383E 03	0.1111E 04	0.1402E 04	0.1871E 04	0.2221E 04	-0.4093E 03	-0.3037E 04
-0.2684E 04	-0.2214E 04	-0.1923E 04	-0.1750E 04	-0.1649E 04	-0.1597E 04	-0.1582E 04			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

OBLATE SPHEROID KUWABARA'S MODEL MARK= 30

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	0.01	0.7605523E-01	2.3602	0.2029	1.0000	0.0199	0.0785	41	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 4.50 DEGREES INTERVAL

0.0	0.1958E 00	0.3920E 00	0.5950E 00	0.8096E 00	0.1040E 01	0.1294E 01	0.1580E 01	0.1907E 01	0.2293E 01
0.2758E 01	0.3339E 01	0.4086E 01	0.5085E 01	0.6479E 01	0.8510E 01	0.1159E 02	0.1639E 02	0.2356E 02	0.3715E 02
0.3661E 02	0.3215E 02	0.2355E 02	0.1638E 02	0.1158E 02	0.8592E 01	0.6473E 01	0.5080E 01	0.4081E 01	0.3334E 01
0.2755E 01	0.2290E 01	0.1905E 01	0.1578E 01	0.1293E 01	0.1030E 01	0.8084E 00	0.5942E 00	0.3915E 00	0.1955E 00
0.4647E-11									

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.31154E 04	0.12111E 05	0.15226E 05	0.25724E 00	0.38874E 01	0.22019E 02	0.64900E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 9.00 DEGREES INTERVAL

0.1036E 04	0.1041E 04	0.1065E 04	0.1118E 04	0.1220E 04	0.1409E 04	0.1750E 04	0.2337E 04	0.3168E 04	0.2888E 04
-0.4370E 04	-0.1162E 05	-0.1190E 05	-0.1107E 05	-0.1048E 05	-0.1014E 05	-0.9946E 04	-0.9843E 04	-0.9790E 04	-0.9764E 04
-0.9761E 04									

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.31154E 04	0.12109E 05	0.15225E 05	0.25727E 00	0.38869E 01	0.22017E 02	0.64900E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 9.00 DEGREES INTERVAL

0.1043E 04	0.1048E 04	0.1071E 04	0.1124E 04	0.1226E 04	0.1415E 04	0.1755E 04	0.2343E 04	0.3180E 04	0.2933E 04
-0.4360E 04	-0.1165E 05	-0.1189E 05	-0.1105E 05	-0.1046E 05	-0.1012E 05	-0.9933E 04	-0.9831E 04	-0.9778E 04	-0.9754E 04
-0.9749E 04									

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

OBLATE SPHEROID KUWABARA'S MODEL MARK= 33

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	0.01	0.1832548E 00	1.7605	0.2029	0.6000	0.0122	0.2785	41	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 4.50 DEGREES INTERVAL

0.0	0.5459E 00	0.1098E 01	0.1675E 01	0.2293E 01	0.2940E 01	0.3724E 01	0.4583E 01	0.5578E 01	0.6725E 01
0.8174E 01	0.9925E 01	0.1215E 02	0.1505E 02	0.1901E 02	0.2444E 02	0.3300E 02	0.4581E 02	0.6481E 02	0.9265E 02
0.9917E 02	0.8744E 02	0.4479E 02	0.4579E 02	0.3298E 02	0.2462E 02	0.1900E 02	0.1504E 02	0.1214E 02	0.9919E 01
0.8149E 01	0.6751E 01	0.5575E 01	0.4581E 01	0.3723E 01	0.2969E 01	0.2292E 01	0.1674E 01	0.1097E 01	0.5454E 00
0.1617E-10									

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.86824E 04	0.47793E 05	0.56475E 05	0.18167E 00	0.55046E 01	0.23613E 02	0.66900E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 9.00 DEGREES INTERVAL

0.1455E 04	0.1414E 04	0.1315E 04	0.1155E 04	0.9504E 03	0.7418E 03	0.4961E 03	0.1916E 03	-0.1174E 04	-0.1463E 04
-0.2313E 05	-0.4459E 05	-0.4742E 05	-0.4703E 05	-0.4684E 05	-0.4693E 05	-0.4718E 05	-0.4738E 05	-0.4754E 05	-0.4764E 05
-0.4768E 05									

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.86824E 04	0.47793E 05	0.56475E 05	0.18167E 00	0.55045E 01	0.23613E 02	0.66900E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 9.00 DEGREES INTERVAL

0.1466E 04	0.1427E 04	0.1326E 04	0.1166E 04	0.9617E 03	0.7529E 03	0.5070E 03	0.2026E 03	-0.1191E 04	-0.1441E 04
-0.2312E 05	-0.4462E 05	-0.4741E 05	-0.4700E 05	-0.4686E 05	-0.4694E 05	-0.4716E 05	-0.4737E 05	-0.4753E 05	-0.4763E 05
-0.4767E 05									

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

OBLATE SPHEROID KUWABARA'S MODEL MARK= 24

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	0.01	0.4011493E 00	1.3559	0.2029	0.4300	0.0057	0.2785	41	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 4.50 DEGREES INTERVAL

0.0	0.2413E 01	0.4875E 01	0.7478E 01	0.1030E 02	0.1344E 02	0.1702E 02	0.2119E 02	0.2614E 02	0.3220E 02
0.3971E 02	0.4924E 02	0.5162E 02	0.7820E 02	0.1006E 03	0.1323E 03	0.1796E 03	0.2476E 03	0.3448E 03	0.4832E 03
0.5230E 03	0.4632E 03	0.3467E 03	0.2473E 03	0.1785E 03	0.1323E 03	0.1006E 03	0.7807E 02	0.6160E 02	0.4923E 02
0.3970E 02	0.3220E 02	0.2614E 02	0.2119E 02	0.1702E 02	0.1344E 02	0.1030E 02	0.7477E 01	0.4874E 01	0.2411E 01
0.1197E-09									

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.46000E 05	0.50803E 06	0.55403E 06	0.90564E-01	0.11045E 02	0.41343E 02	0.66900E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 9.00 DEGREES INTERVAL

0.2790E 04	0.2196E 04	0.3852E 03	-0.2827E 04	-0.7799E 04	-0.1514E 05	-0.2584E 05	-0.4161E 05	-0.6445E 05	-0.1308E 06
-0.2799E 06	-0.4389E 06	-0.4932E 06	-0.5190E 06	-0.5338E 06	-0.5445E 06	-0.5518E 06	-0.5568E 06	-0.5600E 06	-0.5618E 06
-0.5624E 06									

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.46000E 05	0.50805E 06	0.55405E 06	0.90564E-01	0.11044E 02	0.41341E 02	0.66900E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 9.00 DEGREES INTERVAL

0.2818E 04	0.2221E 04	0.4149E 03	-0.2794E 04	-0.7762E 04	-0.1513E 05	-0.2579E 05	-0.4154E 05	-0.6438E 05	-0.1308E 06
-0.2798E 06	-0.4389E 06	-0.4932E 06	-0.5190E 06	-0.5337E 06	-0.5444E 06	-0.5517E 06	-0.5567E 06	-0.5599E 06	-0.5617E 06
-0.5623E 06									

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

OBLATE SPHEROID KUWABARA'S MODEL MARK= 33

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	0.01	0.5912186E 00	1.1915	0.2029	0.3200	0.0040	0.2785	41	25

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 4.50 DEGREES INTERVAL

0.0	0.8858E 01	0.1795E 02	0.2758E 02	0.3805E 02	0.4976E 02	0.6314E 02	0.7884E 02	0.9748E 02	0.1208E 03
0.1499E 03	0.1874E 03	0.2369E 03	0.3041E 03	0.3980E 03	0.5333E 03	0.7314E 03	0.1033E 04	0.1465E 04	0.2066E 04
0.2222E 04	0.1966E 04	0.1465E 04	0.1033E 04	0.7333E 03	0.5333E 03	0.3979E 03	0.3040E 03	0.2368E 03	0.1873E 03
0.1499E 03	0.1208E 03	0.9767E 02	0.7883E 02	0.6313E 02	0.4974E 02	0.3805E 02	0.2757E 02	0.1795E 02	0.8855E 01
0.6180E-09									

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.19103E 06	0.40573E 07	0.42483E 07	0.47083E-01	0.21239E 02	0.68444E 02	0.64900E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 9.00 DEGREES INTERVAL

0.5213E 04	0.6066E 03	-0.1367E 05	-0.3935E 05	-0.7989E 05	-0.1417E 06	-0.2365E 06	-0.3879E 06	-0.6447E 06	-0.1167E 07
-0.2279E 07	-0.3390E 07	-0.3908E 07	-0.4169E 07	-0.4320E 07	-0.4415E 07	-0.4477E 07	-0.4517E 07	-0.4543E 07	-0.4557E 07
-0.4562E 07									

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.19103E 06	0.40574E 07	0.42484E 07	0.47082E-01	0.21240E 02	0.68446E 02	0.64900E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 9.00 DEGREES INTERVAL

0.5264E 04	0.6575E 03	-0.1362E 05	-0.3930E 05	-0.7984E 05	-0.1416E 06	-0.2364E 06	-0.3878E 06	-0.6445E 06	-0.1167E 07
-0.2279E 07	-0.3390E 07	-0.3908E 07	-0.4169E 07	-0.4320E 07	-0.4415E 07	-0.4477E 07	-0.4517E 07	-0.4543E 07	-0.4557E 07
-0.4562E 07									

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

Swarms of Prolate Spheroids, Happel's Model

PROLATE SPHEROID HAPPEL'S MODEL MARK= 5519

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	0.01	0.1006319E-01	4.6318	1.4750	2.9900	0.0379	0.0982	33	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.2644E 00	0.5220E 00	0.7679E 00	0.9978E 00	0.1208E 01	0.1397E 01	0.1563E 01	0.1707E 01	0.1829E 01
0.1930E 01	0.2013E 01	0.2078E 01	0.2127E 01	0.2160E 01	0.2180E 01	0.2186E 01	0.2180E 01	0.2159E 01	0.2125E 01
0.2076E 01	0.2011E 01	0.1928E 01	0.1827E 01	0.1704E 01	0.1561E 01	0.1394E 01	0.1206E 01	0.9958E 00	0.7664E 00
0.5209E 00	0.2639E 00	0.5235E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.26956E 04	0.12146E 04	0.39102E 04	0.22193E 01	0.45060E 00	0.75545E 02	0.45274E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.8871E 03	0.8607E 03	0.7844E 03	0.6695E 03	0.5297E 03	0.3769E 03	0.2187E 03	0.5909E 02	-0.1001E 03	-0.2594E 03
-0.4189E 03	-0.5769E 03	-0.7295E 03	-0.8690E 03	-0.9836E 03	-0.1060E 04	-0.1086E 04			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.26956E 04	0.12200E 04	0.39156E 04	0.22094E 01	0.45261E 00	0.75650E 02	0.45274E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.8852E 03	0.8597E 03	0.7818E 03	0.6663E 03	0.5258E 03	0.3723E 03	0.2135E 03	0.5320E 02	-0.1066E 03	-0.2664E 03
-0.4267E 03	-0.5855E 03	-0.7388E 03	-0.8791E 03	-0.9945E 03	-0.1071E 04	-0.1098E 04			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

PROLATE SPHEROID HAPPEL'S MODEL MARK= 5507

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	0.01	0.4015230E-01	2.9203	1.4750	2.5300	0.0264	0.0982	33	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

-0.0	0.3381E 00	0.6672E 00	0.9814E 00	0.1275E 01	0.1543E 01	0.1783E 01	0.1995E 01	0.2177E 01	0.2332E 01
0.2460E 01	0.2564E 01	0.2645E 01	0.2706E 01	0.2749E 01	0.2774E 01	0.2782E 01	0.2773E 01	0.2748E 01	0.2706E 01
0.2644E 01	0.2562E 01	0.2458E 01	0.2330E 01	0.2178E 01	0.1993E 01	0.1782E 01	0.1541E 01	0.1273E 01	0.9802E 00
0.6664E 00	0.3377E 00	0.6576E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.34337E 04	0.15511E 04	0.49848E 04	0.22137E 01	0.45173E 00	0.22002E 02	0.45274E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1080E 04	0.1046E 04	0.9478E 03	0.8000E 03	0.6206E 03	0.4242E 03	0.2217E 03	0.1867E 02	-0.1939E 03	-0.3865E 03
-0.5898E 03	-0.7913E 03	-0.9866E 03	-0.1166E 04	-0.1313E 04	-0.1411E 04	-0.1445E 04			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.34337E 04	0.15548E 04	0.49885E 04	0.22084E 01	0.45282E 00	0.22019E 02	0.45274E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1077E 04	0.1043E 04	0.9444E 03	0.7961E 03	0.6161E 03	0.4194E 03	0.2162E 03	0.1780E 02	-0.1901E 03	-0.3791E 03
-0.5971E 03	-0.7991E 03	-0.9946E 03	-0.1174E 04	-0.1322E 04	-0.1421E 04	-0.1455E 04			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

PROLATE SPHEROID HAPPEL'S MODEL MARK= 5509

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	0.01	0.1993559E 00	1.7118	1.4750	2.0000	0.0164	0.0982	33	33

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

-0.0	0.8382E 00	0.1655E 01	0.2434E 01	0.3161E 01	0.3825E 01	0.4420E 01	0.4941E 01	0.5388E 01	0.5765E 01
0.6076E 01	0.6327E 01	0.6522E 01	0.6667E 01	0.6764E 01	0.6824E 01	0.6846E 01	0.6826E 01	0.6767E 01	0.6667E 01
0.6521E 01	0.6326E 01	0.6075E 01	0.5764E 01	0.5387E 01	0.4940E 01	0.4419E 01	0.3824E 01	0.3160E 01	0.2433E 01
0.1654E 01	0.8380E 00	0.1572E-08							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.84712E 04	0.53487E 04	0.13820E 05	0.15839E 01	0.63139E 00	0.71305E 01	0.45274E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1747E 04	0.1638E 04	0.1320E 04	0.8342E 03	0.2336E 03	-0.4323E 03	-0.1130E 04	-0.1838E 04	-0.2548E 04	-0.3259E 04
-0.3967E 04	-0.4665E 04	-0.5331E 04	-0.5932E 04	-0.6417E 04	-0.6735E 04	-0.6844E 04			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.84712E 04	0.53542E 04	0.13825E 05	0.15827E 01	0.63204E 00	0.71333E 01	0.45274E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1742E 04	0.1632E 04	0.1314E 04	0.8287E 03	0.2271E 03	-0.4389E 03	-0.1137E 04	-0.1844E 04	-0.2553E 04	-0.3264E 04
-0.3978E 04	-0.4677E 04	-0.5344E 04	-0.5944E 04	-0.6429E 04	-0.6747E 04	-0.6857E 04			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

PROLATE SPHEROID HAPPEL'S MODEL MARK= 5511

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	0.01	0.40220504E 00	1.3549	1.4750	1.7700	0.0105	0.0982	33	29

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

-0.0	0.2166E 01	0.4279E 01	0.6298E 01	0.8182E 01	0.9903E 01	0.1144E 02	0.1279E 02	0.1395E 02	0.1493E 02
0.1573E 02	0.1637E 02	0.1688E 02	0.1725E 02	0.1751E 02	0.1766E 02	0.1771E 02	0.1766E 02	0.1751E 02	0.1725E 02
0.1688E 02	0.1637E 02	0.1573E 02	0.1492E 02	0.1395E 02	0.1279E 02	0.1144E 02	0.9902E 01	0.8181E 01	0.6297E 01
0.4279E 01	0.2166E 01	0.3999E-08							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.21922E 05	0.25037E 05	0.46959E 05	0.87560E 00	0.11421E 01	0.50045E 01	0.45274E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2701E 04	0.2226E 04	0.8419E 03	-0.1292E 04	-0.3985E 04	-0.7041E 04	-0.1030E 05	-0.1367E 05	-0.1708E 05	-0.2048E 05
-0.2385E 05	-0.2711E 05	-0.3017E 05	-0.3286E 05	-0.3499E 05	-0.3638E 05	-0.3685E 05			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.21922E 05	0.25046E 05	0.46969E 05	0.87527E 00	0.11425E 01	0.50055E 01	0.45274E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2690E 04	0.2215E 04	0.8305E 03	-0.1303E 04	-0.3995E 04	-0.7051E 04	-0.1031E 05	-0.1368E 05	-0.1709E 05	-0.2050E 05
-0.2387E 05	-0.2713E 05	-0.3019E 05	-0.3288E 05	-0.3501E 05	-0.3640E 05	-0.3687E 05			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

PROLATE SPHEROID HAPPEL'S MODEL MARK= 5512

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	0.01	0.5903171E 00	1.1921	1.4750	1.6450	0.0085	0.0982	33	21

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

-0.0	0.5859E 01	0.1158E 02	0.1705E 02	0.2216E 02	0.2682E 02	0.3100E 02	0.3467E 02	0.3782E 02	0.4048E 02
0.4267E 02	0.4443E 02	0.4580E 02	0.4683E 02	0.4753E 02	0.4795E 02	0.4808E 02	0.4795E 02	0.4753E 02	0.4683E 02
0.4580E 02	0.4443E 02	0.4267E 02	0.4047E 02	0.3782E 02	0.3466E 02	0.3100E 02	0.2682E 02	0.2215E 02	0.1705E 02
0.1158E 02	0.5860E 01	0.1078E-07							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.59487E 05	0.12902E 06	0.18851E 06	0.46106E 00	0.21689E 01	0.44006E 01	0.45274E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.4238E 04	0.1907E 04	-0.4883E 04	-0.1546E 05	-0.2897E 05	-0.4450E 05	-0.6131E 05	-0.7882E 05	-0.9663E 05	-0.1144E 06
-0.1319E 06	-0.1487E 06	-0.1643E 06	-0.1778E 06	-0.1884E 06	-0.1952E 06	-0.1975E 06			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.59487E 05	0.12903E 06	0.18852E 06	0.46101E 00	0.21691E 01	0.44009E 01	0.45274E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.4215E 04	0.1884E 04	-0.4909E 04	-0.1549E 05	-0.2899E 05	-0.4454E 05	-0.6135E 05	-0.7886E 05	-0.9666E 05	-0.1145E 06
-0.1320E 06	-0.1488E 06	-0.1643E 06	-0.1778E 06	-0.1884E 06	-0.1952E 06	-0.1975E 06			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

PROLATE SPHEROID HAPPEL'S MODEL MARK= 5520

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	0.01	0.9998173E-02	4.6419	0.5490	1.9170	0.0342	0.0982	33	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.5193E 00	0.9647E 00	0.1283E 01	0.1477E 01	0.1576E 01	0.1611E 01	0.1608E 01	0.1586E 01	0.1554E 01
0.1521E 01	0.1490E 01	0.1463E 01	0.1441E 01	0.1425E 01	0.1415E 01	0.1412E 01	0.1415E 01	0.1425E 01	0.1440E 01
0.1462E 01	0.1489E 01	0.1519E 01	0.1552E 01	0.1583E 01	0.1606E 01	0.1608E 01	0.1573E 01	0.1475E 01	0.1281E 01
0.9628E 00	0.5183E 00	0.4802E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.37197E 04	0.79534E 03	0.45150E 04	0.46768E 01	0.21382E 00	0.62475E 02	0.31244E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1094E 04	0.9823E 03	0.7336E 03	0.5059E 03	0.3404E 03	0.2242E 03	0.1386E 03	0.7004E 02	0.9065E 01	-0.5187E 02
-0.1202E 03	-0.2055E 03	-0.3213E 03	-0.4862E 03	-0.7133E 03	-0.9613E 03	-0.1073E 04			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.37197E 04	0.81190E 03	0.45316E 04	0.45815E 01	0.21827E 00	0.62704E 02	0.31244E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1071E 04	0.9570E 03	0.7028E 03	0.4708E 03	0.3025E 03	0.1840E 03	0.9669E 02	0.2644E 02	-0.3608E 02	-0.9856E 02
-0.1685E 03	-0.2556E 03	-0.3735E 03	-0.5412E 03	-0.7726E 03	-0.1026E 04	-0.1140E 04			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

PROLATE SPHEROID HAPPEL'S MODEL MARK= 5506

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	0.01	0.3957498E-01	2.9344	0.5490	1.4700	0.0230	0.0982	33	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

-0.0	0.6833E 00	0.1269E 01	0.1688E 01	0.1943E 01	0.2071E 01	0.2116E 01	0.2110E 01	0.2077E 01	0.2033E 01
0.1986E 01	0.1941E 01	0.1902E 01	0.1871E 01	0.1848E 01	0.1834E 01	0.1829E 01	0.1834E 01	0.1848E 01	0.1871E 01
0.1902E 01	0.1941E 01	0.1985E 01	0.2032E 01	0.2076E 01	0.2108E 01	0.2114E 01	0.2069E 01	0.1941E 01	0.1686E 01
0.1268E 01	0.6828E 00	0.5739E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.48474E 04	0.10830E 04	0.59304E 04	0.44761E 01	0.22341E 00	0.14928E 02	0.31244E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1344E 04	0.1195E 04	0.8636E 03	0.5592E 03	0.3370E 03	0.1797E 03	0.6243E 02	-0.3165E 02	-0.1159E 03	-0.2001E 03
-0.2944E 03	-0.4120E 03	-0.5700E 03	-0.7927E 03	-0.1097E 04	-0.1429E 04	-0.1577E 04			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.48474E 04	0.10912E 04	0.59386E 04	0.44423E 01	0.22511E 00	0.14955E 02	0.31244E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1315E 04	0.1164E 04	0.8393E 03	0.5229E 03	0.2997E 03	0.1417E 03	0.2364E 02	-0.7117E 02	-0.1563E 03	-0.2416E 03
-0.3366E 03	-0.4553E 03	-0.6143E 03	-0.8384E 03	-0.1144E 04	-0.1470E 04	-0.1629E 04			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

PROLATE SPHEROID HAPPEL'S MODEL MARK= 5510

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	0.01	0.1997475E 00	1.7107	0.5490	0.9700	0.0132	0.0982	33	33

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

-0.0	0.1679E 01	0.3127E 01	0.4177E 01	0.4833E 01	0.5182E 01	0.5320E 01	0.5328E 01	0.5263E 01	0.5140E 01
0.5043E 01	0.4927E 01	0.4822E 01	0.4734E 01	0.4668E 01	0.4627E 01	0.4613E 01	0.4627E 01	0.4668E 01	0.4734E 01
0.4821E 01	0.4927E 01	0.5042E 01	0.5159E 01	0.5262E 01	0.5328E 01	0.5319E 01	0.5180E 01	0.4833E 01	0.4177E 01
0.3126E 01	0.1678E 01	0.1204E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.12296E 05	0.81204E 04	0.17176E 05	0.23935E 01	0.41780E 00	0.63864E 01	0.31244E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2293E 04	0.1877E 04	0.9099E 03	-0.7855E 02	-0.9254E 03	-0.1641E 04	-0.2255E 04	-0.2803E 04	-0.3316E 04	-0.3827E 04
-0.4375E 04	-0.4989E 04	-0.5702E 04	-0.6549E 04	-0.7536E 04	-0.8498E 04	-0.8914E 04			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.12296E 05	0.51280E 04	0.17384E 05	0.23909E 01	0.41941E 00	0.63592E 01	0.31244E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2228E 04	0.1812E 04	0.8836E 03	-0.1446E 03	-0.9908E 03	-0.1707E 04	-0.2322E 04	-0.2873E 04	-0.3387E 04	-0.3900E 04
-0.4450E 04	-0.5064E 04	-0.5777E 04	-0.6622E 04	-0.7609E 04	-0.8573E 04	-0.8988E 04			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

PROLATE SPHEROID HAPPEL'S MODEL MARK= 5513

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A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	0.01	0.4072310E 00	1.3491	0.5490	0.7700	0.0079	0.0982	33	20

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

-0.0	0.4383E 01	0.8156E 01	0.1090E 02	0.1263E 02	0.1356E 02	0.1394E 02	0.1398E 02	0.1382E 02	0.1356E 02
0.1326E 02	0.1297E 02	0.1270E 02	0.1247E 02	0.1231E 02	0.1220E 02	0.1216E 02	0.1220E 02	0.1231E 02	0.1247E 02
0.1270E 02	0.1297E 02	0.1326E 02	0.1356E 02	0.1382E 02	0.1398E 02	0.1394E 02	0.1356E 02	0.1263E 02	0.1090E 02
0.8156E 01	0.4383E 01	0.2883E-08							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.32244E 05	0.28601E 05	0.60844E 05	0.11274E 01	0.88702E 00	0.44371E 01	0.31244E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.3736E 04	0.2166E 04	-0.1645E 04	-0.6006E 04	-0.1021E 05	-0.1409E 05	-0.1765E 05	-0.2097E 05	-0.2416E 05	-0.2735E 05
-0.3067E 05	-0.3424E 05	-0.3812E 05	-0.4232E 05	-0.4669E 05	-0.5049E 05	-0.5206E 05			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.32244E 05	0.28613E 05	0.60857E 05	0.11269E 01	0.88740E 00	0.44380E 01	0.31244E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.3604E 04	0.2034E 04	-0.1778E 04	-0.6138E 04	-0.1034E 05	-0.1422E 05	-0.1778E 05	-0.2111E 05	-0.2429E 05	-0.2749E 05
-0.3082E 05	-0.3438E 05	-0.3826E 05	-0.4247E 05	-0.4683E 05	-0.5064E 05	-0.5221E 05			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

PROLATE SPHEROID HAPPEL'S MODEL MARK= 5515

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A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	0.01	0.5992489E 00	1.1861	0.5490	0.6700	0.0060	0.0982	33	21

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

-0.0	0.1226E 02	0.2271E 02	0.3029E 02	0.3503E 02	0.3753E 02	0.3851E 02	0.3855E 02	0.3807E 02	0.3733E 02
0.3651E 02	0.3571E 02	0.3499E 02	0.3440E 02	0.3395E 02	0.3368E 02	0.3359E 02	0.3368E 02	0.3395E 02	0.3440E 02
0.3499E 02	0.3571E 02	0.3651E 02	0.3733E 02	0.3807E 02	0.3855E 02	0.3851E 02	0.3753E 02	0.3503E 02	0.3029E 02
0.2271E 02	0.1226E 02	0.7654E-08							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.88928E 05	0.15876E 06	0.24769E 06	0.56015E 00	0.17852E 01	0.37929E 01	0.31244E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.6149E 04	-0.1313E 04	-0.1967E 05	-0.4186E 05	-0.6419E 05	-0.8542E 05	-0.1054E 06	-0.1243E 06	-0.1427E 06	-0.1611E 06
-0.1800E 06	-0.2000E 06	-0.2212E 06	-0.2436E 06	-0.2658E 06	-0.2841E 06	-0.2916E 06			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.88928E 05	0.15880E 06	0.24772E 06	0.56001E 00	0.17857E 01	0.37935E 01	0.31244E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.5899E 04	-0.1567E 04	-0.1993E 05	-0.4213E 05	-0.6446E 05	-0.8570E 05	-0.1057E 06	-0.1246E 06	-0.1430E 06	-0.1614E 06
-0.1803E 06	-0.2003E 06	-0.2216E 06	-0.2439E 06	-0.2661E 06	-0.2844E 06	-0.2919E 06			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

PROLATE SPHEROID HAPPEL'S MODEL MARK= 5521

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	0.01	0.9997617E-02	4.6419	0.2029	1.2100	0.0252	0.0982	33	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1547E 01	0.2110E 01	0.2032E 01	0.1811E 01	0.1601E 01	0.1429E 01	0.1293E 01	0.1187E 01	0.1104E 01
0.1045E 01	0.9894E 00	0.9519E 00	0.9240E 00	0.9049E 00	0.8937E 00	0.8900E 00	0.8936E 00	0.9046E 00	0.9236E 00
0.9514E 00	0.9852E 00	0.1039E 01	0.1103E 01	0.1186E 01	0.1291E 01	0.1427E 01	0.1598E 01	0.1808E 01	0.2028E 01
0.2106E 01	0.1544E 01	0.4381E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.66278E 04	0.35630E 03	0.69841E 04	0.18602E 02	0.53759E-01	0.44291E 02	0.26002E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1845E 04	0.1293E 04	0.8225E 03	0.6542E 03	0.5844E 03	0.5484E 03	0.5258E 03	0.5089E 03	0.4942E 03	0.4796E 03
0.4629E 03	0.4404E 03	0.4044E 03	0.3347E 03	0.1670E 03	-0.3025E 03	-0.8582E 03			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.66278E 04	0.42756E 03	0.70553E 04	0.15501E 02	0.64511E-01	0.44743E 02	0.26002E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1886E 04	0.1296E 04	0.7971E 03	0.6139E 03	0.5332E 03	0.4882E 03	0.4576E 03	0.4334E 03	0.4116E 03	0.3898E 03
0.3653E 03	0.3394E 03	0.2904E 03	0.2098E 03	0.2724E 02	-0.4703E 03	-0.1059E 04			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

PROLATE SPHEROID HAPPEL'S MODEL MARK= 5523

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	0.01	0.4039268E-01	2.9147	0.2029	0.8000	0.0160	0.0982	33	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

-0.0	0.2176E 01	0.2975E 01	0.2874E 01	0.2572E 01	0.2282E 01	0.2043E 01	0.1854E 01	0.1704E 01	0.1594E 01
0.1492E 01	0.1418E 01	0.1361E 01	0.1318E 01	0.1289E 01	0.1271E 01	0.1265E 01	0.1271E 01	0.1289E 01	0.1318E 01
0.1361E 01	0.1418E 01	0.1491E 01	0.1585E 01	0.1704E 01	0.1853E 01	0.2042E 01	0.2281E 01	0.2570E 01	0.2872E 01
0.2972E 01	0.2175E 01	0.5098E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.94700E 04	0.78635E 03	0.10256E 05	0.12043E 02	0.83036E-01	0.14665E 02	0.26002E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2455E 04	0.1638E 04	0.9309E 03	0.6526E 03	0.5131E 03	0.4329E 03	0.3549E 03	0.2983E 03	0.2469E 03	0.1953E 03
0.1387E 03	0.7087E 02	-0.1941E 02	-0.1591E 03	-0.4347E 03	-0.1141E 04	-0.1958E 04			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.94700E 04	0.83067E 03	0.10301E 05	0.11400E 02	0.87716E-01	0.14729E 02	0.26002E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2506E 04	0.1668E 04	0.9454E 03	0.6578E 03	0.5115E 03	0.4155E 03	0.3426E 03	0.2813E 03	0.2257E 03	0.1697E 03
0.1085E 03	0.3575E 02	-0.6026E 02	-0.2069E 03	-0.4036E 03	-0.1215E 04	-0.2051E 04			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

PROLATE SPHEROID HAPPEL'S MODEL MARK= 5504

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	0.01	0.1981004E 00	1.7154	0.2029	0.4300	0.0071	0.0982	33	33

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

-0.0	0.5806E 01	0.7983E 01	0.7814E 01	0.7082E 01	0.6339E 01	0.5704E 01	0.5182E 01	0.4760E 01	0.4420E 01
0.4148E 01	0.3932E 01	0.3763E 01	0.3637E 01	0.3549E 01	0.3496E 01	0.3479E 01	0.3496E 01	0.3549E 01	0.3637E 01
0.3764E 01	0.3932E 01	0.4148E 01	0.4420E 01	0.4760E 01	0.5182E 01	0.5703E 01	0.6339E 01	0.7081E 01	0.7813E 01
0.7982E 01	0.5805E 01	0.9913E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.26220E 05	0.73668E 04	0.33586E 05	0.35592E 01	0.28096E 00	0.57126E 01	0.26002E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.4732E 04	0.2781E 04	-0.2565E 03	-0.1795E 04	-0.2942E 04	-0.3897E 04	-0.4733E 04	-0.5498E 04	-0.6226E 04	-0.6955E 04
-0.7721E 04	-0.8559E 04	-0.9516E 04	-0.1066E 05	-0.1220E 05	-0.1474E 05	-0.1718E 05			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.26220E 05	0.73967E 04	0.33616E 05	0.35448E 01	0.28211E 00	0.57177E 01	0.26002E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.4886E 04	0.2428E 04	-0.1081E 03	-0.1640E 04	-0.2782E 04	-0.3738E 04	-0.4578E 04	-0.5350E 04	-0.6085E 04	-0.6822E 04
-0.7595E 04	-0.8439E 04	-0.9396E 04	-0.1054E 05	-0.1207E 05	-0.1461E 05	-0.1706E 05			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

PROLATE SPHEROID HAPPEL'S MODEL MARK= 5514

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	0.01	0.40951D6E 00	1.3464	0.2029	0.3100	0.0038	0.0082	33	29

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

-0.0	0.1693E 02	0.2285E 02	0.2222E 02	0.2002E 02	0.1781E 02	0.1595E 02	0.1445E 02	0.1335E 02	0.1279E 02
0.1155E 02	0.1096E 02	0.1051E 02	0.1017E 02	0.9939E 01	0.9801E 01	0.9756E 01	0.9802E 01	0.9939E 01	0.1017E 02
0.1051E 02	0.1096E 02	0.1155E 02	0.1230E 02	0.1335E 02	0.1445E 02	0.1595E 02	0.1781E 02	0.2001E 02	0.2222E 02
0.2285E 02	0.1694E 02	0.2372E-08							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.73328E 05	0.53691E 05	0.12701E 06	0.13660E 01	0.73206E 00	0.41726E 01	0.26002E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.8380E 04	-0.2607E 04	-0.1670E 05	-0.2725E 05	-0.3562E 05	-0.4269E 05	-0.4803E 05	-0.5471E 05	-0.5024E 05	-0.4877E 05
-0.7153E 05	-0.7779E 05	-0.8488E 05	-0.9332E 05	-0.1037E 06	-0.1173E 06	-0.1284E 06			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.73328E 05	0.53707E 05	0.12704E 06	0.13653E 01	0.73242E 00	0.41734E 01	0.26003E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.8852E 04	-0.2233E 04	-0.1624E 05	-0.2678E 05	-0.3515E 05	-0.4221E 05	-0.4847E 05	-0.5425E 05	-0.5979E 05	-0.6532E 05
-0.7109E 05	-0.7735E 05	-0.8443E 05	-0.9278E 05	-0.1033E 06	-0.1173E 06	-0.1284E 06			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

PROLATE SPHEROID HAPPEL'S MODEL MARK= 5514

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	0.01	0.59599070E 00	1.1883	0.2029	0.2600	0.0029	0.0082	33	21

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.4838E 02	0.6608E 02	0.6168E 02	0.5517E 02	0.4886E 02	0.4358E 02	0.3938E 02	0.3607E 02	0.3345E 02
0.3140E 02	0.2980E 02	0.2857E 02	0.2767E 02	0.2704E 02	0.2667E 02	0.2655E 02	0.2667E 02	0.2704E 02	0.2767E 02
0.2857E 02	0.2980E 02	0.3140E 02	0.3345E 02	0.3607E 02	0.3938E 02	0.4358E 02	0.4886E 02	0.5517E 02	0.6168E 02
0.6608E 02	0.4838E 02	0.7282E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.19983E 06	0.30515E 06	0.50518E 06	0.65444E 00	0.15280E 01	0.36555E 01	0.26002E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1405E 05	-0.4157E 05	-0.1170E 06	-0.1763E 06	-0.2238E 06	-0.2640E 06	-0.2997E 06	-0.3327E 06	-0.3645E 06	-0.3962E 06
-0.4292E 06	-0.4649E 06	-0.5051E 06	-0.5527E 06	-0.6120E 06	-0.6875E 06	-0.7431E 06			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.19983E 06	0.30543E 06	0.50526E 06	0.65426E 00	0.15284E 01	0.36561E 01	0.26002E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1511E 05	-0.4054E 05	-0.1162E 06	-0.1753E 06	-0.2228E 06	-0.2630E 06	-0.2987E 06	-0.3318E 06	-0.3635E 06	-0.3953E 06
-0.4283E 06	-0.4640E 06	-0.5042E 06	-0.5518E 06	-0.6111E 06	-0.6866E 06	-0.7423E 06			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

PROLATE SPHEROID HAPPEL'S MODEL MARK= 5517

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	0.01	0.59599070E 00	1.1883	0.2029	0.2600	0.0029	0.0491	65	21

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 2.81 DEGREES INTERVAL

0.0	0.2791E 02	0.4472E 02	0.6004E 02	0.6413E 02	0.6396E 02	0.6168E 02	0.5853E 02	0.5516E 02	0.5188E 02
0.4884E 02	0.4607E 02	0.4358E 02	0.4136E 02	0.3938E 02	0.3762E 02	0.3607E 02	0.3468E 02	0.3345E 02	0.3236E 02
0.3140E 02	0.3056E 02	0.2980E 02	0.2914E 02	0.2857E 02	0.2808E 02	0.2766E 02	0.2732E 02	0.2704E 02	0.2682E 02
0.2667E 02	0.2658E 02	0.2655E 02	0.2658E 02	0.2667E 02	0.2683E 02	0.2704E 02	0.2732E 02	0.2766E 02	0.2808E 02
0.2857E 02	0.2914E 02	0.2980E 02	0.3056E 02	0.3140E 02	0.3236E 02	0.3345E 02	0.3468E 02	0.3606E 02	0.3762E 02
0.3938E 02	0.4136E 02	0.4358E 02	0.4607E 02	0.4884E 02	0.5188E 02	0.5516E 02	0.5853E 02	0.6168E 02	0.6396E 02
0.6413E 02	0.6004E 02	0.4472E 02	0.2793E 02	-0.2179E-07					

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.19985E 06	0.30511E 06	0.50496E 06	0.65501E 00	0.15267E 01	0.36539E 01	0.26002E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.1357E 05	-0.4535E 04	-0.4310E 05	-0.8290E 05	-0.1187E 06	-0.1501E 06	-0.1780E 06	-0.2029E 06	-0.2255E 06	-0.2463E 06
-0.2657E 06	-0.2840E 06	-0.3014E 06	-0.3182E 06	-0.3344E 06	-0.3504E 06	-0.3662E 06	-0.3820E 06	-0.3979E 06	-0.4142E 06
-0.4309E 06	-0.4484E 06	-0.4666E 06	-0.4860E 06	-0.5069E 06	-0.5295E 06	-0.5544E 06	-0.5827E 06	-0.6137E 06	-0.6495E 06
-0.6893E 06	-0.7279E 06	-0.7460E 06							

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.19985E 06	0.30518E 06	0.50503E 06	0.65485E 00	0.15271E 01	0.36544E 01	0.26002E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.1286E 05	-0.5262E 04	-0.4385E 05	-0.8366E 05	-0.1195E 06	-0.1509E 06	-0.1787E 06	-0.2037E 06	-0.2263E 06	-0.2471E 06
-0.2665E 06	-0.2848E 06	-0.3022E 06	-0.3190E 06	-0.3353E 06	-0.3512E 06	-0.3670E 06	-0.3828E 06	-0.3988E 06	-0.4150E 06
-0.4318E 06	-0.4492E 06	-0.4675E 06	-0.4869E 06	-0.5077E 06	-0.5304E 06	-0.5553E 06	-0.5831E 06	-0.6146E 06	-0.6504E 06
-0.6902E 06	-0.7288E 06	-0.7469E 06							

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

Swarms of Prolate Spheroids, Kuwabara's Model

PROLATE SPHEROID KUWABARA'S MODEL MARK= 619

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	0.01	0.1006319E-01	4.6318	1.4750	2.9900	0.0379	0.0982	33	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

-0.0	0.2472E 00	0.4878E 00	0.7175E 00	0.932CE 00	0.1128E 01	0.1304E 01	0.1459E 01	0.1593E 01	0.1706E 01
0.1690E 01	0.1876E 01	0.1936E 01	0.1981E 01	0.2012E 01	0.2030E 01	0.2036E 01	0.2030E 01	0.2011E 01	0.1979E 01
0.1934E 01	0.1874E 01	0.1797E 01	0.1703E 01	0.159CE 01	0.1456E 01	0.1302E 01	0.1126E 01	0.9302E 00	0.7161E 00
0.4869E 00	0.2467E 00	0.4865E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

COS	COF	COT	COS/COF	COF/COS	K1	K2
0.25119E 04	0.10976E 04	0.36095E 04	0.22885E 01	0.43698E 00	0.69737E 02	0.45274E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.8723E 03	0.8450E 03	0.7789E 03	0.6737E 03	0.5480E 03	0.4069E 03	0.2636E 03	0.1201E 03	-0.2313E 02	-0.1664E 03
-0.3097E 03	-0.4534E 03	-0.5909E 03	-0.7178E 03	-0.8224E 03	-0.8922E 03	-0.9163E 03			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

COS	COF	COT	COS/COF	COF/COS	K1	K2
0.25119E 04	0.11027E 04	0.36146E 04	0.22779E 01	0.43901E 00	0.69835E 02	0.45274E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.8713E 03	0.8466E 03	0.7762E 03	0.6703E 03	0.5419E 03	0.4020E 03	0.2581E 03	0.1139E 03	-0.2984E 02	-0.1738E 03
-0.3177E 03	-0.4610E 03	-0.6002E 03	-0.7277E 03	-0.8329E 03	-0.9031E 03	-0.9274E 03			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

PROLATE SPHEROID KUWABARA'S MODEL MARK= 600

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	0.01	0.4015230E-01	2.9203	1.4750	2.5300	0.0264	0.0982	33	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.3730E 00	0.7365E 00	0.1084E 01	0.1409E 01	0.1706E 01	0.1976E 01	0.2210E 01	0.2414E 01	0.2587E 01
0.2732E 01	0.2850E 01	0.2942E 01	0.3012E 01	0.3061E 01	0.3089E 01	0.3099E 01	0.3089E 01	0.3060E 01	0.3011E 01
0.2941E 01	0.2848E 01	0.2730E 01	0.2586E 01	0.2412E 01	0.2208E 01	0.1972E 01	0.1704E 01	0.1407E 01	0.1082E 01
0.7358E 00	0.3727E 00	0.7347E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

COS	COF	COT	COS/COF	COF/COS	K1	K2
0.38171E 04	0.18848E 04	0.57019E 04	0.20253E 01	0.49376E 00	0.25168E 02	0.45274E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1079E 04	0.1060E 04	0.9768E 03	0.7522E 03	0.5411E 03	0.3076E 03	0.6321E 02	-0.1850E 03	-0.4368E 03	-0.6904E 03
-0.9394E 03	-0.1183E 04	-0.1417E 04	-0.1630E 04	-0.1801E 04	-0.1914E 04	-0.1956E 04			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

COS	COF	COT	COS/COF	COF/COS	K1	K2
0.38171E 04	0.18849E 04	0.57044E 04	0.20230E 01	0.49432E 00	0.25177E 02	0.45274E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1076E 04	0.1037E 04	0.9217E 03	0.7491E 03	0.5385E 03	0.3056E 03	0.6115E 02	-0.1869E 03	-0.4398E 03	-0.6950E 03
-0.9442E 03	-0.1188E 04	-0.1422E 04	-0.1634E 04	-0.1806E 04	-0.1919E 04	-0.1958E 04			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

PROLATE SPHEROID KUWABARA'S MODEL MARK= 601

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	0.01	0.1993559E 00	1.7118	1.4750	2.0000	0.0164	0.0982	33	33

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.9221E 00	0.1822E 01	0.2683E 01	0.3490E 01	0.4233E 01	0.4902E 01	0.5493E 01	0.6007E 01	0.6445E 01
0.6811E 01	0.7110E 01	0.7346E 01	0.7525E 01	0.7649E 01	0.7722E 01	0.7746E 01	0.7722E 01	0.7648E 01	0.7525E 01
0.7344E 01	0.7108E 01	0.6810E 01	0.6444E 01	0.6005E 01	0.5491E 01	0.4900E 01	0.4232E 01	0.3489E 01	0.2482E 01
0.1821E 01	0.9219E 00	0.1798E-08							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

COS	COF	COT	COS/COF	COF/COS	K1	K2
0.95256E 04	0.74747E 04	0.17000E 05	0.12744E 01	0.78470E 00	0.87714E 01	0.45274E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1689E 04	0.1553E 04	0.1157E 04	0.5388E 03	-0.2462E 03	-0.1145E 04	-0.2118E 04	-0.3133E 04	-0.4163E 04	-0.5197E 04
-0.6214E 04	-0.7179E 04	-0.8080E 04	-0.8862E 04	-0.9481E 04	-0.9877E 04	-0.1001E 05			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

COS	COF	COT	COS/COF	COF/COS	K1	K2
0.95256E 04	0.74745E 04	0.17000E 05	0.12744E 01	0.78468E 00	0.87713E 01	0.45274E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1684E 04	0.1549E 04	0.1156E 04	0.5408E 03	-0.2417E 03	-0.1138E 04	-0.2112E 04	-0.3129E 04	-0.4159E 04	-0.5196E 04
-0.6216E 04	-0.7178E 04	-0.8078E 04	-0.8858E 04	-0.9473E 04	-0.9867E 04	-0.1000E 05			

SHEAR STRESS IS POSITIVE EVERYWHERE

PROLATE SPHEROID KUWABARA'S MODEL MARK= 602

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	0.01	0.4020504E 00	1.3540	1.4750	1.7700	0.0105	0.0082	33	20

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.2314E 01	0.4575E 01	0.6740E 01	0.8768E 01	0.1064E 02	0.1232E 02	0.1381E 02	0.1510E 02	0.1620E 02	
0.1712E 02	0.1788E 02	0.1846E 02	0.1892E 02	0.1923E 02	0.1941E 02	0.1947E 02	0.1941E 02	0.1923E 02	0.1891E 02	
0.1846E 02	0.1787E 02	0.1712E 02	0.1620E 02	0.1509E 02	0.1380E 02	0.1232E 02	0.1064E 02	0.8768E 01	0.6740E 01	
0.4574E 01	0.2314E 01	0.4456E-08								

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.23944E 05	0.33012E 05	0.56956E 05	0.72532E 00	0.13787E 01	0.60698E 01	0.45274E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2601E 04	0.2032E 04	0.3753E 03	-0.2254E 04	-0.5624E 04	-0.9529E 04	-0.1386E 05	-0.1839E 05	-0.2303E 05	-0.2764E 05
-0.3214E 05	-0.3641E 05	-0.4032E 05	-0.4366E 05	-0.4632E 05	-0.4800E 05	-0.4857E 05			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.23944E 05	0.32998E 05	0.56942E 05	0.72561E 00	0.13781E 01	0.60684E 01	0.45274E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2590E 04	0.2024E 04	0.3760E 03	-0.2253E 04	-0.5619E 04	-0.9514E 04	-0.1386E 05	-0.1840E 05	-0.2303E 05	-0.2764E 05
-0.3214E 05	-0.3639E 05	-0.4030E 05	-0.4363E 05	-0.4630E 05	-0.4798E 05	-0.4855E 05			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

PROLATE SPHEROID KUWABARA'S MODEL MARK= 603

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	0.01	0.5903171E 00	1.1921	1.4750	1.6450	0.0085	0.0082	33	21

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.6100E 01	0.1207E 02	0.1778E 02	0.2313E 02	0.2804E 02	0.3247E 02	0.3638E 02	0.3978E 02	0.4268E 02	
0.4509E 02	0.4706E 02	0.4862E 02	0.4980E 02	0.5061E 02	0.5110E 02	0.5125E 02	0.5109E 02	0.5061E 02	0.4980E 02	
0.4862E 02	0.4706E 02	0.4509E 02	0.4268E 02	0.3978E 02	0.3638E 02	0.3247E 02	0.2804E 02	0.2313E 02	0.1778E 02	
0.1207E 02	0.6101E 01	0.1162E-07								

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.63055E 05	0.15515E 06	0.21820E 06	0.40642E 00	0.24605E 01	0.50938E 01	0.45274E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.4115E 04	0.1482E 04	-0.6224E 04	-0.1835E 05	-0.3402E 05	-0.5236E 05	-0.7252E 05	-0.9382E 05	-0.1156E 06	-0.1375E 06
-0.1588E 06	-0.1789E 06	-0.1973E 06	-0.2130E 06	-0.2251E 06	-0.2328E 06	-0.2354E 06			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.63055E 05	0.15516E 06	0.21822E 06	0.40638E 00	0.24608E 01	0.50942E 01	0.45274E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.4092E 04	0.1459E 04	-0.6248E 04	-0.1838E 05	-0.3403E 05	-0.5238E 05	-0.7255E 05	-0.9384E 05	-0.1157E 06	-0.1375E 06
-0.1588E 06	-0.1790E 06	-0.1973E 06	-0.2130E 06	-0.2251E 06	-0.2328E 06	-0.2355E 06			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

PROLATE SPHEROID KUWABARA'S MODEL MARK= 624

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	0.01	0.9998173E-02	4.6419	0.5490	1.9170	0.0342	0.0982	33	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

-0.0	0.4954E 00	0.9198E 00	0.1223E 01	0.1406E 01	0.1498E 01	0.1530E 01	0.1525E 01	0.1501E 01	0.1469E 01
0.1436E 01	0.1404E 01	0.1377E 01	0.1356E 01	0.1340E 01	0.1330E 01	0.1327E 01	0.1330E 01	0.1339E 01	0.1355E 01
0.1376E 01	0.1403E 01	0.1434E 01	0.1467E 01	0.1499E 01	0.1522E 01	0.1527E 01	0.1496E 01	0.1404E 01	0.1220E 01
0.9181E 00	0.4945E 00	0.4519E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.35083E 04	0.72293E 03	0.42312E 04	0.48529E 01	0.20606E 00	0.58547E 02	0.31244E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1068E 04	0.9610E 03	0.7242E 03	0.5086E 03	0.3536E 03	0.2469E 03	0.1702E 03	0.1101E 03	0.5735E 02	0.4692E 01
-0.5529E 02	-0.1320E 03	-0.2386E 03	-0.3932E 03	-0.6082E 03	-0.8444E 03	-0.9510E 03			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.35083E 04	0.73821E 03	0.42465E 04	0.47524E 01	0.21042E 00	0.58759E 02	0.31244E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1046E 04	0.9366E 03	0.6945E 03	0.4750E 03	0.3174E 03	0.2087E 03	0.1305E 03	0.6888E 02	0.1469E 02	-0.3940E 02
-0.1009E 03	-0.1793E 03	-0.2878E 03	-0.4451E 03	-0.6641E 03	-0.9056E 03	-0.1015E 04			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

PROLATE SPHEROID KUWABARA'S MODEL MARK= 604

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	0.01	0.3957488E-01	2.9344	0.5490	1.4700	0.0230	0.0982	33	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.7104E 00	0.1321E 01	0.1761E 01	0.2031E 01	0.2172E 01	0.2227E 01	0.2229E 01	0.2204E 01	0.2166E 01
0.2125E 01	0.2086E 01	0.2052E 01	0.2025E 01	0.2004E 01	0.1992E 01	0.1988E 01	0.1992E 01	0.2004E 01	0.2024E 01
0.2051E 01	0.2085E 01	0.2124E 01	0.2165E 01	0.2202E 01	0.2227E 01	0.2224E 01	0.2170E 01	0.2029E 01	0.1758E 01
0.1320E 01	0.7099E 00	0.6320E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.52034E 04	0.12867E 04	0.64901E 04	0.40439E 01	0.24729E 00	0.20715E 02	0.31244E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1363E 04	0.1208E 04	0.8580E 03	0.5316E 03	0.2882E 03	0.1071E 03	-0.3542E 02	-0.1574E 03	-0.2687E 03	-0.3809E 03
-0.5037E 03	-0.6469E 03	-0.8283E 03	-0.1073E 04	-0.1397E 04	-0.1744E 04	-0.1900E 04			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.52034E 04	0.12972E 04	0.65006E 04	0.40112E 01	0.24930E 00	0.20748E 02	0.31244E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1333E 04	0.1176E 04	0.8221E 03	0.4927E 03	0.2483E 03	0.6625E 02	-0.7797E 02	-0.2006E 03	-0.3127E 03	-0.4259E 03
-0.5502E 03	-0.6948E 03	-0.8775E 03	-0.1124E 04	-0.1450E 04	-0.1800E 04	-0.1958E 04			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

PROLATE SPHEROID KUWABARA'S MODEL MARK= 605

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	0.01	0.1997475E 00	1.7107	0.5490	0.9700	0.0132	0.0982	33	33

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1699E 01	0.3169E 01	0.4238E 01	0.4915E 01	0.5285E 01	0.5448E 01	0.5483E 01	0.5445E 01	0.5373E 01
0.5283E 01	0.5203E 01	0.5127E 01	0.5063E 01	0.5017E 01	0.4989E 01	0.4979E 01	0.4989E 01	0.5017E 01	0.5063E 01
0.5125E 01	0.5201E 01	0.5287E 01	0.5372E 01	0.5445E 01	0.5483E 01	0.5446E 01	0.5283E 01	0.4914E 01	0.4236E 01
0.3167E 01	0.1698E 01	0.1379E-08							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.12942E 05	0.61033E 04	0.19045E 05	0.21205E 01	0.47159E 00	0.60670E 01	0.31244E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2288E 04	0.1859E 04	0.9581E 03	-0.1825E 03	-0.1100E 04	-0.1905E 04	-0.2643E 04	-0.3332E 04	-0.4012E 04	-0.4689E 04
-0.5385E 04	-0.6118E 04	-0.6926E 04	-0.7851E 04	-0.8886E 04	-0.9880E 04	-0.1031E 05			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.12942E 05	0.61098E 04	0.19052E 05	0.21183E 01	0.47209E 00	0.60704E 01	0.31244E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2223E 04	0.1792E 04	0.7894E 03	-0.2522E 03	-0.1148E 04	-0.1973E 04	-0.2711E 04	-0.3409E 04	-0.4083E 04	-0.4743E 04
-0.5460E 04	-0.6193E 04	-0.6998E 04	-0.7928E 04	-0.8961E 04	-0.9955E 04	-0.1038E 05			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

PROLATE SPHEROID KUWAHARA'S MODEL MARK= 602

A.R.	PE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	0.01	0.4072310E 00	1.2401	0.5630	0.7700	0.0070	0.0082	33	21

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.4400E 01	0.9207E 01	0.1009E 02	0.1274E 02	0.1378E 02	0.1411E 02	0.1419E 02	0.1407E 02	0.1384E 02
0.1342E 02	0.1339E 02	0.1317E 02	0.1299E 02	0.1284E 02	0.1279E 02	0.1276E 02	0.1279E 02	0.1287E 02	0.1299E 02
0.1317E 02	0.1339E 02	0.1362E 02	0.1384E 02	0.1407E 02	0.1419E 02	0.1411E 02	0.1378E 02	0.1274E 02	0.1009E 02
0.9207E 01	0.4400E 01	0.3248E-08							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDE	CDT	CDS/CDE	CDE/CDS	K1	K2
0.3330E 05	0.3179E 05	0.4500E 05	0.1047E 01	0.9547E 00	0.4747E 01	0.3124E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.3726E 04	0.2123E 04	-0.1747E 04	-0.6264E 04	-0.1066E 05	-0.1496E 05	-0.1880E 05	-0.2242E 05	-0.2636E 05	-0.3011E 05
-0.3392E 05	-0.3787E 05	-0.4203E 05	-0.4564E 05	-0.5003E 05	-0.5482E 05	-0.5842E 05			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDE	CDT	CDS/CDE	CDE/CDS	K1	K2
0.3330E 05	0.3190E 05	0.4510E 05	0.1043E 01	0.9584E 00	0.4747E 01	0.3124E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.3593E 04	0.1987E 04	-0.1906E 04	-0.6401E 04	-0.1082E 05	-0.1490E 05	-0.1894E 05	-0.2276E 05	-0.2661E 05	-0.3024E 05
-0.3407E 05	-0.3802E 05	-0.4217E 05	-0.4667E 05	-0.5107E 05	-0.5497E 05	-0.5857E 05			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

PROLATE SPHEROID KUWAHARA'S MODEL MARK= 606

A.R.	PE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	0.01	0.5992489E 00	1.1841	0.5400	0.6700	0.0060	0.0082	33	21

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1230E 02	0.2279E 02	0.3041E 02	0.3519E 02	0.3774E 02	0.3877E 02	0.3887E 02	0.3846E 02	0.3780E 02
0.3707E 02	0.3635E 02	0.3573E 02	0.3522E 02	0.3484E 02	0.3462E 02	0.3454E 02	0.3462E 02	0.3484E 02	0.3522E 02
0.3573E 02	0.3635E 02	0.3706E 02	0.3780E 02	0.3846E 02	0.3887E 02	0.3877E 02	0.3774E 02	0.3519E 02	0.3041E 02
0.2279E 02	0.1230E 02	0.8339E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDE	CDT	CDS/CDE	CDE/CDS	K1	K2
0.9059E 05	0.1684E 06	0.2590E 06	0.5378E 00	0.1859E 01	0.3966E 01	0.3124E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.6136E 04	-0.1390E 04	-0.1995E 05	-0.4251E 05	-0.6541E 05	-0.8750E 05	-0.1086E 06	-0.1291E 06	-0.1492E 06	-0.1693E 06
-0.1897E 06	-0.2109E 06	-0.2329E 06	-0.2558E 06	-0.2784E 06	-0.2970E 06	-0.3045E 06			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDE	CDT	CDS/CDE	CDE/CDS	K1	K2
0.9059E 05	0.1684E 06	0.2590E 06	0.5377E 00	0.1859E 01	0.3967E 01	0.3124E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.5886E 04	-0.1644E 04	-0.2021E 05	-0.4278E 05	-0.6568E 05	-0.8778E 05	-0.1089E 06	-0.1294E 06	-0.1495E 06	-0.1696E 06
-0.1900E 06	-0.2112E 06	-0.2332E 06	-0.2561E 06	-0.2787E 06	-0.2973E 06	-0.3048E 06			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

PROLATE SPHEROID KUWABARA'S MODEL MARK= 626

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	0.01	0.9997617E-02	4.6419	0.2029	1.2100	0.0252	0.0982	33	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

-0.0	0.1518E 01	0.2069E 01	0.1990E 01	0.1771E 01	0.1563E 01	0.1391E 01	0.1256E 01	0.1150E 01	0.1067E 01
0.1002E 01	0.9520E 00	0.9134E 00	0.8850E 00	0.8655E 00	0.8540E 00	0.8502E 00	0.8539E 00	0.8653E 00	0.8847E 00
0.9130E 00	0.9513E 00	0.1002E 01	0.1066E 01	0.1149E 01	0.1255E 01	0.1390E 01	0.1560E 01	0.1769E 01	0.1987E 01
0.2065E 01	0.1515E 01	0.4184E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.63870E 04	0.32001E 03	0.67070E 04	0.19959E 02	0.50103E-01	0.42534E 02	0.26002E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1822E 04	0.1276E 04	0.8148E 03	0.6514E 03	0.5855E 03	0.5532E 03	0.5348E 03	0.5225E 03	0.5127E 03	0.5030E 03
0.4907E 03	0.4724E 03	0.4404E 03	0.3747E 03	0.2118E 03	-0.2483E 03	-0.7939E 03			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.63870E 04	0.38824E 03	0.67752E 04	0.16451E 02	0.60786E-01	0.42967E 02	0.26002E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1858E 04	0.1279E 04	0.7904E 03	0.6125E 03	0.5360E 03	0.4950E 03	0.4690E 03	0.4497E 03	0.4333E 03	0.4168E 03
0.3976E 03	0.3717E 03	0.3311E 03	0.2550E 03	0.7764E 02	-0.4101E 03	-0.9878E 03			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

PROLATE SPHEROID KUWABARA'S MODEL MARK= 609

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	0.01	0.4038264E-01	2.9147	0.2029	0.8000	0.0140	0.0982	33	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.2198E 01	0.3009E 01	0.2911E 01	0.2611E 01	0.2324E 01	0.2087E 01	0.1900E 01	0.1752E 01	0.1635E 01
0.1543E 01	0.1471E 01	0.1416E 01	0.1375E 01	0.1347E 01	0.1330E 01	0.1324E 01	0.1330E 01	0.1344E 01	0.1375E 01
0.1416E 01	0.1471E 01	0.1543E 01	0.1635E 01	0.1751E 01	0.1899E 01	0.2086E 01	0.2332E 01	0.2660E 01	0.2998E 01
0.3005E 01	0.2196E 01	0.5525E-09							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.98030E 04	0.85946E 03	0.10662E 05	0.11406E 02	0.87672E-01	0.15246E 02	0.26002E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2474E 04	0.1653E 04	0.9484E 03	0.6689E 03	0.5251E 03	0.4306E 03	0.3653E 03	0.2846E 03	0.2183E 03	0.1538E 03
0.8542E 02	0.7125E 01	-0.9013E 02	-0.2306E 03	-0.5078E 03	-0.1203E 04	-0.3021E 04			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.98030E 04	0.89867E 03	0.10702E 05	0.10908E 02	0.91673E-01	0.15332E 02	0.26002E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2525E 04	0.1686E 04	0.9653E 03	0.6773E 03	0.5275E 03	0.4288E 03	0.3503E 03	0.2744E 03	0.2036E 03	0.1350E 03
0.6249E 02	-0.2056E 02	-0.1230E 03	-0.2682E 03	-0.5530E 03	-0.1259E 04	-0.2996E 04			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

PROLATE SPHEROID KUWABARA'S MODEL MARK= 609

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	0.01	0.1981004E 00	1.7154	0.2029	0.4300	0.0071	0.0982	33	33

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.5792E 01	0.7954E 01	0.7775E 01	0.7046E 01	0.6313E 01	0.5688E 01	0.5180E 01	0.4772E 01	0.4444E 01
0.4187E 01	0.3985E 01	0.3829E 01	0.3714E 01	0.3635E 01	0.3589E 01	0.3573E 01	0.3589E 01	0.3636E 01	0.3715E 01
0.3830E 01	0.3985E 01	0.4188E 01	0.4446E 01	0.4772E 01	0.5179E 01	0.5687E 01	0.6312E 01	0.7046E 01	0.7775E 01
0.7953E 01	0.5792E 01	0.1133E-08							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.26547E 05	0.77227E 04	0.34280E 05	0.34381E 01	0.29088E 00	0.58306E 01	0.26002E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.4726E 04	0.2345E 04	-0.3083E 03	-0.1895E 04	-0.3078E 04	-0.4063E 04	-0.4849E 04	-0.5755E 04	-0.6543E 04	-0.7330E 04
-0.8149E 04	-0.9031E 04	-0.1003E 05	-0.1113E 05	-0.1278E 05	-0.1535E 05	-0.1789E 05			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.26547E 05	0.77412E 04	0.34308E 05	0.34305E 01	0.29136E 00	0.58356E 01	0.26002E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.4880E 04	0.2389E 04	-0.1579E 03	-0.1750E 04	-0.2935E 04	-0.3921E 04	-0.4800E 04	-0.5620E 04	-0.6413E 04	-0.7206E 04
-0.8028E 04	-0.8915E 04	-0.9921E 04	-0.1108E 05	-0.1267E 05	-0.1524E 05	-0.1776E 05			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

PROLATE SPHEROID KUWABARA'S MODEL MARK= 611

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A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	0.01	0.4095106E 00	1.3466	0.2029	0.3100	0.0038	0.0982	33	20

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1693E 02	0.2285E 02	0.2722E 02	0.2002E 02	0.1782E 02	0.1597E 02	0.1447E 02	0.1328E 02	0.1235E 02
0.1160E 02	0.1103E 02	0.1059E 02	0.1026E 02	0.1004E 02	0.9907E 01	0.9863E 01	0.9906E 01	0.1006E 02	0.1026E 02
0.1059E 02	0.1103E 02	0.1160E 02	0.1235E 02	0.1328E 02	0.1449E 02	0.1597E 02	0.1782E 02	0.2002E 02	0.2722E 02
0.2285E 02	0.1693E 02	0.2688E-08							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.73758E 05	0.54758E 05	0.12852E 06	0.13470E 01	0.74240E 00	0.42221E 01	0.26002E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.8380E 04	-0.2727E 04	-0.1673E 05	-0.2727E 05	-0.3570E 05	-0.4287E 05	-0.4925E 05	-0.5517E 05	-0.6091E 05	-0.6663E 05
-0.7257E 05	-0.7896E 05	-0.8612E 05	-0.9460E 05	-0.1051E 06	-0.1191E 06	-0.1302E 06			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.73758E 05	0.54775E 05	0.12853E 06	0.13466E 01	0.74263E 00	0.42226E 01	0.26002E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.8851E 04	-0.2271E 04	-0.1626E 05	-0.2678E 05	-0.3521E 05	-0.4239E 05	-0.4877E 05	-0.5469E 05	-0.6044E 05	-0.6616E 05
-0.7210E 05	-0.7850E 05	-0.8566E 05	-0.9415E 05	-0.1046E 06	-0.1186E 06	-0.1298E 06			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

PROLATE SPHEROID KUWABARA'S MODEL MARK= 610

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A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	0.01	0.5958970E 00	1.1883	0.2029	0.2600	0.0029	0.0982	33	21

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.4838E 02	0.6409E 02	0.6170E 02	0.5518E 02	0.4886E 02	0.4361E 02	0.3942E 02	0.3612E 02	0.3351E 02
0.3148E 02	0.2989E 02	0.2868E 02	0.2779E 02	0.2718E 02	0.2682E 02	0.2670E 02	0.2682E 02	0.2718E 02	0.2779E 02
0.2868E 02	0.2989E 02	0.3147E 02	0.3351E 02	0.3612E 02	0.3942E 02	0.4361E 02	0.4886E 02	0.5518E 02	0.6169E 02
0.6409E 02	0.4838E 02	0.6703E-08							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.20044E 06	0.30848E 06	0.50892E 06	0.64976E 00	0.15390E 01	0.36826E 01	0.26002E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1405E 05	-0.4162E 05	-0.1172E 06	-0.1765E 06	-0.2242E 06	-0.2647E 06	-0.3007E 06	-0.3342E 06	-0.3665E 06	-0.3989E 06
-0.4324E 06	-0.4684E 06	-0.5090E 06	-0.5567E 06	-0.6161E 06	-0.6916E 06	-0.7472E 06			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.20044E 06	0.30860E 06	0.50904E 06	0.64951E 00	0.15396E 01	0.36835E 01	0.26002E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1511E 05	-0.4060E 05	-0.1162E 06	-0.1755E 06	-0.2232E 06	-0.2637E 06	-0.2998E 06	-0.3333E 06	-0.3656E 06	-0.3979E 06
-0.4315E 06	-0.4676E 06	-0.5081E 06	-0.5559E 06	-0.6153E 06	-0.6908E 06	-0.7465E 06			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

Clusters of Elliptical Cylinders with O.R.> 1,Happel's Model

FLOW ALONG MAJOR AXIS FLL. CYLINDER HAPPEL'S MODEL MARK= 1539

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
1.00	0.01	0.2029529E-02	22.1974	4.0000	7.1000	0.0775	0.0982	33	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.7616E-01	0.1516E 00	0.2255E 00	0.2971E 00	0.3659E 00	0.4311E 00	0.4920E 00	0.5481E 00	0.5988E 00
0.6437E 00	0.6827E 00	0.7143E 00	0.7393E 00	0.7573E 00	0.7679E 00	0.7711E 00	0.7670E 00	0.7555E 00	0.7367E 00
0.7109E 00	0.6783E 00	0.6392E 00	0.5941E 00	0.5433E 00	0.4871E 00	0.4266E 00	0.3619E 00	0.2938E 00	0.2228E 00
0.1497E 00	0.7524E-01	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.48502E 03	0.48259E 03	0.96761E 03	0.10050E 01	0.99501E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2965E 03	0.2905E 03	0.2727E 03	0.2439E 03	0.2052E 03	0.1582E 03	0.1047E 03	0.4689E 02	-0.1306E 02	-0.7286E 02
-0.1302E 03	-0.1830E 03	-0.2292E 03	-0.2670E 03	-0.2951E 03	-0.3124E 03	-0.3182E 03			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.48502E 03	0.48341E 03	0.96842E 03	0.10033E 01	0.99668E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2955E 03	0.2895E 03	0.2717E 03	0.2428E 03	0.2040E 03	0.1560E 03	0.1034E 03	0.4546E 02	-0.1459E 02	-0.7449E 02
-0.1319E 03	-0.1848E 03	-0.2310E 03	-0.2689E 03	-0.2971E 03	-0.3144E 03	-0.3203E 03			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MAJOR AXIS FLL. CYLINDER HAPPEL'S MODEL MARK= 1544

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
1.00	0.01	0.1005208E-01	9.9741	4.0000	6.3000	0.0719	0.0982	33	33

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1097E 00	0.2184E 00	0.3249E 00	0.4282E 00	0.5273E 00	0.6212E 00	0.7091E 00	0.7900E 00	0.8633E 00
0.9281E 00	0.9840E 00	0.1030E 01	0.1067E 01	0.1093E 01	0.1108E 01	0.1113E 01	0.1107E 01	0.1091E 01	0.1064E 01
0.1027E 01	0.9801E 00	0.9238E 00	0.8587E 00	0.7853E 00	0.7045E 00	0.6169E 00	0.5234E 00	0.4248E 00	0.3222E 00
0.2166E 00	0.1088E 00	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.70017E 03	0.69833E 03	0.13985E 04	0.10026E 01	0.99738E 00	0.53703E 02	0.49966E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.4019E 03	0.3932E 03	0.3676E 03	0.3261E 03	0.2704E 03	0.2026E 03	0.1255E 03	0.4196E 02	-0.4480E 02	-0.1314E 03
-0.2146E 03	-0.2911E 03	-0.3581E 03	-0.4131E 03	-0.4539E 03	-0.4791E 03	-0.4875E 03			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.70017E 03	0.69937E 03	0.13995E 04	0.10011E 01	0.99886E 00	0.53743E 02	0.49966E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.4006E 03	0.3920E 03	0.3663E 03	0.3247E 03	0.2689E 03	0.2011E 03	0.1239E 03	0.4023E 02	-0.4667E 02	-0.1334E 03
-0.2168E 03	-0.2934E 03	-0.3605E 03	-0.4156E 03	-0.4565E 03	-0.4816E 03	-0.4901E 03			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MAJOR AXIS FLL. CYLINDER HAPPEL'S MODEL MARK= 1525

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
1.00	0.01	0.4025324E 00	1.5762	3.0000	3.4550	0.0142	0.0982	33	33

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1499E 01	0.2983E 01	0.4437E 01	0.5846E 01	0.7197E 01	0.8476E 01	0.9670E 01	0.1077E 02	0.1176E 02
0.1264E 02	0.1340E 02	0.1402E 02	0.1452E 02	0.1487E 02	0.1509E 02	0.1516E 02	0.1509E 02	0.1487E 02	0.1451E 02
0.1402E 02	0.1339E 02	0.1264E 02	0.1176E 02	0.1076E 02	0.9664E 01	0.8470E 01	0.7192E 01	0.5842E 01	0.4434E 01
0.2981E 01	0.1498E 01	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.95927E 04	0.16928E 05	0.26521E 05	0.56668E 00	0.17647E 01	0.55909E 01	0.49753E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1743E 04	0.1533E 04	0.9134E 03	-0.9201E 02	-0.1442E 04	-0.3081E 04	-0.4944E 04	-0.6962E 04	-0.9057E 04	-0.1115E 05
-0.1317E 05	-0.1503E 05	-0.1667E 05	-0.1801E 05	-0.1901E 05	-0.1963E 05	-0.1983E 05			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.95927E 04	0.16930E 05	0.26522E 05	0.56663E 00	0.17648E 01	0.55912E 01	0.49753E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1737E 04	0.1527E 04	0.9078E 03	-0.9789E 02	-0.1448E 04	-0.3087E 04	-0.4951E 04	-0.6969E 04	-0.9064E 04	-0.1116E 05
-0.1318E 05	-0.1504E 05	-0.1667E 05	-0.1802E 05	-0.1902E 05	-0.1963E 05	-0.1984E 05			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MAJOR AXIS ELL. CYLINDER HAPPEL'S MODEL MARK= 1516

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	0.01	0.2003842E-02	22.3392	1.4750	4.5800	0.0776	0.0982	33	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.8329E-01	0.1647E 00	0.2424E 00	0.3150E 00	0.3815E 00	0.4410E 00	0.4934E 00	0.5386E 00	0.5768E 00
0.6085E 00	0.6341E 00	0.6542E 00	0.6691E 00	0.6794E 00	0.6852E 00	0.6869E 00	0.6844E 00	0.6777E 00	0.6667E 00
0.6510E 00	0.6303E 00	0.6042E 00	0.5732E 00	0.5378E 00	0.4884E 00	0.4364E 00	0.3772E 00	0.3113E 00	0.2395E 00
0.1626E 00	0.8223E-01	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.50422E 03	0.45315E 03	0.95736E 03	0.11127E 01	0.89871E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2942E 03	0.2857E 03	0.2616E 03	0.2257E 03	0.1821E 03	0.1347E 03	0.8585E 02	0.3692E 02	-0.1181E 02	-0.6042E 02
-0.1090E 03	-0.1573E 03	-0.2046E 03	-0.2468E 03	-0.2821E 03	-0.3056E 03	-0.3139E 03			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.50422E 03	0.45396E 03	0.95818E 03	0.11107E 01	0.90033E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2928E 03	0.2842E 03	0.2600E 03	0.2238E 03	0.1801E 03	0.1325E 03	0.8369E 02	0.3474E 02	-0.1398E 02	-0.6259E 02
-0.1112E 03	-0.1596E 03	-0.2064E 03	-0.2496E 03	-0.2848E 03	-0.3085E 03	-0.3168E 03			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MAJOR AXIS ELL. CYLINDER HAPPEL'S MODEL MARK= 1520

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	0.01	0.4024656E-01	4.9847	1.4750	3.0800	0.0401	0.0982	33	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1920E 00	0.3797E 00	0.5591E 00	0.7247E 00	0.8802E 00	0.1018E 01	0.1139E 01	0.1244E 01	0.1332E 01
0.1406E 01	0.1466E 01	0.1513E 01	0.1548E 01	0.1573E 01	0.1587E 01	0.1591E 01	0.1586E 01	0.1571E 01	0.1546E 01
0.1510E 01	0.1462E 01	0.1402E 01	0.1328E 01	0.1239E 01	0.1135E 01	0.1013E 01	0.8762E 00	0.7232E 00	0.5563E 00
0.3778E 00	0.1911E 00	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.11678E 04	0.10596E 04	0.22274E 04	0.11021E 01	0.90737E 00	0.19387E 02	0.45274E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.5679E 03	0.5481E 03	0.4921E 03	0.4083E 03	0.3067E 03	0.1962E 03	0.8258E 02	-0.3171E 02	-0.1457E 03	-0.2595E 03
-0.3734E 03	-0.4844E 03	-0.5961E 03	-0.6964E 03	-0.7792E 03	-0.8344E 03	-0.8539E 03			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.11678E 04	0.10605E 04	0.22283E 04	0.11011E 01	0.90817E 00	0.19395E 02	0.45274E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.5650E 03	0.5452E 03	0.4891E 03	0.4050E 03	0.3031E 03	0.1926E 03	0.7891E 02	-0.3543E 02	-0.1494E 03	-0.2633E 03
-0.3772E 03	-0.4904E 03	-0.6001E 03	-0.7006E 03	-0.7835E 03	-0.8389E 03	-0.8584E 03			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MAJOR AXIS ELL. CYLINDER HAPPEL'S MODEL MARK= 1521

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	0.01	0.1993647E 00	2.2396	1.4750	2.2800	0.0252	0.0982	33	33

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.5562E 00	0.1100E 01	0.1621E 01	0.2109E 01	0.2556E 01	0.2960E 01	0.3317E 01	0.3627E 01	0.3892E 01
0.4112E 01	0.4293E 01	0.4436E 01	0.4543E 01	0.4619E 01	0.4663E 01	0.4677E 01	0.4662E 01	0.4617E 01	0.4541E 01
0.4433E 01	0.4290E 01	0.4109E 01	0.3867E 01	0.3623E 01	0.3312E 01	0.2956E 01	0.2553E 01	0.2105E 01	0.1618E 01
0.1098E 01	0.5551E 00	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.34205E 04	0.36100E 04	0.70305E 04	0.94751E 00	0.10554E 01	0.71716E 01	0.45274E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1072E 04	0.1009E 04	0.8306E 03	0.5613E 03	0.2287E 03	-0.1414E 03	-0.5306E 03	-0.9284E 03	-0.1329E 04	-0.1729E 04
-0.2127E 04	-0.2515E 04	-0.2884E 04	-0.3214E 04	-0.3482E 04	-0.3660E 04	-0.3722E 04			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.34205E 04	0.36099E 04	0.70304E 04	0.94753E 00	0.10554E 01	0.71715E 01	0.45274E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1066E 04	0.1003E 04	0.8239E 03	0.5547E 03	0.2221E 03	-0.1480E 03	-0.5371E 03	-0.9349E 03	-0.1336E 04	-0.1736E 04
-0.2133E 04	-0.2522E 04	-0.2891E 04	-0.3220E 04	-0.3488E 04	-0.3666E 04	-0.3728E 04			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MAJOR AXIS ELL. CYLINDER HAPPEL'S MODEL MARK= 1522

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	0.01	0.4016074E 00	1.5780	1.4750	1.9300	0.0163	0.0982	33	29

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1536E 01	0.3039E 01	0.4480E 01	0.5834E 01	0.7081E 01	0.8210E 01	0.9212E 01	0.1009E 02	0.1084E 02
0.1147E 02	0.1198E 02	0.1239E 02	0.1271E 02	0.1292E 02	0.1305E 02	0.1309E 02	0.1305E 02	0.1292E 02	0.1270E 02
0.1239E 02	0.1198E 02	0.1146E 02	0.1083E 02	0.1008E 02	0.9209E 01	0.8205E 01	0.7077E 01	0.5831E 01	0.4478E 01
0.3037E 01	0.1535E 01	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.95446E 04	0.15377E 05	0.24922E 05	0.62069E 00	0.16111E 01	0.52688E 01	0.45274E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1757E 04	0.1522E 04	0.8436E 03	-0.2069E 03	-0.1546E 04	-0.3084E 04	-0.4758E 04	-0.6508E 04	-0.8293E 04	-0.1008E 05
-0.1183E 05	-0.1349E 05	-0.1503E 05	-0.1637E 05	-0.1742E 05	-0.1800E 05	-0.1833E 05			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.95446E 04	0.15374E 05	0.24918E 05	0.62083E 00	0.16107E 01	0.52691E 01	0.45274E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1745E 04	0.1511E 04	0.8323E 03	-0.2179E 03	-0.1557E 04	-0.3094E 04	-0.4768E 04	-0.6519E 04	-0.8304E 04	-0.1009E 05
-0.1184E 05	-0.1350E 05	-0.1504E 05	-0.1638E 05	-0.1742E 05	-0.1810E 05	-0.1833E 05			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MAJOR AXIS ELL. CYLINDER HAPPEL'S MODEL MARK= 1523

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	0.01	0.5994505E 00	1.2916	1.4750	1.7300	0.0128	0.0982	33	21

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.4639E 01	0.9180E 01	0.1354E 02	0.1763E 02	0.2140E 02	0.2481E 02	0.2785E 02	0.3049E 02	0.3276E 02
0.3466E 02	0.3622E 02	0.3746E 02	0.3840E 02	0.3906E 02	0.3945E 02	0.3958E 02	0.3945E 02	0.3906E 02	0.3840E 02
0.3746E 02	0.3622E 02	0.3466E 02	0.3275E 02	0.3049E 02	0.2784E 02	0.2481E 02	0.2140E 02	0.1762E 02	0.1353E 02
0.9178E 01	0.4637E 01	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.28852E 05	0.85317E 05	0.11417E 06	0.33818E 00	0.29570E 01	0.48499E 01	0.45274E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2886E 04	0.1673E 04	-0.1858E 04	-0.7421E 04	-0.1463E 05	-0.2308E 05	-0.3240E 05	-0.4226E 05	-0.5239E 05	-0.6251E 05
-0.7237E 05	-0.8168E 05	-0.9012E 05	-0.9732E 05	-0.1029E 06	-0.1064E 06	-0.1076E 06			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.28852E 05	0.85320E 05	0.11417E 06	0.33816E 00	0.29571E 01	0.48501E 01	0.45274E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2866E 04	0.1652E 04	-0.1879E 04	-0.7443E 04	-0.1465E 05	-0.2310E 05	-0.3242E 05	-0.4228E 05	-0.5241E 05	-0.6253E 05
-0.7239E 05	-0.8170E 05	-0.9015E 05	-0.9735E 05	-0.1029E 06	-0.1064E 06	-0.1076E 06			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MAJOR AXIS ELL. CYLINDER HAPPEL'S MODEL MARK= 1537

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	0.01	0.2009378E-02	22.3084	0.5490	3.5950	0.0761	0.0982	33	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1409E 00	0.2593E 00	0.3437E 00	0.3949E 00	0.4205E 00	0.4291E 00	0.4275E 00	0.4207E 00	0.4116E 00
0.4020E 00	0.3930E 00	0.3852E 00	0.3789E 00	0.3743E 00	0.3714E 00	0.3702E 00	0.3708E 00	0.3732E 00	0.3774E 00
0.3832F 00	0.3904E 00	0.3989E 00	0.4079E 00	0.4166E 00	0.4229E 00	0.4241E 00	0.4154E 00	0.3899E 00	0.33926 00
0.2558E 00	0.1390E 00	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.62013E 03	0.30925E 03	0.92938E 03	0.20053E 01	0.49869E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2940E 03	0.2607E 03	0.1925E 03	0.1305E 03	0.8582E 02	0.5498E 02	0.3286E 02	0.1562E 02	0.5596E 00	-0.1444E 02
-0.3153E 02	-0.5336E 02	-0.8373E 02	-0.1277E 03	-0.1887E 03	-0.2557E 03	-0.2884E 03			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.62013E 03	0.30983E 03	0.92996E 03	0.20015E 01	0.49962E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2879E 03	0.2534E 03	0.1847E 03	0.1211E 03	0.7643E 02	0.4577E 02	0.2381E 02	0.6691E 01	-0.8263E 01	-0.2316E 02
-0.4012E 02	-0.6179E 02	-0.9198E 02	-0.1359E 03	-0.1974E 03	-0.2660E 03	-0.2999E 03			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MAJOR AXIS ELL. CYLINDER HAPPEL'S MODEL MARK= 1516

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	0.01	0.3996782E-01	5.0020	0.5490	2.1000	0.0388	0.0982	33	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.3142E 00	0.5782E 00	0.7664E 00	0.8807E 00	0.9382E 00	0.9579E 00	0.9553E 00	0.9409E 00	0.9214E 00
0.9010E 00	0.8818E 00	0.8651E 00	0.8517E 00	0.8419E 00	0.8359E 00	0.8338E 00	0.8355E 00	0.8411E 00	0.8505E 00
0.8634E 00	0.8796E 00	0.8984E 00	0.9185E 00	0.9375E 00	0.9515E 00	0.9539E 00	0.9340E 00	0.8767E 00	0.7628E 00
0.5754E 00	0.3127E 00	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.13932E 04	0.70264E 03	0.20959E 04	0.19828E 01	0.50433E 00	0.15526E 02	0.31244E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.5764E 03	0.4998E 03	0.3449E 03	0.2059E 03	0.1060E 03	0.3688E 02	-0.1326E 02	-0.5286E 02	-0.8781E 02	-0.1277E 03
-0.1622E 03	-0.2121E 03	-0.2809E 03	-0.3800E 03	-0.5182E 03	-0.6723E 03	-0.7484E 03			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.13932E 04	0.70299E 03	0.20961E 04	0.19821E 01	0.50452E 00	0.15528E 02	0.31244E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.5631E 03	0.4856E 03	0.3297E 03	0.1904E 03	0.9065E 02	0.2170E 02	-0.2832E 02	-0.6785E 02	-0.1027E 03	-0.1376E 03
-0.1771E 03	-0.2269E 03	-0.2955E 03	-0.3945E 03	-0.5330E 03	-0.6882E 03	-0.7652E 03			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MAJOR AXIS ELL. CYLINDER HAPPEL'S MODEL MARK= 1517

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	0.01	0.1990136E 00	2.2416	0.5490	1.3000	0.0235	0.0982	33	33

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.8494E 00	0.1567E 01	0.2084E 01	0.2407E 01	0.2581E 01	0.2654E 01	0.2668E 01	0.2649E 01	0.2616E 01
0.2579E 01	0.2542E 01	0.2510E 01	0.2484E 01	0.2465E 01	0.2454E 01	0.2450E 01	0.2453E 01	0.2465E 01	0.2483E 01
0.2509E 01	0.2541E 01	0.2577E 01	0.2614E 01	0.2647E 01	0.2665E 01	0.2651E 01	0.2577E 01	0.2404E 01	0.2081E 01
0.1564E 01	0.8481E 00	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.39843E 04	0.25071E 04	0.64914E 04	0.15892E 01	0.62925E 00	0.56089E 01	0.31244E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1160E 04	0.9500E 03	0.5108E 03	0.1185E 03	-0.1926E 03	-0.4369E 03	-0.6417E 03	-0.8261E 03	-0.1002E 04	-0.1178E 04
-0.1362E 04	-0.1567E 04	-0.1809E 04	-0.2120E 04	-0.2521E 04	-0.2950E 04	-0.3159E 04			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.39843E 04	0.25080E 04	0.64923E 04	0.15886E 01	0.62948E 00	0.56097E 01	0.31244E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1127E 04	0.9159E 03	0.4844E 03	0.8316E 02	-0.2276E 03	-0.4720E 03	-0.6768E 03	-0.8612E 03	-0.1037E 04	-0.1213E 04
-0.1398E 04	-0.1603E 04	-0.1844E 04	-0.2156E 04	-0.2556E 04	-0.2986E 04	-0.3196E 04			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MAJOR AXIS ELL. CYLINDER HAPPEL'S MODEL MARK= 1518

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	0.01	0.3992346E 00	1.5827	0.5490	0.9600	0.0147	0.0982	33	29

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.2181E 01	0.4037E 01	0.5401E 01	0.6282E 01	0.6786E 01	0.7036E 01	0.7128E 01	0.7127E 01	0.7080E 01
0.7011E 01	0.6936E 01	0.6866E 01	0.6807E 01	0.6763E 01	0.6737E 01	0.6727E 01	0.6736E 01	0.6763E 01	0.6807E 01
0.6866E 01	0.6935E 01	0.7009E 01	0.7078E 01	0.7126E 01	0.7126E 01	0.7034E 01	0.6784E 01	0.6278E 01	0.5398E 01
0.4035E 01	0.2180E 01	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.10783E 05	0.11212E 05	0.21994E 05	0.96175E 00	0.10398E 01	0.39971E 01	0.31244E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2030E 04	0.1447E 04	0.1848E 03	-0.1130E 04	-0.2330E 04	-0.3440E 04	-0.4499E 04	-0.5531E 04	-0.6554E 04	-0.7574E 04
-0.8605E 04	-0.9662E 04	-0.1077E 05	-0.1197E 05	-0.1328E 05	-0.1454E 05	-0.1513E 05			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.10783E 05	0.11213E 05	0.21996E 05	0.96162E 00	0.10399E 01	0.39974E 01	0.31244E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1959E 04	0.1376E 04	0.1125E 03	-0.1201E 04	-0.2401E 04	-0.3512E 04	-0.4571E 04	-0.5604E 04	-0.6628E 04	-0.7648E 04
-0.8678E 04	-0.9735E 04	-0.1084E 05	-0.1204E 05	-0.1335E 05	-0.1461E 05	-0.1520E 05			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MAJOR AXIS ELL. CYLINDER HAPPEL'S MODEL MARK= 1519

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	0.01	0.5858028E 00	1.3065	0.5490	0.7800	0.0115	0.0982	33	21

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.5975E 01	0.1109E 02	0.1489E 02	0.1738E 02	0.1883E 02	0.1956E 02	0.1982E 02	0.1980E 02	0.1964E 02
0.1940E 02	0.1915E 02	0.1891E 02	0.1871E 02	0.1857E 02	0.1847E 02	0.1844E 02	0.1847E 02	0.1857E 02	0.1871E 02
0.1891E 02	0.1915E 02	0.1940E 02	0.1964E 02	0.1980E 02	0.1982E 02	0.1956E 02	0.1883E 02	0.1738E 02	0.1488E 02
0.1109E 02	0.5974E 01	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.29769E 05	0.56696E 05	0.86466E 05	0.52507E 00	0.19045E 01	0.35096E 01	0.31244E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.3417E 04	0.1357E 04	-0.3465E 04	-0.9184E 04	-0.1503E 05	-0.2080E 05	-0.2647E 05	-0.3205E 05	-0.3758E 05	-0.4311E 05
-0.4868E 05	-0.5435E 05	-0.6012E 05	-0.6597E 05	-0.7168E 05	-0.7650E 05	-0.7856E 05			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.29769E 05	0.56697E 05	0.86467E 05	0.52506E 00	0.19046E 01	0.35097E 01	0.31244E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.3279E 04	0.1217E 04	-0.3606E 04	-0.9326E 04	-0.1517E 05	-0.2095E 05	-0.2661E 05	-0.3219E 05	-0.3772E 05	-0.4325E 05
-0.4882E 05	-0.5449E 05	-0.6026E 05	-0.6611E 05	-0.7182E 05	-0.7664E 05	-0.7870E 05			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MAJOR AXIS ELL. CYLINDER HAPPEL'S MODEL MARK= 1538

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	0.01	0.2026551E-02	22.2137	0.2029	3.0100	0.0702	0.0982	33	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.2948E 00	0.3864E 00	0.3679E 00	0.3258E 00	0.2863E 00	0.2541E 00	0.2287E 00	0.2089E 00	0.1934E 00
0.1812E 00	0.1718E 00	0.1646E 00	0.1593E 00	0.1556E 00	0.1533E 00	0.1525E 00	0.1530E 00	0.1549E 00	0.1583E 00
0.1633E 00	0.1702E 00	0.1792E 00	0.1909E 00	0.2059E 00	0.2252E 00	0.2499E 00	0.2813E 00	0.3199E 00	0.3611E 00
0.3790E 00	0.2892E 00	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.79694E 03	0.15631E 03	0.95325E 03	0.50984E 01	0.19614E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.3240E 03	0.2001E 03	0.1045E 03	0.6952E 02	0.5498E 02	0.4762E 02	0.4322E 02	0.4014E 02	0.3759E 02	0.3505E 02
0.3203E 02	0.2774E 02	0.2057E 02	0.6375E 01	-0.2784E 02	-0.1215E 03	-0.2429E 03			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.79694E 03	0.15616E 03	0.95310E 03	0.51032E 01	0.19595E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.3221E 03	0.1887E 03	0.9200E 02	0.5810E 02	0.4403E 02	0.3685E 02	0.3252E 02	0.2948E 02	0.2695E 02	0.2444E 02
0.2146E 02	0.1724E 02	0.1025E 02	-0.3485E 01	-0.3665E 02	-0.1313E 03	-0.2621E 03			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MAJOR AXIS ELL. CYLINDER HAPPEL'S MODEL MARK= 1512

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	0.01	0.3880194E-01	5.0766	0.2029	1.5350	0.0333	0.0982	33	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.6792E 00	0.8887E 00	0.8451E 00	0.7489E 00	0.6595E 00	0.5871E 00	0.5303E 00	0.4860E 00	0.4516E 00
0.4249E 00	0.4042E 00	0.3885E 00	0.3770E 00	0.3691E 00	0.3645E 00	0.3630E 00	0.3644E 00	0.3688E 00	0.3765E 00
0.3878E 00	0.4033E 00	0.4237E 00	0.4502E 00	0.4843E 00	0.5282E 00	0.5845E 00	0.6565E 00	0.7453E 00	0.8409E 00
0.8842E 00	0.6758E 00	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.18709E 04	0.37901E 03	0.22499E 04	0.49362E 01	0.20259E 00	0.91683E 01	0.26002E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.6858E 03	0.3770E 03	0.1566E 03	0.7836E 02	0.4477E 02	0.2650E 02	0.1631E 02	0.4830E 01	-0.3706E 01	-0.1220E 02
-0.2151E 02	-0.3341E 02	-0.5150E 02	-0.8486E 02	-0.1624E 03	-0.3812E 03	-0.6881E 03			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.18709E 04	0.37877E 03	0.22496E 04	0.49394E 01	0.20245E 00	0.91673E 01	0.26002E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.6806E 03	0.3638E 03	0.1433E 03	0.6570E 02	0.3241E 02	0.1422E 02	0.2047E 01	-0.7423E 01	-0.1598E 02	-0.2448E 02
-0.3373E 02	-0.4552E 02	-0.6351E 02	-0.9664E 02	-0.1734E 03	-0.3921E 03	-0.7069E 03			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MAJOR AXIS ELL. CYLINDER HAPPEL'S MODEL MARK= 1513

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	0.01	0.2002396E 00	2.2347	0.2029	0.7400	0.0168	0.0982	33	33

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.2060E 01	0.2713E 01	0.2610E 01	0.2351E 01	0.2111E 01	0.1918E 01	0.1770E 01	0.1655E 01	0.1565E 01
0.1495E 01	0.1441E 01	0.1399E 01	0.1368E 01	0.1347E 01	0.1334E 01	0.1330E 01	0.1334E 01	0.1347E 01	0.1368E 01
0.1399E 01	0.1441E 01	0.1496E 01	0.1566E 01	0.1655E 01	0.1769E 01	0.1918E 01	0.2110E 01	0.2349E 01	0.2608E 01
0.2710E 01	0.2058E 01	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.64293E 04	0.21829E 04	0.86120E 04	0.29452E 01	0.33954E 00	0.39172E 01	0.26002E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1698E 04	0.7406E 03	0.4443E 02	-0.2528E 03	-0.4416E 03	-0.6028E 03	-0.7556E 03	-0.9045E 03	-0.1052E 04	-0.1200E 04
-0.1350E 04	-0.1503E 04	-0.1665E 04	-0.1853E 04	-0.2150E 04	-0.2844E 04	-0.3799E 04			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.64291E 04	0.21822E 04	0.86113E 04	0.29461E 01	0.33943E 00	0.39169E 01	0.26002E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1686E 04	0.7212E 03	0.2495E 02	-0.2716E 03	-0.4599E 03	-0.6209E 03	-0.7738E 03	-0.9225E 03	-0.1070E 04	-0.1218E 04
-0.1368E 04	-0.1521E 04	-0.1683E 04	-0.1871E 04	-0.2167E 04	-0.2860E 04	-0.3822E 04			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MAJOR AXIS ELL. CYLINDER HAPPEL'S MODEL MARK= 1514

A.R.	RF	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	0.01	0.40625846E 00	1.5689	0.2029	0.4500	0.0088	0.0982	33	29

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.6126E 01	0.9194E 01	0.8059E 01	0.7423E 01	0.6778E 01	0.6219E 01	0.5753E 01	0.5368E 01	0.5052E 01
0.4795E 01	0.4591E 01	0.4431E 01	0.4312E 01	0.4230E 01	0.4181E 01	0.4165E 01	0.4182E 01	0.4230E 01	0.4313E 01
0.4431E 01	0.4591E 01	0.4796E 01	0.5052E 01	0.5368E 01	0.5753E 01	0.6220E 01	0.6778E 01	0.7422E 01	0.8058E 01
0.8191E 01	0.6124E 01	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.20419E 05	0.15074E 05	0.35493E 05	0.13545E 01	0.73827E 00	0.32559E 01	0.26002E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.3627E 04	0.6124E 03	-0.2072E 04	-0.3884E 04	-0.5437E 04	-0.6844E 04	-0.8154E 04	-0.9404E 04	-0.1062E 05	-0.1185E 05
-0.1310E 05	-0.1441E 05	-0.1582E 05	-0.1737E 05	-0.1918E 05	-0.2187E 05	-0.2487E 05			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.20419E 05	0.15079E 05	0.35498E 05	0.13541E 01	0.73852E 00	0.32564E 01	0.26002E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.3650E 04	0.6255E 03	-0.2058E 04	-0.3875E 04	-0.5425E 04	-0.6834E 04	-0.8143E 04	-0.9393E 04	-0.1061E 05	-0.1184E 05
-0.1309E 05	-0.1440E 05	-0.1582E 05	-0.1736E 05	-0.1917E 05	-0.2186E 05	-0.2487E 05			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MAJOR AXIS ELL. CYLINDER HAPPEL'S MODEL MARK= 1515

A.R.	RF	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	0.01	0.59853946E 00	1.2926	0.2029	0.3250	0.0061	0.0982	33	21

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1949E 02	0.2642E 02	0.2624E 02	0.2416E 02	0.2189E 02	0.1986E 02	0.1817E 02	0.1678E 02	0.1567E 02
0.1478E 02	0.1408E 02	0.1355E 02	0.1315E 02	0.1287E 02	0.1271E 02	0.1266E 02	0.1271E 02	0.1287E 02	0.1315E 02
0.1355E 02	0.1408E 02	0.1478E 02	0.1567E 02	0.1678E 02	0.1817E 02	0.1986E 02	0.2189E 02	0.2416E 02	0.2624E 02
0.2641E 02	0.1949E 02	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.63658E 05	0.98392E 05	0.16205E 06	0.64698E 00	0.15456E 01	0.31191E 01	0.26002E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.7018E 04	-0.5190E 04	-0.2038E 05	-0.3308E 05	-0.4395E 05	-0.5352E 05	-0.6221E 05	-0.7038E 05	-0.7830E 05	-0.8621E 05
-0.9438E 05	-0.1031E 06	-0.1126E 06	-0.1235E 06	-0.1362E 06	-0.1514E 06	-0.1636E 06			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.63658E 05	0.98392E 05	0.16205E 06	0.64698E 00	0.15456E 01	0.31191E 01	0.26002E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.7312E 04	-0.4906E 04	-0.2009E 05	-0.3280E 05	-0.4367E 05	-0.5324E 05	-0.6193E 05	-0.7010E 05	-0.7801E 05	-0.8593E 05
-0.9409E 05	-0.1028E 06	-0.1124E 06	-0.1232E 06	-0.1359E 06	-0.1511E 06	-0.1633E 06			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

Clusters of Elliptical Cylinders with O.R.> 1,Kuwabara's Model

FLOW ALONG MAJOR AXIS ELL. CYLINDER KUWABARA'S MODEL MARK= 1268

A.R.	RF	CONCENTRATION	DM	X1	X2	A	B	IM	JM
1.00	0.01	0.2029529E-02	22.1974	4.0000	7.1000	0.0775	0.0982	33	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.8374E-01	0.1667E 00	0.2479E 00	0.3268E 00	0.4024E 00	0.4741E 00	0.5411E 00	0.6028E 00	0.6586E 00
0.7080E 00	0.7505E 00	0.7857E 00	0.8132E 00	0.8330E 00	0.8447E 00	0.8482E 00	0.8436E 00	0.8310E 00	0.8103E 00
0.7820E 00	0.7461E 00	0.7031E 00	0.6535E 00	0.5976E 00	0.5360E 00	0.4693E 00	0.3981E 00	0.3231E 00	0.2451E 00
0.1647E 00	0.8274E-01	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.53349E 03	0.53374E 03	0.10672E 04	0.99953E 00	0.10005E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.3124E 03	0.3058E 03	0.2863E 03	0.2545E 03	0.2118E 03	0.1599E 03	0.1007E 03	0.3677E 02	-0.2954E 02	-0.9569E 02
-0.1592E 03	-0.2176E 03	-0.2687E 03	-0.3105E 03	-0.3416E 03	-0.3608E 03	-0.3673E 03			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.53349E 03	0.53466E 03	0.10681E 04	0.99780E 00	0.10022E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.3114E 03	0.3048E 03	0.2853E 03	0.2535E 03	0.2107E 03	0.1587E 03	0.9947E 02	0.3540E 02	-0.3104E 02	-0.9730E 02
-0.1609E 03	-0.2194E 03	-0.2706E 03	-0.3126E 03	-0.3437E 03	-0.3629E 03	-0.3694E 03			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MAJOR AXIS ELL. CYLINDER KUWABARA'S MODEL MARK= 1272

A.R.	RF	CONCENTRATION	DM	X1	X2	A	B	IM	JM
1.00	0.01	0.1005208E-01	9.9741	4.0000	6.3000	0.0719	0.0982	33	33

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1250E 00	0.2487E 00	0.3701E 00	0.4878E 00	0.6007E 00	0.7077E 00	0.8079E 00	0.9001E 00	0.9836E 00
0.1057E 01	0.1121E 01	0.1174E 01	0.1215E 01	0.1245E 01	0.1263E 01	0.1269E 01	0.1262E 01	0.1243E 01	0.1213E 01
0.1170E 01	0.1117E 01	0.1053E 01	0.9785E 00	0.8950E 00	0.8028E 00	0.7030E 00	0.5964E 00	0.4842E 00	0.3672E 00
0.2466E 00	0.1240E 00	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.79781E 03	0.81175E 03	0.16096E 04	0.98283E 00	0.10175E 01	0.61808E 02	0.49966E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.4174E 03	0.4074E 03	0.3779E 03	0.3297E 03	0.2669E 03	0.1863E 03	0.9646E 02	-0.6936E 00	-0.1016E 03	-0.2022E 03
-0.2989E 03	-0.3879E 03	-0.4657E 03	-0.5296E 03	-0.5771E 03	-0.6063E 03	-0.6161E 03			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.79781E 03	0.81308E 03	0.16109E 04	0.98122E 00	0.10191E 01	0.61859E 02	0.49966E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.4163E 03	0.4062E 03	0.3765E 03	0.3283E 03	0.2634E 03	0.1845E 03	0.9465E 02	-0.2653E 01	-0.1037E 03	-0.2046E 03
-0.3014E 03	-0.3905E 03	-0.4685E 03	-0.5325E 03	-0.5800E 03	-0.6093E 03	-0.6191E 03			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MAJOR AXIS ELL. CYLINDER KUWABARA'S MODEL MARK= 1526

A.R.	RF	CONCENTRATION	DM	X1	X2	A	B	IM	JM
1.00	0.01	0.4025324E 00	1.5762	3.0000	3.4550	0.0142	0.0982	33	33

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1750E 01	0.1482E 01	0.5170E 01	0.6823E 01	0.8400E 01	0.9892E 01	0.1129E 02	0.1257E 02	0.1373E 02
0.1475E 02	0.1564E 02	0.1637E 02	0.1694E 02	0.1736E 02	0.1761E 02	0.1769E 02	0.1761E 02	0.1736E 02	0.1694E 02
0.1636E 02	0.1563E 02	0.1475E 02	0.1372E 02	0.1256E 02	0.1128E 02	0.9887E 01	0.8395E 01	0.6820E 01	0.5176E 01
0.3480E 01	0.1749E 01	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.11194E 05	0.26142E 05	0.37339E 05	0.42829E 00	0.23349E 01	0.78714E 01	0.49753E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1602E 04	0.1270E 04	0.3230E 03	-0.1225E 04	-0.3303E 04	-0.5829E 04	-0.8710E 04	-0.1183E 05	-0.1507E 05	-0.1830E 05
-0.2142E 05	-0.2429E 05	-0.2682E 05	-0.2890E 05	-0.3044E 05	-0.3139E 05	-0.3172E 05			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.11194E 05	0.26143E 05	0.37339E 05	0.42828E 00	0.23349E 01	0.78715E 01	0.49753E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1596E 04	0.1273E 04	0.3170E 03	-0.1229E 04	-0.3306E 04	-0.5831E 04	-0.8712E 04	-0.1183E 05	-0.1507E 05	-0.1831E 05
-0.2142E 05	-0.2429E 05	-0.2683E 05	-0.2890E 05	-0.3044E 05	-0.3140E 05	-0.3172E 05			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MAJOR AXIS: ELL. CYLINDER KUWABARA'S MODEL MARK= 1267

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	0.01	0.2003842E-02	22.3392	1.4750	4.5800	0.0776	0.0982	33	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.9149E-01	0.1809E 00	0.2663E 00	0.3462E 00	0.4192E 00	0.4847E 00	0.5423E 00	0.5919E 00	0.6340E 00
0.6688E 00	0.6970E 00	0.7191E 00	0.7355E 00	0.7468E 00	0.7533E 00	0.7551E 00	0.7523E 00	0.7450E 00	0.7329E 00
0.7157E 00	0.6929E 00	0.6642E 00	0.6290E 00	0.5867E 00	0.5371E 00	0.4797E 00	0.4146E 00	0.3422E 00	0.2637E 00
0.1787E 00	0.9038E-01	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.55425E 03	0.49987E 03	0.10541E 04	0.11088E 01	0.90189E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.3106E 03	0.3013E 03	0.2748E 03	0.2352E 03	0.1871E 03	0.1348E 03	0.8088E 02	0.2685E 02	-0.2693E 02	-0.8058E 02
-0.1342E 03	-0.1874E 03	-0.2390E 03	-0.2861E 03	-0.3249E 03	-0.3508E 03	-0.3600E 03			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.55425E 03	0.50041E 03	0.10551E 04	0.11067E 01	0.90358E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.3091E 03	0.2997E 03	0.2731E 03	0.2332E 03	0.1850E 03	0.1325E 03	0.7851E 02	0.2446E 02	-0.2933E 02	-0.8297E 02
-0.1366E 03	-0.1899E 03	-0.2416E 03	-0.2889E 03	-0.3279E 03	-0.3540E 03	-0.3632E 03			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MAJOR AXIS ELL. CYLINDER KUWABARA'S MODEL MARK= 1271

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	0.01	0.9926695E-02	10.0379	1.4750	3.7809	0.0720	0.0982	33	33

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1356E 00	0.2681E 00	0.3947E 00	0.5131E 00	0.6215E 00	0.7188E 00	0.8043E 00	0.8783E 00	0.9410E 00
0.9930E 00	0.1035E 01	0.1068E 01	0.1093E 01	0.1110E 01	0.1120E 01	0.1123E 01	0.1119E 01	0.1108E 01	0.1090E 01
0.1065E 01	0.1031E 01	0.9885E 00	0.9361E 00	0.8732E 00	0.7993E 00	0.7139E 00	0.6171E 00	0.5093E 00	0.3917E 00
0.2660E 00	0.1345E 00	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.82393E 03	0.75530E 03	0.15792E 04	0.10909E 01	0.91670E 00	0.61193E 02	0.45274E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.4156E 03	0.4016E 03	0.3620E 03	0.3026E 03	0.2305E 03	0.1518E 03	0.7048E 02	-0.1128E 02	-0.9282E 02	-0.1742E 03
-0.2555E 03	-0.3361E 03	-0.4140E 03	-0.4852E 03	-0.5437E 03	-0.5827E 03	-0.5965E 03			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.82393E 03	0.75654E 03	0.15805E 04	0.10891E 01	0.91821E 00	0.61242E 02	0.45274E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.4135E 03	0.3994E 03	0.3594E 03	0.3000E 03	0.2276E 03	0.1487E 03	0.6729E 02	-0.1450E 02	-0.9606E 02	-0.1774E 03
-0.2588E 03	-0.3395E 03	-0.4176E 03	-0.4890E 03	-0.5478E 03	-0.5870E 03	-0.6009E 03			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MAJOR AXIS ELL. CYLINDER KUWABARA'S MODEL MARK= 1219

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	0.01	0.4024656E-01	4.9847	1.4750	3.0800	0.0401	0.0982	33	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.2268E 00	0.4485E 00	0.6605E 00	0.8588E 00	0.1041E 01	0.1204E 01	0.1348E 01	0.1473E 01	0.1579E 01
0.1667E 01	0.1739E 01	0.1796E 01	0.1838E 01	0.1867E 01	0.1885E 01	0.1890E 01	0.1884E 01	0.1866E 01	0.1835E 01
0.1792E 01	0.1735E 01	0.1663E 01	0.1574E 01	0.1468E 01	0.1343E 01	0.1199E 01	0.1036E 01	0.8551E 00	0.6575E 00
0.4464E 00	0.2257E 00	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.13850E 04	0.13514E 04	0.27364E 04	0.10248E 01	0.97577E 00	0.23818E 03	0.45274E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.5739E 03	0.5494E 03	0.4799E 03	0.3755E 03	0.2483E 03	0.1084E 03	-0.3704E 02	-0.1945E 03	-0.3320E 03	-0.4793E 03
-0.6259E 03	-0.7705E 03	-0.9093E 03	-0.1035E 04	-0.1138E 04	-0.1207E 04	-0.1231E 04			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.13850E 04	0.13521E 04	0.27371E 04	0.10243E 01	0.97634E 00	0.23824E 03	0.45274E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.5709E 03	0.5462E 03	0.4765E 03	0.3717E 03	0.2443E 03	0.1044E 03	-0.4113E 02	-0.1886E 03	-0.3262E 03	-0.4735E 03
-0.6300E 03	-0.7746E 03	-0.9134E 03	-0.1040E 04	-0.1143E 04	-0.1211E 04	-0.1235E 04			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MAJOR AXIS ELL. CYLINDER KUWABARA'S MODEL MARK= 1217

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	0.01	0.1993647E 00	2.2396	1.4750	2.2800	0.0252	0.0982	33	33

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.6691E 00	0.1324E 01	0.1951E 01	0.2530E 01	0.3080E 01	0.3569E 01	0.4003E 01	0.4378E 01	0.4700E 01
0.4970E 01	0.5191E 01	0.5365E 01	0.5498E 01	0.5590E 01	0.5645E 01	0.5663E 01	0.5644E 01	0.5588E 01	0.5496E 01
0.5363E 01	0.5187E 01	0.4966E 01	0.4696E 01	0.4374E 01	0.3997E 01	0.3564E 01	0.3076E 01	0.2535E 01	0.1948E 01
0.1322E 01	0.6681E 00	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.41348E 04	0.55869E 04	0.97217E 04	0.74009E 00	0.13512E 01	0.99168E 01	0.45274E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1011E 04	0.9209E 03	0.6623E 03	0.2663E 03	-0.2356E 03	-0.7998E 03	-0.1405E 04	-0.2031E 04	-0.2666E 04	-0.3303E 04
-0.3929E 04	-0.4534E 04	-0.5099E 04	-0.5595E 04	-0.5991E 04	-0.6249E 04	-0.6339E 04			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.41344E 04	0.55902E 04	0.97250E 04	0.73965E 00	0.13520E 01	0.99202E 01	0.45274E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1005E 04	0.9147E 03	0.6560E 03	0.2574E 03	-0.2431E 03	-0.8073E 03	-0.1413E 04	-0.2038E 04	-0.2674E 04	-0.3311E 04
-0.3937E 04	-0.4543E 04	-0.5109E 04	-0.5606E 04	-0.6002E 04	-0.6260E 04	-0.6350E 04			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MAJOR AXIS ELL. CYLINDER KUWABARA'S MODEL MARK= 1219

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	0.01	0.4016074E 00	1.5780	1.4750	1.9300	0.0163	0.0982	33	29

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1789E 01	0.3540E 01	0.5218E 01	0.6793E 01	0.8242E 01	0.9553E 01	0.1071E 02	0.1173E 02	0.1259E 02
0.1332E 02	0.1391E 02	0.1438E 02	0.1474E 02	0.1499E 02	0.1514E 02	0.1518E 02	0.1514E 02	0.1499E 02	0.1474E 02
0.1438E 02	0.1391E 02	0.1331E 02	0.1259E 02	0.1172E 02	0.1071E 02	0.9548E 01	0.8239E 01	0.6789E 01	0.5215E 01
0.3538E 01	0.1788E 01	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.11083E 05	0.23430E 05	0.34503E 05	0.47321E 00	0.21132E 01	0.72943E 01	0.45274E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1619E 04	0.1271E 04	0.2606E 03	-0.1314E 04	-0.3336E 04	-0.5674E 04	-0.8223E 04	-0.1090E 05	-0.1363E 05	-0.1637E 05
-0.1905E 05	-0.2160E 05	-0.2393E 05	-0.2595E 05	-0.2753E 05	-0.2854E 05	-0.2889E 05			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.11083E 05	0.23417E 05	0.34500E 05	0.47327E 00	0.21129E 01	0.72936E 01	0.45274E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1608E 04	0.1261E 04	0.2516E 03	-0.1321E 04	-0.3342E 04	-0.5680E 04	-0.8228E 04	-0.1090E 05	-0.1364E 05	-0.1637E 05
-0.1905E 05	-0.2160E 05	-0.2394E 05	-0.2596E 05	-0.2753E 05	-0.2855E 05	-0.2890E 05			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MAJOR AXIS ELL. CYLINDER KUWABARA'S MODEL MARK= 1220

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	0.01	0.5994505E 00	1.2916	1.4750	1.7300	0.0128	0.0982	33	21

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.5163E 01	0.1027E 02	0.1505E 02	0.1959E 02	0.2377E 02	0.2753E 02	0.3087E 02	0.3376E 02	0.3624E 02
0.3831E 02	0.4000E 02	0.4134E 02	0.4235E 02	0.4306E 02	0.4347E 02	0.4361E 02	0.4347E 02	0.4305E 02	0.4235E 02
0.4134E 02	0.4000E 02	0.3830E 02	0.3623E 02	0.3376E 02	0.3086E 02	0.2753E 02	0.2376E 02	0.1959E 02	0.1505E 02
0.1071E 02	0.5162E 01	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.31874E 05	0.11499E 06	0.14687E 06	0.27718E 00	0.36078E 01	0.62390E 01	0.45274E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2679E 04	0.1021E 04	-0.3802E 04	-0.1138E 05	-0.2116E 05	-0.3258E 05	-0.4513E 05	-0.5838E 05	-0.7195E 05	-0.8552E 05
-0.9876E 05	-0.1113E 06	-0.1227E 06	-0.1325E 06	-0.1401E 06	-0.1449E 06	-0.1465E 06			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.31874E 05	0.11500E 06	0.14687E 06	0.27716E 00	0.36080E 01	0.62392E 01	0.45274E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2660E 04	0.1002E 04	-0.3821E 04	-0.1140E 05	-0.2118E 05	-0.3261E 05	-0.4516E 05	-0.5840E 05	-0.7197E 05	-0.8554E 05
-0.9878E 05	-0.1113E 06	-0.1227E 06	-0.1325E 06	-0.1401E 06	-0.1449E 06	-0.1466E 06			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MAJOR AXIS ELL. CYLINDER KUWABARA'S MODEL MARK= 1266

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	0.01	0.2009378E-02	22.3084	0.5490	3.5950	0.0761	0.0982	33	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1643E 00	0.2837E 00	0.3741E 00	0.4322E 00	0.4603E 00	0.4698E 00	0.4682E 00	0.4609E 00	0.4510E 00
0.4406E 00	0.4309E 00	0.4224E 00	0.4155E 00	0.4105E 00	0.4073E 00	0.4061E 00	0.4068E 00	0.4094E 00	0.4139E 00
0.4202E 00	0.4281E 00	0.4373E 00	0.4471E 00	0.4565E 00	0.4634E 00	0.4646E 00	0.4549E 00	0.4269E 00	0.3714E 00
0.2801E 00	0.1521E 00	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.67971E 03	0.34022E 03	0.10199E 04	0.19978E 01	0.50054E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.3127E 03	0.2764E 03	0.2019E 03	0.1340E 03	0.8497E 02	0.4107E 02	0.2667E 02	0.7560E 01	-0.9181E 01	-0.2587E 02
-0.4480E 02	-0.6891E 02	-0.1023E 03	-0.1506E 03	-0.2174E 03	-0.2908E 03	-0.3766E 03			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.67971E 03	0.34079E 03	0.10205E 04	0.19945E 01	0.50139E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.3061E 03	0.2685E 03	0.1922E 03	0.1237E 03	0.7479E 02	0.4111E 02	0.1689E 02	-0.2084E 01	-0.1871E 02	-0.3528E 02
-0.5409E 02	-0.7801E 02	-0.1112E 03	-0.1594E 03	-0.2268E 03	-0.3020E 03	-0.3391E 03			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MAJOR AXIS ELL. CYLINDER KUWABARA'S MODEL MARK= 1270

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	0.01	0.9853933E-02	10.0738	0.5490	2.8000	0.0703	0.0982	33	33

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.2237E 00	0.4118E 00	0.5661E 00	0.6279E 00	0.6691E 00	0.6834E 00	0.6817E 00	0.6716E 00	0.6579E 00
0.6434E 00	0.6297E 00	0.6179E 00	0.6083E 00	0.6013E 00	0.5969E 00	0.5953E 00	0.5964E 00	0.6002E 00	0.6067E 00
0.6158E 00	0.6271E 00	0.6403E 00	0.6543E 00	0.6675E 00	0.6772E 00	0.6785E 00	0.6641E 00	0.6229E 00	0.5416E 00
0.4084E 00	0.2218E 00	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.99367E 03	0.50664E 03	0.15003E 04	0.19613E 01	0.50986E 00	0.49455E 02	0.31244E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.4232E 03	0.3701E 03	0.2613E 03	0.1622E 03	0.9030E 02	0.4001E 02	0.3264E 01	-0.2595E 02	-0.5182E 02	-0.7762E 02
-0.1067E 03	-0.1431E 03	-0.1928E 03	-0.2640E 03	-0.3620E 03	-0.4697E 03	-0.5222E 03			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.99367E 03	0.50741E 03	0.15011E 04	0.19583E 01	0.51064E 00	0.49481E 02	0.31244E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.4137E 03	0.3589E 03	0.2479E 03	0.1481E 03	0.7628E 02	0.2625E 02	-0.1028E 02	-0.3933E 02	-0.6506E 02	-0.9073E 02
-0.1196E 03	-0.1558E 03	-0.2053E 03	-0.2763E 03	-0.3751E 03	-0.4850E 03	-0.5392E 03			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MAJOR AXIS ELL. CYLINDER KUWABARA'S MODEL MARK= 1273

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	0.01	0.3996782E-01	5.0020	0.5490	2.1000	0.0388	0.0982	33	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.3607E 00	0.6644E 00	0.8819E 00	0.1015E 01	0.1084E 01	0.1110E 01	0.1110E 01	0.1097E 01	0.1077E 01
0.1056E 01	0.1036E 01	0.1019E 01	0.1005E 01	0.9950E 00	0.9887E 00	0.9865E 00	0.9883E 00	0.9941E 00	0.1006E 01
0.1017E 01	0.1034E 01	0.1053E 01	0.1074E 01	0.1093E 01	0.1106E 01	0.1106E 01	0.1080E 01	0.1011E 01	0.8780E 00
0.6614E 00	0.3591E 00	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.16323E 04	0.89188E 03	0.25240E 04	0.18306E 01	0.54628E 00	0.18697E 02	0.31244E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.6003E 03	0.5123E 03	0.3329E 03	0.1692E 03	0.4830E 02	-0.3917E 02	-0.1064E 03	-0.1625E 03	-0.2139E 03	-0.2651E 03
-0.3211E 03	-0.3879E 03	-0.4749E 03	-0.5951E 03	-0.7578E 03	-0.9363E 03	-0.1024E 04			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.16323E 04	0.89238E 03	0.25247E 04	0.18291E 01	0.54671E 00	0.18702E 02	0.31244E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.5855E 03	0.4965E 03	0.3158E 03	0.1517E 03	0.3094E 02	-0.5631E 02	-0.1235E 03	-0.1795E 03	-0.2309E 03	-0.2822E 03
-0.3382E 03	-0.4049E 03	-0.4917E 03	-0.6118E 03	-0.7749E 03	-0.9547E 03	-0.1043E 04			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MAJOR AXIS FLL. CYLINDER KUWABARA'S MODEL MARK= 1221

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	0.01	0.1999136E 00	2.2416	0.5490	1.3000	0.0235	0.0982	33	31

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.9760E 00	0.1803E 01	0.2404E 01	0.2785E 01	0.2995E 01	0.3089E 01	0.3116E 01	0.3100E 01	0.3067E 01
0.3027E 01	0.2987E 01	0.2951E 01	0.2921E 01	0.2900E 01	0.2886E 01	0.2882E 01	0.2886E 01	0.2899E 01	0.2921E 01
0.2950E 01	0.2986E 01	0.3026E 01	0.3065E 01	0.3097E 01	0.3111E 01	0.3086E 01	0.2991E 01	0.2782E 01	0.2402E 01
0.1801E 01	0.9749E 00	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.46673E 04	0.36647E 04	0.83320E 04	0.12736E 01	0.78519E 00	0.71993E 01	0.31244E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1135E 04	0.9883E 03	0.3612E 03	-0.1526E 03	-0.5800E 03	-0.9626E 03	-0.1263E 04	-0.1563E 04	-0.1853E 04	-0.2143E 04
-0.2444E 04	-0.2766E 04	-0.3128E 04	-0.3556E 04	-0.4069E 04	-0.4634E 04	-0.4944E 04			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.46673E 04	0.36648E 04	0.83321E 04	0.12735E 01	0.78522E 00	0.71994E 01	0.31244E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1100E 04	0.8499E 03	0.3252E 03	-0.1884E 03	-0.6151E 03	-0.9789E 03	-0.1298E 04	-0.1597E 04	-0.1888E 04	-0.2178E 04
-0.2478E 04	-0.2801E 04	-0.3163E 04	-0.3590E 04	-0.4104E 04	-0.4631E 04	-0.4882E 04			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MAJOR AXIS FLL. CYLINDER KUWABARA'S MODEL MARK= 1222

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	0.01	0.3992346E 00	1.5827	0.5490	0.9600	0.0147	0.0982	33	30

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.2491E 01	0.4611E 01	0.6167E 01	0.7167E 01	0.7732E 01	0.7996E 01	0.8075E 01	0.8047E 01	0.7943E 01
0.7855E 01	0.7745E 01	0.7645E 01	0.7561E 01	0.7498E 01	0.7460E 01	0.7447E 01	0.7460E 01	0.7498E 01	0.7561E 01
0.7643E 01	0.7744E 01	0.7854E 01	0.7961E 01	0.8045E 01	0.8073E 01	0.7993E 01	0.7728E 01	0.7163E 01	0.6143E 01
0.4609E 01	0.2490E 01	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.12083E 05	0.15524E 05	0.27607E 05	0.77833E 00	0.12848E 01	0.50171E 01	0.31244E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1911E 04	0.1168E 04	-0.4861E 03	-0.2287E 04	-0.3975E 04	-0.5548E 04	-0.7028E 04	-0.8454E 04	-0.9854E 04	-0.1125E 05
-0.1268E 05	-0.1416E 05	-0.1573E 05	-0.1742E 05	-0.1922E 05	-0.2087E 05	-0.2161E 05			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.12083E 05	0.15535E 05	0.27618E 05	0.77782E 00	0.12856E 01	0.50190E 01	0.31244E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1842E 04	0.1099E 04	-0.5562E 03	-0.2360E 04	-0.4047E 04	-0.5624E 04	-0.7104E 04	-0.8530E 04	-0.9930E 04	-0.1133E 05
-0.1276E 05	-0.1424E 05	-0.1581E 05	-0.1750E 05	-0.1930E 05	-0.2095E 05	-0.2170E 05			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MAJOR AXIS FLL. CYLINDER KUWABARA'S MODEL MARK= 1224

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	0.01	0.5858028E 00	1.3065	0.5490	0.7800	0.0115	0.0982	33	21

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.6702E 01	0.1241E 02	0.1660E 02	0.1928E 02	0.2077E 02	0.2144E 02	0.2159E 02	0.2145E 02	0.2116E 02
0.2081E 02	0.2047E 02	0.2015E 02	0.1990E 02	0.1971E 02	0.1959E 02	0.1955E 02	0.1959E 02	0.1971E 02	0.1990E 02
0.2015E 02	0.2047E 02	0.2081E 02	0.2116E 02	0.2145E 02	0.2159E 02	0.2144E 02	0.2077E 02	0.1928E 02	0.1659E 02
0.1741E 02	0.6701E 01	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.32031E 05	0.70534E 05	0.10257E 06	0.45412E 00	0.22021E 01	0.41631E 01	0.31244E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.3176E 04	0.4487E 03	-0.5959E 04	-0.1350E 05	-0.2104E 05	-0.2828E 05	-0.3523E 05	-0.4196E 05	-0.4857E 05	-0.5519E 05
-0.6192E 05	-0.6887E 05	-0.7611E 05	-0.8364E 05	-0.9118E 05	-0.9759E 05	-0.1003E 06			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.32031E 05	0.70537E 05	0.10257E 06	0.45410E 00	0.22022E 01	0.41632E 01	0.31244E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.3049E 04	0.3190E 03	-0.6092E 04	-0.1364E 05	-0.2117E 05	-0.2841E 05	-0.3536E 05	-0.4209E 05	-0.4871E 05	-0.5533E 05
-0.6206E 05	-0.6900E 05	-0.7624E 05	-0.8378E 05	-0.9132E 05	-0.9772E 05	-0.1005E 06			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MAJOR AXIS ELL. CYLINDER KUWABARA'S MODEL MARK= 1265

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	0.01	0.2026551E-02	22.2137	0.2029	3.0100	0.0702	0.0982	33	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.3227E 00	0.4230E 00	0.4029E 00	0.3569E 00	0.3137E 00	0.2786E 00	0.2509E 00	0.2293E 00	0.2124E 00
0.1991E 00	0.1889E 00	0.1810E 00	0.1752E 00	0.1712E 00	0.1688E 00	0.1679E 00	0.1685E 00	0.1706E 00	0.1742E 00
0.1797E 00	0.1871E 00	0.1970E 00	0.2098E 00	0.2262E 00	0.2472E 00	0.2742E 00	0.3085E 00	0.3508E 00	0.3958E 00
0.4153E 00	0.3168E 00	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.87540E 03	0.17260E 03	0.10480E 04	0.50720E 01	0.19716E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.3491E 03	0.2137E 03	0.1091E 03	0.7080E 02	0.5480E 02	0.4661E 02	0.4162E 02	0.3805E 02	0.3505E 02	0.3207E 02
0.2858E 02	0.2371E 02	0.1572E 02	0.5664E-01	-0.3749E 02	-0.1401E 03	-0.2731E 03			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.87540E 03	0.17237E 03	0.10478E 04	0.50785E 01	0.19691E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.3471E 03	0.2013E 03	0.9559E 02	0.5848E 02	0.4299E 02	0.3500E 02	0.3010E 02	0.2657E 02	0.2360E 02	0.2065E 02
0.1720E 02	0.1242E 02	0.4521E 01	-0.1051E 02	-0.4692E 02	-0.1507E 03	-0.2939E 03			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MAJOR AXIS ELL. CYLINDER KUWABARA'S MODEL MARK= 1269

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	0.01	0.1003897E-01	9.9806	0.2029	2.2100	0.0627	0.0982	33	33

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.4733E 00	0.6205E 00	0.5913E 00	0.5243E 00	0.4616E 00	0.4107E 00	0.3708E 00	0.3396E 00	0.3153E 00
0.2964E 00	0.2817E 00	0.2705E 00	0.2623E 00	0.2567E 00	0.2533E 00	0.2521E 00	0.2530E 00	0.2561E 00	0.2615E 00
0.2694E 00	0.2802E 00	0.2945E 00	0.3131E 00	0.3370E 00	0.3677E 00	0.4071E 00	0.4573E 00	0.5192E 00	0.5853E 00
0.6141E 00	0.4684E 00	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.13030E 04	0.26471E 03	0.15677E 04	0.49222E 01	0.20316E 00	0.26976E 02	0.26002E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.4915E 03	0.2892E 03	0.1354E 03	0.7909E 02	0.5406E 02	0.4192E 02	0.3341E 02	0.2685E 02	0.2107E 02	0.1531E 02
0.8830E 01	0.4453E 00	-0.1234E 02	-0.3615E 02	-0.9173E 02	-0.7438E 03	-0.4439E 03			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.13030E 04	0.26445E 03	0.15674E 04	0.49271E 01	0.20296E 00	0.26971E 02	0.26002E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.4884E 03	0.2727E 03	0.1177E 03	0.6287E 02	0.3933E 02	0.2654E 02	0.1811E 02	0.1160E 02	0.5851E 01	0.1233E 00
-0.6312E 01	-0.1660E 02	-0.2718E 02	-0.5038E 02	-0.1045E 03	-0.2577E 03	-0.4711E 03			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MAJOR AXIS ELL. CYLINDER KUWABARA'S MODEL MARK= 1215

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	0.01	0.3889194E-01	5.0766	0.2029	1.5350	0.0333	0.0982	33	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.7591E 00	0.9051E 00	0.9491E 00	0.8444E 00	0.7473E 00	0.6686E 00	0.6073E 00	0.5598E 00	0.5229E 00
0.4944E 00	0.4724E 00	0.4558E 00	0.4436E 00	0.4354E 00	0.4305E 00	0.4289E 00	0.4303E 00	0.4350E 00	0.4431E 00
0.4551E 00	0.4714E 00	0.4931E 00	0.5214E 00	0.5579E 00	0.6051E 00	0.6659E 00	0.7440E 00	0.8406E 00	0.9446E 00
0.9904E 00	0.7556E 00	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.21633E 04	0.48725E 03	0.26505E 04	0.44397E 01	0.22524E 00	0.10801E 02	0.26003E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.7327E 03	0.3882E 03	0.1404E 03	0.4937E 02	0.6574E 01	-0.2030E 02	-0.4098E 02	-0.5903E 02	-0.7635E 02	-0.9357E 02
-0.1117E 03	-0.1321E 03	-0.1588E 03	-0.2014E 03	-0.2910E 03	-0.5383E 03	-0.9813E 03			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.21633E 04	0.48677E 03	0.26503E 04	0.44441E 01	0.22502E 00	0.10798E 02	0.26003E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.7271E 03	0.3738E 03	0.1261E 03	0.3594E 02	-0.6490E 01	-0.3327E 02	-0.5391E 02	-0.7189E 02	-0.8922E 02	-0.1064E 03
-0.1245E 03	-0.1449E 03	-0.1714E 03	-0.2137E 03	-0.3034E 03	-0.5495E 03	-0.9915E 03			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MAJOR AXIS ELL. CYLINDER KUWABARA'S MODEL MARK= 1213

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	0.01	0.2002396E 00	2.2347	0.2029	0.7400	0.0168	0.0982	33	33

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.2275E 01	0.3007E 01	0.2907E 01	0.2630E 01	0.2368E 01	0.2153E 01	0.1983E 01	0.1849E 01	0.1742E 01
0.1657E 01	0.1590E 01	0.1538E 01	0.1499E 01	0.1472E 01	0.1457E 01	0.1451E 01	0.1457E 01	0.1472E 01	0.1499E 01
0.1538E 01	0.1589E 01	0.1657E 01	0.1742E 01	0.1848E 01	0.1983E 01	0.2152E 01	0.2366E 01	0.2628E 01	0.2905E 01
0.3004E 01	0.2273E 01	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.71174E 04	0.28733E 04	0.99906E 04	0.24771E 01	0.40370E 00	0.45443E 01	0.26002E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1712E 04	0.6440E 03	-0.1699E 03	-0.5606E 03	-0.8304E 03	-0.1061E 04	-0.1273E 04	-0.1475E 04	-0.1672E 04	-0.1869E 04
-0.2070E 04	-0.2281E 04	-0.2512E 04	-0.2783E 04	-0.3176E 04	-0.3990E 04	-0.5056E 04			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.71174E 04	0.28731E 04	0.99904E 04	0.24773E 01	0.40367E 00	0.45442E 01	0.26002E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1706E 04	0.6301E 03	-0.1828E 03	-0.5723E 03	-0.8416E 03	-0.1073E 04	-0.1285E 04	-0.1487E 04	-0.1684E 04	-0.1881E 04
-0.2082E 04	-0.2293E 04	-0.2524E 04	-0.2795E 04	-0.3187E 04	-0.4001E 04	-0.5075E 04			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MAJOR AXIS ELL. CYLINDER KUWABARA'S MODEL MARK= 1214

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	0.01	0.4062584E 00	1.5689	0.2029	0.4500	0.0088	0.0982	33	29

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.6840E 01	0.9148E 01	0.8961E 01	0.8181E 01	0.7386E 01	0.6702E 01	0.6137E 01	0.5678E 01	0.5309E 01
0.5014E 01	0.4781E 01	0.4601E 01	0.4468E 01	0.4375E 01	0.4323E 01	0.4305E 01	0.4323E 01	0.4377E 01	0.4468E 01
0.4602E 01	0.4781E 01	0.5014E 01	0.5309E 01	0.5679E 01	0.6137E 01	0.6701E 01	0.7388E 01	0.8189E 01	0.8960E 01
0.9145E 01	0.6837E 01	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.21609E 05	0.17766E 05	0.39375E 05	0.12163E 01	0.82214E 00	0.36121E 01	0.26002E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.3484E 04	-0.1100E 03	-0.3561E 04	-0.5902E 04	-0.7794E 04	-0.9436E 04	-0.1092E 05	-0.1231E 05	-0.1366E 05	-0.1501E 05
-0.1641E 05	-0.1790E 05	-0.1954E 05	-0.2143E 05	-0.2378E 05	-0.2723E 05	-0.3082E 05			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.21609E 05	0.17765E 05	0.39374E 05	0.12164E 01	0.82208E 00	0.36120E 01	0.26002E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.3541E 04	-0.6167E 02	-0.3610E 04	-0.5849E 04	-0.7740E 04	-0.9383E 04	-0.1087E 05	-0.1226E 05	-0.1361E 05	-0.1496E 05
-0.1635E 05	-0.1784E 05	-0.1949E 05	-0.2138E 05	-0.2373E 05	-0.2719E 05	-0.3078E 05			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MAJOR AXIS ELL. CYLINDER KUWABARA'S MODEL MARK= 1215

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	0.01	0.5985394E 00	1.2934	0.2029	0.3250	0.0061	0.0982	33	21

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.2171E 02	0.2904E 02	0.2836E 02	0.2568E 02	0.2296E 02	0.2063E 02	0.1874E 02	0.1723E 02	0.1603E 02
0.1508E 02	0.1434E 02	0.1377E 02	0.1335E 02	0.1307E 02	0.1290E 02	0.1284E 02	0.1290E 02	0.1307E 02	0.1335E 02
0.1377E 02	0.1434E 02	0.1508E 02	0.1603E 02	0.1723E 02	0.1874E 02	0.2063E 02	0.2296E 02	0.2568E 02	0.2836E 02
0.2904E 02	0.2171E 02	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.65683E 05	0.10709E 06	0.17359E 06	0.60872E 00	0.16428E 01	0.33412E 01	0.26002E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.6549E 04	-0.9107E 04	-0.2810E 05	-0.4283E 05	-0.5681E 05	-0.6906E 05	-0.7974E 05	-0.8939E 05	-0.9907E 05	-0.1092E 06
-0.1079E 06	-0.1171E 06	-0.1273E 06	-0.1393E 06	-0.1554E 06	-0.1730E 06	-0.1987E 06			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.65683E 05	0.10709E 06	0.17358E 06	0.60874E 00	0.16427E 01	0.33411E 01	0.26002E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.6855E 04	-0.8814E 04	-0.2780E 05	-0.4254E 05	-0.5651E 05	-0.6876E 05	-0.7945E 05	-0.8911E 05	-0.9879E 05	-0.1089E 06
-0.1076E 06	-0.1168E 06	-0.1270E 06	-0.1390E 06	-0.1551E 06	-0.1727E 06	-0.1984E 06			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

Clusters of Elliptical Cylinders with O.R.< 1,Happel's Model

FLOW ALONG MINOR AXIS ELL. CYLINDER HAPPEL'S MODEL MARK= 1531

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
1.00	0.01	0.20220529E-03	22.1974	4.0000	7.1000	0.0775	0.0982	33	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.7605E-01	0.1514E 00	0.2252E 00	0.2968E 00	0.3656E 00	0.4308E 00	0.4918E 00	0.5480E 00	0.5989E 00
0.6439E 00	0.6827E 00	0.7149E 00	0.7401E 00	0.7581E 00	0.7688E 00	0.7721E 00	0.7679E 00	0.7563E 00	0.7374E 00
0.7115E 00	0.6787E 00	0.6394E 00	0.5941E 00	0.5431E 00	0.4870E 00	0.4263E 00	0.3616E 00	0.2934E 00	0.2225E 00
0.1495E 00	0.7511E-01	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.48462E 03	0.48342E 03	0.96825E 03	0.10021E 01	0.99794E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2964E 03	0.2904E 03	0.2728E 03	0.2440E 03	0.2054E 03	0.1584E 03	0.1049E 03	0.4684E 02	-0.1338E 02	-0.7345E 02
-0.1310E 03	-0.1839E 03	-0.2302E 03	-0.2680E 03	-0.2960E 03	-0.3133E 03	-0.3191E 03			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.48462E 03	0.48458E 03	0.96920E 03	0.10001E 01	0.99991E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2955E 03	0.2895E 03	0.2718E 03	0.2430E 03	0.2043E 03	0.1572E 03	0.1036E 03	0.4543E 02	-0.1492E 02	-0.7512E 02
-0.1328E 03	-0.1858E 03	-0.2321E 03	-0.2700E 03	-0.2981E 03	-0.3154E 03	-0.3212E 03			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MINOR AXIS ELL. CYLINDER HAPPEL'S MODEL MARK= 1535

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
1.00	0.01	0.10052088E-01	9.9741	4.0000	6.3000	0.0719	0.0982	33	33

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1096E 00	0.2181E 00	0.3246E 00	0.4279E 00	0.5270E 00	0.6211E 00	0.7091E 00	0.7903E 00	0.8638E 00
0.9289E 00	0.9850E 00	0.1032E 01	0.1068E 01	0.1094E 01	0.1110E 01	0.1115E 01	0.1109E 01	0.1093E 01	0.1065E 01
0.1028E 01	0.9810E 00	0.9244E 00	0.8590E 00	0.7855E 00	0.7044E 00	0.6167E 00	0.5231E 00	0.4245E 00	0.3219E 00
0.2163E 00	0.1087E 00	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.69984E 03	0.69947E 03	0.13993E 04	0.10005E 01	0.99947E 00	0.53735E 02	0.50034E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.4019E 03	0.3934E 03	0.3679E 03	0.3265E 03	0.2708E 03	0.2029E 03	0.1255E 03	0.4155E 02	-0.4554E 02	-0.1324E 03
-0.2157E 03	-0.2923E 03	-0.3592E 03	-0.4141E 03	-0.4548E 03	-0.4798E 03	-0.4883E 03			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.69984E 03	0.70069E 03	0.14005E 04	0.99879E 00	0.10012E 01	0.53782E 02	0.50034E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.4006E 03	0.3921E 03	0.3666E 03	0.3252E 03	0.2694E 03	0.2013E 03	0.1237E 03	0.3961E 02	-0.4766E 02	-0.1347E 03
-0.2181E 03	-0.2948E 03	-0.3618E 03	-0.4167E 03	-0.4575E 03	-0.4826E 03	-0.4910E 03			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MINOR AXIS ELL. CYLINDER HAPPEL'S MODEL MARK= 1528

A.R.	PE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	0.01	0.2003842E-02	22.3392	1.4750	4.5800	0.0776	0.0982	33	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.6933E-01	0.1387E 00	0.2082E 00	0.2776E 00	0.3470E 00	0.4159E 00	0.4838E 00	0.5500E 00	0.6134E 00
0.6720E 00	0.7269E 00	0.7740E 00	0.8125E 00	0.8411E 00	0.8585E 00	0.8641E 00	0.8575E 00	0.8390E 00	0.8095E 00
0.7702E 00	0.7225E 00	0.6681E 00	0.6095E 00	0.5451E 00	0.4791E 00	0.4115E 00	0.3431E 00	0.2744E 00	0.2056E 00
0.1370E 00	0.6843E-01	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.46344E 03	0.51330E 03	0.97674E 03	0.90286E 00	0.11076E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2978E 03	0.2939E 03	0.2818E 03	0.2624E 03	0.2281E 03	0.1835E 03	0.1263E 03	0.5853E 02	-0.1535E 02	-0.8902E 02
-0.1562E 03	-0.2126E 03	-0.2564E 03	-0.2879E 03	-0.3096E 03	-0.3203E 03	-0.3240E 03			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.46344E 03	0.51432E 03	0.97776E 03	0.90107E 00	0.11098E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2972E 03	0.2933E 03	0.2813E 03	0.2599E 03	0.2276E 03	0.1839E 03	0.1257E 03	0.5771E 02	-0.1645E 02	-0.9041E 02
-0.1578E 03	-0.2143E 03	-0.2581E 03	-0.2895E 03	-0.3102E 03	-0.3218E 03	-0.3255E 03			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MINOR AXIS ELL. CYLINDER HAPPEL'S MODEL MARK= 1532

A.R.	PE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	0.01	0.9924495E-02	10.0370	1.4750	3.7800	0.0720	0.0982	33	33

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1006E 00	0.2010E 00	0.3017E 00	0.4026E 00	0.5031E 00	0.6031E 00	0.7016E 00	0.7977E 00	0.8898E 00
0.9762E 00	0.1055E 01	0.1123E 01	0.1180E 01	0.1221E 01	0.1247E 01	0.1255E 01	0.1246E 01	0.1219E 01	0.1177E 01
0.1120E 01	0.1051E 01	0.9716E 00	0.8850E 00	0.7939E 00	0.6970E 00	0.5988E 00	0.4993E 00	0.3993E 00	0.2992E 00
0.1993E 00	0.9965E-01	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.67320E 03	0.74681E 03	0.14200E 04	0.90141E 00	0.11094E 01	0.55035E 02	0.55928E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.4042E 03	0.3986E 03	0.3812E 03	0.3503E 03	0.3035E 03	0.2388E 03	0.1558E 03	0.5731E 02	-0.5018E 02	-0.1575E 03
-0.2554E 03	-0.3377E 03	-0.4015E 03	-0.4475E 03	-0.4778E 03	-0.4948E 03	-0.5003E 03			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.67320E 03	0.74802E 03	0.14212E 04	0.89998E 00	0.11111E 01	0.55071E 02	0.55928E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.4035E 03	0.3979E 03	0.3805E 03	0.3497E 03	0.3030E 03	0.2384E 03	0.1553E 03	0.5651E 02	-0.5135E 02	-0.1590E 03
-0.2572E 03	-0.3396E 03	-0.4035E 03	-0.4494E 03	-0.4796E 03	-0.4965E 03	-0.5020E 03			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MINOR AXIS ELL. CYLINDER HAPPEL'S MODEL MARK= 1500

A.R.	PE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	0.01	0.4024656E-01	4.9847	1.4750	3.0800	0.0401	0.0982	33	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1655E 00	0.3311E 00	0.4971E 00	0.6632E 00	0.8291E 00	0.9940E 00	0.1157E 01	0.1315E 01	0.1468E 01
0.1610E 01	0.1741E 01	0.1854E 01	0.1947E 01	0.2017E 01	0.2059E 01	0.2073E 01	0.2058E 01	0.2014E 01	0.1944E 01
0.1850E 01	0.1734E 01	0.1602E 01	0.1463E 01	0.1311E 01	0.1152E 01	0.9897E 00	0.8263E 00	0.6601E 00	0.4964E 00
0.3295E 00	0.1644E 00	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.11117E 04	0.12501E 04	0.23619E 04	0.88926E 00	0.11245E 01	0.20557E 02	0.55828E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.5750E 03	0.5666E 03	0.5376E 03	0.4868E 03	0.4077E 03	0.2996E 03	0.1605E 03	-0.4405E 01	-0.1843E 03	-0.3637E 03
-0.5276E 03	-0.6663E 03	-0.7734E 03	-0.8495E 03	-0.8996E 03	-0.9291E 03	-0.9343E 03			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.11117E 04	0.12501E 04	0.23619E 04	0.88926E 00	0.11245E 01	0.20557E 02	0.55828E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.5749E 03	0.5665E 03	0.5376E 03	0.4868E 03	0.4077E 03	0.2996E 03	0.1598E 03	-0.5576E 01	-0.1853E 03	-0.3647E 03
-0.5286E 03	-0.6662E 03	-0.7732E 03	-0.8503E 03	-0.9011E 03	-0.9298E 03	-0.9350E 03			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MINOR AXIS ELL. CYLINDER HAPPEL'S MODEL MARK= 1501

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	0.01	0.19936476 00	2.2396	1.4750	2.2800	0.0252	0.0982	33	33

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.5145E 00	0.1030E 01	0.1547E 01	0.2065E 01	0.2583E 01	0.3099E 01	0.3609E 01	0.4108E 01	0.4587E 01
0.5037E 01	0.5447E 01	0.5805E 01	0.6100E 01	0.6320E 01	0.6455E 01	0.6500E 01	0.6454E 01	0.6317E 01	0.6097E 01
0.5802E 01	0.5443E 01	0.5031E 01	0.4581E 01	0.4103E 01	0.3604E 01	0.3095E 01	0.2579E 01	0.2062E 01	0.1544E 01
0.1028E 01	0.5136E 00	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.34809E 04	0.48096E 04	0.82905E 04	0.72375E 00	0.13817E 01	0.84569E 01	0.55828E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1048E 04	0.1030E 04	0.9103E 03	0.7018E 03	0.3914E 03	-0.3136E 02	-0.5665E 03	-0.1189E 04	-0.1868E 04	-0.2564E 04
-0.3149E 04	-0.3702E 04	-0.4121E 04	-0.4431E 04	-0.4639E 04	-0.4758E 04	-0.4796E 04			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.34809E 04	0.48121E 04	0.82930E 04	0.72337E 00	0.13824E 01	0.84594E 01	0.55828E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1067E 04	0.1028E 04	0.9088E 03	0.7004E 03	0.3900E 03	-0.3329E 02	-0.5671E 03	-0.1191E 04	-0.1870E 04	-0.2546E 04
-0.3172E 04	-0.3705E 04	-0.4125E 04	-0.4435E 04	-0.4644E 04	-0.4763E 04	-0.4801E 04			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MINOR AXIS ELL. CYLINDER HAPPEL'S MODEL MARK= 1502

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	0.01	0.40160746 00	1.5780	1.4750	1.9300	0.0163	0.0982	33	29

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1489E 01	0.2981E 01	0.4478E 01	0.5982E 01	0.7489E 01	0.8991E 01	0.1048E 02	0.1193E 02	0.1333E 02
0.1465E 02	0.1585E 02	0.1699E 02	0.1775E 02	0.1839E 02	0.1879E 02	0.1892E 02	0.1879E 02	0.1839E 02	0.1775E 02
0.1689E 02	0.1584E 02	0.1464E 02	0.1333E 02	0.1193E 02	0.1047E 02	0.8986E 01	0.7484E 01	0.5979E 01	0.4475E 01
0.2978E 01	0.1488E 01	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.10125E 05	0.21924E 05	0.32050E 05	0.46183E 00	0.21653E 01	0.67757E 01	0.55828E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1722E 04	0.1526E 04	0.9273E 03	-0.9659E 02	-0.1578E 04	-0.3551E 04	-0.5982E 04	-0.8775E 04	-0.1178E 05	-0.1478E 05
-0.1768E 05	-0.2000E 05	-0.2197E 05	-0.2346E 05	-0.2448E 05	-0.2508E 05	-0.2527E 05			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.10125E 05	0.21908E 05	0.32033E 05	0.46217E 00	0.21637E 01	0.67722E 01	0.55828E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1720E 04	0.1523E 04	0.9241E 03	-0.9825E 02	-0.1575E 04	-0.3543E 04	-0.5978E 04	-0.8766E 04	-0.1177E 05	-0.1477E 05
-0.1757E 05	-0.1999E 05	-0.2195E 05	-0.2344E 05	-0.2447E 05	-0.2506E 05	-0.2526E 05			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MINOR AXIS ELL. CYLINDER HAPPEL'S MODEL MARK= 1503

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	0.01	0.59945056 00	1.2916	1.4750	1.7300	0.0128	0.0982	33	21

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.4599E 01	0.9210E 01	0.1384E 02	0.1849E 02	0.2315E 02	0.2779E 02	0.3239E 02	0.3689E 02	0.4121E 02
0.4527E 02	0.4897E 02	0.5220E 02	0.5485E 02	0.5683E 02	0.5805E 02	0.5846E 02	0.5805E 02	0.5683E 02	0.5485E 02
0.5219E 02	0.4896E 02	0.4536E 02	0.4120E 02	0.3698E 02	0.3238E 02	0.2779E 02	0.2314E 02	0.1848E 02	0.1384E 02
0.9207E 01	0.4599E 01	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.31293E 05	0.12244E 06	0.15373E 06	0.25557E 00	0.39128E 01	0.65306E 01	0.55828E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2811E 04	0.1643E 04	-0.1900E 04	-0.7948E 04	-0.1657E 05	-0.2777E 05	-0.4133E 05	-0.5672E 05	-0.7313E 05	-0.8954E 05
-0.1049E 06	-0.1185E 06	-0.1297E 06	-0.1383E 06	-0.1443E 06	-0.1479E 06	-0.1490E 06			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.31293E 05	0.12245E 06	0.15374E 06	0.25555E 00	0.39129E 01	0.65308E 01	0.55828E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2810E 04	0.1644E 04	-0.1910E 04	-0.7949E 04	-0.1657E 05	-0.2777E 05	-0.4133E 05	-0.5672E 05	-0.7314E 05	-0.8955E 05
-0.1049E 06	-0.1185E 06	-0.1297E 06	-0.1383E 06	-0.1443E 06	-0.1479E 06	-0.1490E 06			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MINOR AXIS ELL. CYLINDER HAPPEL'S MODEL MARK= 1529

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	0.01	0.2009378E-02	22.3084	0.5490	3.5950	0.0761	0.0982	33	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.4216E-01	0.8575E-01	0.1323E 00	0.1835E 00	0.2414E 00	0.3084E 00	0.3875E 00	0.4823E 00	0.5968E 00
0.7352E 00	0.9003E 00	0.1091E 01	0.1296E 01	0.1490E 01	0.1635E 01	0.1688E 01	0.1633E 01	0.1487E 01	0.1291E 01
0.1085E 01	0.8945E 00	0.7296E 00	0.5916E 00	0.4776E 00	0.3834E 00	0.3049E 00	0.2384E 00	0.1811E 00	0.1305E 00
0.8457E-01	0.4157E-01	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.35439E 03	0.70876E 03	0.10631E 04	0.50001E 00	0.20000E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.3160E 03	0.3192E 03	0.3286E 03	0.3430E 03	0.3586E 03	0.3636E 03	0.3287E 03	0.2035E 03	-0.2645E 02	-0.2557E 03
-0.3797E 03	-0.4134E 03	-0.4075E 03	-0.3914E 03	-0.3767E 03	-0.3671E 03	-0.3638E 03			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.35439E 03	0.71049E 03	0.10649E 04	0.49879E 00	0.20049E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.3166E 03	0.3199E 03	0.3294E 03	0.3440E 03	0.3601E 03	0.3664E 03	0.3333E 03	0.2083E 03	-0.2583E 02	-0.2593E 03
-0.3829E 03	-0.4149E 03	-0.4077E 03	-0.3910E 03	-0.3761E 03	-0.3664E 03	-0.3631E 03			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MINOR AXIS ELL. CYLINDER HAPPEL'S MODEL MARK= 1533

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	0.01	0.9853933E-02	10.0738	0.5490	2.8000	0.0703	0.0982	33	33

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.6428E-01	0.1307E 00	0.2017E 00	0.2797E 00	0.3679E 00	0.4700E 00	0.5904E 00	0.7347E 00	0.9091E 00
0.1120E 01	0.1371E 01	0.1661E 01	0.1976E 01	0.2271E 01	0.2491E 01	0.2573E 01	0.2489E 01	0.2266E 01	0.1968E 01
0.1655E 01	0.1365E 01	0.1114E 01	0.9037E 00	0.7298E 00	0.5861E 00	0.4663E 00	0.3648E 00	0.2772E 00	0.1998E 00
0.1295E 00	0.6366E-01	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.54026E 03	0.10936E 04	0.16239E 04	0.49856E 00	0.20058E 01	0.53530E 02	0.12509E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.4333E 03	0.4381E 03	0.4522E 03	0.4739E 03	0.4975E 03	0.5052E 03	0.4522E 03	0.2615E 03	-0.8979E 02	-0.4405E 03
-0.6298E 03	-0.6815E 03	-0.6729E 03	-0.6488E 03	-0.6266E 03	-0.6123E 03	-0.6074E 03			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.54026E 03	0.10853E 04	0.16256E 04	0.49778E 00	0.20089E 01	0.53585E 02	0.12509E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.4344E 03	0.4392E 03	0.4534E 03	0.4754E 03	0.4997E 03	0.5090E 03	0.4586E 03	0.2684E 03	-0.9840E 02	-0.4446E 03
-0.6334E 03	-0.6826E 03	-0.6723E 03	-0.6474E 03	-0.6250E 03	-0.6105E 03	-0.6056E 03			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MINOR AXIS ELL. CYLINDER HAPPEL'S MODEL MARK= 1504

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	0.01	0.3996782E-01	5.0020	0.5490	2.1000	0.0388	0.0982	33	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1203E 00	0.2445E 00	0.3768E 00	0.5220E 00	0.6855E 00	0.8743E 00	0.1096E 01	0.1362E 01	0.1682E 01
0.2068E 01	0.2528E 01	0.3058E 01	0.3630E 01	0.4173E 01	0.4577E 01	0.4728E 01	0.4575E 01	0.4169E 01	0.3624E 01
0.3052E 01	0.2521E 01	0.2061E 01	0.1676E 01	0.1356E 01	0.1082E 01	0.8702E 00	0.6821E 00	0.5191E 00	0.3747E 00
0.2430E 00	0.1195E 00	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.99596E 03	0.20758E 04	0.30718E 04	0.47979E 00	0.20842E 01	0.22755E 02	0.12509E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.6161E 03	0.6276E 03	0.6458E 03	0.6802E 03	0.7165E 03	0.7233E 03	0.6201E 03	0.2622E 03	-0.3981E 03	-0.1058E 04
-0.1415E 04	-0.1516E 04	-0.1507E 04	-0.1470E 04	-0.1435E 04	-0.1413E 04	-0.1405E 04			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.99596E 03	0.20756E 04	0.30716E 04	0.47984E 00	0.20840E 01	0.22754E 02	0.12509E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.6183E 03	0.6258E 03	0.6480E 03	0.6826E 03	0.7193E 03	0.7271E 03	0.6255E 03	0.2684E 03	-0.3949E 03	-0.1059E 04
-0.1415E 04	-0.1514E 04	-0.1504E 04	-0.1467E 04	-0.1431E 04	-0.1409E 04	-0.1401E 04			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MINOR AXIS ELL. CYLINDER HAPPEL'S MODEL MARK= 1505

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	0.01	0.1990136E 00	2.2416	0.5490	1.3000	0.0235	0.0982	33	33

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.5250E 00	0.1066E 01	0.1639E 01	0.2264E 01	0.2961E 01	0.3755E 01	0.4674E 01	0.5755E 01	0.7038E 01
0.8563E 01	0.1036E 02	0.1240E 02	0.1459E 02	0.1666E 02	0.1819E 02	0.1877E 02	0.1819E 02	0.1665E 02	0.1458E 02
0.1239E 02	0.1035E 02	0.8552E 01	0.7029E 01	0.5747E 01	0.4667E 01	0.3749E 01	0.2956E 01	0.2260E 01	0.1637E 01
0.1064E 01	0.5239E 00	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.40437E 04	0.12062E 05	0.16106E 05	0.33525E 00	0.29828E 01	0.13916E 02	0.12509E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1086E 04	0.1074E 04	0.1036E 04	0.9528E 03	0.7850E 03	0.4220E 03	-0.4336E 03	-0.2308E 04	-0.5354E 04	-0.8411E 04
-0.1028E 05	-0.1114E 05	-0.1150E 05	-0.1167E 05	-0.1175E 05	-0.1179E 05	-0.1180E 05			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.40437E 04	0.12058E 05	0.16102E 05	0.33536E 00	0.29819E 01	0.13913E 02	0.12509E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1093E 04	0.1080E 04	0.1042E 04	0.9582E 03	0.7899E 03	0.4298E 03	-0.4211E 03	-0.2293E 04	-0.5340E 04	-0.8403E 04
-0.1028E 05	-0.1113E 05	-0.1149E 05	-0.1165E 05	-0.1174E 05	-0.1177E 05	-0.1179E 05			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MINOR AXIS ELL. CYLINDER HAPPEL'S MODEL MARK= 1506

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	0.01	0.3992346E 00	1.5827	0.5490	0.9600	0.0147	0.0982	33	29

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1777E 01	0.3614E 01	0.5574E 01	0.7721E 01	0.1013E 02	0.1288E 02	0.1607E 02	0.1981E 02	0.2423E 02
0.2943E 02	0.3569E 02	0.4234E 02	0.4959E 02	0.5641E 02	0.6143E 02	0.6331E 02	0.6142E 02	0.5639E 02	0.4957E 02
0.4232E 02	0.3547E 02	0.2941E 02	0.2421E 02	0.1980E 02	0.1606E 02	0.1287E 02	0.1012E 02	0.7717E 01	0.5572E 01
0.3613E 01	0.1776E 01	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.13766E 05	0.68558E 05	0.82324E 05	0.20079E 00	0.49803E 01	0.14961E 02	0.12509E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1746E 04	0.1516E 04	0.7781E 03	-0.6041E 03	-0.2909E 04	-0.6593E 04	-0.1265E 05	-0.2266E 05	-0.3687E 05	-0.5107E 05
-0.6106E 05	-0.6710E 05	-0.7076E 05	-0.7304E 05	-0.7443E 05	-0.7517E 05	-0.7540E 05			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.13766E 05	0.68563E 05	0.82329E 05	0.20078E 00	0.49806E 01	0.14962E 02	0.12509E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1759E 04	0.1529E 04	0.7913E 03	-0.5928E 03	-0.2901E 04	-0.6586E 04	-0.1264E 05	-0.2264E 05	-0.3686E 05	-0.5107E 05
-0.6106E 05	-0.6710E 05	-0.7075E 05	-0.7303E 05	-0.7442E 05	-0.7517E 05	-0.7540E 05			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MINOR AXIS ELL. CYLINDER HAPPEL'S MODEL MARK= 1507

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	0.01	0.5858028E 00	1.3065	0.5490	0.7800	0.0115	0.0982	33	21

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.5591E 01	0.1138E 02	0.1758E 02	0.2440E 02	0.3209E 02	0.4093E 02	0.5126E 02	0.6344E 02	0.7790E 02
0.9503E 02	0.1150E 03	0.1376E 03	0.1615E 03	0.1839E 03	0.2004E 03	0.2065E 03	0.2003E 03	0.1839E 03	0.1615E 03
0.1376E 03	0.1150E 03	0.9500E 02	0.7788E 02	0.6342E 02	0.5124E 02	0.4092E 02	0.3208E 02	0.2439E 02	0.1757E 02
0.1138E 02	0.5591E 01	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.44657E 05	0.38657E 06	0.43122E 06	0.11552E 00	0.86564E 01	0.17503E 02	0.12509E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2870E 04	0.1246E 04	-0.3929E 04	-0.1355E 05	-0.2921E 05	-0.5353E 05	-0.9076E 05	-0.1462E 06	-0.2188E 06	-0.2913E 06
-0.3467E 06	-0.3839E 06	-0.4082E 06	-0.4238E 06	-0.4334E 06	-0.4386E 06	-0.4402E 06			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.44657E 05	0.38659E 06	0.43125E 06	0.11551E 00	0.86570E 01	0.17504E 02	0.12509E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2895E 04	0.1272E 04	-0.3902E 04	-0.1352E 05	-0.2918E 05	-0.5349E 05	-0.9072E 05	-0.1461E 06	-0.2187E 06	-0.2913E 06
-0.3467E 06	-0.3839E 06	-0.4082E 06	-0.4238E 06	-0.4334E 06	-0.4386E 06	-0.4402E 06			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MINOR AXIS ELL. CYLINDER HAPPEL'S MODEL MARK= 1530

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	0.01	0.2026551E-02	22.2137	0.2029	3.0100	0.0702	0.0982	33	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.2073E-01	0.4244E-01	0.6619E-01	0.9328E-01	0.1255E 00	0.1652E 00	0.2162E 00	0.2842E 00	0.3787E 00
0.5164E 00	0.7276E 00	0.1070E 01	0.1657E 01	0.2669E 01	0.4140E 01	0.5042E 01	0.4132E 01	0.2659E 01	0.1648E 01
0.1062E 01	0.7210E 00	0.5109E 00	0.3741E 00	0.2802E 00	0.2129E 00	0.1625E 00	0.1232E 00	0.9154E-01	0.6491E-01
0.4161E-01	0.2032E-01	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.21553E 03	0.10693E 04	0.12848E 04	0.20157E 00	0.49611E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.3646E 03	0.3721E 03	0.3957E 03	0.4399E 03	0.5139E 03	0.6345E 03	0.8196E 03	0.9770E 03	-0.4700E 02	-0.1018E 04
-0.9076E 03	-0.7216E 03	-0.6005E 03	-0.5263E 03	-0.4820E 03	-0.4582E 03	-0.4508E 03			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.21553E 03	0.10690E 04	0.12845E 04	0.20163E 00	0.49596E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.3660E 03	0.3734E 03	0.3969E 03	0.4408E 03	0.5144E 03	0.6352E 03	0.8262E 03	0.9624E 03	-0.4390E 02	-0.1047E 04
-0.9078E 03	-0.7158E 03	-0.5946E 03	-0.5208E 03	-0.4767E 03	-0.4531E 03	-0.4457E 03			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MINOR AXIS ELL. CYLINDER HAPPEL'S MODEL MARK= 1534

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	0.01	0.1003897E-01	9.9806	0.2029	2.2100	0.0627	0.0982	33	33

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.3759E-01	0.7684E-01	0.1196E 00	0.1681E 00	0.2253E 00	0.2956E 00	0.3854E 00	0.5045E 00	0.6696E 00
0.9093E 00	0.1276E 01	0.1871E 01	0.2888E 01	0.4647E 01	0.7208E 01	0.8779E 01	0.7200E 01	0.4636E 01	0.2878E 01
0.1862E 01	0.1269E 01	0.9029E 00	0.6641E 00	0.4998E 00	0.3814E 00	0.2924E 00	0.2227E 00	0.1660E 00	0.1180E 00
0.7582E-01	0.3708E-01	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.37649E 03	0.18932E 04	0.22697E 04	0.19886E 00	0.50285E 01	0.39055E 02	0.64900E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.5134E 03	0.5259E 03	0.5655E 03	0.6399E 03	0.7652E 03	0.9711E 03	0.1291E 04	0.1487E 04	-0.2220E 03	-0.1927E 04
-0.1728E 04	-0.1407E 04	-0.1200E 04	-0.1075E 04	-0.1000E 04	-0.9603E 03	-0.9478E 03			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.37649E 03	0.18918E 04	0.22683E 04	0.19901E 00	0.50249E 01	0.39031E 02	0.64900E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.5160E 03	0.5284E 03	0.5678E 03	0.6418E 03	0.7665E 03	0.9724E 03	0.1300E 04	0.1539E 04	-0.2165E 03	-0.1968E 04
-0.1726E 04	-0.1397E 04	-0.1191E 04	-0.1065E 04	-0.9911E 03	-0.9515E 03	-0.9391E 03			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MINOR AXIS ELL. CYLINDER HAPPEL'S MODEL MARK= 1508

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	0.01	0.3880194E-01	5.0766	0.2029	1.5350	0.0333	0.0982	33	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1045E 00	0.2125E 00	0.3281E 00	0.4563E 00	0.6034E 00	0.7788E 00	0.9965E 00	0.1278E 01	0.1661E 01
0.2206E 01	0.3030E 01	0.4355E 01	0.6613E 01	0.1052E 02	0.1625E 02	0.1976E 02	0.1624E 02	0.1051E 02	0.6598E 01
0.4342E 01	0.3019E 01	0.2197E 01	0.1653E 01	0.1272E 01	0.9999E 00	0.7742E 00	0.5995E 00	0.4532E 00	0.3258E 00
0.2110E 00	0.1037E 00	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.86455E 03	0.47816E 04	0.56461E 04	0.18081E 00	0.55307E 01	0.23008E 02	0.64900E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.7064E 03	0.7271E 03	0.7946E 03	0.9260E 03	0.1157E 04	0.1557E 04	0.2212E 04	0.2671E 04	-0.1288E 04	-0.5242E 04
-0.4776E 04	-0.4117E 04	-0.3716E 04	-0.3484E 04	-0.3352E 04	-0.3284E 04	-0.3263E 04			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.86455E 03	0.47749E 04	0.56394E 04	0.18106E 00	0.55230E 01	0.22981E 02	0.64900E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.7120E 03	0.7324E 03	0.7998E 03	0.9309E 03	0.1162E 04	0.1560E 04	0.2219E 04	0.2714E 04	-0.1278E 04	-0.5264E 04
-0.4763E 04	-0.4100E 04	-0.3700E 04	-0.3468E 04	-0.3337E 04	-0.3269E 04	-0.3248E 04			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MINOR AXIS ELL. CYLINDER HAPPEL'S MODEL MARK= 1509

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	0.01	0.2002396E 00	2.2347	0.2029	0.7400	0.0168	0.0982	33	33

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1011E 01	0.2041E 01	0.3187E 01	0.4438E 01	0.5871E 01	0.7556E 01	0.9598E 01	0.1215E 02	0.1545E 02
0.1992E 02	0.2631E 02	0.3611E 02	0.5222E 02	0.7955E 02	0.1192E 03	0.1435E 03	0.1192E 03	0.7950E 02	0.5217E 02
0.3607E 02	0.2628E 02	0.1989E 02	0.1443E 02	0.1213E 02	0.9587E 01	0.7548E 01	0.5865E 01	0.4435E 01	0.3185E 01
0.2059E 01	0.1011E 01	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.67248E 04	0.67678E 05	0.74403E 05	0.99363E-01	0.10064E 02	0.33843E 02	0.64900E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1289E 04	0.1216E 04	0.1008E 04	0.6802E 03	0.3391E 03	0.2759E 03	0.9866E 03	-0.3947E 03	-0.3309E 05	-0.6579E 05
-0.6715E 05	-0.6642E 05	-0.6648E 05	-0.6682E 05	-0.6714E 05	-0.6736E 05	-0.6743E 05			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.67248E 04	0.67672E 05	0.74397E 05	0.99372E-01	0.10063E 02	0.33840E 02	0.64900E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1305E 04	0.1232E 04	0.1025E 04	0.6943E 03	0.3520E 03	0.2885E 03	0.1004E 04	-0.3057E 03	-0.3306E 05	-0.6583E 05
-0.6713E 05	-0.6639E 05	-0.6644E 05	-0.6679E 05	-0.6712E 05	-0.6733E 05	-0.6740E 05			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MINOR AXIS ELL. CYLINDER HAPPEL'S MODEL MARK= 1510

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	0.01	0.4062584E 00	1.5689	0.2029	0.4500	0.0088	0.0982	33	29

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.4877E 01	0.9979E 01	0.1555E 02	0.2187E 02	0.2932E 02	0.3841E 02	0.4984E 02	0.6470E 02	0.8466E 02
0.1124E 03	0.1526E 03	0.2135E 03	0.3109E 03	0.4705E 03	0.4965E 03	0.8335E 03	0.6964E 03	0.4703E 03	0.3107E 03
0.2134E 03	0.1525E 03	0.1124E 03	0.8462E 02	0.6468E 02	0.4982E 02	0.3840E 02	0.2932E 02	0.2187E 02	0.1554E 02
0.9977E 01	0.4876E 01	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.39070E 05	0.80228E 06	0.84135E 06	0.46699E-01	0.20534E 02	0.77181E 02	0.64900E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2543E 04	0.1173E 04	-0.3173E 04	-0.1123E 05	-0.2452E 05	-0.4568E 05	-0.7978E 05	-0.1525E 06	-0.4242E 06	-0.6962E 06
-0.7688E 06	-0.8028E 06	-0.8239E 06	-0.8371E 06	-0.8452E 06	-0.8495E 06	-0.8509E 06			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.39070E 05	0.80192E 06	0.84099E 06	0.48721E-01	0.20525E 02	0.77148E 02	0.64900E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2577E 04	0.1203E 04	-0.3156E 04	-0.1121E 05	-0.2451E 05	-0.4568E 05	-0.7976E 05	-0.1524E 06	-0.4239E 06	-0.6959E 06
-0.7684E 06	-0.8023E 06	-0.8235E 06	-0.8367E 06	-0.8448E 06	-0.8492E 06	-0.8505E 06			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MINOR AXIS ELL. CYLINDER HAPPEL'S MODEL MARK= 1511

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	0.01	0.5985394E 00	1.2926	0.2029	0.3250	0.0061	0.0982	33	21

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1994E 02	0.4083E 02	0.6369E 02	0.8977E 02	0.1207E 03	0.1588E 03	0.2073E 03	0.2714E 03	0.3593E 03
0.4848E 03	0.6719E 03	0.9640E 03	0.1440E 04	0.2223E 04	0.3324E 04	0.3989E 04	0.3323E 04	0.2222E 04	0.1440E 04
0.9637E 03	0.6717E 03	0.4847E 03	0.3592E 03	0.2713E 03	0.2072E 03	0.1587E 03	0.1207E 03	0.8976E 02	0.6368E 02
0.4083E 02	0.1995E 02	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.18151E 06	0.74522E 07	0.76337E 07	0.24357E-01	0.41056E 02	0.14693E 03	0.64900E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.4972E 04	-0.7404E 04	-0.4703E 05	-0.1222E 06	-0.2509E 06	-0.4720E 06	-0.8772E 06	-0.1748E 07	-0.3987E 07	-0.6224E 07
-0.7094E 07	-0.7498E 07	-0.7719E 07	-0.7848E 07	-0.7923E 07	-0.7962E 07	-0.7975E 07			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.18151E 06	0.74523E 07	0.76338E 07	0.24356E-01	0.41057E 02	0.14693E 03	0.64900E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.5042E 04	-0.7331E 04	-0.4696E 05	-0.1221E 06	-0.2508E 06	-0.4719E 06	-0.8770E 06	-0.1747E 07	-0.3987E 07	-0.6225E 07
-0.7094E 07	-0.7498E 07	-0.7719E 07	-0.7848E 07	-0.7923E 07	-0.7962E 07	-0.7975E 07			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

Clusters of Elliptical Cylinders with O.R.< 1,Kuwabara's Model

FLOW ALONG MINOR AXIS ELL. CYLINDER KUWABARA'S MODEL MARK= 1280

A.R.	RF	CONCENTRATION	DM	X1	X2	A	B	IM	JM
1.00	0.01	0.2029529E-02	22.1974	4.0010	7.1000	0.0775	0.0982	33	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.8366E-01	0.1665E 00	0.2477E 00	0.3266E 00	0.4022E 00	0.4740E 00	0.5411E 00	0.6030E 00	0.6590E 00
0.7086E 00	0.7513E 00	0.7867E 00	0.8145E 00	0.8344E 00	0.8462E 00	0.8498E 00	0.8452E 00	0.8325E 00	0.8117E 00
0.7832E 00	0.7472E 00	0.7041E 00	0.6542E 00	0.5981E 00	0.5363E 00	0.4695E 00	0.3982E 00	0.3232E 00	0.2451E 00
0.1647E 00	0.8276E-01	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.53342E 03	0.53275E 03	0.10662E 04	0.10013E 01	0.99875E 00

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.3126E 03	0.3060E 03	0.2865E 03	0.2548E 03	0.2122E 03	0.1604E 03	0.1013E 03	0.3741E 02	-0.2890E 02	-0.9503E 02
-0.1584E 03	-0.2167E 03	-0.2576E 03	-0.3092E 03	-0.3401E 03	-0.3591E 03	-0.3656E 03			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.53342E 03	0.53347E 03	0.10669E 04	0.99990E 00	0.10001E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.3116E 03	0.3050E 03	0.2854E 03	0.2537E 03	0.2111E 03	0.1592E 03	0.1000E 03	0.3599E 02	-0.3042E 02	-0.9663E 02
-0.1601E 03	-0.2184E 03	-0.2694E 03	-0.3111E 03	-0.3420E 03	-0.3611E 03	-0.3675E 03			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MINOR AXIS ELL. CYLINDER KUWABARA'S MODEL MARK= 1276

A.R.	RF	CONCENTRATION	DM	X1	X2	A	B	IM	JM
1.00	0.01	0.1005208E-01	9.9741	4.0000	6.3000	0.0719	0.0982	33	33

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1249E 00	0.2485E 00	0.3698E 00	0.4874E 00	0.6004E 00	0.7075E 00	0.8078E 00	0.9003E 00	0.9841E 00
0.1058E 01	0.1122E 01	0.1175E 01	0.1217E 01	0.1247E 01	0.1265E 01	0.1270E 01	0.1264E 01	0.1245E 01	0.1214E 01
0.1172E 01	0.1118E 01	0.1053E 01	0.9790E 00	0.8951E 00	0.8028E 00	0.7028E 00	0.5961E 00	0.4838E 00	0.3669E 00
0.2466E 00	0.1239E 00	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.79742E 03	0.81272E 03	0.16101E 04	0.98117E 00	0.10192E 01	0.61831E 02	0.50034E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.4176E 03	0.4076E 03	0.3780E 03	0.3299E 03	0.2651E 03	0.1862E 03	0.9621E 02	-0.1249E 01	-0.1024E 03	-0.2033E 03
-0.3001E 03	-0.3890E 03	-0.4669E 03	-0.5306E 03	-0.5779E 03	-0.6070E 03	-0.6168E 03			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.79742E 03	0.81424E 03	0.16117E 04	0.97934E 00	0.10211E 01	0.61889E 02	0.50034E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.4163E 03	0.4063E 03	0.3766E 03	0.3284E 03	0.2635E 03	0.1844E 03	0.9418E 02	-0.3495E 01	-0.1048E 03	-0.2059E 03
-0.3028E 03	-0.3919E 03	-0.4699E 03	-0.5337E 03	-0.5811E 03	-0.6102E 03	-0.6200E 03			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MINOR AXIS ELL. CYLINDER KUWABARA'S MODEL MARK= 1279

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	0.01	0.2003842E-02	22.3392	1.4750	4.5900	0.0776	0.0982	33	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.7630E-01	0.1527E 00	0.2291E 00	0.3056E 00	0.3819E 00	0.4578E 00	0.5325E 00	0.6053E 00	0.6751E 00
0.7405E 00	0.8000E 00	0.8518E 00	0.8942E 00	0.9256E 00	0.9448E 00	0.9509E 00	0.9437E 00	0.9234E 00	0.8910E 00
0.8478E 00	0.7953E 00	0.7354E 00	0.6698E 00	0.6000E 00	0.5274E 00	0.4531E 00	0.3778E 00	0.3021E 00	0.2264E 00
0.1508E 00	0.7537E-01	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.5100E 03	0.5667E 03	0.1076E 04	0.9000E 00	0.1111E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.3134E 03	0.3091E 03	0.2958E 03	0.2721E 03	0.2366E 03	0.1871E 03	0.1240E 03	0.4923E 02	-0.3224E 02	-0.1135E 03
-0.1877E 03	-0.2500E 03	-0.2984E 03	-0.3332E 03	-0.3562E 03	-0.3691E 03	-0.3732E 03			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.5100E 03	0.5676E 03	0.1077E 04	0.8985E 00	0.1113E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.3128E 03	0.3085E 03	0.2953E 03	0.2717E 03	0.2360E 03	0.1867E 03	0.1235E 03	0.4853E 02	-0.3323E 02	-0.1148E 03
-0.1892E 03	-0.2516E 03	-0.3000E 03	-0.3348E 03	-0.3577E 03	-0.3705E 03	-0.3746E 03			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MINOR AXIS ELL. CYLINDER KUWABARA'S MODEL MARK= 1275

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	0.01	0.9924695E-02	10.0379	1.4750	3.7800	0.0720	0.0982	33	33

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1144E 00	0.2289E 00	0.3436E 00	0.4583E 00	0.5728E 00	0.6864E 00	0.7985E 00	0.9076E 00	0.1012E 01
0.1110E 01	0.1200E 01	0.1277E 01	0.1341E 01	0.1388E 01	0.1417E 01	0.1427E 01	0.1416E 01	0.1386E 01	0.1338E 01
0.1273E 01	0.1195E 01	0.1105E 01	0.1007E 01	0.9023E 00	0.7934E 00	0.6818E 00	0.5686E 00	0.4548E 00	0.3409E 00
0.2271E 00	0.1135E 00	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.7656E 03	0.8656E 03	0.1631E 04	0.8846E 00	0.1130E 01	0.6320E 02	0.5582E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.4181E 03	0.4115E 03	0.3910E 03	0.3547E 03	0.3001E 03	0.2248E 03	0.1287E 03	0.1483E 02	-0.1092E 03	-0.2331E 03
-0.3463E 03	-0.4416E 03	-0.5159E 03	-0.5696E 03	-0.6052E 03	-0.6252E 03	-0.6316E 03			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.7656E 03	0.8669E 03	0.1632E 04	0.8831E 00	0.1132E 01	0.6325E 02	0.5582E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.4174E 03	0.4109E 03	0.3904E 03	0.3542E 03	0.2996E 03	0.2244E 03	0.1281E 03	0.1392E 02	-0.1106E 03	-0.2348E 03
-0.3484E 03	-0.4438E 03	-0.5181E 03	-0.5717E 03	-0.6071E 03	-0.6271E 03	-0.6335E 03			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MINOR AXIS ELL. CYLINDER KUWABARA'S MODEL MARK= 1201

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.90	0.01	0.4024656E-01	4.9847	1.4750	3.0800	0.0401	0.0982	33	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1958E 00	0.3916E 00	0.5876E 00	0.7836E 00	0.9791E 00	0.1173E 01	0.1365E 01	0.1551E 01	0.1729E 01
0.1896E 01	0.2048E 01	0.2181E 01	0.2290E 01	0.2370E 01	0.2420E 01	0.2437E 01	0.2419E 01	0.2368E 01	0.2287E 01
0.2177E 01	0.2044E 01	0.1892E 01	0.1724E 01	0.1546E 01	0.1360E 01	0.1169E 01	0.9753E 00	0.7804E 00	0.5850E 00
0.3898E 00	0.1948E 00	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.1308E 04	0.1579E 04	0.2888E 04	0.8283E 00	0.1207E 01	0.2514E 02	0.5582E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.5739E 03	0.5613E 03	0.5226E 03	0.4548E 03	0.3533E 03	0.2150E 03	0.3964E 02	-0.1662E 03	-0.3901E 03	-0.6141E 03
-0.8197E 03	-0.9940E 03	-0.1131E 04	-0.1232E 04	-0.1299E 04	-0.1337E 04	-0.1350E 04			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.1308E 04	0.1580E 04	0.2888E 04	0.8282E 00	0.1207E 01	0.2514E 02	0.5582E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.5730E 03	0.5605E 03	0.5219E 03	0.4542E 03	0.3528E 03	0.2144E 03	0.3900E 02	-0.1668E 03	-0.3907E 03	-0.6149E 03
-0.8206E 03	-0.9949E 03	-0.1132E 04	-0.1232E 04	-0.1300E 04	-0.1338E 04	-0.1350E 04			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MINOR AXIS ELL. CYLINDER KUWABARA'S MODEL MARK= 1202

A.R.	RE	CONCENTRATION	OM	X1	X2	A	B	IM	JM
0.90	0.01	0.1993647E 00	2.2396	1.4750	2.2800	0.0252	0.0982	33	33

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.6153E 00	0.1230E 01	0.1845E 01	0.2458E 01	0.3068E 01	0.3671E 01	0.4263E 01	0.4838E 01	0.5386E 01
0.5898E 01	0.6362E 01	0.6766E 01	0.7096E 01	0.7342E 01	0.7494E 01	0.7544E 01	0.7492E 01	0.7339E 01	0.7093E 01
0.6761E 01	0.6357E 01	0.5893E 01	0.5380E 01	0.4832E 01	0.4258E 01	0.3666E 01	0.3064E 01	0.2455E 01	0.1842E 01
0.1228E 01	0.6142E 00	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.40681E 04	0.67784E 04	0.10847E 05	0.60015E 00	0.16662E 01	0.11064E 02	0.55828E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.9945E 03	0.9312E 03	0.7397E 03	0.4143E 03	-0.5365E 02	-0.6673E 03	-0.1416E 04	-0.2275E 04	-0.3198E 04	-0.4121E 04
-0.4979E 04	-0.5727E 04	-0.6337E 04	-0.6802E 04	-0.7127E 04	-0.7317E 04	-0.7380E 04			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.40681E 04	0.67817E 04	0.10850F 05	0.59986E 00	0.16671E 01	0.11068E 02	0.55828E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.9937E 03	0.9303E 03	0.7387E 03	0.4134E 03	-0.5512E 02	-0.6699E 03	-0.1419E 04	-0.2277E 04	-0.3201E 04	-0.4125E 04
-0.4983E 04	-0.5731E 04	-0.6342E 04	-0.6807E 04	-0.7132E 04	-0.7322E 04	-0.7385E 04			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MINOR AXIS ELL. CYLINDER KUWABARA'S MODEL MARK= 1203

A.R.	RE	CONCENTRATION	OM	X1	X2	A	B	IM	JM
0.90	0.01	0.4016074E 00	1.5780	1.4750	1.9300	0.0163	0.0982	33	29

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1711E 01	0.3421E 01	0.5130E 01	0.6835E 01	0.8530E 01	0.1021E 02	0.1185E 02	0.1344E 02	0.1497E 02
0.1639E 02	0.1767E 02	0.1879E 02	0.1971E 02	0.2039E 02	0.2081E 02	0.2095E 02	0.2081E 02	0.2038E 02	0.1970E 02
0.1879E 02	0.1767E 02	0.1698E 02	0.1496E 02	0.1344E 02	0.1184E 02	0.1020E 02	0.8525E 01	0.6831E 01	0.5127E 01
0.3419E 01	0.1710E 01	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.11303E 05	0.29457E 05	0.40760F 05	0.38371E 00	0.26062E 01	0.86171E 01	0.55828F 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1584E 04	0.1286E 04	0.3900E 03	-0.1115E 04	-0.3234E 04	-0.5948E 04	-0.9203E 04	-0.1288E 05	-0.1678E 05	-0.2069E 05
-0.2436E 05	-0.2761E 05	-0.3032E 05	-0.3243E 05	-0.3393E 05	-0.3483E 05	-0.3512E 05			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.11303E 05	0.29453E 05	0.40756F 05	0.38376E 00	0.26058E 01	0.86162E 01	0.55828F 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1583E 04	0.1286E 04	0.3897E 03	-0.1116E 04	-0.3236E 04	-0.5950E 04	-0.9206E 04	-0.1288E 05	-0.1678E 05	-0.2069E 05
-0.2436E 05	-0.2761E 05	-0.3031E 05	-0.3243E 05	-0.3393E 05	-0.3482E 05	-0.3512E 05			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MINOR AXIS ELL. CYLINDER KUWABARA'S MODEL MARK= 1204

A.R.	RE	CONCENTRATION	OM	X1	X2	A	B	IM	JM
0.90	0.01	0.5994505E 00	1.2916	1.4750	1.7300	0.0128	0.0982	33	21

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.5048F 01	0.1010E 02	0.1514E 02	0.2018E 02	0.2520E 02	0.3017E 02	0.3505E 02	0.3979E 02	0.4432F 02
0.4855E 02	0.5239E 02	0.5573E 02	0.5846E 02	0.6050E 02	0.6175E 02	0.6218E 02	0.6175E 02	0.6049E 02	0.5846E 02
0.5572E 02	0.5238E 02	0.4854E 02	0.4431F 02	0.3978E 02	0.3504E 02	0.3016E 02	0.2520E 02	0.2018F 02	0.1514F 02
0.1009E 02	0.5047E 01	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.33504E 05	0.14905E 06	0.18255E 06	0.22478E 00	0.44488E 01	0.77550F 01	0.55828F 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2623E 04	0.1067E 04	-0.3609E 04	-0.1141E 05	-0.2231E 05	-0.3616F 05	-0.5262E 05	-0.7107E 05	-0.9061E 05	-0.1101E 06
-0.1286E 06	-0.1450E 06	-0.1589E 06	-0.1698E 06	-0.1776E 06	-0.1822F 06	-0.1838E 06			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.33504E 05	0.14906E 06	0.18256E 06	0.22477E 00	0.44490E 01	0.77553E 01	0.55828E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2623E 04	0.1067E 04	-0.3608E 04	-0.1141E 05	-0.2231E 05	-0.3616F 05	-0.5262E 05	-0.7107E 05	-0.9062F 05	-0.1102F 06
-0.1286E 06	-0.1450E 06	-0.1589E 06	-0.1698E 06	-0.1776F 06	-0.1822E 06	-0.1838E 06			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MINOR AXIS ELL. CYLINDER KUWABARA'S MODEL MARK= 1278

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	0.01	0.2009378E-02	22.3084	0.5490	3.5950	0.0761	0.0982	33	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.4671E-01	0.9499E-01	0.1465E 00	0.2032E 00	0.2672E 00	0.3412E 00	0.4286E 00	0.5332E 00	0.6596E 00
0.8122E 00	0.9943E 00	0.1204E 01	0.1430E 01	0.1645E 01	0.1804E 01	0.1863E 01	0.1802E 01	0.1641E 01	0.1425E 01
0.1198E 01	0.9881E 00	0.8062E 00	0.6540E 00	0.5281E 00	0.4241E 00	0.3374E 00	0.2640E 00	0.2006E 00	0.1446E 00
0.9370E-01	0.4606E-01	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.39132E 03	0.78503E 03	0.11764E 04	0.49848E 00	0.20061E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.3292E 03	0.3326E 03	0.3428E 03	0.3583E 03	0.3751E 03	0.3802E 03	0.3413E 03	0.2030E 03	-0.5073E 02	-0.3039E 03
-0.4410E 03	-0.4787E 03	-0.4727E 03	-0.4552E 03	-0.4392E 03	-0.4288E 03	-0.4253E 03			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.39132E 03	0.78677E 03	0.11781E 04	0.49738E 00	0.20105E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.3299E 03	0.3334E 03	0.3436E 03	0.3594E 03	0.3768E 03	0.3832E 03	0.3463E 03	0.2083E 03	-0.4991E 02	-0.3076E 03
-0.4444E 03	-0.4801E 03	-0.4727E 03	-0.4546E 03	-0.4384E 03	-0.4279E 03	-0.4244E 03			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MINOR AXIS ELL. CYLINDER KUWABARA'S MODEL MARK= 1274

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	0.01	0.9853933E-02	10.0738	0.5490	2.8000	0.0703	0.0982	33	33

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.7371E-01	0.1498E 00	0.2310E 00	0.3200E 00	0.4203E 00	0.5360E 00	0.6723E 00	0.8351E 00	0.1031E 01
0.1268E 01	0.1551E 01	0.1876E 01	0.2227E 01	0.2559E 01	0.2807E 01	0.2898E 01	0.2804E 01	0.2555E 01	0.2221E 01
0.1870E 01	0.1544E 01	0.1262E 01	0.1026E 01	0.8299E 00	0.6676E 00	0.5320E 00	0.4169E 00	0.3173E 00	0.2290E 00
0.1485E 00	0.7304E-01	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.61046E 03	0.12465E 04	0.18570E 04	0.48972E 00	0.20420E 01	0.61214E 02	0.12509E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.4370E 03	0.4420E 03	0.4565E 03	0.4789E 03	0.5026E 03	0.5080E 03	0.4451E 03	0.2276E 03	-0.1698E 03	-0.5665E 03
-0.7826E 03	-0.8441E 03	-0.8377E 03	-0.8133E 03	-0.7905E 03	-0.7756E 03	-0.7706E 03			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.61046E 03	0.12485E 04	0.18590E 04	0.48896E 00	0.20452E 01	0.61278E 02	0.12509E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.4384E 03	0.4434E 03	0.4580E 03	0.4807E 03	0.5053E 03	0.5125E 03	0.4524E 03	0.2355E 03	-0.1681E 03	-0.5710E 03
-0.7864E 03	-0.8452E 03	-0.8369E 03	-0.8117E 03	-0.7885E 03	-0.7736E 03	-0.7685E 03			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MINOR AXIS ELL. CYLINDER KUWARARA'S MODEL MARK= 1207

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	0.01	0.2960614E-01	5.8118	0.5490	2.2500	0.0425	0.0982	33	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1188E 00	0.2413E 00	0.3713E 00	0.5134E 00	0.6726E 00	0.8553E 00	0.1069E 01	0.1324E 01	0.1630E 01
0.1998E 01	0.2435E 01	0.2939E 01	0.3481E 01	0.3996E 01	0.4379E 01	0.4521E 01	0.4376E 01	0.3991E 01	0.3475E 01
0.2932E 01	0.2428E 01	0.1991E 01	0.1623E 01	0.1318E 01	0.1064E 01	0.8511E 00	0.6691E 00	0.5106E 00	0.3692E 00
0.2399E 00	0.1181E 00	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.95765E 03	0.20403E 04	0.29980E 04	0.46937E 00	0.21305E 01	0.30962E 02	0.12509E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.5507E 03	0.5570E 03	0.5751E 03	0.6027E 03	0.6308E 03	0.6300E 03	0.5235E 03	0.1755E 03	-0.4589E 03	-0.1092E 04
-0.1437E 04	-0.1542E 04	-0.1541E 04	-0.1512E 04	-0.1484E 04	-0.1466E 04	-0.1460E 04			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.95765E 03	0.20397E 04	0.29973E 04	0.46951E 00	0.21299E 01	0.30956E 02	0.12509E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.5531E 03	0.5594E 03	0.5776E 03	0.6055E 03	0.6343E 03	0.6348E 03	0.5303E 03	0.1831E 03	-0.4554E 03	-0.1092E 04
-0.1437E 04	-0.1539E 04	-0.1537E 04	-0.1508E 04	-0.1479E 04	-0.1461E 04	-0.1455E 04			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MINOR AXIS ELL. CYLINDER KUWABARA'S MODEL MARK= 1227

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	0.01	0.3996782E-01	5.0020	0.5490	2.1000	0.0388	0.0982	33	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1407E 00	0.2856E 00	0.4392E 00	0.6066E 00	0.7938E 00	0.1008E 01	0.1259E 01	0.1556E 01	0.1912E 01
0.2340E 01	0.2849E 01	0.3432E 01	0.4061E 01	0.4658E 01	0.5102E 01	0.5267E 01	0.5099E 01	0.4653E 01	0.4055E 01
0.3425E 01	0.2840E 01	0.2332E 01	0.1905E 01	0.1550E 01	0.1253E 01	0.1004E 01	0.7901E 00	0.6036E 00	0.4369E 00
0.2840E 00	0.1399E 00	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.11190E 04	0.24425E 04	0.35615E 04	0.45812E 00	0.21828E 01	0.26383E 02	0.12509E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.5908E 03	0.5969E 03	0.6149E 03	0.6420E 03	0.6675E 03	0.6579E 03	0.5256E 03	0.1142E 03	-0.6290E 03	-0.1373E 04
-0.1782E 04	-0.1912E 04	-0.1919E 04	-0.1892E 04	-0.1864E 04	-0.1846E 04	-0.1840E 04			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.11190E 04	0.24421E 04	0.35611E 04	0.45819E 00	0.21825E 01	0.26380E 02	0.12509E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.5936E 03	0.5997E 03	0.6177E 03	0.6450E 03	0.6706E 03	0.6617E 03	0.5309E 03	0.1204E 03	-0.6267E 03	-0.1373E 04
-0.1782E 04	-0.1909E 04	-0.1915E 04	-0.1888E 04	-0.1860E 04	-0.1842E 04	-0.1835E 04			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MINOR AXIS ELL. CYLINDER KUWABARA'S MODEL MARK= 1205

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	0.01	0.1500525E 00	2.5815	0.5490	1.4400	0.0378	0.0982	33	33

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.4156E 00	0.8419E 00	0.1290E 01	0.1774E 01	0.2308E 01	0.2910E 01	0.3602E 01	0.4411E 01	0.5368E 01
0.6504E 01	0.7839E 01	0.9363E 01	0.1099E 02	0.1256E 02	0.1368E 02	0.1411E 02	0.1368E 02	0.1253E 02	0.1099E 02
0.9352E 01	0.7829E 01	0.6494E 01	0.5359E 01	0.4403E 01	0.3595E 01	0.2904E 01	0.2303E 01	0.1771E 01	0.1288E 01
0.8401E 00	0.4146E 00	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.30594E 04	0.85976E 04	0.11657E 05	0.35585E 00	0.28102E 01	0.15961E 02	0.12509E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.8873E 03	0.8775E 03	0.8466E 03	0.7877E 03	0.6764E 03	0.4322E 03	-0.1610E 03	-0.1500E 04	-0.3708E 04	-0.5916E 04
-0.7250E 04	-0.7838E 04	-0.8079E 04	-0.8188E 04	-0.8245E 04	-0.8275E 04	-0.8285E 04			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.30594E 04	0.85975E 04	0.11657E 05	0.35585E 00	0.28102E 01	0.15961E 02	0.12509E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.8940E 03	0.8841E 03	0.8529E 03	0.7936E 03	0.6825E 03	0.4399E 03	-0.1503E 03	-0.1488E 04	-0.3701E 04	-0.5915E 04
-0.7246E 04	-0.7832E 04	-0.8071E 04	-0.8180E 04	-0.8237E 04	-0.8268E 04	-0.8277E 04			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MINOR AXIS ELL. CYLINDER KUWABARA'S MODEL MARK= 1229

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	0.01	0.1990136E 00	2.2416	0.5490	1.3000	0.0235	0.0982	33	33

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.5845E 00	0.1184E 01	0.1814E 01	0.2493E 01	0.3241E 01	0.4084E 01	0.5051E 01	0.6177E 01	0.7505E 01
0.9075E 01	0.1091E 02	0.1301E 02	0.1524E 02	0.1735E 02	0.1892E 02	0.1950E 02	0.1892E 02	0.1735E 02	0.1523E 02
0.1300E 02	0.1090E 02	0.9064E 01	0.7495E 01	0.6169E 01	0.5043E 01	0.4078E 01	0.3237E 01	0.2489E 01	0.1811E 01
0.1182E 01	0.5833E 00	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.42501E 04	0.13384E 05	0.17634E 05	0.31755E 00	0.31491E 01	0.15237E 02	0.12509E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1009E 04	0.9798E 03	0.8915E 03	0.7320E 03	0.4617E 03	-0.2356E 02	-0.1017E 04	-0.3045E 04	-0.6275E 04	-0.9511E 04
-0.1154E 05	-0.1253E 05	-0.1301E 05	-0.1328E 05	-0.1344E 05	-0.1352E 05	-0.1355E 05			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.42501E 04	0.13390E 05	0.17640E 05	0.31742E 00	0.31504E 01	0.15242E 02	0.12509E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1017E 04	0.9877E 03	0.8991E 03	0.7390E 03	0.4668E 03	-0.1797E 02	-0.1009E 04	-0.3034E 04	-0.6267E 04	-0.9510E 04
-0.1154E 05	-0.1253E 05	-0.1301E 05	-0.1328E 05	-0.1343E 05	-0.1352E 05	-0.1355E 05			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MINOR AXIS ELL. CYLINDER KUWABARA'S MODEL MARK= 1206

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	0.01	0.2989220E 00	1.8290	0.5490	1.1000	0.0197	0.0982	33	29

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1075E 01	0.2179E 01	0.3342E 01	0.4599E 01	0.5987E 01	0.7551E 01	0.9344E 01	0.1143E 02	0.1388E 02
0.1677E 02	0.2014E 02	0.2395E 02	0.2801E 02	0.3183E 02	0.3465E 02	0.3570E 02	0.3464E 02	0.3182E 02	0.2799E 02
0.2394E 02	0.2013E 02	0.1676E 02	0.1387E 02	0.1142E 02	0.9336E 01	0.7543E 01	0.5981E 01	0.4595E 01	0.3340E 01
0.2178E 01	0.1074E 01	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.78173E 04	0.31256E 05	0.39073E 05	0.25011E 00	0.39983E 01	0.15072E 02	0.12509E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1288E 04	0.1180E 04	0.8480E 03	0.2487E 03	-0.6885E 03	-0.2183E 04	-0.4764E 04	-0.9375E 04	-0.1621E 05	-0.2303E 05
-0.2761E 05	-0.3019E 05	-0.3168E 05	-0.3261E 05	-0.3320E 05	-0.3354E 05	-0.3365E 05			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.78173E 04	0.31279E 05	0.39096E 05	0.24992E 00	0.40012E 01	0.15081E 02	0.12509E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1300E 04	0.1191E 04	0.8593E 03	0.2566E 03	-0.6801E 03	-0.2170E 04	-0.4746E 04	-0.9365E 04	-0.1622E 05	-0.2304E 05
-0.2762E 05	-0.3020E 05	-0.3169E 05	-0.3263E 05	-0.3322E 05	-0.3355E 05	-0.3366E 05			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MINOR AXIS ELL. CYLINDER KUWABARA'S MODEL MARK= 1228

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	0.01	0.3992346E 00	1.5827	0.5490	0.9600	0.0147	0.0982	33	29

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1904E 01	0.3862E 01	0.5932E 01	0.8176E 01	0.1067E 02	0.1349E 02	0.1673E 02	0.2051E 02	0.2496E 02
0.3020E 02	0.3629E 02	0.4317E 02	0.5066E 02	0.5730E 02	0.6235E 02	0.6424E 02	0.6234E 02	0.5729E 02	0.5064E 02
0.4316E 02	0.3628E 02	0.3018E 02	0.2495E 02	0.2050E 02	0.1672E 02	0.1348E 02	0.1066E 02	0.8172E 01	0.5930E 01
0.3861E 01	0.1903E 01	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.14065E 05	0.72305E 05	0.86370E 05	0.19452E 00	0.51408E 01	0.15696E 02	0.12509E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1645E 04	0.1341E 04	0.3999E 03	-0.1281E 04	-0.3929E 04	-0.7966E 04	-0.1440E 05	-0.2482E 05	-0.3944E 05	-0.5406E 05
-0.6448E 05	-0.7092E 05	-0.7497E 05	-0.7761E 05	-0.7928E 05	-0.8022E 05	-0.8052E 05			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.14065E 05	0.72304E 05	0.86369E 05	0.19453E 00	0.51407E 01	0.15696E 02	0.12509E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1661E 04	0.1358E 04	0.4121E 03	-0.1271E 04	-0.3925E 04	-0.7951E 04	-0.1437E 05	-0.2480E 05	-0.3941E 05	-0.5403E 05
-0.6445E 05	-0.7091E 05	-0.7495E 05	-0.7759E 05	-0.7927E 05	-0.8021E 05	-0.8051E 05			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MINOR AXIS ELL. CYLINDER KUWABARA'S MODEL MARK= 1225

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.50	0.01	0.5858028E 00	1.3065	0.5490	0.7800	0.0115	0.0982	33	21

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.5851E 01	0.1188E 02	0.1829E 02	0.2528E 02	0.3311E 02	0.4204E 02	0.5243E 02	0.6465E 02	0.7914E 02
0.9628E 02	0.1163E 03	0.1389E 03	0.1628E 03	0.1852E 03	0.2017E 03	0.2078E 03	0.2017E 03	0.1852E 03	0.1628E 03
0.1389E 03	0.1163E 03	0.9625E 02	0.7911E 02	0.6443E 02	0.5241E 02	0.4203E 02	0.3310E 02	0.2528E 02	0.1829E 02
0.1188E 02	0.5851E 01	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.45135E 05	0.39789E 06	0.44302E 06	0.11344E 00	0.88156E 01	0.17982E 02	0.12509E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2751E 04	0.8674E 03	-0.5012E 04	-0.1562E 05	-0.3241E 05	-0.5790E 05	-0.9631E 05	-0.1529E 06	-0.2267E 06	-0.3006E 06
-0.3670E 06	-0.3954E 06	-0.4208E 06	-0.4376E 06	-0.4482E 06	-0.4540E 06	-0.4559E 06			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.45135E 05	0.39790E 06	0.44303E 06	0.11343E 00	0.88157E 01	0.17983E 02	0.12509E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2779E 04	0.8962E 03	-0.4983E 04	-0.1559E 05	-0.3238E 05	-0.5786E 05	-0.9627E 05	-0.1529E 06	-0.2267E 06	-0.3006E 06
-0.3670E 06	-0.3953E 06	-0.4208E 06	-0.4375E 06	-0.4481E 06	-0.4540E 06	-0.4559E 06			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MINOR AXIS ELL. CYLINDER KUWABARA'S MODEL MARK= 1277

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	0.01	0.2026551E-02	22.2137	0.2029	3.0100	0.0702	0.0982	33	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.2364E-01	0.4834E-01	0.7529E-01	0.1059E 00	0.1422E 00	0.1869E 00	0.2440E 00	0.3200E 00	0.4256E 00
0.5789E 00	0.8138E 00	0.1195E 01	0.1847E 01	0.2971E 01	0.4604E 01	0.5408E 01	0.4598E 01	0.2961E 01	0.1837E 01
0.1186E 01	0.8065E 00	0.5728E 00	0.4203E 00	0.3157E 00	0.2404E 00	0.1839E 00	0.1398E 00	0.1040E 00	0.7386E-01
0.4739E-01	0.2316E-01	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.24025E 03	0.12004E 04	0.14407E 04	0.20013E 00	0.49967E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.3721E 03	0.3803E 03	0.4061E 03	0.4545E 03	0.5357E 03	0.6685E 03	0.8725E 03	0.9902E 03	-0.9337E 02	-0.1173E 04
-0.1053E 04	-0.8472E 03	-0.7138E 03	-0.6322E 03	-0.5837E 03	-0.5577E 03	-0.5496E 03			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS
0.24025E 03	0.12002E 04	0.14404E 04	0.20018E 00	0.49956E 01

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.3737E 03	0.3818E 03	0.4075E 03	0.4556E 03	0.5363E 03	0.6693E 03	0.8798E 03	0.1029E 04	-0.9004E 02	-0.1205E 04
-0.1053E 04	-0.8408E 03	-0.7072E 03	-0.6261E 03	-0.5779E 03	-0.5521E 03	-0.5440E 03			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MINOR AXIS ELL. CYLINDER KUWABARA'S MODEL MARK= 1273

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	0.01	0.1003897E-01	9.9806	0.2029	2.2100	0.0627	0.0982	33	33

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.4505E-01	0.9190E-01	0.1425E 00	0.1994E 00	0.2658E 00	0.3465E 00	0.4484E 00	0.5825E 00	0.7671E 00
0.1034E 01	0.1441E 01	0.2099E 01	0.3223E 01	0.5166E 01	0.7994E 01	0.9729E 01	0.7985E 01	0.5154E 01	0.3212E 01
0.2089E 01	0.1433E 01	0.1027E 01	0.7613E 00	0.5776E 00	0.4442E 00	0.3430E 00	0.2630E 00	0.1972E 00	0.1409E 00
0.9081E-01	0.4452E-01	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.42021E 03	0.21576E 04	0.25778E 04	0.19476E 00	0.51346E 01	0.44356E 02	0.64900E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.4964E 03	0.5093E 03	0.5506E 03	0.6288E 03	0.7617E 03	0.9825E 03	0.1328E 04	0.1536E 04	-0.3583E 03	-0.2249E 04
-0.2038E 04	-0.1691E 04	-0.1469E 04	-0.1336E 04	-0.1257E 04	-0.1216E 04	-0.1203E 04			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.42021E 03	0.21561E 04	0.25763E 04	0.19480E 00	0.51311E 01	0.44332E 02	0.64900E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.4996E 03	0.5124E 03	0.5534E 03	0.6311E 03	0.7634E 03	0.9842E 03	0.1338E 04	0.1594E 04	-0.3520E 03	-0.2294E 04
-0.2035E 04	-0.1679E 04	-0.1458E 04	-0.1325E 04	-0.1247E 04	-0.1206E 04	-0.1193E 04			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MINOR AXIS ELL. CYLINDER KUWABARA'S MODEL MARK= 1211

A.R.	RE	CONCENTRATION	DM	X1	X2	A	B	IM	JM
0.20	0.01	0.3880194E-01	5.0766	0.2029	1.5350	0.0333	0.0982	33	41

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1215E 00	0.2465E 00	0.3792E 00	0.5245E 00	0.6891E 00	0.8826E 00	0.1120E 01	0.1423E 01	0.1930E 01
0.2407E 01	0.3275E 01	0.4667E 01	0.7034E 01	0.1113E 02	0.1713E 02	0.2081E 02	0.1712E 02	0.1112E 02	0.7020E 01
0.4654E 01	0.3265E 01	0.2398E 01	0.1822E 01	0.1416E 01	0.1114E 01	0.8779E 00	0.6852E 00	0.5214E 00	0.3769E 00
0.2450E 00	0.1207E 00	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.91999E 03	0.52507E 04	0.61707E 04	0.17521E 00	0.57073E 01	0.25146E 02	0.64900E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.6571E 03	0.6759E 03	0.7375E 03	0.8609E 03	0.1085E 04	0.1480E 04	0.2143E 04	0.2597E 04	-0.1581E 04	-0.5756E 04
-0.5300E 04	-0.4635E 04	-0.4238E 04	-0.4014E 04	-0.3889E 04	-0.3827E 04	-0.3808E 04			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.91999E 03	0.52497E 04	0.61697E 04	0.17525E 00	0.57062E 01	0.25142E 02	0.64900E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.6636E 03	0.6823E 03	0.7437E 03	0.8668E 03	0.1090E 04	0.1485E 04	0.2152E 04	0.2643E 04	-0.1572E 04	-0.5785E 04
-0.5292E 04	-0.4623E 04	-0.4226E 04	-0.4002E 04	-0.3879E 04	-0.3816E 04	-0.3798E 04			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MINOR AXIS ELL. CYLINDER KUWABARA'S MODEL MARK= 1209

A.R.	RF	CONCENTRATION	OM	X1	X2	A	B	IM	JM
0.20	0.01	0.20023396E 00	2.2347	0.2029	0.7400	0.0168	0.0982	33	33

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.1031E 01	0.2099E 01	0.3244E 01	0.4512E 01	0.5962E 01	0.7664E 01	0.9724E 01	0.1229E 02	0.1562E 02
0.2011E 02	0.2453E 02	0.3637E 02	0.5253E 02	0.7992E 02	0.1197E 03	0.1441E 03	0.1197E 03	0.7987E 02	0.5247E 02
0.3632E 02	0.2650E 02	0.2008E 02	0.1559E 02	0.1238E 02	0.9713E 01	0.7657E 01	0.5956E 01	0.4509E 01	0.3241E 01
0.2097E 01	0.1030E 01	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.67634E 04	0.48515E 05	0.75279E 05	0.98714E-01	0.10130E 02	0.34241E 02	0.64900E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1261E 04	0.1177E 04	0.9310E 03	0.5475E 03	0.1388E 03	-0.4643E 01	0.6440E 03	-0.8287E 03	-0.3368E 05	-0.6652E 05
-0.6795E 05	-0.6720E 05	-0.6741E 05	-0.6782E 05	-0.6820E 05	-0.6845E 05	-0.6853E 05			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.67634E 04	0.48459E 05	0.75222E 05	0.98794E-01	0.10122E 02	0.34215E 02	0.64900E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.1278E 04	0.1193E 04	0.9440E 03	0.5545E 03	0.1415E 03	-0.5922E 01	0.6557E 03	-0.7434E 03	-0.3363E 05	-0.6651E 05
-0.6787E 05	-0.6720E 05	-0.6733E 05	-0.6774E 05	-0.6813E 05	-0.6838E 05	-0.6846E 05			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MINOR AXIS ELL. CYLINDER KUWABARA'S MODEL MARK= 1210

A.R.	RF	CONCENTRATION	OM	X1	X2	A	B	IM	JM
0.20	0.01	0.40425846E 00	1.5689	0.2029	0.4500	0.0088	0.0982	33	29

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.4930E 01	0.1008E 02	0.1568E 02	0.2203E 02	0.2960E 02	0.3859E 02	0.5003E 02	0.6489E 02	0.8487E 02
0.1126E 03	0.1528E 03	0.2139E 03	0.3113E 03	0.4709E 03	0.6971E 03	0.8361E 03	0.6960E 03	0.4707E 03	0.3111E 03
0.2137E 03	0.1528E 03	0.1125E 03	0.8482E 02	0.6486E 02	0.5001E 02	0.3858E 02	0.2949E 02	0.2203E 02	0.1568E 02
0.1008E 02	0.4930E 01	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.39118E 05	0.80743E 06	0.84655E 06	0.48448E-01	0.20641E 02	0.77658E 02	0.64900E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2508E 04	0.1057E 04	-0.3514E 04	-0.1189E 05	-0.2556E 05	-0.4710E 05	-0.8164E 05	-0.1549E 06	-0.4279E 06	-0.7010E 06
-0.7736E 06	-0.8081E 06	-0.8295E 06	-0.8430E 06	-0.8514E 06	-0.8559E 06	-0.8574E 06			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.39118E 05	0.80816E 06	0.84728E 06	0.48404E-01	0.20659E 02	0.77725E 02	0.64900E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.2544E 04	0.1080E 04	-0.3520E 04	-0.1195E 05	-0.2569E 05	-0.4730E 05	-0.8189E 05	-0.1552E 06	-0.4284E 06	-0.7018E 06
-0.7743E 06	-0.8089E 06	-0.8303E 06	-0.8438E 06	-0.8522E 06	-0.8568E 06	-0.8582E 06			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

FLOW ALONG MINOR AXIS ELL. CYLINDER KUWABARA'S MODEL MARK= 1212

A.R.	RF	CONCENTRATION	OM	X1	X2	A	B	IM	JM
0.20	0.01	0.59853946E 00	1.2926	0.2029	0.3250	0.0061	0.0982	33	21

DIMENSIONLESS SURFACE VORTICITY DISTRIBUTION AT 5.63 DEGREES INTERVAL

0.0	0.2013E 02	0.4118E 02	0.6418E 02	0.9034E 02	0.1213E 03	0.1594E 03	0.2079E 03	0.2720E 03	0.3599E 03
0.4854E 03	0.6725E 03	0.9666E 03	0.1441E 04	0.2224E 04	0.3325E 04	0.3990E 04	0.3324E 04	0.2223E 04	0.1440E 04
0.9644E 03	0.6724E 03	0.4853E 03	0.3599E 03	0.2720E 03	0.2079E 03	0.1594E 03	0.1213E 03	0.9034E 02	0.6417E 02
0.4118E 02	0.2013E 02	0.0							

THREE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.18162E 06	0.74654E 07	0.76470E 07	0.24328E-01	0.41105E 02	0.14719E 03	0.64900E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.4923E 04	-0.7830E 04	-0.4840E 05	-0.1247E 06	-0.2547E 06	-0.4768E 06	-0.8834E 06	-0.1755E 07	-0.3995E 07	-0.6234E 07
-0.7105E 07	-0.7511E 07	-0.7734E 07	-0.7864E 07	-0.7940E 07	-0.7981E 07	-0.7993E 07			

FIVE POINTS LAGRANGE DIFFERENTIATION FORMULA SIMPSON'S RULE FOR INTEGRATION

CDS	CDF	CDT	CDS/CDF	CDF/CDS	K1	K2
0.18162E 06	0.74659E 07	0.76475E 07	0.24326E-01	0.41108E 02	0.14720E 03	0.64900E 02

DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION AT 11.25 DEGREES INTERVAL

0.4995E 04	-0.7767E 04	-0.4835E 05	-0.1247E 06	-0.2546E 06	-0.4766E 06	-0.8831E 06	-0.1754E 07	-0.3995E 07	-0.6235E 07
-0.7105E 07	-0.7512E 07	-0.7734E 07	-0.7864E 07	-0.7941E 07	-0.7981E 07	-0.7994E 07			

SURFACE SHEAR STRESS IS POSITIVE EVERYWHERE

APPENDIX III

1. Evaluation of the Kozeny Constant from Basic Definition

The basic definition of the Kozeny constant is given by

$$k = \frac{\varepsilon^3}{U\mu\ (1-\varepsilon)^2\ S_v^2}\ \frac{\Delta P'}{L'} \qquad \text{(III.1)}$$

where ε is the porosity of the bed , S_v the specific surface of the particle and $\Delta P'$ the pressure drop across the bed of length L'

A. Spheroids

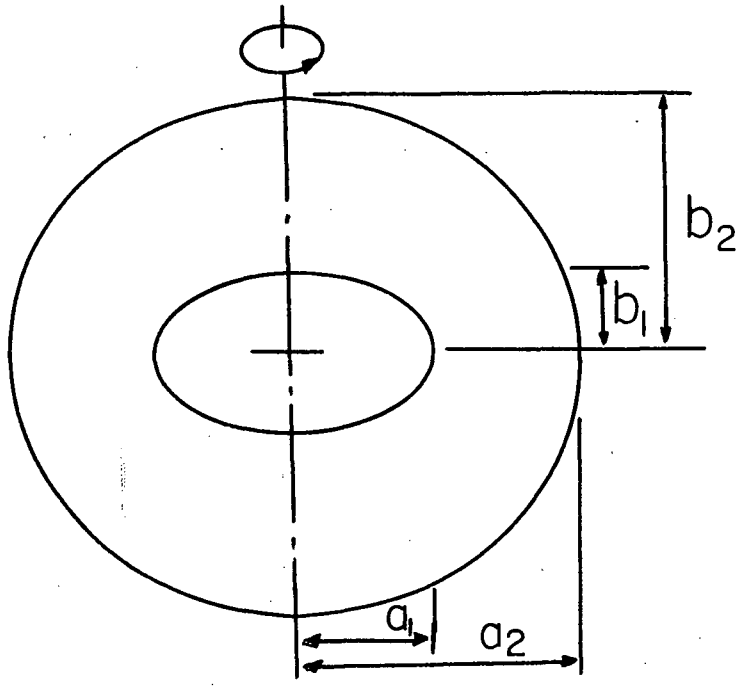

Diagram III.1 Oblate spheroid cell model

The total drag force associated with an oblate spheroid in a swarm may be related to the pressure gradient through the corresponding cell as follows :

$$\frac{\Delta P'}{L'} = \frac{F}{\frac{4}{3}\pi\ b_2\ a_2^2} \qquad \text{(III.2)}$$

The total drag coefficient is given by

$$C_{DT} = \frac{F}{\frac{1}{2}\rho U^2 \pi a_1^2} \qquad \text{(III.3)}$$

and the surface area of an oblate spheroid is

$$2\pi a_1^2 + \frac{\pi b_1^2}{(1 - r^2)^{1/2}} \ln \frac{1 + (1 - r^2)^{1/2}}{1 - (1 - r^2)^{1/2}} ,$$

where $r = b_1 / a_1$ (= aspect ratio) .

The latter expression leads to

$$S_V = \frac{2\pi a_1^2 + \frac{\pi b_1^2}{(1 - r^2)^{1/2}} \ln \frac{1 + (1 - r^2)^{1/2}}{1 - (1 - r^2)^{1/2}}}{\frac{4}{3}\pi a_1^2 b_1} \qquad \text{(III.4)}$$

Combining equatios III.1 - III.4 yields

$$k = \frac{1}{12} C_{DT} \frac{\varepsilon^3 Re}{(1 - \varepsilon) r m^2} \qquad \text{(III.5)}$$

where $Re = 2 a_1 U\rho/\mu$, $1-\varepsilon = c = a_1^2 b_1 / a_2^2 b_2$, and

$$m = \frac{1}{r} + \frac{r}{2(1 - r^2)^{1/2}} \ln \frac{1 + (1 - r^2)^{1/2}}{1 - (1 - r^2)^{1/2}}$$

The term $1/rm^2$ is the only shape dependent term in equation III.5 for the Kozeny constant . For the prolate spheroid ,

$$m = 1 + \frac{\sin^{-1} (1 - r^2)^{1/2}}{r (1 - r^2)^{1/2}} ,$$

r remains the aspect ratio and Re is again based on the equatorial diameter of the spheroid .

B. Elliptical Cylinders

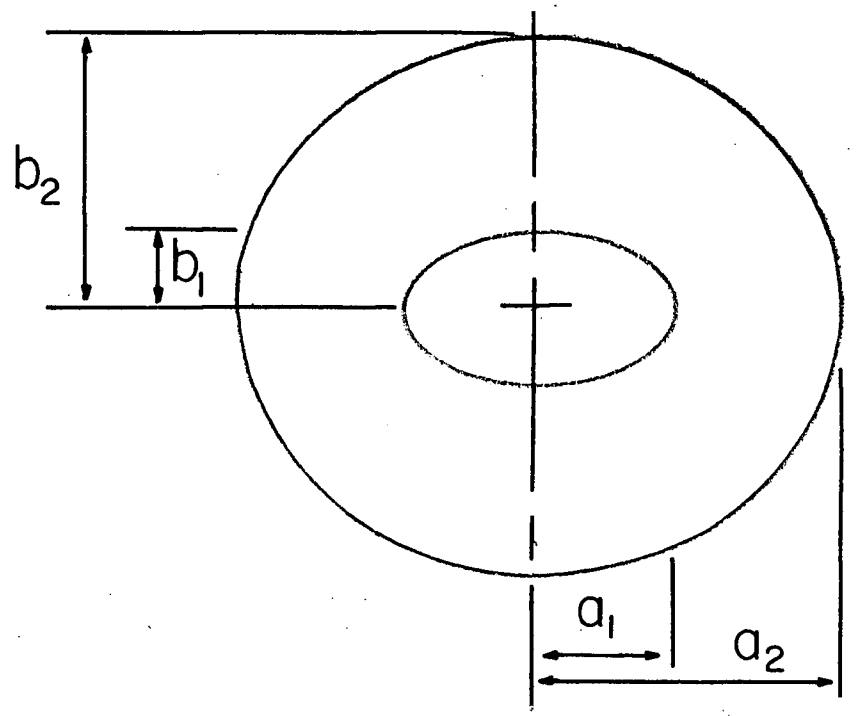

Diagram III.2 Elliptical cell model

The total drag force per unit volume of a cell associated with an elliptical cylinder may be equated to the pressure gradient through the array of cylinders giving

$$\frac{\Delta P'}{L'} = \frac{F}{\pi a_2 b_2} \qquad \text{(III.6)}$$

The circumference of an ellipse is given by

$$C_r = \pi(a_1 + b_1) X \qquad \text{(III.7)}$$

where

$$X = 1 + \frac{Y^2}{4} + \frac{Y^4}{64} + \frac{Y^6}{256} + \frac{25Y^8}{16384} + \cdots \quad , \quad Y = \frac{1-r}{1+r} \quad ,$$

and $r = b_1 / a_1$ (= aspect ratio) . The specific surface, S_V, is then given by

$$S_V = C_r / \pi a_1 b_1 \qquad \text{(III.8)}$$

For flow perpendicular to the major axis (O.R.≤1.0) , by definition

$$C_{DT} = \frac{F}{\frac{1}{2}\rho U^2 \; 2\, a_1} \qquad \text{(III.9)}$$

and $Re = 2a_1 \rho U/\mu$ (III.10)

Combining equations III.1 and III.6 - III.10 yields

$$k = \frac{\varepsilon^3 \; C_{DT} \; Re}{2\pi \; (1 - \varepsilon)} \cdot \frac{r}{(1 + r)^2 X^2} \qquad \text{(III.11)}$$

where $1-\varepsilon = c = a_1 b_1 / a_2 b_2$.

The above equation also gives the Kozeny constant for flow parallel to the major axis (O.R.> 1.0) .

2. Evaluation of the Kozeny Constant Using the Tortuosity Method

Another possible way to evaluate the Kozeny constant (105) is the employment of the tortuosity criterion, by which

$$k = k_o \; (\; H_e \; / \; H \;)^2 \qquad \text{(III.12)}$$

where k_o is the capillary constant , H the bed height and H_e the effective bed length.

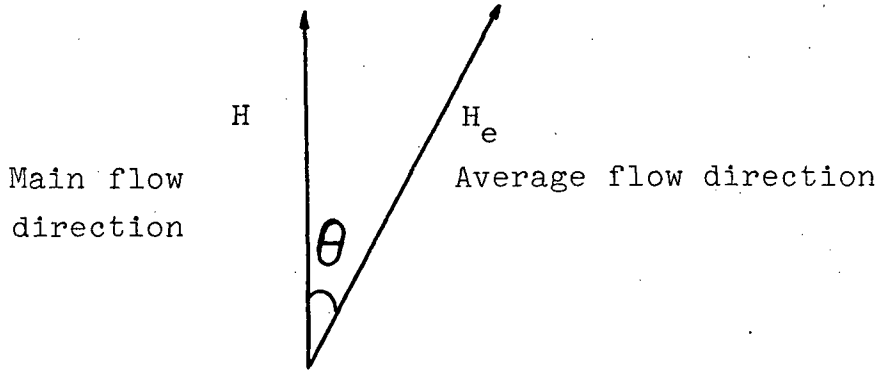

Diagram III.3 Main and average flow directions for packed beds

The term H_e/H is the tortuosity of the bed and is given by $H_e/H = \sec\theta$. Taking $k_o = 2.5$, equation III.12 becomes

$$k = 2.5 \sec^2\theta \qquad \text{(III.13)}$$

The above value of k_o is chosen so that to give $k_o = 5$ for spheres . The exact value of the angle θ is difficult to evaluate . In this work it is taken as the angle between the semi-axis parallel to the main flow and the hypotenuse joining the extremities of the two semi-axes , as shown in diagram III.4 . This method is at best very approximate , and it does not distinguish between a spheroid and an elliptical cylinder with the same aspect ratio .

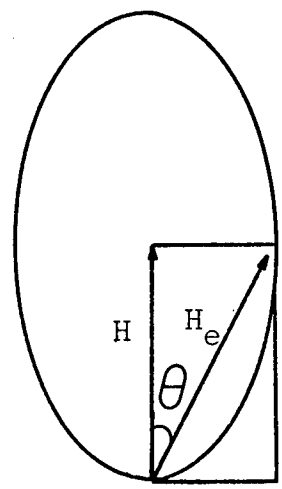

Diagram III.4 Evaluation of angle θ

3. Evaluation of $\Delta P/L$ for a Cluster of Elliptical cylinders at Constant Rew .

The total drag force per unit volume of a cell associated with an elliptical cylinder may be equated to the pressure gradient through the array of cylinders , giving

$$\frac{\Delta P'}{L'} = \frac{F}{\pi a_2 b_2} \qquad \text{(III.14)}$$

where a_2 and b_2 are the semi-axes of the cell perpendicular and parallel to the main flow direction , respectively . Defining the total drag coefficient as

$$C_{DT} = \frac{F}{\frac{1}{2}\rho U^2 \; 2 \; a_1} \qquad \text{(III.15)}$$

and introducing the dimensionless variables

$$\Delta P = \frac{\Delta P'}{\frac{1}{2}\rho U^2} \quad , \quad L = \frac{L'}{b_1} \quad \text{and} \quad c = \frac{a_1 b_1}{a_2 b_2} \quad ,$$

equation III.14 then becomes

$$\frac{\Delta P}{L} = \frac{2}{\pi} \; c \; C_{DT} \qquad \text{(III.16)}$$

where a_1 and b_1 are the semi-axes of the cylinder perpendicular and parallel to the main flow , respectively .

In this work C_{DT} was evaluated at Re = 0.01 , where Re is the Reynolds number based on the characteristic length $2a_1$. For creeping flow , the product of C_{DT}.Re is constant for a given array . Using this relationship , $\Delta P/L$ for Rew = 0.01 becomes

$$\left.\frac{\Delta P}{L}\right|_{Rew} = \frac{2}{\pi}\, c\, C_{DT}\Big|_{Re\,=\,0.01} \cdot \frac{Re}{Rew} \qquad \text{(III.17)}$$

Putting O.R. = b_1 / a_1 = Rew / Re , equation III.17 reducse to

$$\left.\frac{\Delta P}{L}\right|_{Rew\,=\,0.01} = \frac{2}{\pi}\,\frac{c}{O.R.} \cdot C_{DT}\Big|_{Re\,=\,0.01} \qquad \text{(III.18)}$$

which is the basis of figure 105 .

APPENDIX IV

Computer Programs

1. Spheroids

```
C
C     OBLATE AND PROLATE SPHEROIDS  , HAPPEL / KUWABARA MODELS
C
C     FIRST CARD
C
C     MODEL , SB      FORMAT( I2, F15.3 )
C
C     SECOND CARD
C     MARK,MSHAPE,ICARD,IPUT,NREAD,NWRITE,IND,NSTEP,NTURNS,ITR,
C     ITRR,IM,JM          FORMAT ( 1315 )
C
C     THIRD CARD
C     RELAXS,TS,RELAXG,TG,GB,RE,X1,X2     FORMAT ( 8F10.4 )
C
C     MODEL=1 HAPPEL'S MODEL
C     MODEL=2 KUWABARA'S MODEL
C
C     SB  RELAXATION FACTOR FOR THE OUTER BOUNDARY FOR HAPPEL'S MODEL
C     USUALLY = 0.7
C
C     MARK  RUN NUMBER
C
C     MSHAPE=1  OBLATE SPHEROID
C     MSHAPE=2  PROLATE SPHEROID
C
C     ICARD=0 INPUT DATA ARE FROM A FILE/TAPE
C     ICARD=1 PROGRAM INTERNALLY GENERATES APPROXIMATE VALUES FOR THE
C     STREAM AND VORTICITY FUNCTIONS USING STOKES ' SOLUTION FOR A SPHERE
C     ICARD=2 STREAM AND VORTICITY FUNCTIONS ARE FED FROM CARDS
C     FORMAT(20A4)
C     ( THE FIRST CARD OF THE DATA SET IS AN IDENTIFICATION CARD )
C
C     IPUT=0 NO CARDS ARE PUNCHED FOR OUTPUT
C     IPUT=2 CARDS ARE PUNCHED FOR OUTPUT    FORMAT(20A4)
C
C     NREAD  THE UNIT FROM WHICH INPUT DATA ARE EXPECTED ( THE FIRST
C     THREE CARDS ARE FROM UNIT #5 )
C
C     NWRITE  THE UNIT ON WHICH OUTPUT DATA ARE STORED
C
C     IND=0 NO FILE/TAPE FOR OUTPUT IS USED
C     IND=2 FILE/TAPE IS USED FOR OUTPUT
C
C     NSTEP THE INTERVAL IN J AND I (RADIAL AND ANGULAR DIRECTIONS)
C     FOR THE OUTPUT TO BE PRINTED
C
C     NTURNS  # OF CYCLES FOR OUTPUT TO BE PRINTED
C     ITR  # OF INITIAL ITERATIONS TO BE PERFORMED I.E. FOR NTURNS=1
C
C     ITRR  # OF ITERATIONS TO BE PERFORMED FOR NTURNS=2,3,....
C      THE TOTAL # OF ITERATIONS IS GIVEN BY ITR+(NTURNS-1)*ITRR
C     IM  # OF POINTS IN THE ANGULAR DIRECTION
C     JM  # OF POINTS IN THE RADIAL DIRECTION
C     MAXIMUM VALUES OF IM & JM ARE 65 & 105 RESPECTIVELY
C
C
C     RELAXS  RELAXATION FACTOR FOR THE STREAM FUNCTION FOR THE FIRST
C     CYCLE (ITR ITERATIONS)
C     TS  RELAXATION FACTOR FOR THE STREAM FUNCTION FOR THE REMAINING
C     (NTURNS-1)*ITRR ITERATIONS
C     RELAXG  RELAXATION FACTOR FOR THE VORTICITY FUNCTION FOR THE
C     FIRST CYCLE ( ITR ITERATIONS )
C     TG  RELAXATION FACTOR FOR THE VORTICITY FUNCTION FOR THE REMAINING
C     (NTURNS-1) CYCLES
C     GB  RELAXATION FACTOR FOR THE VORTICITY FOR ENTIRE NTURNS CYCLES
C     AT THE SURFACE OF THE SPHEROID
C     RE  REYNOLDS NUMBER
C     X1  THE VALUE OF XI AT THE SPHEROIDAL SURFACE
C     X2  THE VALUE OF XI FOR THE OUTER BOUNDARY
C
C     THE CARD THAT PROCEEDS THE INPUT DATA IS   MARK, IM,JM,NTURNS,
C     ITR,ITRR,X1,X2,RE
C
      READ(5,852) MODEL,SB
  852 FORMAT(I2,F15.3)
      READ(5,850) MARK,MSHAPE,ICARD,IPUT,NREAD,NWRITE,IND,NSTEP,NTURNS,
     1 ITR,ITRR,IM,JM
       READ(5,851) RELAXS,TS,RELAXG,TG,GB,RE,X1,X2
      WRITE(6,1008)
 1008 FORMAT('   THE FIRST THREE INPUT CARDS ARE :')
      WRITE(6,852) MODEL,SB
      WRITE(6,850) MARK,MSHAPE,ICARD,IPUT,NREAD,NWRITE,IND,NSTEP,NTURNS,
     1 ITR,ITRR,IM,JM
      WRITE(6,851) RELAXS,TS,RELAXG,TG,GB,RE,X1,X2
  850 FORMAT(1315)
  851 FORMAT(8F10.5)
      IF(MODEL.EQ.1)WRITE(6,1009)
      IF(MODEL.EQ.2)WRITE(6,1010)
 1009 FORMAT('     HAPPEL''S MODEL')
 1010 FORMAT('     KUWABARA''S MODEL')
      IF(MSHAPE.EQ.1) WRITE(6,1011)
      IF(MSHAPE.EQ.2) WRITE(6,1012)
 1011 FORMAT('     OBLATE SPHEROID')
 1012 FORMAT('     PROLATE SPHEROID')
      NTOT=ITR+ITRR*(NTURNS-1)
      WRITE(6,1013) NTURNS,NTOT
 1013 FORMAT(/'   # OF CYCLES ='I3,20X,'TOTAL # OF ITERATIONS ='I3/)
C
      DIMENSION S(73,107),G(73,107),SINA(73),COSA(73),COTA(73),
     1 COSH(107),SINH(107),TANH(107),A1(107),A2(107),B1(107),B2(107)
       DIMENSION R(107),PT(109),P2(107),COSA22(107),SINH22(107)
      DIMENSION RACRC(107) , SINRR(73) ,RACRS(73),COSHRR(107)
      IF(ICARD.EQ.2) GO TO 996
      IF(ICARD.EQ.0) GO TO 998
      IMM=IM-1
       JMM=JM-1
      IMMM=IM-2
      JMMM=JM-2
      IM2=IM+2
```

```
      XIMM=IMM
      XJMM=JMM
      B=3.141593/XIMM
      A=(X2-X1)/XJMM
       ANGLE=-B
      DO  20 I=1,IM
      ANGLE=B+ANGLE
   20 SINA(I)=SIN(ANGLE)
      IF(MSHAPE.EQ.2)  Z=(EXP(X1)-EXP(-X1))/2.0
      IF(MSHAPE.EQ.1)  Z=(EXP(X1)+EXP(-X1))/2.0
      X=X1-A
      DO 21 J=1,JM
      X=X+A
      IF(MSHAPE.EQ.1)  R(J)=(EXP(X)+EXP(-X))/2.0
      IF(MSHAPE.EQ.2)  R(J)=(EXP(X)-EXP(-X))/2.0
   21 R(J)=R(J)/Z
      F=1.0/R(JM)
      F3=F**3
      F5=F**5
      F6=F**6
      IF(MODEL.EQ.2) D=2.*(2.*F6-10.-10.*F3+18.*F)
      IF(MODEL.EQ.1) D=2.*F6+3.*F-3.*F5-2.0
      IF(MODEL-1) 222,225,222
  222 DO 23 J=1,JM
      DO 23 I=1,IM
      S(I,J)=SINA(I)**2/D*((2.*F3-5.0)/R(J)+15.0*R(J)
     1  -(10.*5.*F3)*R(J)**2 +3.*F3*R(J)**4)
      G(I,J)= 15./D/R(J)*SINA(I)**2*(F3*R(J)**3-1.0)*2.0
   23 CONTINUE
C
      GO TO 224
  225 DO 223 J=1,JM
      DO 223 I=1,IM
      S(I,J)=(SINA(I)**2/2./D)*(R(J)**4*F5-(3.*F5+2.)*R(J)**2+
     1 R(J)*(3.+2.*F5)-1.0/R(J))
      G(I,J)=(SINA(I)**2/R(J)/D)*(5.0*F5*R(J)**3-3.-2.*F5)
  223 CONTINUE
  224 CONTINUE
  998 CONTINUE
      IF(ICARD.EQ.1) GO TO 997
C
      REWIND NREAD
      READ(NREAD,942) MARR,IM,JM,JTURNS,JTR,JTRR,X1,X2,REDMP
  996 IF(ICARD.EQ.2) READ(5,942) MARR,IM,JM,JTURNS,JTR,JTRR,X1,X2,REDMP
      IF(ICARD.EQ.2) NREAD=5
      DO 55 J=1,JM
   55 READ(NREAD,1212) (S(I,J) , I=1,IM)
      DO  56 J=1,JM
   56 READ(NREAD,1212) (G(I,J) , I=1,IM)
      IMM=IM-1
       JMM=JM-1
      IMMM=IM-2
      JMMM=JM-2
      IM2=IM+2
      XIMM=IMM
      XJMM=JMM
      B=3.141593/XIMM
      A=(X2-X1)/XJMM
  997 CONTINUE
C
      REYNLS=RE/2.0
      AA=A*A
      BB=B*B
      AT=A*2.
      BT=B*2.
      AB=2./AA+2.0/BB
      AB4=8.0*(A/B+B/A)
      ANGLE=0.0
      SINA(1)=0.0
      SINA(IM)=0.0
      DO 1 I=2,IMM
      ANGLE=B+ANGLE
      SINA(I)=SIN(ANGLE)
      COSA(I)=COS(ANGLE)
      IF(MSHAPE.EQ.1) COSA22(I)= COSA(I)**2
      IF(MSHAPE.EQ.2) COSA22(I)=-COSA(I) **2
    1 COTA(I)=COSA(I)/SINA(I)
      X=X1-A
      DO 2 J=1,JM
      X=X+A
      IF(MSHAPE.EQ.1)  COSH(J)=(EXP(X)+EXP(-X))/2.0
      IF(MSHAPE.EQ.1)  SINH(J)=(EXP(X)-EXP(-X))/2.0
      IF(MSHAPE.EQ.2)  SINH(J)=(EXP(X)+EXP(-X))/2.0
      IF(MSHAPE.EQ.2)  COSH(J)=(EXP(X)-EXP(-X))/2.0
      SINH22(J)=SINH(J)**2
    2  TANH(J)=SINH(J)/COSH(J)
      DO 3 J=2,JMM
      A1(J)=(2.0-A*TANH(J))/4./(1.0+(A/B)**2)
    3 A2(J)=(2.0+A*TANH(J))/4./(1.0+(A/B)**2)
      DO 4 I=2,IMM
      B1(I)=(2.0-B*COTA(I))/4./(1.0+(B/A)**2)
    4 B2(I)=(2.0+B*COTA(I))/4./(1.0+(B/A)**2)
      SECH=1.0/COSH(1)
      SECHAB=SECH**2/AB
      IFLAG=1
      RAC=REYNLS/AB4*COSH(1)
      DO 100 I=2,IMM
      RACRS(I)=RAC/SINA(I)
  100 SINRR(I)=1.0/SINA(I)**2
      DO 101 J=1,JM
      RACRC(J)=RAC/COSH(J)
  101 COSHRR(J)=1.0/COSH(J)**2
C
      DO 33 KOR=1,IM
      I=KOR
      S(I,JM)= 0.5*(COSH(JM)/COSH(1))**2 * SINA(I)**2
      S(I,1)=0.0
   33 CONTINUE
      IF(MODEL.EQ.2) G(I,JM)=0.0
      WRITE(6,1000)
 1000 FORMAT(' INITIAL INPUT FOR THE STREAM FUNCTION & VORTICITY')
      DO 25 J=1,JM,NSTEP
   25 WRITE(6,800)   (S(I,J), I=1,IM,NSTEP)
      WRITE (6,801)
      DO  26 J=1,JM ,NSTEP
   26  WRITE (6,800) (G(I,J) , I=1,IM,NSTEP)
      WRITE (6,801)
      DO 105 NN=1,NTURNS
      WRITE(6,1001) NN
 1001 FORMAT('    CYCLE =',I4)
```

```
      DO 5 NITR=1,ITR
      IF (1-IFLAG)11,9,11
C
    9 DO 6 II=2,IMM
      I=II
      IF(I-2)30,31,30
   31 DO 35 JJ=2,JMM
      J=JJ
      TEMPS=S(I,J+1)*A1(J)+S(I,J-1)*A2(J)+S(I+1,J)*B1(I)+S(I-1,J)*B2(I)
     1 -G(I,J)*(SECHAB) * (SINH22(J) + COSA22(I) )
      S(I,J)=(TEMPS-S(I,J))*RELAXS+S(I,J)
      TEMPG=     G(I,J+1)*A1(J)+G(I,J-1)*A2(J)+G(I+1,J)*B1(I)+G(I-1,J)*
     1B2(I)-RAC/COSH(J) *                SINA(I)*((S(I,J+1)-S(I,J-1))*
     2 (G(I+1,J)/SINA(I+1)**2-G(2,J)/B/SINA(2) ) ) +
     3RAC/SINA(I)          *    COSH(J)*((S(I+1,J)-S(I-1,J))*
     4 (G(I,J+1)*COSHRR(J+1)-G(I,J-1)*COSHRR(J-1)))
      G(I,J)=(TEMPG-G(I,J))*RELAXG+G(I,J)
   35 CONTINUE
      GO TO 6
   30 IF (I.EQ.IMM) GO TO 32
      DO  34 JJ=2,JMM
      J=JJ
      TEMPS=S(I,J+1)*A1(J)+S(I,J-1)*A2(J)+S(I+1,J)*B1(I)+S(I-1,J)*B2(I)
     1 -G(I,J)*(SECHAB) * (SINH22(J) + COSA22(I) )
      S(I,J)=(TEMPS-S(I,J))*RELAXS+S(I,J)
      TEMPG=     G(I,J+1)*A1(J)+G(I,J-1)*A2(J)+G(I+1,J)*B1(I)+G(I-1,J)*
     1B2(I)-RACRC(J)*SINA(I)*((S(I,J+1)-S(I,J-1))*
     2 (G(I+1,J)*SINRR(I+1)-G(I-1,J)*SINRR(I-1))) +
     3RACRS(I)*COSH(J)*((S(I+1,J)-S(I-1,J))*
     4 (G(I,J+1)*COSHRR(J+1)-G(I,J-1)*COSHRR(J-1)))
      G(I,J)=(TEMPG-G(I,J))*RELAXG+G(I,J)
   34 CONTINUE
      GO TO 6
   32  DO 36 JJ=2,JMM
      J=JJ
      TEMPS=S(I,J+1)*A1(J)+S(I,J-1)*A2(J)+S(I+1,J)*B1(I)+S(I-1,J)*B2(I)
     1 -G(I,J)*(SECHAB) * (SINH22(J) + COSA22(I) )
      S(I,J)=(TEMPS-S(I,J))*RELAXS+S(I,J)
      TEMPG=     G(I,J+1)*A1(J)+G(I,J-1)*A2(J)+G(I+1,J)*B1(I)+G(I-1,J)*
     1B2(I)-RAC/COSH(J) *                SINA(I)*((S(I,J+1)-S(I,J-1))*
     2(G(IMM,J)/B/SINA(IMM)  -G(I-1,J)/SINA(I-1)**2)) +
     3RAC/SINA(I)          *    COSH(J)*((S(I+1,J)-S(I-1,J))*
     4 (G(I,J+1)*COSHRR(J+1)-G(I,J-1)*COSHRR(J-1)))
      G(I,J)=(TEMPG-G(I,J))*RELAXG+G(I,J)
   36 CONTINUE
    6 CONTINUE
      IFLAG=2
      GO TO 10
   11 DO 7 II=2,IMM
      I=IM+1-II
      IF(I-IMM)40,41,40
   41 DO 45 JJ=2,JMM
      J=JM+1-JJ
      TEMPS=S(I,J+1)*A1(J)+S(I,J-1)*A2(J)+S(I+1,J)*B1(I)+S(I-1,J)*B2(I)
     1 -G(I,J)*(SECHAB) * (SINH22(J) + COSA22(I) )
      S(I,J)=(TEMPS-S(I,J))*RELAXS+S(I,J)
      TEMPG=     G(I,J+1)*A1(J)+G(I,J-1)*A2(J)+G(I+1,J)*B1(I)+G(I-1,J)*
     1B2(I)-RAC/COSH(J) *                SINA(I)*((S(I,J+1)-S(I,J-1))*
     2(G(IMM,J)/B/SINA(IMM)  -G(I-1,J)/SINA(I-1)**2)) +
     3RAC/SINA(I)          *    COSH(J)*((S(I+1,J)-S(I-1,J))*
     4 (G(I,J+1)*COSHRR(J+1)-G(I,J-1)*COSHRR(J-1)))
      G(I,J)=(TEMPG-G(I,J))*RELAXG+G(I,J)
   45 CONTINUE
      GO TO 7
   40 IF (   I.EQ.2) GO TO 42
      DO 44 JJ=2,JMM
      J=JM+1-JJ
      TEMPS=S(I,J+1)*A1(J)+S(I,J-1)*A2(J)+S(I+1,J)*B1(I)+S(I-1,J)*B2(I)
     1 -G(I,J)*(SECHAB) * (SINH22(J) + COSA22(I) )
      S(I,J)=(TEMPS-S(I,J))*RELAXS+S(I,J)
      TEMPG=     G(I,J+1)*A1(J)+G(I,J-1)*A2(J)+G(I+1,J)*B1(I)+G(I-1,J)*
     1B2(I)-RACRC(J)*SINA(I)*((S(I,J+1)-S(I,J-1))*
     2 (G(I+1,J)*SINRR(I+1)-G(I-1,J)*SINRR(I-1))) +
     3RACRS(I)*COSH(J)*((S(I+1,J)-S(I-1,J))*
     4 (G(I,J+1)*COSHRR(J+1)-G(I,J-1)*COSHRR(J-1)))
      G(I,J)=(TEMPG-G(I,J))*RELAXG+G(I,J)
   44 CONTINUE
      GO TO 7
   42 DO 46 JJ=2,JMM
      J=JM+1-JJ
      TEMPS=S(I,J+1)*A1(J)+S(I,J-1)*A2(J)+S(I+1,J)*B1(I)+S(I-1,J)*B2(I)
     1 -G(I,J)*(SECHAB) * (SINH22(J) + COSA22(I) )
      S(I,J)=(TEMPS-S(I,J))*RELAXS+S(I,J)
      TEMPG=     G(I,J+1)*A1(J)+G(I,J-1)*A2(J)+G(I+1,J)*B1(I)+G(I-1,J)*
     1B2(I)-RAC/COSH(J) *                SINA(I)*((S(I,J+1)-S(I,J-1))*
     2 (G(I+1,J)/SINA(I+1)**2-G(2,J)/B/SINA(2) ) ) +
     3RAC/SINA(I)          *    COSH(J)*((S(I+1,J)-S(I-1,J))*
     4 (G(I,J+1)*COSHRR(J+1)-G(I,J-1)*COSHRR(J-1)))
      G(I,J)=(TEMPG-G(I,J))*RELAXG+G(I,J)
   46 CONTINUE
    7 CONTINUE
      IFLAG=1
   10 CONTINUE
      DO 8 I=2,IMM
      GTT=(8.*S(I,2)-S(I,3))*COSH(1)**2/2./AA/(SINH22(1) + COSA22(I)))
    8 G(I,1)= (GTT-G(I,1))*GB+G(I,1)
C
      IF(MODEL.EQ.2) GO TO 5
      DO 208 I=2,IMM
      SCQ=SINH(JM)**2+COSA(I)**2
      TTB=(2.*COSH(JM)/SCQ)*(-COSH(JM)*SINA(I)**2+COSH(JM)*SINA(I)**2
     1 *COSA(I)**2/SCQ+(SINH(JM)/SCQ*COSH(1)**2)
     2 *(3.0*S(I,JM)-4.0*S(I,JMM)+S(I,JM-2))/2.0/AI
  208 G(I,JM)=(TTB-G(I,JM))*SB+G(I,JM)
    5 CONTINUE
      DO 15 J=1,JM,NSTEP
   15 WRITE(6,800)  (S(I,J), I=1,IM,NSTEP)
      WRITE (6,801)
      DO  16 J=1,JM ,NSTEP
   16  WRITE (6,800) (G(I,J) , I=1,IM,NSTEP)
      WRITE (6,801)
  801 FORMAT(//)
  800 FORMAT(10E13.5)
      ITR=ITRR
      RELAXS=TS
      RELAXG=TG
  105 CONTINUE
      CONC=(SINH(1)/SINH(JM)) * (COSH(1)/COSH(JM) ) **2
      IF (INO.EQ.0) GO TO 999
      REWIND NWRITE
```

```
      WRITE(NWRITE,942)MARK,IM,JM,NTURNS,ITR,ITRR,X1,X2,RE
      DO 17 J=1,JM
   17 WRITE(NWRITE,1212) (S(I,J) , I=1,IM )
      DO 18 J=1,JM
   18 WRITE(NWRITE,1212) (G(I,J) , I=1,IM)
      WRITE (6,801 )
      WRITE (6,801 )
      END FILE NWRITE
      REWIND NWRITE
  999 CONTINUE
      WRITE(6,1005)
 1005 FORMAT('      STREAM  FUNCTION')
      DO 820 J=1,JM
  820 WRITE(6,800) (S(I,J), I=1,IM )
      WRITE (6,801)
      WRITE(6,1006)
 1006 FORMAT('      VORTICITY   FUNCTION (MODIFIED)')
      DO 2000 J=1,JM
 2000 WRITE(6,800)(G(I,J),I=1,IM)
      WRITE (6,801 )
      DO 108 I=2,IMM
      DO 108 J=1,JM
  108 G(I,J)=G(I,J)*COSH(1)/COSH(J)/SINA(I)
      CDSKIN=0.0
      DO 110 I=1,IMMM,2
  110 CDSKIN= SINA(I)**2 *G(I,1)+4.*SINA(I+1)**2 *G(I+1,1)
     1  +SINA(I+2)**2 *G(I+2,1)+CDSKIN
      CDSKIN=CDSKIN*4.0*TANH(1)/REYNLS/3.*B
      P1=0.0
      DO 111 J=1,JMMM,2
      P1=P1+((G(2,J)*4.0-G(3,J))+4.*(G(2,J+1)*4.-G(3,J+1))
     1  +(G(2,J+2)*4.-G(3,J+2)))/2.0
  111 CONTINUE
      P1= 1.0+4./REYNLS*A/3./B*P1
       P2(1)=0.0
      SINA(IM2)=0.0
      COSA(IM2)=0.0
       PT(IM2)=0.0
      DO 112 I=1,IMMM,2
      II=I+2
      P2(II)=((-G(I,1)*3.0+4.0*G(I,2)-G(I,3)) + (-G(I+1,1)*3.0 +
     1 4.0*G(I+1,2)-G(I+1,3))*4.0 + (-G(I+2,1)*3.0+4.0*G(I+2,2)
     2 -G(I+2,3)))/A/2.0 + (G(I,1)+G(I+1,1)*4. +G(I+2,1))*TANH(1)+P2(I)
  112 PT(II)=P1 +P2(II)*2.0/REYNLS/3.*B
      PT(1)=P1
      CDFORM=0.0
      DO 113 I=1,IMMM,4
  113 CDFORM=CDFORM+PT(I)*COSA(I)*SINA(I)*2. + 8.*COSA(I+2)   *SINA(I+2)
     1 *PT(I+2) +2.*PT(I+4)*SINA(I+4)*COSA(I+4)
      CDFORM=CDFORM*B/1.5
      CDTTT=CDFORM+CDSKIN
      WRITE(6,1007) CONC
      WRITE(6,1003)
 1003 FORMAT(12X,'CDSKIN',14X,'CDFORM',14X,'CDTOTAL',13X,'PO'
     1 ,20X,'A',17X,'B')
      WRITE (6,822) CDSKIN , CDFORM , CDTTT , P1 , A, B
 1007 FORMAT('   CONCENTRATION ='E16.5/)
  822  FORMAT(6E20.5/)
      WRITE (6,801 )
      WRITE(6,1004)
 1004 FORMAT('    DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION')
      WRITE (6,823) (PT(I) , I=1,IM ,2 )
  823 FORMAT(8E16.5)
      WRITE (6,801 )
      IF(IPUT.EQ.0) GO TO 940
      DO 941 I=2,IMM
      DO 941 J=1,JM
  941 G(I,J)=G(I,J)/COSH(1)*COSH(J)*SINA(I)
C     CARDS PUNCHED HERE
      WRITE(7,942) MARK,IM,JM,NTURNS,ITR,ITRR,X1,X2,RE
  942 FORMAT(6I6,3F14.7)
      DO 943 J=1,JM
  943 WRITE(7,1212) (S(I,J) , I=1,IM)
      DO 944 J=1,JM
  944 WRITE(7,1212) (G(I,J), I=1,IM)
  940 CONTINUE
 1212 FORMAT(20A4)
      STOP
      END
```

2. Elliptical Cylinders

```
C
C
C     ELLIPTICAL CYLINDERS , HAPPEL / KUWABARA  MODELS
C
C     FIRST CARD
C
C     MODEL , SB      FORMAT( I2, F15.3 )
C
C     SECOND CARD
C     MARK,MSHAPE,ICARD,IPUT,NREAD,NWRITE,NSTEPI,NSTEPJ,IND,NTURNS,ITR,
C     ITRR,IM,JM         FORMAT ( 14I5 )
C
C     THIRD CARD
C     RELAXS,TS,RELAXG,TG,GB,RE,X1,X2     FORMAT ( 8F10.4 )
C
C     MODEL=1 HAPPEL'S MODEL
C     MODEL=2 KUWABARA'S MODEL
C
C     SB  RELAXATION FACTOR FOR THE OUTER BOUNDARY FOR HAPPEL'S MODEL.
C     USUALLY = 0.7
C
      READ(5,582) MODEL,SB
      WRITE(6,1008)
 1008 FORMAT('    THE FIRST THREE INPUT CARDS ARE :')
C
C     MARK  RUN NUMBER
C
C     MSHAPE=1  FLOW ALONG MAJOR AXIS
C     MSHAPE=2  FLOW ALONG MINOR AXIS
C
C     ICARD=1 PROGRAM INTERNALLY GENERATES APPROXIMATE VALUES FOR THE
C     STREAM AND VORTICITY FUNCTIONS USING STOKES ' SOLUTION FOR A
C     CIRCULAR CYLINDER
C     ICARD=2 STREAM AND VORTICITY FUNCTIONS ARE FED FROM CARDS
C     ( THE FIRST CARD OF THE DATA SET IS AN IDENTIFICATION CARD )
C     ICARD=3 INPUT DATA ARE FROM A FILE/TAPE
C
C     FORMAT ( 20A4 )
C
C     IPUT=1 NO CARDS ARE PUNCHED FOR OUTPUT
C     IPUT=2 CARDS ARE PUNCHED FOR OUTPUT    FORMAT(20A4)
C
C     NREAD  THE UNIT FROM WHICH INPUT DATA ARE EXPECTED ( THE FIRST
C     THREE CARDS ARE FROM UNIT #5 )
C     NWRITE  THE UNIT ON WHICH OUTPUT DATA ARE STORED
C
C     NSTEPI  THE INTERVAL IN I (ANGULAR DIRECTION) FOR OUTPUT TO BE
C     PRINTED
C     NSTEPJ  THE INTERVAL IN J (RADIAL DIRECTION) FOR THE OUTPUT DATA
C     TO BE PRINTED
C
C     IND=1 NO FILE/TAPE FOR OUTPUT IS USED
C     IND=2 FILE/TAPE IS USED FOR OUTPUT
C
C     NTURNS  # OF CYCLES FOR OUTPUT TO BE PRINTED
C     ITR  # OF INITIAL ITERATIONS TO BE PERFORMED I.E. FOR NTURNS=1
C     ITRR  # OF ITERATIONS TO BE PERFORMED FOR NTURNS=2,3,....
C      THE TOTAL # OF ITERATIONS IS GIVEN BY ITR+(NTURNS-1)*ITRR
C     IM  # OF POINTS IN THE ANGULAR DIRECTION
C     JM  # OF POINTS IN THE RADIAL DIRECTION
C     THE MAXIMUM VALUES OF IM & JM ARE 65 AND 105 RESPECTIVELY
C
      WRITE(6,582) MODEL,SB
  582 FORMAT(I2,F15.3)
C
C     RELAXS  RELAXATION FACTOR FOR THE STREAM FUNCTION FOR THE FIRST
C     CYCLE (ITR ITERATIONS)
C     TS  RELAXATION FACTOR FOR THE STREAM FUNCTION FOR THE REMAINING
C     (NTURNS-1)*ITRR ITERATIONS
C     RELAXG  RELAXATION FACTOR FOR THE VORTICITY FUNCTION FOR THE
C     FIRST CYCLE ( ITR ITERATIONS )
C     TG  RELAXATION FACTOR FOR THE VORTICITY FUNCTION FOR THE REMAINING
C     (NTURNS-1) CYCLES
C     GB  RELAXATION FACTOR FOR THE VORTICITY FOR ENTIRE NTURNS CYCLES
C     AT THE SURFACE OF THE CYLINDER
C     RE  REYNOLDS NUMBER
C     X1  THE VALUE OF XI AT THE ELLIPTICAL SURFACE
C     X2  THE VALUE OF XI FOR THE OUTER BOUNDARY
C
C     THE CARD THAT PROCEEDS THE INPUT DATA IS   MARK, IM,JM,NTURNS,
C     ITR,ITRR,X1,X2,RE
C
      READ (5,103)MARK,MSHAPE,ICARD,IPUT,NREAD,NWRITE,NSTEPI,
     1 NSTEPJ,IND,NTURNS,ITR,ITRR,IM,JM
      WRITE(6,103)MARK,MSHAPE,ICARD,IPUT,NREAD,NWRITE,NSTEPI,
     1 NSTEPJ,IND,NTURNS,ITR,ITRR,IM,JM
      READ (5,104)RELAXS,TS,RELAXG,TG,GB,RE,X1,X2
      WRITE(6,104)RELAXS,TS,RELAXG,TG,GB,RE,X1,X2
  103 FORMAT(14I5)
  104 FORMAT(8F10.4)
      IF(MODEL.EQ.1) WRITE(6,1009)
      IF(MODEL.EQ.2) WRITE(6,1010)
 1009 FORMAT('   HAPPEL''S MODEL')
 1010 FORMAT('  KUWABARA''S MODEL')
      IF(MSHAPE.EQ.1) WRITE(6,1011)
      IF(MSHAPE.EQ.2) WRITE(6,1012)
 1011 FORMAT('   FLOW ALONG MAJOR AXIS')
```

```
 1012  FORMAT('   FLOW ALONG MINOR AXIS')
       NTOT=ITR+ITRR*(NTURNS-1)
       WRITE(6,1013) NTURNS,NTOT
 1013  FORMAT(/'  # OF CYCLES = '13,15X,'  TOTAL # OF ITERATIONS ='13/)
       DIMENSION S(71,107),G(71,107),SINA(71),COSA(71) ,SINA22(71),
      1 SINH(107),COSH(107),SINH22(107),COSH22(107),TANH(107),R(107)
       DIMENSION P(107) , PT(107)
        ITR=ITR/2
         ITRR=ITRR/2
       IMM=IM-1
       JMM=JM-1
       JM2=JM-2
       IM2=IM-2
       XIMM=IMM
       XJMM=JMM
       B=3.141595/XIMM
       A=(X2-X1)/XJMM
       ANGLE=-B
       DO 1 I=1,IM
       ANGLE=B+ANGLE
       SINA(I)=SIN(ANGLE)
       IF(MSHAPE.EQ.1) SINA22(I)= SINA(I)**2
       IF(MSHAPE.EQ.2) SINA22(I)=-SINA(I)**2
       COSA(I)=COS(ANGLE)
     1 CONTINUE
       X=X1-A
       IF(MSHAPE.EQ.1) Z=(EXP(X1)-EXP(-X1))/2.0
       IF(MSHAPE.EQ.2) Z=(EXP(X1)+EXP(-X1))/2.0
       DO 2 J=1,JM
       X=X+A
       IF(MSHAPE.EQ.1) R(J)=(EXP(X)-EXP(-X))/2.0
       IF(MSHAPE.EQ.2) R(J)=(EXP(X)+EXP(-X))/2.0
        R(J)=R(J)/Z
       IF(MSHAPE.EQ.1) COSH(J)=(EXP(X)+EXP(-X))/2.0
       IF(MSHAPE.EQ.2) COSH(J)=(EXP(X)-EXP(-X))/2.0
       IF(MSHAPE.EQ.1) SINH(J)=(EXP(X)-EXP(-X))/2.0
       IF(MSHAPE.EQ.2) SINH(J)=(EXP(X)+EXP(-X))/2.0
       SINH22(J)=SINH(J)**2
       COSH22(J)=COSH(J)**2
       TANH(J)=SINH(J)/COSH(J)
     2 CONTINUE
       AB=2.0*(1.0/A/A+1.0/B/B)
       ABR=1.0/AB
       ABRE=RE/8./AB/A/B
       CSC2AB=1.0/SINH22(1)/AB
       A1=0.5/((A/B)**2+1.0)
       A2=0.5/((B/A)**2+1.0)
   100 FORMAT(616,3F14.5)
       GO TO (3,4,5) , ICARD
     3 CONTINUE
       F=1.0/R(JM)
       F2=F*F
       F4=F2*F2
       IF(MODEL.EQ.2) DE=4.0*F2-F4-3.0-4.*ALOG(F)
       IF(MODEL.EQ.1) DE=(F4-1.0)-2.0*(F4+1.0)*ALOG(F)
       IF(MODEL-1)222,225,222
   222 CONTINUE
       DO 11 I=1,IM
       DO 11 J=1,JM
       G(I,J)=8.0*SINA(I)*(1.0/R(J)-F2*R(J))/DE
      11 S(I,J)=SINA(I)  / DE*((2.-F2)/R(J)+R(J)*(F2-1.0)*2.0
      1 -F2*R(J)**3 + 4.0*R(J)*ALOG(R(J)))
         GO TO 224
   225 DO 111 I=1,IM
       DO 111 J=1,JM
       G(I,J)=4.*SINA(I)*((1.+F4)/R(J)-2.*F4*R(J))/DE
       S(I,J)=SINA(I)/DE*(1./R(J)+R(J)*(F4-1.)*2.*R(J)*(1.+F4)
      1 *ALOG(R(J))-F4*R(J)**3)
   111 CONTINUE
   224 CONTINUE
       GO TO 14
     4 READ(5,100) MARR,IM,JM,JTUU,JTR,JTRR,X1,X2,REDO
       DO 15 J=1,JM
    15 READ(5,1212) (S(I,J) , I=1,IM )
       DO 16 J=1,JM
    16 READ(5,1212) (G(I,J),I=1,IM)
       GO TO 14
     5 REWIND NREAD
       READ(NREAD,100) MARR,IM,JM,JTURNS,JTR,JTRR,X1,X2,REDO
       DO 17 J=1,JM
    17 READ(NREAD,1212) (S(I,J), I=1,IM)
       DO 18 J=1,JM
    18 READ(NREAD,1212) (G(I,J) , I=1,IM)
    14 CONTINUE
       WRITE(6,1000)
  1000 FORMAT(' INITIAL INPUT FOR THE STREAM FUNCTION &'VORTICITY')
       DO 19 J=1,JM,NSTEPJ
    19 WRITE(6,101) ( S(I,J) , I=1,IM,NSTEPI)
       WRITE(6,102)
       DO 20 J=1,JM,NSTEPJ
    20 WRITE(6,101) ( G(I,J) , I=1,IM,NSTEPI)
       WRITE(6,102)
   101 FORMAT(10E13.5)
   102 FORMAT(//)
       DO 40 I=1,IM
       S(I,1)=0.00
        IF(MODEL.EQ.2) G(I,JM)=0.
    40 S(I,JM)=     SINA(I)*SINH(JM)/SINH(1)
       DO 105 J=1,JM
       S(1,J)=0.0
       S(IM,J)=0.0
       G(1,J)=0.0
   105 G(IM,J)=0.0
       DO 21 NN=1,NTURNS
        WRITE(6,1001) NN
  1001  FORMAT('  CYCLE =',I4)
       DO 22 NITR=1,ITR
       DO 25 I=2,IMM
       DO 25 J=2,JMM
       TEMPS=-G(I,J)*(SINH22(J)+SINA22(I))*CSC2AB +(S(I,J+1)+S(I,J-1))*A1
      1 +(S(I+1,J)+S(I-1,J))*A2
       S(I,J)=(TEMPS-S(I,J))*RELAXS+S(I,J)
       TEMPG =-ABRE*(((S(I,J+1)-S(I,J-1))*(G(I+1,J)-G(I-1,J))) -
      1 ((S(I+1,J)-S(I-1,J))* (G(I,J+1)-G(I,J-1)))) +
      2 A1*(G(I,J+1)+G(I,J-1))+ A2*(G(I+1,J)+G(I-1,J))
       G(I,J)=(TEMPG-G(I,J))*RELAXG+G(I,J)
    25 CONTINUE
       DO 23 I=2,IMM
       GTT=(.5*SINH22(1)/(SINH22(1)+SINA22(I)))/A**2)*(8.*S(I,2)-S(I,3))
    23 G(I,1)=(GTT-G(I,1))*GB+G(I,1)
```

```
      IF(MODEL.EQ.2) GO TO 112
      DO 208 I=2,IMM
      SCQ=SINH(JM)**2+SINA(I)**2
      TTB=(2.*SINH(1)*SINH(JM)/SCQ)*(-SINA(I)-SINA(I)*COSA(I)**2/SCQ+
     1 SINH(1)*COSH(JM)/SCQ*(3.*S(I,JM)-4.*S(I,JMM)+S(I,JM-2))/2./A)
208   G(I,JM)=(TTB-G(I,JM))*SB+G(I,JM)
112   CONTINUE
      DO 27 II=2,IMM
      I=IM+1-II
      DO 27 JJ=2,JMM
      J=JM+1-JJ
      TEMPS=-G(I,J)*(SINH22(J)+SINA22(I))*CSC2AB +(S(I,J+1)+S(I,J-1))*A1
     1 +(S(I+1,J)+S(I-1,J))*A2
      S(I,J)=(TEMPS-S(I,J))*RELAXS+S(I,J)
      TEMPG =-ABRE*(((S(I,J+1)-S(I,J-1))*(G(I+1,J)-G(I-1,J))) -
     1 ((S(I+1,J)-S(I-1,J))* (G(I,J+1)-G(I,J-1)))) +
     2 A1*(G(I,J+1)+G(I,J-1))+ A2*(G(I+1,J)+G(I-1,J))
      G(I,J)=(TEMPG-G(I,J))*RELAXG+G(I,J)
27    CONTINUE
      DO 24 I=2,IMM
      GTT=(.5*SINH22(1)/(SINH22(1)+SINA22(I))/A**2)*(8.*S(I,2)-S(I,3))
24    G(I,1)=(GTT-G(I,1))*GB+G(I,1)
      IF(MODEL.EQ.2) GO TO 22
      DO 209 I=2,IMM
      SCQ=SINH(JM)**2+SINA(I)**2
      TTB=(2.*SINH(1)*SINH(JM)/SCQ)*(-SINA(I)-SINA(I)*COSA(I)**2/SCQ+
     1 SINH(1)*COSH(JM)/SCQ*(3.*S(I,JM)-4.*S(I,JMM)+S(I,JM-2))/2./A)
209     G(I,JM)=(TTB-G(I,JM))*SB+G(I,JM)
22    CONTINUE
      DO 28 J=1,JM,NSTEPJ
28    WRITE(6,101) ( S(I,J) , I= 1,IM , NSTEPI)
      WRITE(6,102)
      DO 29 J=1,JM,NSTEPJ
29    WRITE(6,101) ( G(I,J) , I=1,IM,NSTEPI)
      WRITE(6,102)
      ITR=ITRR
      RELAXS=TS
      RELAXG=TG
21    CONTINUE
      CONC=SINH(1)*COSH(1)/COSH(JM)/SINH(JM)
      GO TO (31,30) , IND
30    REWIND NWRITE
      WRITE(NWRITE,100)MARK,IM,JM,NTURNS,ITR,ITRR,X1,X2,RE
      DO 33 J=1,JM
33    WRITE(NWRITE,1212) (S(I,J) , I=1,IM)
      DO 34 J=1,JM
34    WRITE(NWRITE,1212) (G(I,J) , I=1,IM)
      END FILE NWRITE
31    CONTINUE
      GO TO (35,44) , IPUT
44    WRITE(7,100) MARK,IM,JM,NTURNS,ITR,ITRR,X1,X2,RE
      DO 36 J=1,JM
36    WRITE(7,1212) (S(I,J) , I=1,IM)
      DO 37 J=1,JM
37    WRITE(7,1212) (G(I,J) , I=1,IM)
35    CONTINUE
      WRITE(6,102)
      CDSKIN=0.0
      DO 50 I=1,IM2,2
50    CDSKIN=(SINA(I)*G(I,1)+4.*SINA(I+1)*G(I+1,1)+
     1  SINA(I+2)*G(I+2,1) ) + CDSKIN
      CDSKIN=CDSKIN*B/3./TANH(1)/RE*4.0
      PO=0.0
      DO 51 J=1,JM2,2
51    PO=PO+ (-3.0*G(1,J) + 4.0*G(2,J) - G(3,J))
     1 + 4.0 * (-3.0*G(1,J+1) + 4.0*G(2,J+1) - G(3,J+1 ))
     2 + (-3.0*G(1,J+2) + 4.0*G(2,J+2) - G(3,J+2))
      PO=PO/B/2.*A/3.*4./RE + 1.0
      P(1)=0.0
      DO 52 I=1,IM2,2
      II=I+2
      P(II)= ((-3.*G(I,1)+4.0*G(I,2)-G(I,3))
     1 +  (-3.0*G(I+1,1) +4.0*G(I+1,2)-G(I+1,3)) *4.0
     2 +  (-3.0*G(I+2,1)+4.0*G(I+2,2)-G(I+2,3)))/A/2. +P(I)
52    PT(II)=PO+P(II)*4./RE/3.0*B
      PT(1)=PO
      CDFORM=0.0
      DO 53 I=1,IM2,4
53    CDFORM=CDFORM+PT(I)*COSA(I)+4.*PT(I+2)*COSA(I+2)+PT(I+4)*COSA(I+4)
      CDFORM=CDFORM*B/1.50
      CDTOT=CDFORM+CDSKIN
      WRITE(6,1007)CONC
1007  FORMAT('   CONCENTRATION ='E16.5/)
      WRITE(6,1003)
1003  FORMAT(12X,'CDSKIN',14X,'CDFORM',14X,'CDTOTAL'13X,'PO'
     1 ,20X,'A',17X,'B')
      WRITE(6,109) CDSKIN,CDFORM,CDTOT,PO,A,B
      WRITE(6,1004)
1004  FORMAT('   DIMENSIONLESS SURFACE PRESSURE DISTRIBUTION')
      WRITE(6,110) ( PT(I) , I=1,IM,2 )
109   FORMAT(6E20.5/7)
110   FORMAT(8E16.4)
      WRITE(6,1005)
1005  FORMAT('          STREAM  FUNCTION')
      DO 38 J=1,JM
38    WRITE(6,101) ( S(I,J),I=1,IM )
      WRITE(6,102)
      WRITE(6,1006)
1006  FORMAT('     VORTICITY FUNCTION')
      DO 39 J=1,JM
39    WRITE(6,101) ( G(I,J),I=1,IM )
1212  FORMAT(20A4)
      STOP
      END
```