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THE KINETICS OF 'SALTING-OUT' OF NEUTRAL SODIUM SULFATE FROM SULFURIC ACID SOLUTION

by

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(B.Sc, University of Lagos, Nigeria 1977)

A THESIS SUBMITTED IN PARTIAL FULFILMENT OF

THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF APPLIED SCIENCE

in

THE FACULTY OF GRADUATE STUDIES

(Chemical Engineering Department)

We accept this thesis as conforming

to the required standard

THE UNIVERSITY OF BRITISH COLUMBIA

May, 1980

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ABSTRACT

The equilibrium phase diagram for the system sodium sulfate-methanol/water-sulfuric acid at 35° was determined. The nucleation, and growth characteristics of sodium sulfate have been studied in a laboratory scale crystallizer (Mixed Suspension Mixed Product Removal 'MSMPR') under carefully controlled conditions of supersaturation, temperature, agitation rate and residence time. From a statistical analysis of the data it was found that supersaturation, temperature, the interactions of supersaturation with temperature and agitation rate with temperature had positive effects on growth and nucleation rates, while agitation rate, residence time, the interactions of agitation rate with supersaturation, residence time with supersaturation had negative effects on growth and nucleation rates.

The 'order' of the nucleation process, b, defined by $B = K_N S^b$ was about 5. The growth rate, defined by $G = K_G S^c$ was first order ($C = 1$). For both processes the activation energy varied from 12 to 15 kcal/mol. The growth process was considered to be surface integration controlled for the various conditions tested. The nucleation rate was considered essentially to be homogeneous nucleation.

A non-linear mathematical relationship was developed for both growth rate and nucleation rate in terms of the three factors, temperature, supersaturation and residence time. In both the growth and nucleation rate models the measured data fit poorly. This indicates that the model (a reaction rate type) poorly represents the data for crystallization found in this study.

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ACKNOWLEDGEMENTS

I wish to place on record my sincere gratitude to Dr. K. Pinder, under whom this investigation was conducted, for his guidance in helping to carry out this project.

I wish to thank my State government (Imo State of Nigeria) for their financial support during the course of this project.

I would like to express my deep appreciation for the assistance of Mr. M. Ohanomah in debugging the computer program.

My grateful acknowledgement is also due to my mother for her love and permission given to me to carry out the project.

CHAPTER I

INTRODUCTION:

Whenever a crystalline solid is formed out of other phases, whether solid, liquid or gas, the process is known as crystallization. It is a commonly used industrial separation and purification technique. Fundamental research on this unit operation has focussed mainly on understanding and predicting the particulate nature of the crystalline phase, recognizing that better knowledge and control of this aspect will permit improvements in the unit operation of crystallization, both as a separation and purification technique.

Although thorough scientific investigations into the nature of crystal structure have been carried out, very limited reliable information has been published on the chemical engineering aspects of crystallization. In most cases, plant design is still based almost entirely upon experience and tradition rather than on scientific measurements. In some industries where crystallization is employed on a very large scale, the equipment has been brought to a high state of perfection, but this has been mainly an outcome of long experience with the particular product. The basic principles, an exact knowledge of which will enable the chemical engineer to calculate the dimensions of an installation for any specific performance, have not yet been fully analysed. As a result, many chemical works are using primitive disign methods for crystallization units. The crystal size distribution (CSD) of the product, which is a basic parameter in any crystallization process, is a function of the kinetics of the process and in most cases this basic information, needed for a scientific knowledge of crystallization, is lacking.

The formation of a new phase from a mother phase can be considered as

involving two processes viz: the formation of three-dimensional (in some cases two dimensional) nuclei and the growth of these critical nuclei to macroscopic dimensions. The former is known as nucleation and its rate is defined as, "the number of nuclei formed per unit time per unit volume of reaction phase;" while the latter is the growth rate and is expressed as, 'the rate of linear translation of a growing crystal face.' The experimental study of nucleation rate is rendered particularly difficult by the fact that in the early stages of crystallization both nucleation and growth take place simultaneously. The nuclei themselves are difficult to observe and count, and it becomes necessary to 'develop' them to an observable size by growth. Attempts have been made to measure the nucleation rate without interference of the growth phase but often the conditions for the experiments are so idealised that they are very difficult to reproduce in practice.

Over the last 15 years the engineering understanding of this unit operation has received a tremendous boost from the application of the concept of the crystal population balance which was developed by Randolph and Larson.[37] The approach has facilitated the manipulation of crystal size distributions to satisfy given engineering and commercial criteria. It has highlighted the importance of crystal growth and nucleation rates and the extreme difficulty of scaling up the latter to plant conditions.

[1.2] INTEREST FOR THIS STUDY

The use of chlorine dioxide in the kraft pulp and paper industry, for the bleaching of wood pulp, has become universal. It is estimated that at least 200 chlorine dioxide generators all over the world are operating using the Mathieson, Solvay or R2 processes. In the majority of the mills where environmental protections laws have been enforced the spent acid from these generators is neutralized with black liquor and burned in the recovery furnace.

Where previously there were sufficient losses of sodium sulfate in the brown stock washers and the furnace to make this feasible, the improved water utilization now practiced by most mills and the increasing consumption of chlorine dioxide mean that there tends to be an excess of sodium and sulfur in the furnace smelt.

Many processes and methods have been suggested to deal with the excess sodium and sulfur produced during the bleaching reaction. One of these methods is the 'Acid Recovery Process' (ARP) described by Lobley and Howard.[23] In this process (ARP) the sodium sulfate is removed from the strong (9N) sulfuric acid solution by crystallization. Rather than use evaporation to produce the required supersaturation for crystal growth, in this process the solubility of the salt is reduced by 'salting out', that is, an organic solvent, methanol, is added to the water solution. Since this is not a common chemical engineering method of crystallization, the behaviour of such a process is of fundamental interest.

This study has also been motivated by the importance of the kraft industry to British Columbia and the need to reduce the pollution caused by the disposal of the cholorine dioxide generator effluent. The presently used crystallizers are simple CSTR's with a ten minute residence time. The effect of the various design parameters are not understood and no effort has been made to produce a reactor which will give a good particle distribution.

This work seeks to determine both the growth and nucleation rates for the methanol precipitation of a solution of similar concentration to that produced industrially, and the effects of supersaturation, agitation rate, residence time and temperature on these rates.

CHAPTER 2

LITERATURE SURVEY

2.1 CRYSTALLIZATION HYPOTHESES:

Many theories have been put forward to explain the process of crystallization. According to Becker,[5] the rate of nucleation is a function of activation energy for diffusion and of the work required to form the surface of the nucleus. "The growth process is also amenable to the same kind of treatment as that for nucleation on the assumption that crystal growth is essentially a two dimensional nucleation process." McCabe,[25] observed that, "neither nucleation nor growth can occur unless the precipitated substance has a lower thermodynamic potential after crystallization than before. Also the Gibbs condition for stability of a crystal namely,--that for a given volume the surface free energy shall be a minimum--, is confirmed." Evidence of various kinds have been suggested to show that, there is a definite equilibrium shape for crystals of a given solute precipitating from a particular solvent. There is no tendency for a macroscopic crystal of non-equilibrium shape to approach an equilibrium shape unless crystal growth is permitted. Barkhuysen[4] explained the growth of crystals by assuming that the rate of growth depends on the diffusion rate. Van Hook[47] in his study of the kinetics of sucrose crystallization, concluded that the rate of growth of a crystal is determined primarily by some interfacial (homogeneous, chemical) reaction instead of an interboundary (heterogeneous, physical) reaction. This was postulated from the observation that distorted sucrose crystals were frequently produced from impure syrups. Unequal and variable growths of various faces occurred rather than the uniform and ordered growth which would be expected on the basis of a simple diffusion mechanism. He

showed that, in general the presence of impurities in sucrose syrups depressed the normal rate of crystallization; and also confirmed that the rate-controlling step in sucrose crystal growth is a surface reaction and not diffusion of solute from the bulk of the solution to the surface.

Laurent[20] derived mathematical relations for the number of nuclei formed in a given time and the rate of crystallization, based on the energy of the atom. He utilised this law to explain allotropic transformations. In another mathematical approach, Ramberg[34] applied thermodynamic principles and the relation between mechanical pressure and partial vapour pressure (or escaping tendency) to explain the force or energy of crystallization.

Badger and Seavoy[3] discussed the hypothesis of Ross[42] that, "the process of dissolving a substance in water involves a chemical reaction resulting in the formation of new compounds which can be designated as 'molten hydrates' of the solute." Continuing this line of thought, "the formation of a crystal resolves into a process of freezing just as ice is created from water. Upon lowering the temperature of a solution, a molten hydrate freezes to the solid state. The heat effects are considered as a combination of the heat of reaction and the heat of fusion or what is normally called the heat of crystallization." Ross[42] rationalized his hypothesis to account for crystal growth by presenting photographic evidence to the effect that, "there is a field of attractive force surrounding the original nucleus and nuclei agglomerates which combine to form the small crystals, and these small crystals grow by attracting nuclei which attach themselves in an orderly arrangement to the growing crystals. Each crystal substance appears to have its own inherent rate of growth which is somehow related to the attractive force on each different face of the crystal with which it builds itself by the above phenomenon."

In their study of the growth of magnessium sulfate heptahydrate crystals, Liu et al,[21] reported that the growth of crystals from solution involves two phenomena occurring in series: "the transport of solute from the bulk supersaturated solution to the crystal surface, and the incorporation of solute into the crystal lattice, normally called surface integration. When the solution is quiescent or only slightly agitated, mass transport is essentially due to molecular diffusion and hence is frequently slower than surface integration and is rate limiting. When agitation of the bulk solution is stronger, convection and eddy diffusion will increase the mass transport rate so that both steps may be rate limiting. With stronger agitation, the mass transport process becomes the faster one and the growth rate is controlled by the surface integration step." Volmer[49] developed an absorption theory of crystallization in which he visualized the absorbed molecules as wandering quite freely over the surface until they were desorbed, attached to the surface at a point of growth, or formed with other molecules a nucleus for a new lattice-layer.

It has been shown that crystal nucleation occurs by at least three separate mechanisms called homogeneous, heterogeneous, and secondary. Homogeneous nucleation occurs from clear solutions by molecular driving forces, heterogeneous nucleation is stimulated by the presence of foreign substances or substrates while, secondary nucleation occurs due to the presence of crystals of the solute phase and commonly occurs at supersaturations lower than that required for homogeneous or heterogeneous nucleation. In the case of secondary nucleation, Mason and Strickland-Constable[24] suggested that three stages are involved. The first is initial breeding which results when dry seeds are placed in solution and microscopic crystal-dust washes off the dry seed nuclei. The second is needle breeding resulting from the breakage of large dendritic growth.

The third is collision breeding in which nucleation is induced by collisions of seed crystals with solid surfaces.

2.2 PREVIOUS WORK ON CRYSTALLIZATION FACTORS

[2.2.1] EFFECT OF ALCOHOL:

Thompson and Molstad[46] determined the solubility and isotherms for potassium and ammonium nitrates in aqueous isopropanol solutions over the temperature range 25-70°C. Both salts are very soluble in water and their solubilities increase greatly with increasing temperature. They found, that 15 lb. of isopropanol added to 100 lb. of saturated aqueous solution of potassium nitrate (KNO_3) at 40°C resulted in the precipitation of forty-four percent of the dissolved salt. The salt recovery would be increased to 68% if another 50 lb. of isopropanol were added. In other words, an increase in the quantity of added diluent resulted in a higher yield of salt. D.H. Kohn, I. Yaron et al,[16] found that, the fractional conversion of acid sodium sufate to the neutral salt and the subsequent precipitation of the neutral salt as a function of the organic liquid/aqueous solution ratio exhibited an initial rapid rise followed by a slower approach to a maximum value as the ratio increased; higher initial concentration and lower temperature facilitated conversion and precipitation. Buttler and Dunnicliff[8] found that the extraction of dry sodium bisulfate with absolute alcohols (including methanol) gave a mixed solid of the composition Na_2SO_4- $NaHSO_4$ even after prolonged treatment, whereas moist alcohol gave neutral sodium sulfate.

[2.2.2] AGITATION RATE

The rate at which a single crystal grows at a given temperature under a constant supersaturation condition can be altered appreciably by agitating the liquid or by rotating the crystal in the liquid. The

rate of growth increase initially as the relative velocity between crystals and liquid is increased, but conditions are soon reached when a further increase in agitation rate has no effect.[10] Coulson and Richardson[10] also showed, that in all cases, rotational speeds of crystals in excess of about 20 rev/min had little effect on the growth rate. Similar results have been reported for the growth of sucrose by Van Hook, A[48] and for copper pentahydrate crystals from their supersaturated aqueous solutions by McCabe and Stevens, R.P.[20] In most cases it has been observed [6,13,27,35,44] that, circulation rate only increases single crystal growth up to a limiting value.

2.2.3 TEMPERATURE

The influence of temperature upon both conversion of potassium bisulfate to neutral sulfate and the subsequent crystallization of the neutral salt has been reported by Kohn, D.H., I. Yaron et al,[16] who stated that, a decrease in temperature enhanced both conversion and crystallization. Chanakya Misra and E.T. White[9] observed that crystal growth varied as the Arrhenius temperature law, for aluminum trihydroxide. Liu, C.Y., Tsuei, H.S. et al[21] confirmed this model for magnessium sulfate heptahydrate crystals. The growth rate of the hemihydrate and gypsum was reported by A.B. Amin and M.A. Larson,[1] to increase at higher temperatures but the nucleation rate to be lower.

2.2.4 SUPERSATURATION FACTOR

According to J.W. Mullin and C. Gaska,[28] the growth rate increases with supersaturation, slowly at the initial stages but more rapidly as the supersaturation is increased. They also observed that growth apparently ceased below ΔC = 0.2g K_2SO_4/100g H_2O. Of interest is the fact

that supersaturation did not influence only the growth and nucleation rates, but also the habit and quality of crystals. Tadao Kawakami[45] showed that the rate of growth of copper sulfate was nearly proportional to the concentration of copper sulfate solution and its viscosity. Ishii, T[14] also reported a first order relationship for potassium sulfate. Nyvlt, J.,[33] stated that for the small degrees of supercooling normally found in industrial crystallizers, growth rate increased linearly with supersaturation. In another work, Mullin et al[29] recorded that potassium sulfate crystals in the 250-2500 micron size range grew at a rate proportional to the square of the supersaturation. Rosen and Hulburt[41] reported an identical functionality for the 60-2000 micron size range. A decrease in nucleation rate with increase in supersaturation has been reported by Randolph, A.D. and Cise, M.D.,[36] and confirmed by Randolph and Rajagopal.[40]

2.2.5 RESIDENCE TIME

It has been reported [A.B. Amin and M.A. Larson][1] that the net result of different residence times in continuous crystallizers was the generation of a different supersaturation and consequently different growth and nucleation rates. For the crystallization of calcium sulfate from phosphoric acid, a larger residence time and consequently lower supersaturation gave a larger sized product.[43]

2.3 SODIUM SULFATE SOLUBILITY

A search of the literature for information on the solubilities of inorganic salts in various anhydrous alcohols will show that comparatively little work has been reported. Most of the data have been obtained for salts in aqueous alcohols.[15] The solubilities of the salts in these alcohols show a wide variation with different investigators. "These discrep-

ancies in results may be attributed to varying amounts of water in the alcohols, or the methods for determination may have permitted moisture to reach the solutions."[15] No reference was found on the solubility of sodium sulfate in methanol-water-sulfuric acid solution. Larson and Hunt[19] gave data for sodium and potassium halides at 25°C in absolute isopropanol. Ginnings and Chen,[12] have reported results for potassium chloride, ammonium acid phosphate and sulfate, sodium bromide and carbonate at 25°C in aqueous isopropanol solutions. Frankforter and Temple[11] studied the systems consisting of the aqueous alcohol and potassium carbonate or fluoride at 20°C. The solubilities of sodium choloride and of sodium sulfate in absolute alcohol are reported by Kirn and Dunlap[15] over the temperature range from 20° to 50°C.

2.4 PRINCIPLES UNDERLYING EQUIPMENT CHOICE

Since supersaturation is the molecular driving force in all crystallization processes, a number of techniques have been employed to cause it: these include indirect cooling, evaporation of the solvent, adiabatic vacuum cooling, and 'salting-out' by the addition of a third component to reduce the solubility of the crystallizing substance. The indirect cooling mode, wherein heat is removed through a heat exchanger wall, is utilised when product solubility is strongly temperature dependent. The evaporation technique is suitable for solutions with small or negative temperature dependence. Adiabatic cooling is used for crystals with intermediate types of solubility curves. In this work, 'salting-out' is utilised in the generation of the supersaturated state. The 'salting' substance which may be a liquid, solid or gas is sometimes referred to as a 'diluent' or precipitant. The necessary properties for a diluent are: it should be miscible with the solvent of the original solution,

at least over the desired range of concentration; the solute should be relatively insoluble in it and also the final solvent-diluent mixture should be capable of easy separation, for example, by distillation.

Equipment for heating, cooling, and vacuum generation is not needed as is the case with evaporative or cooling types of crystallizers. The use of a non-saturated feed stream eliminates the problem of feed-line plugging during operation. Insulation of the crystallizer is not necessary; therefore, a transparent vessel can be used enabling visual observation of the crystal suspension during operation. The maintenance of a constant crystal suspension during an upset in production rate does not require the simultaneous change of heat input or removal. The above mentioned advantages are especially important when a small crystallizer is used as in the present work. Probably the biggest disadvantage of 'salting-out' crystallization is the need for a recovery unit to handle fairly large quantities of the mother liquor in order to separate the solvent and diluent, one or both of which may be valuable.

As has been stated earlier, there are many crystallizers that have been used industrially but the ARP process uses the 'salting' method because it gives the desired product easily and is heat efficient. Since this work was intended to determine some of the design parameters of this (ARP) industrial crystallizer, a mixed suspension mixed product removal (MSMPR) crystallizer as recommended by Randolph and Larson[37] was used in the investigation.

CHAPTER 3

BASIS AND EXTENT OF EXPERIMENTAL STUDY

3.1 THEORY

Randolph and Larson[39] described a way in which the rates of the simultaneous processes of nucleation and growth could be quantitatively measured in a backmixed crystal suspension. The essence of the proposed method is to generate in a CSTR a crystal mass with size distribution over some convenient finite size range, and to obtain quantitative nucleation and growth rates by fitting the crystal size distribution (CSD) data to the form of CSD predicted by theory. The basic assumptions made are:

(i) the system is perfectly mixed, in other words, the agitiation is so effective that there is no product classification.

(ii) the product withdrawn from the reactor has the same concentration as that in the reactor and is a representative sample of the vessel contents in shape, size, form and habit.:

(iii) Crystal nuclei appear with zero size;

(iv) the growth rate is independent of crystal size (McCabe ΔL law);[25]

(v) there are no crystals in the feed stream;

(vi) constant slurry volume

(vii) steady state operation.

The analysis of the crystallizer data is based on the population balance equation given by Randolph[39] as

$$\frac{\partial n}{\partial t} + \frac{\partial (Gn)}{\partial L} + \frac{n\, d(\ln V_T)}{\partial t} = \sum_{i=1}^{M} \frac{n_i Q_i}{V} + B(L) - D(L) \qquad (1)$$

This complex relation is simplified by applying the assumptions made viz constant slurry volume ($d/dt^{(\ln V_T)} = 0$); steady state operation

$[(\frac{\partial n}{\partial t} = 0), (B(L) = D(L))]$, also the rate of generation is constant at steady state, thus $(\frac{\Sigma n_i Q_i}{V} = n/\tau$ where $\tau = v/Q)$.

The simplified equation becomes

$$\frac{\partial}{\partial L}(Gn) = \frac{n}{\tau} \qquad (2)$$

n = population density (no. of crystal)
τ = residence time
G = Growth rate
L = size of crystal

The McCabe[25] ΔL law assumption is applied and equation 2 is integrated to give

$$n = n^\circ \exp(-L/G\tau) \qquad (3)$$

where n = population density of crystal
n° = nuclei population density
L = crystal size

A semi-log plot of n versus L gives a straight line of slope $-1/G\tau$ From this, the growth rate G is calculated. The curve is extrapolated to size equal to zero to give the nuclei population density (n°). The product of n° and growth rate gives the nucleation rate.

$$B = n^\circ G \qquad (4)$$

3.2 EXTENT OF EXPERIMENTAL WORK

As solubility cannot be predicted accurately, the first step in the study of crystallization rates is to obtain solubility data for the suggested system in order to estimate the economic feasibility of the proposed method. In the present work the phase equilibrium for sodium sulfate--methanol/water--sulfuric acid system was determined for a methanol-water ratio of 50 by 50% at a temperature of 35°C.

The growth and nucleation rates of neutral sodium sulfate were determined and the effect of the following factors on them tested:

(i) Supersaturation which serves as an expression of the molecular

driving force of the process and its effect at 0.7, 0.823 and 0.95 levels on the growth and nucleation rates was studied.

(ii) Agitation rate at 1260 RPM, 1926 RPM and 2466 RPM was tested.

(iii) Residence time for 170 secs, 235 secs and 380 secs values were employed and the corresponding effect measured.

(iv) Temperature of 15°C, 20°C, 25°C and 35°C were used and their effect on growth and nucleation rate was determined.

This work could have easily employed industrial effluents but as a preliminary study it was not desireable to include all the effects caused by trace elements and other impurities in the waste, so instead an artificial effluent of concentration equivalent to that from the Mathieson process (50% sodium sulfate in 37.5% sulfuric acid solution) was used. A 2^4 statistical factorial design was applied in the analysis of the results because it was not possible to generalise the effect of all the variables on growth and nucleation rates just by observing the trend in the graphical representation.

CHAPTER 4

APPARATUS AND EXPERIMENTAL TECHNIQUE

4.1 APPARATUS

The crystallizer is of the continuous mixed suspension mixed product removal (MSMPR) type. The vessel is a one litre glass reactor (culture flask) fitted with a directly driven variable speed agitator. There are three ports at the top for the introduction of spent acid, water and methanol. A sample withdrawal port is also provided at the top. At the 'neck' of the vessel is an outlet port for product overflow, while in the middle on the water jacket, the temperature controlled water inlet and outlet ports are placed diagonally to each other. Three 0.8 litre containers for spent acid, methanol and water are placed above the reactor to give gravity feed and are connected to the reactor vessel by tygon tubing. The three flows were measured with (Gilmont size 13) rotameters. A stainless steel heat exchange coil was placed in the spent acid storage vessel and copper heat exchangers in the other two. They were connected in series to a constant temperature water bath. (figure 1)

4.2 EXPERIMENTAL TECHNIQUE

4.2.1 PHASE DIAGRAM DETERMINATION

The curves in three-component phase diagrams trace out points of saturation with respect to one or more components. Thus, when any mixture of water-methanol, sulfuric acid and sodium sulfate was taken which left some crystals undissolved, the analysis of the solution gave a point on one of the curves. By testing a wide range of mixtures a number of saturated solutions was obtained and a sufficient number of points

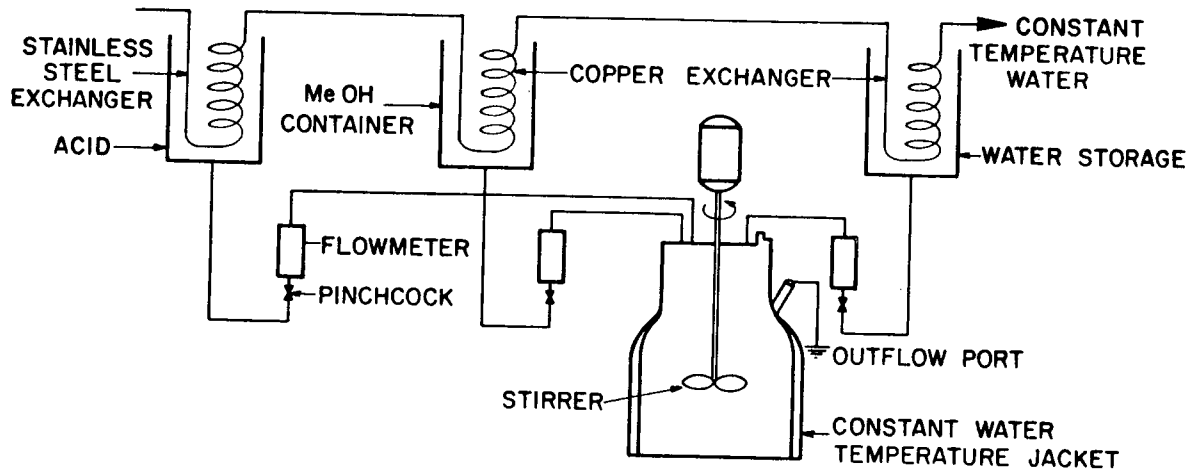


FIGURE 1 SCHEMATIC DIAGRAM OF EQUIPMENT

was determined to draw all the curves in the diagram (fig. 2). To complete the diagram it was necessary to know the form of the salt with which each solution was saturated. By filtering and analysing the crystals an approximate formula was found, but this method was not sufficiently accurate as some mother liquor was left in the filtered crystals. To avoid this handicap, the method of Wet Residues was employed.

4.2.2 METHOD OF WET RESIDUES PRINCIPLE

It will be remembered that if any component is marked on a phase diagram it lies on the straight line joining its solution with its solid. If, therefore, some mother liquor remains with the solid the composition of the wet residue must also lie on the same straight line, but nearer to the solid. By analysing a solution and its wet residue two points can be plotted on a diagram and a straight line is drawn through them. The composition of the solution gives a point on the curve; the composition of the solid phase must lie somewhere on the straight line beyond the position of the wet residue.

4.2.3 TECHNIQUE OF DETERMINATION

It was decided that commercial methanol would be used for making up the aqueous solutions, provided the solubility in a test solution of given composition was the same as that in a solution of the same composition prepared from purified alcohol. Since only traces of organic compounds, in addition to water, are present as impurities in the commercial methanol, it was assumed that these would have a negiligible effect on the solubility of sodium sulfate in the aqueous methanol solution. Moreover, industrially the methanol used is rarely purified before being used.

A 50-50 weight percent mixture of methanol and water was prepared and stored. This was mixed at various weight percents (0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100) with 9N (37.5 weight %) sufuric acid. About 500 ml of each composition was measured out and divided equally into two Erlenmeyer flasks. A fixed weight (100gm) of sodium sulfate granules was added to each of the flasks. The flasks were corked, sealed in order to reduce methanol loss by evaporation, and placed in a water bath maintained at 35°C. The whole set was agitated and allowed to 'stay' at this temperature for about seven days with intermittent shaking of the flasks and their contents, so that equilibrium could be attained. Equilibrium was assumed to have been attained if after seven days, there were still undissolved granules. If there were no undissolved sodium sulfate, another quantity of sodium sulfate was added and the 'end point' test performed at the end of another seven day period.

At equilibrium, the mixture was allowed to settle while still being maintained at 35°C. Some of the clear solution was withdrawn from each flask and analysed. 25ml of clear solution was weighed and heated to dryness, the crystals were weighed again and the weight of dissolved sodium sulfate calculated. A portion of the solution was titrated with Ferrous Ammonium Sulfate to determine the weight percent of methanol and thus water/methanol solution. It should be noted that about a 5% difference was observed in the measured methanol concentration and that initially used. The methanol was plotted as a 50 weight percent water solution on the triangular diagram. The other portion of the clear solution was titrated with sodium hydroxide to calculate the weight percent of sulfuric acid. The second flask at the same composition was used to cross-check for the accuracy of the results. The remainder of the solution in the flask was decanted and the wet residue weighed, and redissolved

in sulfuric acid. This solution was then analysed as has been described, but the concentration was calculated as a percentage of the weight residue and this gave the second point on the diagram.

For each original mixture two analyses were obtained, one representing the solution, the other representing the wet residue. The solution points were joined to form the curves. The crystals were dissolved in water and the solution titrated to determine the type of compound produced.

4.2.4 ANALYSIS OF CRYSTALS

The crystals produced after the evaporation, were dissolved in water and the solution titrated. When the titer for each of the new solutions was equivalent to 36% titratable sulfuric acid, the crystal was classified as sodium bisulfate monohydrate. To confirm this statement, a quantity of the crystals was heated and observed to have melted at about 58°C, which corresponds to the melting point of $NaHSO_4 \cdot H_2O$. But when the titer was equivalent to 18.7% titratable sulfuric acid, sodium sesquisulfate $[Na_3H(SO_4)_2]$, was assumed to have been formed. If 36% equivalent titratable sulfuric acid was used but the melting point of the crystal is above 80°C, sodium bisulfate was assumed to be the product formed. Both sodium sulfate (neutral salt) and hydrated sodium sulfate had no titratable sulfuric acid equivalent.

The specific gravity of the crystals was determined. Crystals with specific gravity of 1.2 to 1.6 were classified as hydrated sodium sulfate ($Na_2SO_4 \cdot 10H_2O$) while those with specific gravity of about 2.5 were grouped as sodium sulfate. To confirm the observation, their melting points were measured. The decahydrate was found to melt around 32°C while the neutral salt did not melt even at temperatures above 100°C.

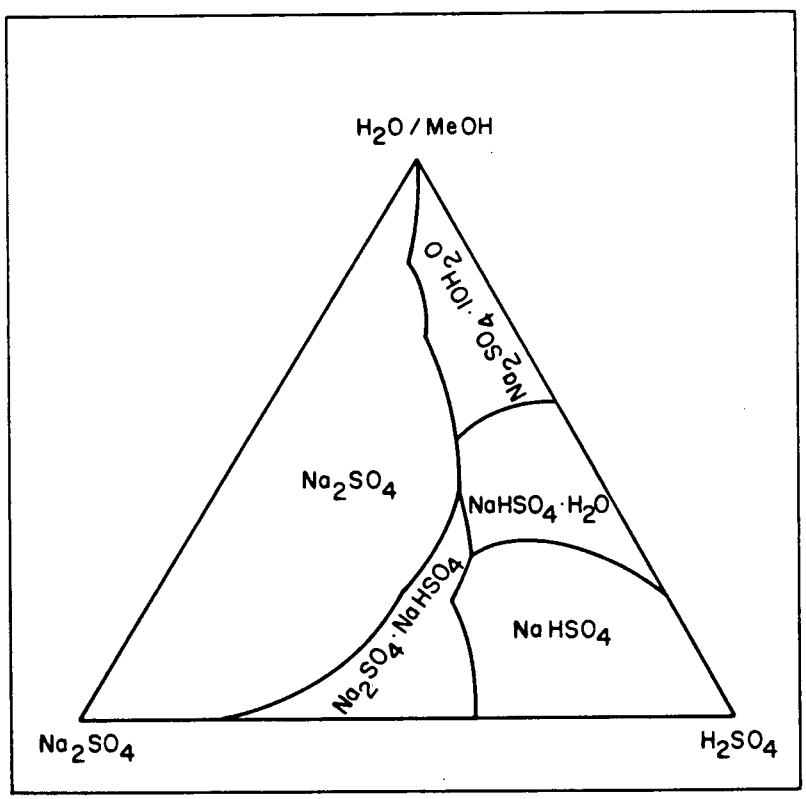


FIGURE 2 PHASE DIAGRAM OF Na_2SO_4 - H_2O/MEOH - H_2SO_4 SYSTEM

4.3 CRYSTALLIZATION RATE EXPERIMENT

4.3.1 TEST SOLUTION PREPARATION

The artificial waste acid solution was prepared by dissolving a fixed weight of sodium sulfate in a 37.5 weight percent (H_2SO_4) sulfuric acid to give a 50% sodium sulfate solution. The acid concentration was measured by titrating with standard sodium hydroxide solution.

The solution was placed in a water bath until its temperature had risen to 5° above the expected working temperature. It was removed and filtered through a sintered glass filter to remove any particles which could cause nucleation.

4.3.2 EXPERIMENTAL PROCEDURE

The artificial effluent solution was poured into its temperature controlled feed reservoir and the other two containers were filled with methanol and water. During this time, the constant temperature water was allowed to circulate through the coils of the reservoir and the jacketted reactor. A sufficient time was allowed to elapse for the whole system to attain the required temperature. The stirrer was then set at the required speed (the low speed shaft rpm was counted for the number of turns per minute by eye and this value was multiplied by 18). The flows were adjusted to give the required rate as shown on the flow meters. This adjustment is very important since in all cases a fixed ratio of methanol to water has to be maintained at 50-50% by weight. This was calculated by multiplying the volume by the specific gravity. (The specific gravity of a methanol-solution mixture at various volumetric ratios is linear--appendix 1--). The time to fill the reactor vessel and start overflowing was noted.

At steady state flow conditions (flow in = flow out), a 60 cm^3 hypodermic syringe with the needle replaced by a 5 mm internal diameter plastic tubing was used to withdraw about 50 cm^3 of the slurry from the vessel. This was quickly transferred to a sintered glass suction filter, where the crystals were separated from the mother liquor. About 25 ml of the clear liquor was heated to evaporation and the crystals deposited were weighed to give the concentration of sodium sulfate in the mother liquor. This final concentration (C^*) was subtracted from the initial concentration. This value was then divided by the final concentration to give the supersation ($\frac{C - C^*}{C^*}$). This definition was used for the supersaturation in order to operate under the same basis as the phase diagram values. When the inital concentration of sodium sulfate was less than 50% it became difficult to crystallize neutral sodium sulfate because the addition of a 50-50 methanol-water solution always lead to precipitation of a mixed salt of neutral sodium sulfate and sodium sequisulfate or even sodium bisulfate (Check fig 2, starting point was always on the Na_2SO_4 - H_2SO_4 horizontal line since it was only a two component system then). The crystals were washed with methanol and dried, after which the crystals were weighed, sieved and the sieve fractions weighed. A portion of this crystal was redissolved in water and titrated in order to determine the amount of acidic component present. For neutral salt product, no acidic component was present.

Reaction steady state was found by repeatedly withdrawing samples with the hypodermic syringe and weighing the crystals. A steady state was assumed to have been attained when the difference in any two consecutive sample weights was less than 2%. The reactor was then washed to remove any trace of crystals and the whole procedure was repeated for a new condition. Since there is no instrument to measure the point concen-

tration during the experiment, a lot of runs have to be made and discarded due to the fact that the concentration is measured at only the initial and final states and that using the same conditions as in the previous experiment, the supersaturation may turn out to be different. This would be caused by small temperature variation of about 1° which would occur during some runs due to the addition of more methanol and sometimes spent acid to the containers.

4.3.3 SIEVE TEST

Screen analyses were made using calibrated U.S. Standard 3-inch screens. The screens used were the following U.S. Standard mesh sizes: 60,80,100,140, and 170. Because of the symmetry of the crystals, reproducible screen analyses were easily achieved.

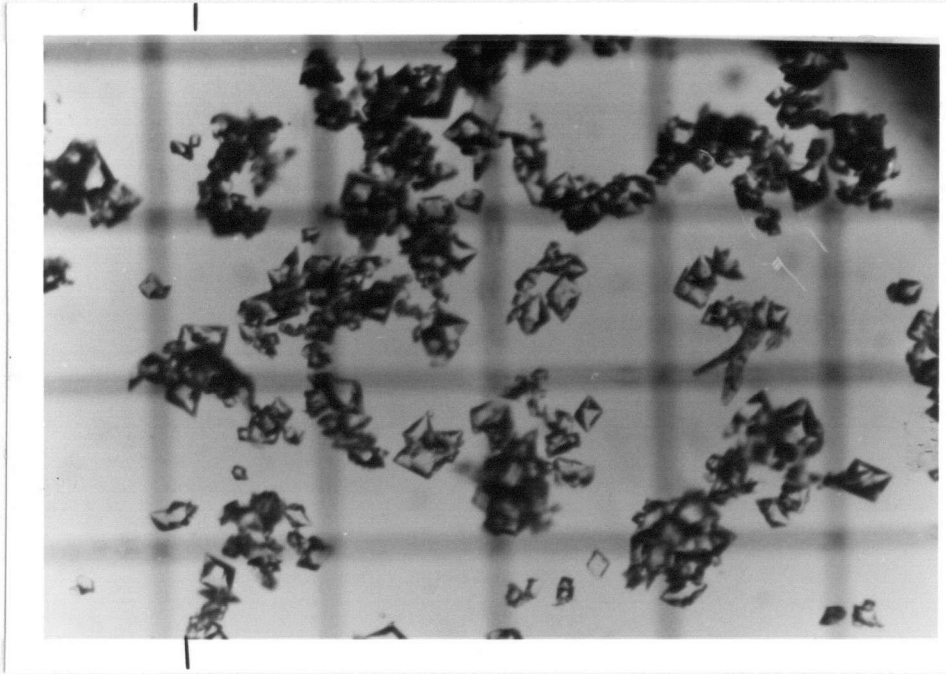
To carry out the sieve analysis all the dried crystals were weighed and placed on the top sieve in a nest which comprised the five sieves arranged in order of decreasing aperture (increasing mesh number) mounted on a bottom collecting pan. A top lid was used to minimise the loss of dust.

The nest of sieves, together with the lid and collector pan were held in the left hand, with the sieve surfaces inclined downwards towards the left at an approximate angle of 30° to the horizontal. The higher side of sieve frame was tapped eight times with the hand. Whilst maintaining the inclination of the sieve, the nest was shaken to and fro several times, while being rotated in the plane of the gauze through an angle of about 60°. These alternate tapping and shaking steps were repeated for about 3 to 5 minutes. The top sieve was removed, inverted over a clean piece of paper, and tapped gently to remove any crystals retained on it. The bottom surface of the gauze, that is, the surface

that was uppermost with the sieve in its inverted position, was brushed gently to aid the cleaning operation. All the discharged material was transferred back to the cleaned sieve mounted on a collector pan and submitted to a further sieving operation, as described above, for about 2 minutes. If the amount of material passing through the sieve in this 2 minute period was less than 0.5% of the original test sample weight, sieving on this sieve was considered complete. If the amount passing exceeded 0.5%, the procedure was repeated until the 'end point' was achieved. All the weighed material from the collector pan was then transferred on to the material retained on the top sieve of the remaining nest which was submitted to another 3 to 5 minutes sieving operation. The 'end point' test was again applied to the top sieve, and the whole procedure was repeated until all the five sieves have been dealt with.

4.3.4 METHANOL EFFECT

It should be noted that a basic assumption made in the experimental procedure was that the purpose for the addition of methanol was to alter the supersaturation level of the solution. In other words methanol acted to change the driving force in the crystallization. Also in the higher temperature experiments both the density and viscosity of methanol changed greatly making it difficult to maintain a steady methanol flow rate. This effect became very pronounced at temperatures above 35°C, and acted as a constraint in carrying out the investigation at temperatures above 35°C.



X1000

FIGURE 3 PHOTOGRAPH OF NEUTRAL SODIUM SULFATE CRYSTALS, AS PRECIPITATED.

CHAPTER 5

RESULTS AND ANALYSIS

5.1 CRYSTAL SIZE AND POPULATION DENSITY

The crystal sizes varied from about 0.1 mm to 0.29 mm and were divided by screen analyses into five different size fractions as previously described. To enhance the representation of the size distribution in terms of population density, the distribution was converted from the weight fractions obtained from the screen analyses by the following method.

(i) The mean diameter of each size fraction (screen analyses fraction) was determined.

(ii) The total weight of the crystals of a given size fraction was then divided by the crystal density, the cube of the mean diameter, and an overall average shape factor. This gave the number of crystals in the size fraction.

(iii) The number of crystals in each fraction was then divided by the width of the size range of the fraction. This gave the population density of crystals in the size fraction.

The actual calculation was performed by first converting the discrete values (screen analyses fractions) of weight to a continuous function by making a cumulative weight percent plot. The abscissa of the plot was broken into thirty-seven equal segments of 0.005 mm width. This width interval was used in order to reduce the error introduced by using the larger value of about 0.05 mm recommended by Mullin, J.[30] A hypothetical diameter was used to represent the mean size of the crystals in the interval. This was necessary because it was relatively difficult

to measure the dimensions of the crystals with a microscope or from photographs. The hypothetical diameter (size) was calculated using the relation:

$$L_h = \sqrt{(A - 0.025)\ (A + 0.025)} \qquad (5)$$

(L_h = hypothetical crystal size, A = mesh opening at uniform interval)

where $A = AD(1) + 0.005(I-1)$ (6) I = iteration counter

(AD = screen size)

This was calculated for every 0.005 mm interval and the corresponding weight percent on the ordinate was read for the segment. The population density for each segment was calculated by:

$$n = \frac{PsV}{P} \frac{\Delta m}{kvL_h^3} \Delta L_h \qquad (7)$$

where Ps = suspension density
V = reactor capacity
Δm = crystal mass increment
P = crystal density
kv = overall shape factor
L_h = hypothetical crystal size
ΔL_h = hypothetical crystal size increment

A computer program was written that performed this operation (Appendix 5)

5.1.2 CRYSTAL SHAPE FACTOR

A value of the overall shape factor, kv is needed for calculating the population density from equation (7), but as the crystal size in the present studies ranged from about 0.3 mm down to a few microns it was necessary to see if kv was size-dependent. Accordingly, sodium sulfate crystals produced by crystallization were carefully separated with five size fractions as described earlier and their volume and surface shape factors were determined separately.

The volume shape factor, fv, was determined by weighing about 100 crystals from each sieve fraction and then apply the relation

$$M = nP\ fv\ L^3 \qquad (8)$$

where L = mean aperture size
P = crystal density
fv = volume shape factor
n = number of crystals
M = mass of crystals

and taking the arithmetic mean aperture size as the characteristic dimension, L, of each sieve fraction. Within the limits of experiment error, fv remained constant at 0.6 ± 0.03.

The surface shape factor, fs, for the crystals in each sieve fraction was determined with the aid of a microscope. It was assumed that the crystal rested on one of its longest faces, its average length, x, and breadth, y, were obtained by making six readings of each of the two dimensions. The thickness of the crystal, Z, was derived by taking the mean sieve aperture size, L, as the characterising dimension and assuming the crystals to be a parallelepiped, that is,

$$Z = fv\ L^3/xy \qquad (9)$$

where Z = crystal thickness
L = mean aperture size
x = length of crystal
y = breadth of crystal
fv = volume shape factor

The surface shape factor of a crystal, characterised by its mean sieve aperture size L, is given by

$$fs = 2(xy + yZ + xZ)/L^2 \qquad (10)$$

where fs = surface shape factor
x = length of crystal
y = breadth of crystal
Z = crystal thickness
L = mean aperture

Over the size range studied the surface shape factor remained reasonably constant at $fs = 3.9 \pm 0.03$. Consequently, a constant overall shape factor

$$kv = fs/fv = 6.5 \pm 0.5$$

was used when calculating population density from equation (7). As can be seen in equation (3), a plot of log of the population density versus crystal size should give a straight line with slope equal to $(-1/G\tau)$ and an intercept of the log of the nuclei population density. A computer program that utilised the least square method of fitting a curve was used to determine the growth rate and the corresponding nucleation rate for all the tested conditions. As can be seen in the semi-log plot of population density versus crystal size (figure 4), the plot fits the simplified Randolph's[37] model very well. The growth rate was calculated by dividing the inverse of the slope by the residence time.

$$G = \frac{-1}{\text{slope} \times \tau}$$

The slope is negative hence the growth rate is positive. The nucleation rate was calculated by multiplying the intercept by the growth rate. See appendix 6 for crystal size and population density results. Table I shows the rates for one set of conditions, all the data are given in appendix 4. As can be seen in Table I the growth rate and nucleation rate increase with supersaturation and temperature in a regular manner.

Table 2 shows the crystal size distribution obtained from the sieve fractions for one set of conditions, while all data are given in appendix 6. The crystal size fractions at various residence times for the same supersaturation, agitation rate and temperature, larger sized product, as would be expected, is generated at longer residence times. In other words more crystals grew to a large size at longer residence times, which resulted in smaller values of growth rate and corresponding lower nucleation rate values.

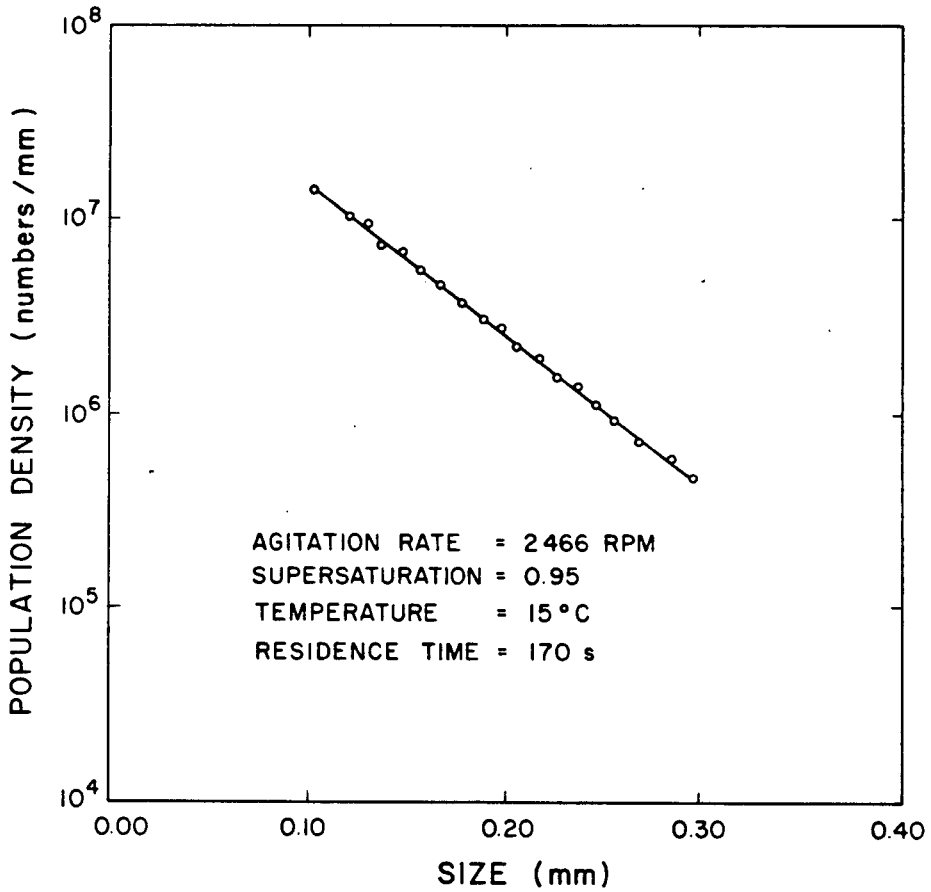


FIGURE 4 POPULATION DENSITY VS CRYSTAL SIZE (SAMPLE PLOT)

TABLE 1

GROWTH RATE, AND NUCLEATION RATE VERSUS

SUPERSATURATION AT VARIOUS TEMPERATURES

RESIDENCE TIME = 170 secs

AGITATION RATE = 2466 RPM

GROWTH RATE UNIT = (mm/HR)

NUCLEATION RATE UNIT = NUMBERS/HR

SUPERSATURATION	GROWTH RATE	NUCLEATION RATE	TEMPERATURE
0.70	0.081	0.7075×10^7	15°C
0.823	0.088	0.82×10^7	
0.95	0.095	0.9825×10^7	
0.70	0.0822	0.88×10^7	20°C
0.823	0.0913	1.0625×10^7	
0.95	0.10	1.3×10^7	
0.70	0.0822	0.88×10^7	25°C
0.823	0.095	1.35×10^7	
0.95	0.1066	1.675×10^7	
0.70	0.08835	1.2125×10^7	35°C
0.823	0.1005	1.5375×10^7	
0.95	0.1134	1.9875×10^7	

TABLE 2

CRYSTAL SIZE FRACTION VERSUS WEIGHT AT VARIOUS RESIDENCE TIMES

SUPERSATURATION = 0.95

AGITATION RATE = 1926 RPM

TEMPERATURE = 15°C

SCREEN SIZE (mm)	WEIGHT (gm)	RESIDENCE TIME (secs)
0.106	0.2780	
0.15	0.3393	
0.18	0.02	170 secs
0.25	0.0296	
0.297	0.01480	

SCREEN SIZE (mm)	WEIGHT (gm)	RESIDENCE TIME (secs)
0.106	0.435	
0.15	0.558	
0.18	0.0696	235
0.25	0.0505	
0.297	0.0625	

SCREEN SIZE (mm)	WEIGHT (gm)	RESIDENCE TIME (secs)
0.106	0.0894	
0.15	0.0905	
0.18	0.036	380 secs
0.25	0.0547	
0.297	0.0433	

5.2 CRYSTAL SIZE DISTRIBUTION

While the most comprehensive method for describing screen sample is a graphical presentation,-- which has been used in this study to determine both growth and nucleation rates--, a more convenient method has been suggested by Mullin, J.[30] The approach uses descriptive methods that are primarily concerned with the bulk of the product rather than extremes. This method reports the screen mean aperture of the crystals (mean size of crystals) and the coefficient of variation (C.V.) of size. These are found by plotting the average particle size against the cummulative weight retained on each screen on arithmetic probability paper, determining the apertures corresponding to 16% and 84% probability (two standard deviations) and comparing their difference with the average particle size. The coefficient of variation (C.V.), as a percentage, is defined as follows:

$$C.V. = 100\left[\frac{P.D_{16\%} - P.D_{84\%}}{(2)\ P.D_{50\%}}\right] \qquad (11)$$

where C.V. = coefficient of variation
$P.D_{16\%}$ = particle diameter at 16% probability
$P.D_{84\%}$ = particle diameter at 84% probability
$P.D_{50\%}$ = mean particle diameter

The coefficient of variation of crystals in this study varied from 28% to 52%. This result agrees very well with Bennett's[7] value of 25% to 54% for non-classified products. A sample calculation is shown for a run with:

Residence time = 170 secs., Agitation rate = 2466 RPM., Temperature = 15°C and supersaturation = 0.95

Screen size (mm)	Weight retained (gm)	Cummulative % wt
0.25	0.03670	4.47998
0.180	0.0395	9.30176
0.15	0.0332	13.27393
0.106	0.2451	43.27393
0.088	0.4647	100

From the graph (see figure 5)

$$P.D_{16\%} = 0.149 \text{ mm}; \qquad P.D_{84\%} = 0.0865 \text{ mm}$$

$$P.D_{50\%} = 0.1001 \text{ mm}$$

Substituting these values in the C.V. equation gave

$$C.V. = 100 \left[\frac{0.149 - 0.0865}{2 \times 0.1001} \right] = 31.2\%$$

Mean size = 0.1001 mm.

Therefore, the crystals can be said to have a coefficient of variation of 31.2% and mean size of 0.1001 mm.

NB: Other results are in appendix 3

This also has confirmed the assumption of perfect mixing used in the theory since according to Bennett, R.C,[7] the C.V. for classified products varies from 12% to 38% while in this system, C.V. varied from 28% to 52% which corresponds closely to Bennett's non-classified products C.V. range of 25% to 54%.

5.3 KINETIC RATE VARIATION AND KINETIC CONSTANT

As has been stated earlier, the crystal size distribution satisfied the simplified Randolph[39] equation and also this characteristic of non-classification of the product has helped in buttressing the theoretical approach which has been employed. The effect of the factors viz super-saturation, agitation rate, residence time and temperature was measured as follows:

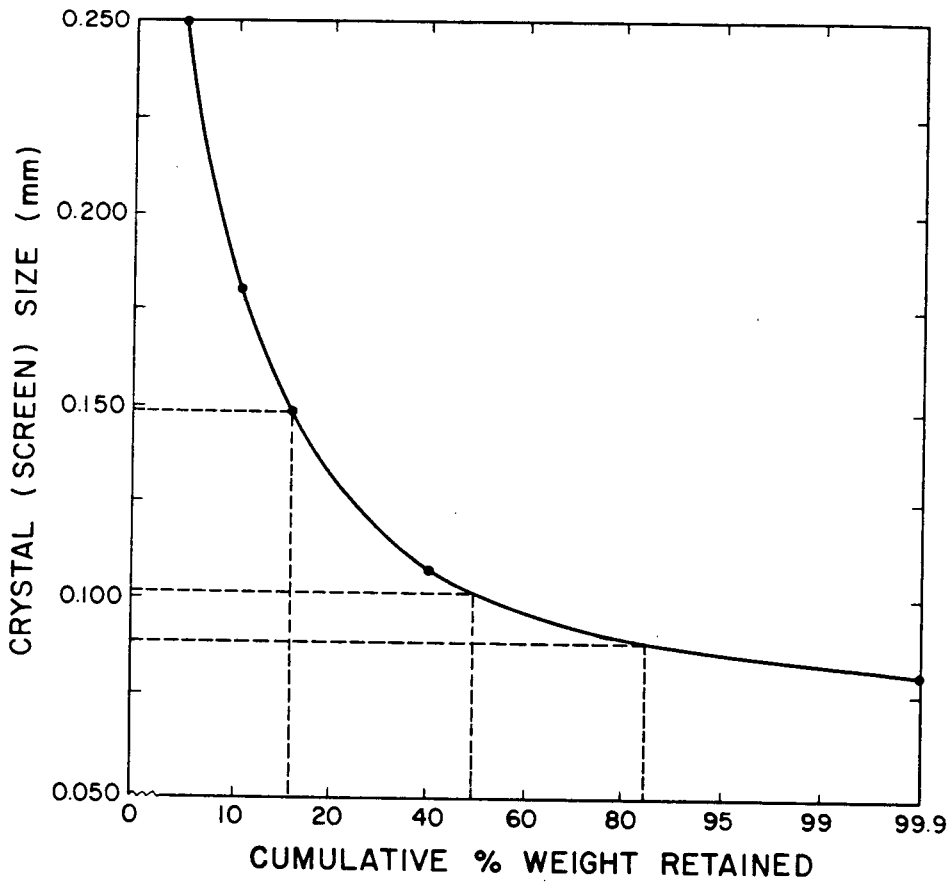


FIGURE 5 COEFFICIENT OF VARIATION DETERMINATION

5.3.1 EFFECT OF SUPERSATURATION AND TEMPERATURE ON GROWTH

A log-log plot of growth rate versus supersaturation is a straight line. The slope of the curve is the 'order' (index of supersaturation) of the relationship between growth rate and supersaturation. For the conditions studied, this 'order' varied from 0.9 to 1.1, thus an average of 1 was used in the final analysis.

The growth rate, supersaturation relationship is now given as

$$G = kaS \qquad (12)$$

where G = Growth rate
ka = Growth rate constant
S = supersaturation

A linear relationship of the function was drawn by 'eye' plotting growth rate (G) against supersaturation (S). The slope of this curve is equal to the growth rate constant (see fig. 6 for sample plot and appendix 6 for complete data).

From the plot, it can be observed that, as would be expected, at higher values of supersaturation the crystal growth rate increased and also at increased temperature levels, the growth rate correspondingly rose. But at increased agitation rates and residence times, the growth rate decreased. It was not possible to quantify these effects from the plots, thus a 2^4 statistical factorial design analysis was employed. Check appendix 2 for a table and appendix 7 for graphs, showing growth rate versus supersaturation, with temperature as parameter at various agitation rates and residence time levels.

5.3.2 EFFECT OF TEMPERATURE AND SUPERSATURATION ON NUCLEATION

A log-log plot of nucleation rate versus supersaturation at various levels of the other factors was drawn. This gave a linear relationship with slope equal to the 'order' (index of supersaturation) of the super-

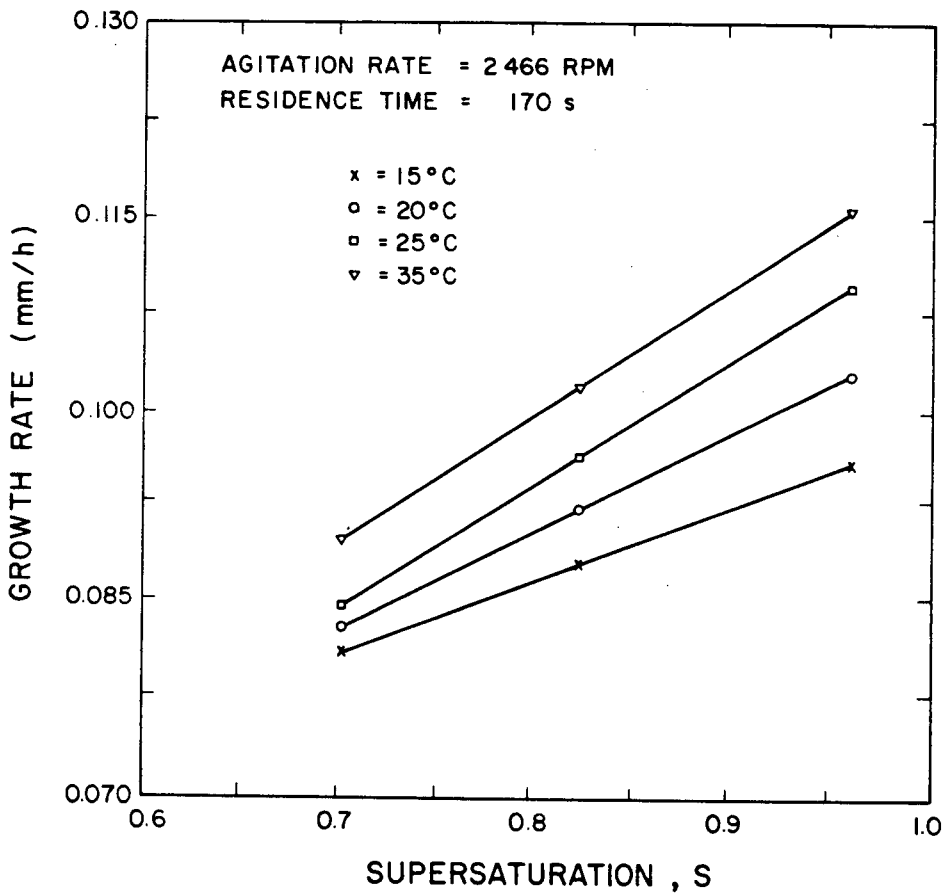


FIGURE 6 GROWTH RATE VERSUS SUPERSATURATION, TEMPERATURE AS PARAMETER

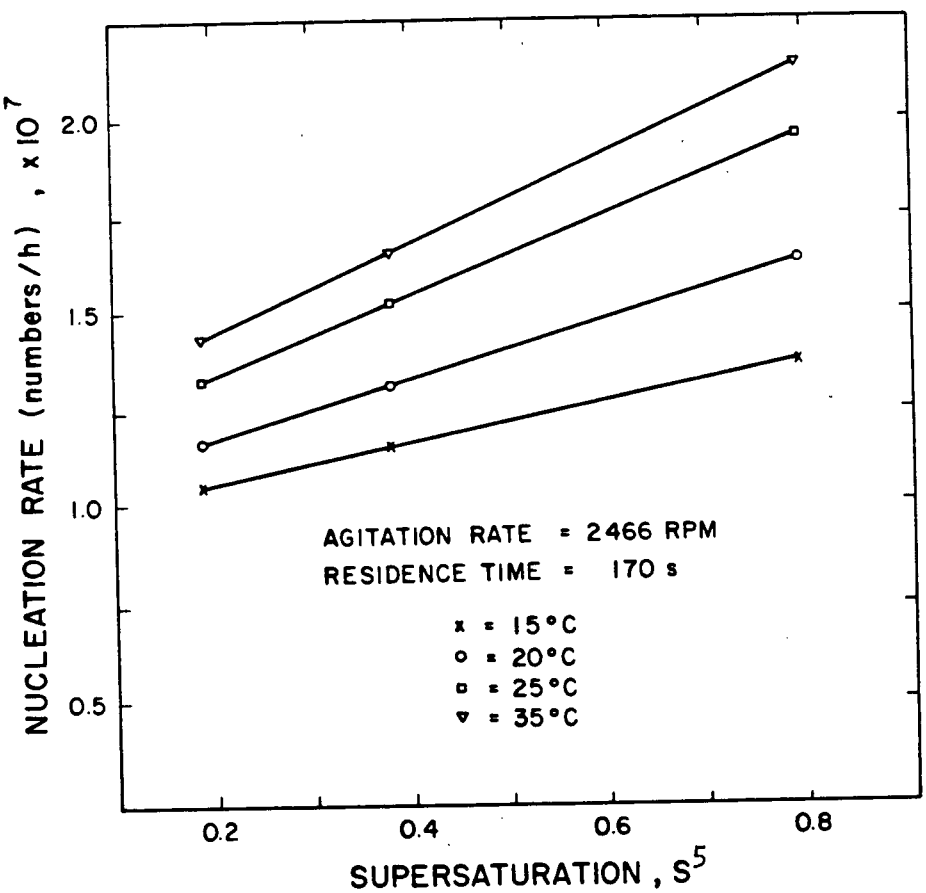


FIGURE 7 NUCLEATION RATE VS SUPERSATURATION, TEMPERATURE AS PARAMETER

saturation - nucleation rate equation.

$$B = knS^n \qquad (13)$$

where kn = kinetic constant
B = nucleation rate
S = supersaturation
n = order

For the conditons tested, this 'order' varied from 4.9 to 5.1, an arithmetic average of 5 was assumed. In other words the nucleation rate relationship can be represented as

$$B = knS^5 \qquad (14)$$

Also in this case (fig. 7) both temperature and supersaturation had positive effects on the nucleation rate, that is, promoted nucleation while agitation rate and residence time decreased this rate as their values increased. (check appendix 7 for more plots)

5.4 DETERMINATION OF ACTIVATION ENERGY

The growth rate of a crystal is a function of both the surface integration process and the rate of the molecular transport process. One of the useful criteria for distinguishing which rate controls is the temperature dependence of the overall growth constant, ka, which can be estimated by assuming an Arrhenius-type relation of the form.

$$ka = A \exp(-Ea/RT) \qquad (15)$$

where ka = kinetic constant
A = Frequency factor
Ea = Activation energy
R = Molar gas constant
T = Absolute temperature

A log-log plot of ka (calculated from the growth rate - supersaturation plot) and the inverse of the absolute temperature gave a straight line of (fig. 8) slope equal to (-Ea/R). From this value the activation

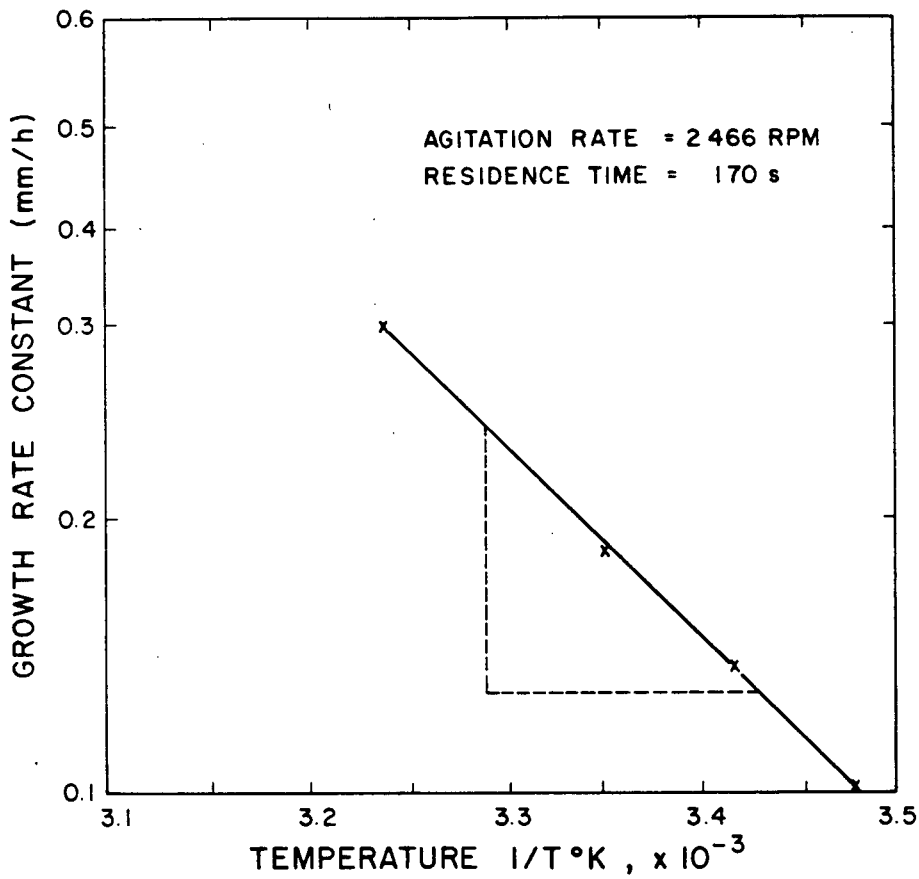


FIGURE 8 GROWTH RATE CONSTANT VERSUS 1/TEMPERATURE °K

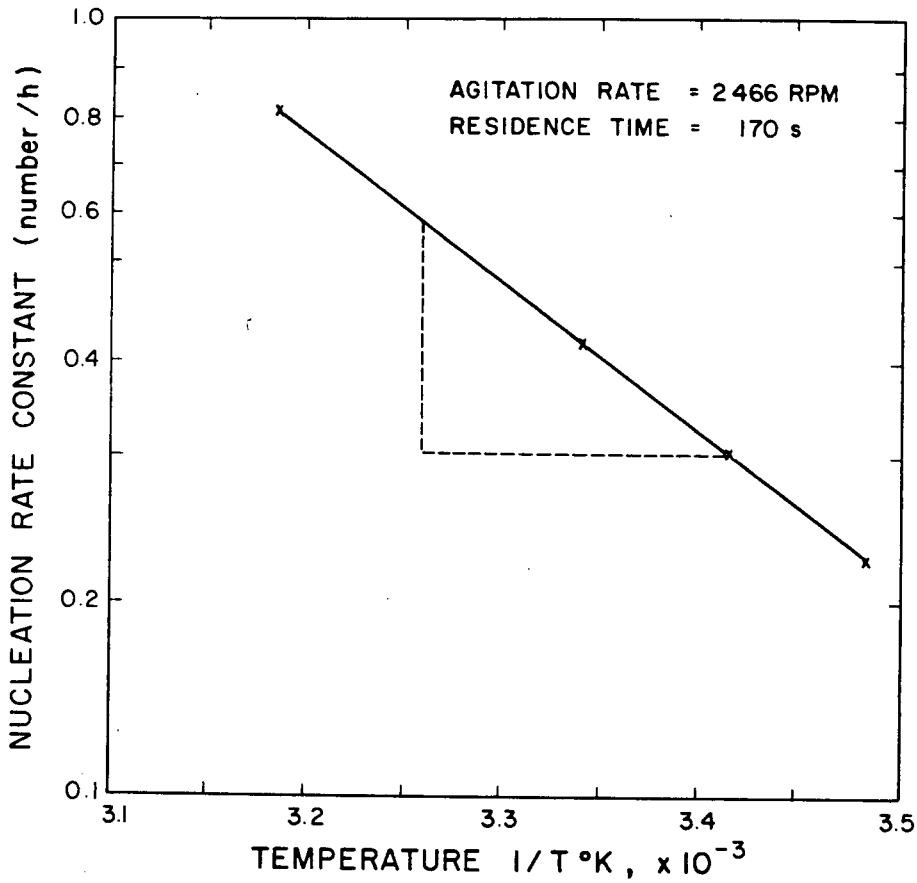


FIGURE 9 NUCLEATION RATE CONSTANT VERSUS 1/TEMPERATURE °K

energy for the process was estimated. In all the conditions tested the activation energy was in the range from 13 - 15 kcal/mol. These high values of activation energy (see table 3 for sample result and appendix 4 for all the data) show a strong dependence of growth rate on temperature, as was noted earlier from the graphs. Coulson and Richardson[10] suggested that, "for most reactions the activation energy lies in the range of 10 kcal to 50 kcal which implies a rapid increase in rate constant with temperature."

The same approach as has just been described was used in the verification of temperature effect on nucleation rate. The activation energy fell within the range from 12 to 15 kcal/mol, which also was an indication of strong temperature dependence. (see fig. 9 for sample plot and table 3 for some results).

These high values of activation energy combined with the fact that they are independent of stirrer speed strongly suggest a surface-integration control. A dependence of the activation energy on stirrer speed would have given values in the range from 4.5 to 8 kcal/mol activation energy and would have suggested a diffusion controlled mechanism.

To buttress the conclusions already made and also to quantify the effect of the other factors (agitation rate and residence time) a 2^4 statistical factorial design analysis was utilised to further analyse the data.

5.5 FACTORIAL ANALYSIS

A 2^4 factorial design statistical analysis was used to quantify the effect of the parameters tested as demonstrated in the plots and table of values. This factorial design was employed because of the following general advantages over other statistical analyses.

TABLE 3

GROWTH AND NUCLEATION RATE CONSTANTS WITH CALCULATED ACTIVATION ENERGY AT VARIOUS CONDITIONS

AGITATION RATE = 2466 RPM RESIDENCE TIME = 170 secs

GROWTH CONSTANT	ACTIVATION ENERGY	1/T°K	NUCLEATION CONSTANT	ACTIVATION ENERGY
2.996		0.0032468	0.819	
1.8807	14.5kcal/mol	0.0033557	0.424474	15 kcal/mol
1.4550		0.003413	0.30573	
1.13029		0.0034722	0.212556	

AGITATION RATE = 1926 RPM RESIDENCE TIME = 170 secs

GROWTH CONSTANT	ACTIVATION ENERGY	1/T°K	NUCLEATION CONSTANT	ACTIVATION ENERGY
1.9		0.0032468	0.49	
1.453	14.4 kcal/mol	0.0033557	0.383864	14.8kcal/mol
1.30		0.003413	0.34432	
1.12		0.0034722	0.3	

AGITATION RATE = 1260 RPM RESIDENCE TIME = 170 secs

GROWTH CONSTANT	ACTIVATION ENERGY	1/T°K	NUCLEATION CONSTANT	ACTIVATION ENERGY
2.295		0.0032468	0.4244748	
1.50	15 kcal/mol	0.0033557	0.3057307	14.5 kcal.mol
1.15		0.003413	0.2308682	
0.9		0.0034722	0.185	

(i) When there are no interactions the factorial design gives the maximum efficiency in the estimation of the effects.

(ii) In the factorial design the effect of a factor is estimated at several levels of the other factors, and the conclusions hold over a wide range of conditions.

(iii) When interactions exist, their nature being unknown, a factorial design is necessary to avoid misleading conclusions.[51]

DEFINITIONS:

(a) Factor: is used to denote the feature of the experimental conditions which was varied from trial to trial. In these experiments; supersaturation, agitation rate, residence time and temperature were the factors tested.

(b) Levels of a factor: The various values of a factor examined in the experiment are known as levels.

(c) Treatment: The set of levels of all factors employed in any given trial or experiment is called Treatment or Treatment combination.

(d) Response: The numerical result of a trial on a given treatment is called the Response corresponding to the treatment. In this case the response was either growth rate or nucleation rate.

(e) Effect of a factor: The effect of a factor is the change in response produced by a change in the level of the factor. In this case, where any single factor was tested in at least two levels,—the analysis was based on two levels, only—, the effect was simply the difference between the average response of all trials carried out at the first level of factor and that of all trials at the second level.

(f) Notation: A factor is denoted by a capital letter, and the two levels of the factor by (one) '1' for the lower level of trial and the

corresponding small letter representing trial at the higher level.

In the present work, let supersaturation be represented by A, agitation rate by B, residence time by C and temperature by D. Thus, when supersaturation is 0.70, which is the lower level of the trial, it will be denoted by (1) while when it is 0.95, it will be represented by (a).

TABLE 4

FACTOR LEVELS AND NOTATION

FACTORS	LOWER LEVEL (1)	UPPER LEVEL (LETTERS)
Supersaturation (A)	0.70	0.95 (a)
Agitation Rate (B)	1260 RPM	2466 RPM (b)
Residence Time (C)	170 secs	380 secs (c)
Temperature (D)	15°C	35°C (d)

For any trials in which two or more factors are at their upper level, the response will be denoted by a combination of their small letters, for instance if supersaturation is 0.95, agitation rate = 2466 RPM and temperature = 35°C., the response will be denoted as abd, while when all the factors are at their lower level, the response will be represented as (1).

There is a convenient order in which to write the treatment combinations and effects. For one factor A, we simply write (1), a. For two factors A,B, we add b, ab, derived by multiplying the first two by the additional letter b. For three factors the standard form is

(1), a, b, ab, c, ac, bc, abc

For four factors as in our case, we have

(1), a, b, ab, c, ac, bc, abc, d, ad, bd, abd, cd, acd, bcd, abcd.

TABLE 5

GROWTH RATE WITH THEIR CORRESPONDING FACTORS

AT THEIR VARIOUS LEVELS

		TEMPERATURE OF CRYSTALLISATION D			
SUPERSATURATION A	AGITATION RATE B	15 + 1 (1)		35 + 1 (d)	
		RESIDENCE TIME (C)		RESIDENCE TIME (C)	
		170 (1)	380 (C)	170 (1)	380 (C)
0.70 (1)	1260 (1)	0.0936(1)	0.044(C)	0.10036(d)	0.04865(cd)
	2466 (b)	0.0810(b)	0.0414(bc)	0.08835(bd)	0.0472(bcd)
0.95 (a)	1260 (1)	0.1057(a)	0.0512(ac)	0.12525(ad)	0.06245(acd)
	2466 (b)	0.095(ab)	0.0451(abc)	0.1134(abd)	0.0573(abcd)

CALCULATION OF EFFECTS AND ANALYSIS OF VARIANCE

Yates'[50] method was applied in the calculation.

Procedure: The column marked (1) (see table 6) is derived from the growth (response) column as follows: the first entry in column (1) is the sum of the first two responses (0.0963 + 0.1057); the second entry is the sum of the second pair of yields (0.0810 + 0.095); the third and fourth entries are the sums of the succeeding pairs (0.044 + 0.0512), (0.0414 + 0.0451) respectively, this is continued until the last entry in the first half is filled by (0.0472 + 0.0573). To fill the second part (middle section of table), the first entry is (0.1057 - 0.0963), the second (0.095 - 0.01810), this is continued until the last entry (0.0573 - 0.0472).

The 3rd part is used to cross-check for the presence of any error. The checks are as follows:

(i) (W + X) in any column = (X + W) + (Z + Y) in previous column.

(ii) (Y + Z) in any column = (X - W) + (Z - Y) in previous column.

This approach is repeated until the 4th column is filled by utilising the entries of the previous column for the new one. The first entry in

TABLE 6

ANALYSIS OF GROWTH RATE DATA
YATES'S METHOD

TREATMENT COMBINATION	MM/HR GROWTH RATE	(1)	(2)	(3)	(4)		EFFECT = COL 4/8	SUM OF SQUARES = MEAN SQUARE = (COL 4)2/16
(1)	0.0963	0.202	0.378	0.5597	1.20261	=Total		
a	0.1057	0.176	0.1817	0.64291	0.10809	=8A	0.0135113	0.0007302
b	0.0810	0.0952	0.42736	0.0343	-0.06511	=8B	-0.0081355	0.000265
ab	0.095	0.0865	0.21555	0.07379	-0.00239	=8AB	-0.0002988	4×10^{-7}
c	0.044	0.22561	0.0234	-0.0347	-0.40811	=8C	-0.0510138	0.0104096
ac	0.0512	0.20175	0.0109	-0.03041	-0.03859	=8AC	-0.0048238	9.31×10^{-5}
bc	0.0414	0.11105	0.04994	0.0011	0.03461	=8BC	0.0043263	7.49×10^{-5}
abc	0.0451	0.1045	0.02385	-0.00349	-0.01191	=8ABC	-0.0014888	8.9×10^{-6}
d	0.10036	0.0094	-0.026	-0.1963	0.08321	=8D	0.0104013	0.0004327
ad	0.12525	0.014	-0.0087	-0.21181	0.03949	=8AD	0.0049363	9.75×10^{-5}
bd	0.08835	0.0072	-0.02386	-0.0125	0.00429	=8BD	0.0005363	1.2×10^{-6}
abd	0.1134	0.0037	-0.00655	-0.02609	-0.00459	=8ABD	-0.0005738	1.3×10^{-6}
cd	0.04865	0.02489	0.0046	0.0173	-0.01551	=8CD	-0.0019388	1.5×10^{-5}
acd	0.0624	0.02505	-0.0035	0.01731	-0.01359	=8ACD	-0.0016988	1.15×10^{-5}
bcd	0.0472	0.01375	0.00016	-0.0081	0.00001	=8BCD	1.3×10^{-6}	0
abcd	0.0573	0.0101	-0.00365	-0.00381	0.00429	=8ABCD	0.0005363	1.2×10^{-6}
TOTAL	1.20261							

SUM OF 1st HALF ODDS W	0.2627	0.63386	0.8787	0.5604	0.764	
SUM OF 1st HALF EVENS X	0.297	0.56875	0.432	0.6828	0.0552	
SUM OF 2nd HALF ODDS Y	0.28456	0.05524	-0.0451	-0.1996	0.072	
SUM OF 2nd HALF EVENS Z	0.35835	0.05285	-0.0224	-0.224	0.0256	
X + W	0.5597	1.2026	1.3107	1.2432	0.8192	
Z + Y	0.64291	0.10809	-0.0675	-0.424	0.0976	
X - W	0.0343	-0.06511	-0.4467	0.1224		
Z - Y	0.07379	-0.00239	0.0227	-0.0248		
X + W + Z + Y	1.20261	1.3107	1.2432	0.8192		
(X-W)+(Z-Y)	0.10809	-0.0675	-0.424	0.0976		

TABLE 6 CONTINUED

column (4) should be equal to the total of the response.

INTERPRETATION:

An estimate of error variance is required for the analysis of variance (ANOVA). There was not a sufficient background of information on the crystallization system studied to provide an external estimate, and one had to be derived from the experiment itself. There was not true internal estimate of error variance, since only a single replication of the experiment was carried out, but assuming that it was highly unlikely that interaction of two, three or four factors would be appreciable; it was decided, subject to experimental confirmation of the validity of the step to combine some of these interaction factors that have very low Mean square values provided they satisfy Nair's[32] condition.

NAIR'S CONDITION: Suppose there are k mean squares, V_1, $V_2 \ldots V_i$ V_k, based on $\emptyset_1, \emptyset_2$ etc; degrees of freedom, and $\emptyset$ is the total number of degrees of freedom, so that the average estimated variance is $V = (\emptyset_i V_i)/\emptyset$

The criterion measuring the divergence in the V's is

$$M = \emptyset \ln V - \lesssim \emptyset_i \ln V_i \qquad (16)$$

From 'significant points for M' table,[51] read off the M corresponding to k mean squares either at 95% or 99% confidence level. If the calculated M is greater than the table value, then there is heterogenity in the error variance thus either one or more of the interaction mean squares is eliminated from the variance and the rest tried as above. If there is no heterogenity, sum up the mean square values of these interactions and use it as the error variance.

To simplify the calculation, the Mean square values were multiplied by 10^7. Multiplying all the mean squares by a constant value did not affect the analysis of variance.

TABLE 7

SIGNIFICANCE POINTS TEST (M) FOR CRYSTALS GROWTH DATA

INTERACTION	MEAN SQARE	ln (MEAN SQURE)	
AB	4	1.3862944	
ABC	89	4.4886364	$\phi_i = 1$
BD	12	2.4849067	$\phi' = 5$
ABD	13	2.5649494	
ABCD	12	2.4849067	
TOTAL	130	13.40964	$= \sum \ln V_i$

$M = \phi \ln V - \sum \phi_i \ln V_i$

$\therefore \quad M = 5 \times 4.8675345 - 13.409694 = 10.9279$

From Nair's table[51] for k = 5, significance point value is 12.0 at 95% confidence level. In other words it can be said with 95% confidence that there is no heterogenity in these summed interactions, thus the mean squares of these interactions are summed and use as the error variance. That is, error variance = $(4 \times 10^{-7} + 8.9 \times 10^{-6} + 1.2 \times 10^{-6} + 1.3 \times 10^{-6} + 1.2 \times 10^{-6}) = 0.000013$.

TABLE 8

ANALYSIS OF VARIANCE FOR CRYSTAL GROWTH

SOURCE OF VARIATION		DEGREE OF FREEDOM	MEAN SQUARES	MEAN SQUARE / ERROR VARIANCE
Supersaturation	A	1	0.0007302	56.1692
Agitation Rate	B	1	0.000265	20.384615
Residence time	C	1	0.0104096	800.73846
Temperature	D	1	0.0004327	33.284615
Interactions	AC	1	0.0000931	7.1615385
	AD	1	0.0000975	7.5
	BC	1	0.0000749	5.7615385
	BCD	1	0	0
	ACD	1	0.0000115	0.8846154
	CD	1	0.000015	1.1538462
Error (AB,ABC,BD, ABD,ABCD)		5	0.000013	

An F-distribution table for F(1,5) gave F = 6.61 at 95% confindence level.

Then, it could be said with 95% confidence with respect to growth rate that the following were significant and with their corresponding values. See table 9.

TABLE 9

ANALYSIS OF VARIANCE RESULT FOR GROWTH RATE

SHOWING THE SIGNIFICANT FACTORS AND THEIR VALUES

FACTORS		VALUES
Supersaturation	A	0.10809
Agitation Rate	B	-0.06511
Residence Time	C	-0.40811
Temperature	D	0.08321
(Supersaturation x Residence Time)	AC	-0.0048238
(Supersaturation x Temperature)	AD	0.0049363

Now the same analysis for nucleation rate is shown in tables 10, 11, 12, 13 and 14.

TABLE 10

NUCLEATION RATE WITH CORRESPONDING FACTORS AT THEIR VARIOUS LEVELS

SUPERSATURATION A	AGITATION RATE B	TEMPERATURE OF CRYSTALLIZATION (D)			
		15 ± 1 (1)		35 ± 1 (d)	
		RESIDENCE TIME (C)		RESIDENCE TIME (C)	
		170 (1)	380 (c)	170 (1)	380 (i)
0.70 (1)	1260 (1)	1.0125 (1)	0.48125(c)	1.3125(d)	0.645(cd)
	2466 (b)	0.7075 (b)	0.45 (bc)	1.2125(bd)	0.6125(bcd)
0.95 (a)	1260 (1)	1.23125(a)	0.6875(ac)	1.925(ad)	1.2825)acd)
	2466 (b)	0.9825(ab)	0.575(abc)	1.9875(abd)	1.1(abcd)

TABLE 11

ANALYSIS OF NUCLEATION RATE RESULTS

YATES'S METHOD

TREATMENT COMBINATION	NUMBERS/HR NUCLEATION	(1)	(2)	(3)	(4)		EFFECT = COL 4/8	SUM OF SQUARES = MEAN SQUARE = $(Col4)^2/16$
(1)	1.0125	2.24375	3.93375	6.1275	16.205	Total		
a	1.23125	1.69	2.19375	10.0775	3.3375	=8A	0.4171875	0.6961816
b	0.7075	1.16875	6.4375	0.825	-0.95	=8B	-0.11875	0.0564063
ab	0.9825	1.025	3.64	2.5125	-0.0125	=8AB	-0.0015625	9.8×10^{-6}
c	0.48125	3.2375	0.49375	-0.6975	-4.5375	=8C	-0.5671875	1.2868066
ac	0.6875	3.2	0.33125	-0.2525	-0.425	=8AC	-0.053125	0.0112891
bc	0.45	1.9275	1.3875	-0.025	0.2325	=8BC	0.0290625	0.003785
abc	0.575	1.7125	1.125	0.0125	-0.45	=8ABC	-0.05625	0.0126563
d	1.3125	0.21875	-0.55375	-1.74	3.95	=8D	0.49375	0.9751563
ad	1.925	0.275	-0.14375	-2.7975	1.6875	=8AD	0.2109375	0.1779785
bd	1.2125	0.20625	-0.0375	-0.1625	0.445	=8BD	0.055625	0.0123766
abd	1.9875	0.125	-0.215	-0.2625	0.0375	=8ABD	0.0046875	8.79×10^{-5}
cd	0.645	0.6125	0.05625	0.41	-1.0575	=8CD	-0.1321875	0.0698941
acd	1.2825	0.775	-0.08125	-0.1775	-0.1	=8ACD	-0.0125	6.25×10^{-4}
bcd	0.6125	0.6375	0.1625	-0.1375	-0.5875	=8BCD	-0.0734375	0.0215723
abcd	1.1	0.4875	-0.15	-0.3125	-0.175	=8ABCD	-0.021875	0.0018706
TOTAL	16.205							

SUM OF 1st HALF ODDS W	2.65125	8.5775	12.2525	6.23	10.95	
SUM OF 1st HALF EVENS X	3.47625	7.6275	7.29	12.35	12.45	
SUM OF 2nd HALF ODDS Y	3.7825	1.675	-0.3725	-1.63	2.75	
SUM OF 2nd HALF EVENS Z	6.295	1.6625	-0.59	-3.55	1.45	
X + W	6.1275	16.205	19.5425	18.58	13.4	
Z + Y	10.0775	3.3375	-0.9625	-5.18	4.2	
X - W	0.825	-0.95	-4.9625	6.12	-8.5	
Z - Y	2.5125	-0.0125	-0.2175	-1.92	-1.3	
X+W+Z+Y	16.205	19.5425	18.58	13.4		
(X-W)+(Z-Y)	3.3375	-0.9625	-5.18	4.2		

TABLE 11 CONTINUED

TABLE 12

SIGNIFICANCE POINTS TEST (M) FOR NUCLEATION RATE

INTERACTION	(MS)	ln (MS)	
AB	9.8	2.2823824	$\phi_i = 1$
ACD	625	6.4377517	$\phi = 3$
ABD	87.9	4.4761998	
Total	722.7	13.196334	$= \leq \ln V_i$

$M = 3 \ln 722.7 - 13.196334$

ie $19.748983 - 13.196334 = 6.5526486.$

From Nair's table for k = 3 ; M = 7.7

Error Variance = $(9.8 \times 10^{-6} + 6.25 \times 10^{-4} + 8.79 \times 10^{-5}) = 0.0007227.$

TABLE 13

ANALYSIS OF VARIANCE FOR NUCLEATION RATE

SOURCE OF VARIATION	DEGREE OF FREEDOM	MEAN SQUARE	MEAN SQUARE / ERROR VARIANCE
Supersaturation A	1	0.6961816	963.30649
Agitation Rate B	1	0.0564063	78.049398
Residence time C	1	1.2868066	1780.5543
Temperature D	1	0.9751563	1349.3238
Interactions AC	1	0.0112891	15.6207280
BC	1	0.003785	4.6748305
ABC	1	0.0126563	17.512522
AD	1	0.1779785	246.26885
BD	1	0.0123766	17.125502
CD	1	0.0698941	96.712467
BCD	1	0.0215723	29.849592
ABCD	1	0.0018706	2.5883492
Error (AB,ACD,ABD)	3	0.0007227	

F - distribution for F(1,3) = 10.1 (95% confidence level)

Therefore, it could be said with 95% confidence that for nucleation rate the following were significant and with their corresponding values.

TABLE 14

FACTORS	VALUES
Supersaturation A	0.4171875
Agitation Rate B	-0.11875
Residence Time C	-0.5671875
Temperature D	0.49375
Supersaturation x Residence Time AC	-0.053125
Supersaturation x Agitation x Residence ABC	-0.05625
Supersaturation x temperature AD	0.2109375
Agitation x temperature BD	0.055625
Residence x temperature CD	-0.1321875
Agitation x Residence x temperature BCD	-0.0734375

ANALYSIS OF VARIANCE RESULT FOR NUCLEATION RATE SHOWING THEIR SIGNIFICANT FACTORS AND THEIR VALUES.

5.6 REGRESSION ANALYSIS

An attempt was made to derive a relationship between growth rate, nucleation rate and the factors studied viz supersaturation, residence time and temperature. It is necessary to point out at this stage that agitation rate was not included in the regression analysis because it has been shown that the effect of agitation rate on both growth and nucleation rates is minimal. Also surface integration was observed to be the controlling step for growth rate while nucleation rate was homogeneous nucleation both of which are independent of agitation rate. Many mathematical models of the type found in chemical kinetics and rate equations were tried and the one that gave the lowest standard deviation was chosen to represent the relationship between either growth rate or nucleation rate

and the variables studied. Crystallization is a physical transformation, thus the mathematical model derived may not necessarily have the same mathematics as does a chemical transformation, even though this form of the relationship is most commonly used.

5.6.1 GROWTH RATE

The suggested growth rate model is the normal basic rate equation found in crystallization kinetics but with some terms included to alter the effective rate constant to take account of residence time. Thus the growth rate model was found to be

$$G = KS\tau^{\beta} e^{\frac{-14166.67}{RT}} \qquad (17)$$

where 14166.67 cal/mol is the mean activation energy for growth rate
G = Growth rate (mm/hr)
S = supersaturation
τ = residence time (seconds)
R = molar gas constant (cal/deg.mol.)
T = Temperature (°K)
K = constant

Logs of both sides of the equation were taken and a non-linear parameter estimate program was written. Also incorporated in the program is the calculation of the residue, which is defined as the sum of squares of the deviations of the predicted values from the measured values, and of the standard deviation. From the computer print-out, the following values were obtained (Appendix 9 for program, parameter values, residues)

$$G = 10^2 S \tau^{3.07471} e^{\frac{-14166.67}{RT}}$$

In other words K = 100; β = 3.07471

sum of squares of Residuals (SOSR) = 224.8826

standard deviation S.D = 1.456549

The relative high values of both standard deviation and sum of

squares of residuals confirmed the problem encountered in trying to use a chemical rate equation type to fit a physical change as in crystallization. Also the positive order of residence time in the equation is contrary to what is observed in the factorial analysis where all the variables were allowed to interact. This discrepancy may be due to the fact that in simple regression analysis, the interactive effect of the factors was not taken into consideration. Since there are no published works on regression analysis involving temperature, supersaturation and residence time, it is not possible to compare the result to published data. Other workers (10,12,13,27) have used a similar model but have not allowed for the effect of residence time on growth rate or on nucleation rate.

5.6.2 NUCLEATION RATE

The same approach used above was applied for the determination of the mathematical model relating nucleation rate and the factors, supersaturation, residence time, temperature. The relationship was found to be,

$$B = KS^{5}\tau^{\beta}e^{\frac{-13811.11}{RT}} \qquad (18)$$

where B = nucleation rate (number/hr)
K = constant
S = supersaturation
13811.11 = mean nucleation rate activation energy (cal/mol)
R = molar gas constant [cal/deg mol]
T = Temperature (°K)
τ = residence time (seconds)

[see Appendix 9b for program and Residuals]

The parameter values are as follows

$$K = 10^{2}; \qquad \beta = 7.57801$$

The sum of squares of Residuals (SOSR) = 315258.2

standard deviation S.D = 54.53567

This high standard deviation can be explained by the possibility that the model is incorrect or that the predicted values were always greater than the measured values. This would confirm the observation made by Ramshaw, C[34a] that, 'the nucleation rates measured by the extrapolation of population density versus crystals size to the size equal to zero from sieve analysis is always smaller than the actual value.' He buttressed his argument by presenting plots of population density versus crystal size for crystals size less than 50μm (measured with electronic counters) which is the limit for most sieve analysis. He found that sizes less than 50μm, the relation ceased to be linear but parabolic (concave upward), thus giving a higher nucleation rate than that measured. Coupled with this, is the fact that the suspension mass was not considered in the experiment. From nucleation theory, suspension mass has a great effect on nucleation rate.

CHAPTER SIX

DISCUSSION AND CONCLUSION

6.1 DISCUSSION

The factorial analysis indicates the response of the growth rate and nucleation rate to variations in the factors which were tested in this study. This measure of response was based on the deviation of both the growth and nucleation rates from zero response, that is, at a growth rate and a nucleation rate equal to zero. All positive values indicate increase in both growth and nucleation rates while negative values imply a decrease in nucleation and growth rates.

6.1.1 EFFECT OF SUPERSATURATION

In both growth and nucleation rates, a variation of supersaturation from 0.70 to 0.95 brought a corresponding increase of 0.10809 and 0.4171875 in the rates respectively. From the analysis of variance (ANOVA) the factor was found to be significant which is in agreement with the results of other workers. Although not much has been published on sodium sulfate crystallization the effect of supersaturation on growth and nucleation rates for other systems like potassium sulfate have been discussed.[14,28,33,41] In all these cases a positive supersaturation effect had been reported. Randolph and Cise,[36] reported a decrease in nucleation rate with increase in supersaturation for the same system. This is contrary to the result obtained in this study.

Considering the relationship between nucleation and growth rates, that is, $B = n^{\circ}G$, an increase in growth rate should cause a corresponding increase in nucleation rate. Growth rate is a function of the crystal size

distribution (CSD). The greater the crystals size displacement to smaller size values the steeper the slopes of the semi-log plots of population density against crystals size will be, which will lead to larger values of nuclei population density (n°), since this is got by extrapolation. Thus, an increase in growth rate due to increase in supersaturation will result in an increase in nucleation rate as has been shown in this work.

6.1.2 EFFECT OF AGITATION RATE

An increase in agitation rate resulted in a decrease in both growth and nucleation rates. An increase in agitation rate from 1260 RPM to 2466 RPM gave a negative (decreased) response of -0.06511 and -0.11875 for the growth and nucleation rates respectively. This is in agreement with the observations made by Coulson and Richardson;[10] Van Hook, A[48] and McCabe and Stevens, R.P.[26] A host of other workers[6,13,37,35,44] have reported the same trend. This was expected because at higher agitation rates, the attrition effect will become very pronounced, which will result in low growth and nucleation rates.

6.1.3 EFFECT OF RESIDENCE TIME

An increase in residence time from 170 secs to 380 secs gave a negative (decreased) effect of -0.40811 and -0.5671875 on both growth and nucleation rates respectively. This also confirmed what has been reported.[1,43] This was expected since the net result of increased residence times was the generation of low supersaturations and consequently low growth and nucleation rate values. Lower growth rate implies that more crystals have grown to larger sizes with a subsequent reduction in the slope of the semi-log plot of population density against crystal size. Also this size enhancement might be primarily due to the fact that nucleation rate decreased to a

greater relative degree than growth rate when the residence time was increased from 170 secs to 180 secs.

6.1.4 EFFECT OF TEMPERATURE

An increase in temperature from 15°C to 35°C gave an increase of 0.08321 in the growth rate response while the increase in nucleation rate was 0.49375 for the same temperature variation. This result confirmed the results reported by the other workers[1,9,22] who studied other systems. This implies that a decrease in temperature resulted in the production of fewer nuclei and larger crystals. This is also confirmed by the relative values of the temperature effect on growth and nucleation rates.

6.1.5 EFFECT OF FACTOR INTERACTIONS

The interaction of supersaturation and residence time gave a decreased rate of growth factor of -0.0048238. This simply implies that at higher supersaturation and residence time values, the effect of residence time predominated over the effect of supersaturation, since supersaturation as a single factor gave a positive growth factor while residence time gave negative factor (growth). As was expected, the interaction of temperature and supersaturation resulted in a positive growth factor of 0.0049363. The other interactions were so small that they were used in the error variance analysis.

The interaction of supersaturation with residence time gave a negative nucleation factor of -0.053125, while the temperature, supersaturation interaction resulted in a positive nucleation factor of 0.2109375. The interaction between agitation rate and temperature gave a positive nucleation rate factor of 0.055625, which shows that the effect of temperature far out-classed that of agitation rate, since agitation rate as a factor had a negative

influence on nucleation. The net effect of the interaction of residence time and temperature was a reduction of 0.1321875 in the nucleation rate factor. In other words at higher residence times, its effect overshadowed the positive effect of temperature. This conclusion could also be made by observing the interaction of the three factors viz residence time, agitation rate and temperature, which resulted in a negative nucleation factor of -0.0734375. The same thing was observed in the interaction of supersaturation, agitation rate and residence time. The effect was a negative (-0.05625) nucleation rate factor.

It can be seen from the foregoing discussion that residence time has a more pronounced effect on both growth and nucleation rates, than does temperature. It was not possible to determine the relative effect of both agitation rate and supersaturation since the mean square of their interaction was so small that it was used in the error variance calculation. The interaction effect of the four factors was not significant.

6.1.6 EFFECT OF FACTORS ON YIELD

The yield expressed as the weight of single neutral sodium sulfate crystal produced during crystallization, in general showed an opposite trend to that of growth and nucleation rates. Increase in supersaturation and temperature resulted in lower crystal yields because more nuclei were formed with a corresponding reduction in growth rate which resulted in smaller sized particles and hence low crystal weights (crystal mass is a function of crystal volume). While increase in residence time produced larger sized particles and a corresponding increase in crystals' mass.

It should be noted that this trend could only be observed when single crystals were measured but yield in terms of weight of total neutral sodium sulfate crystals produced increased with increase in both supersaturation

and temperature. While increase in residence time and agitation rate gave low yields. This can be explained by the fact that what the crystals lost in size at increased supersaturation and temperature, they more than compensated for by an increase in crystal number.

The single crystal weight was determined by measuring the dimesions of about a hundred seed crystals under the microscope for the different conditions tested. The volume of each crystal was calculated and multiplied by the density of neutral sodium sulfate to give the mass. A cross-check operation was performed by measuring the weight of these 100 seed crystals and the value divided to give the average volume of the crystals. A deviation of about 5% was observed in the two volumes.

6.2 CONCLUSION

Nucleation and growth are parallel kinetic reactions. Nucleation determines the rate of particle formation (in the absence of attrition or agglomeration); while growth determines the rate of deposition of solute on existing crystals. In order to control the size distribution of particles, the relative rate of nuclei formation compared to the rate of enlargement is of prime significance. To increase the mean particle size, particle formation must be suppressed relative to growth, resulting in fewer but larger crystals. If a market demands large crystals, crystallization design should be based on increasing the growth rate relative to nucleation rate. Since growth is of lower kinetic 'order' than nucleation rate, decreasing supersaturation will decrease growth rate less than the corresponding reduction in nucleation rate resulting in a reduced relative crystallization rate.

Since activation energy for crystal growth was practically constant

and independent of agitation rate, it has been suggested that surface integration was the controlling resistance. It has been shown that a diffusional mechanism has a lower activation energy, while Coulson and Richardson[10] have shown that for higher values of activation energy, the reaction is in general, surface reaction rate-controlled. Also for diffusional mechanism to be the controlling resistance, an increase in agitation rate should promote growth of crystals and also the growth should be size dependent. In this study it was observed that the growth of crystals was size independent and an increase in agitation rate decreased growth of crystals.

Homogeneous nucleation is suggested as the mechanism of nucleation for the conditions studied in these experiments. This conclusion is drawn from the fact that clear solutions were used in the study and an increase in supersaturation resulted in an increase in nucleation rate. If the mechanism had been collision breeding or by attrition, an increase in agitation rate would have resulted in an increase in nucleation rate, but the reverse was the case. Also there could have been marked breakage points on the crystals but as could be seen from the photographs, the breakage points are minimal.

A first 'order' relation was found to exist for growth rate with supersaturation while that of nucleation was fifth 'order'. The growth rate was found to be independent of the size of the crystals, thus the basic (McCabe ΔL Law)[25] assumption made originally was correct. The calculated mean size and the coefficient of variation confirmed that there was no classification of product in the reactor. A search of the literature showed that, there have not been any published data on sodium sulphate--methanol/water--sulfuric acid phase diagram, thus an attempt was made to present the data for 35°C.

The results of the regression analysis on the data to give a reaction equation of the normal form would indicate that the form of the model may not be correct. In the case of nucleation rate where the fit was especially poor it is possible that an account must be taken of the very small nuclei and the suspension mass must be included in the correlation.

6.3 RECOMMENDATION

As a result of this study, the following recommendations can be made:-

(i) Different ratios of methanol-water in the diluent mixture should be tested and plotted on a phase diagram to get a working combination that will allow greater flexibility in the variation of supersaturation.

(2) If higher temperatures than 35° C are to be used, a different alcolhol precipitant should be utilised.

(3) A larger reactor capacity should be used to aid the testing of residence time effect at levels above 380 secs.

(4) A more sophisticated counting method should be employed in order to get a more accurate measure of the number of crystal seeds with very small sizes.

(5) The effect of the presence of trace elements such as chromates (originally in sodium chlorate) and other corrosion products on growth, nucleation rates and yield should be studied. In other words an effort should be made to use actual industrial effluents and to quantify the effects of its trace components.

(6) The effect of suspension mass on growth, nucleation rates and yield should be investigated.

(7) With this added information an attempt should be made to formulate a better mathematical relationship that predict both growth rate or yield for any specified operating conditons.

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	NOMENCLATURE	TYPICAL UNITS
A	Mesh opening at uniform intervals of 0.005	mm
AD	screen size	mm
A_i	Frequency factor	
B	Nucleation Rate	Numbers/hour
C.V	coefficient of variation	percent
E.	Activation energy	kcal/mol
G	Growth rate	mm/hr
I	Interation counter	
$K_{\bar{G}}$	Growth rate constant	mm/hr
K_N	Nucleation rate constant	Number/hr
K_v	Overall shape factor	
L	crystal size	mm
L_h	hypothetical crystal size	mm
L_h	hypothetical crystal size increment	mm
m	crystal mass increment	gm
n	Population density	No/mm
n°	population nuclei density	No/mm
P.D	Particle (crystal size) diameter	mm
Qi	Flow rate	cm^3/sec
R	Molar gas constant	cal/deg 'mol
S	Supersaturation	
V	Reactor capacity	cm^3
Ps	Suspension density	gm/cm^3
P	crystal density	gm/cm^3
τ	Residence time	secs

APPENDIX I

Specific gravity of methanol/water solution at various temperatures.

Temperature = 15°C

Volume fraction of methanol	Specific gravity
0.2	0.997
0.4	0.978
0.6	0.951
0.8	0.933
1.0	0.909

Temperature = 20°C

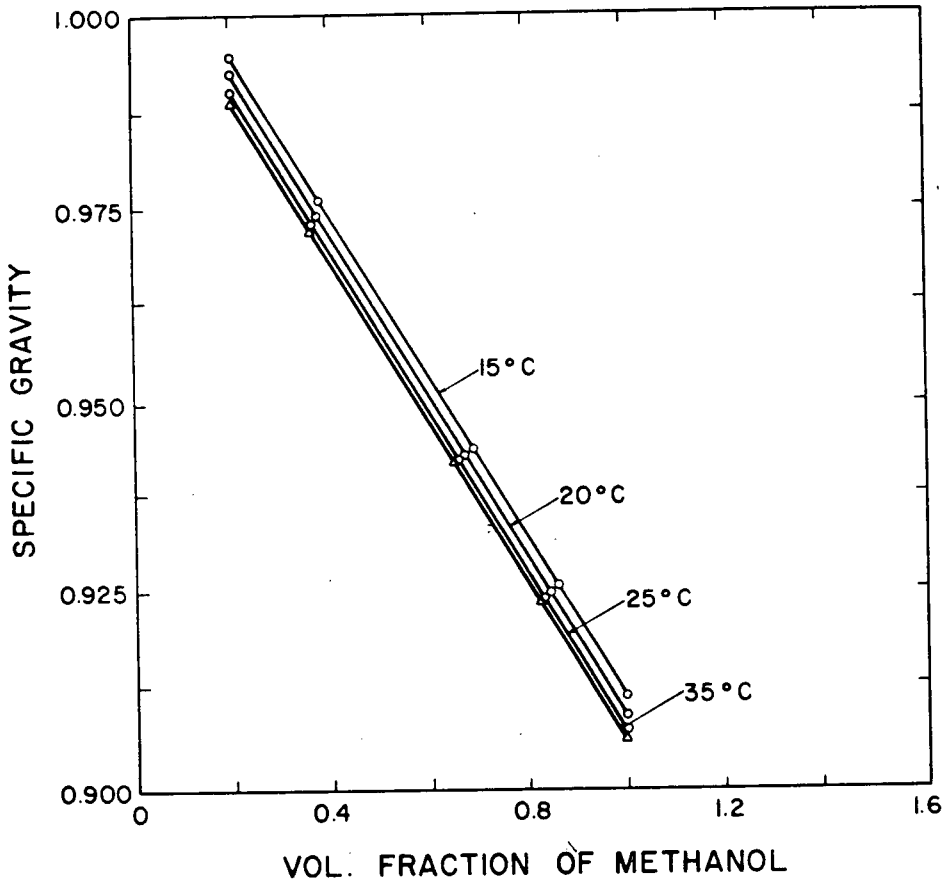
Volume fraction of methanol	Specific gravity
0.2	0.996
0.4	0.976
0.6	0.9505
0.8	0.931
1.0	0.9087

Temperature = 25°C

Volume fraction of methanol	Specific gravity
0.2	0.995
0.4	0.974
0.6	0.946
0.8	0.929
1.0	0.906

Temperature = 35°C

Volume fraction of methanol	Specific gravity
0.2	0.994
0.4	0.97
0.6	0.946
0.8	0.9265
1.0	0.95



SPECIFIC GRAVITY OF METHANOL/WATER SOLUTION VS VOL. FRACTION OF METHANOL

APPENDIX 2

TABLE OF VALUES OF GROWTH RATE, NUCLEATION RATE AT VARIOUS SUPERSATURATION LEVELS, FOR DIFFERENT LEVELS OF TEMPERATURE, AGITATION RATE AND RESIDENCE TIME.

RESIDENCE TIME = 170 secs; GROWTH RATE UNITS: (mm/hr)

AGITATION RATE = 2466 RPM NUCLEATION RATE UNITS: (NUMBER/HR)

SUPERSATURATION	GROWTH RATE	NUCLEATION RATE	TEMPERATURE
0.70	0.081	0.7075×10^7	15°C
0.823	0.088	0.82×10^7	
0.95	0.095	0.9825×10^7	
0.70	0.0822	0.88×10^7	
0.823	0.0913	0.9725×10^7	20°C
0.95	0.10	1.3×10^7	
0.70	0.0838	1.08×10^7	25°C
0.823	0.095	1.30×10^7	
0.95	0.1066	1.675×10^7	
0.70	0.08835	1.2125×10^7	35°C
0.823	0.1005	1.4975×10^7	
0.95	0.1134	1.9875×10^7	

AGITATION RATE = 1926 RPM RESIDENCE TIME = 170 secs.

SUPERSATURATION	GROWTH RATE	NUCLEATION RATE	TEMPERATURE
0.70	0.0995	1.1×10^7	15°C
0.823	0.1058	1.2375×10^7	
0.95	0.1132	1.44375×10^7	
0.70	0.10075	1.20375×10^7	20°C
0.823	0.1085	1.3725×10^7	
0.95	0.1175	1.675×10^7	
0.70	0.10325	1.3125×10^7	25°C
0.823	0.115	1.5075×10^7	
0.95	0.12075	1.975×10^7	
0.70	0.1045	1.42875×10^7	35°C
0.823	0.11475	1.7225×10^7	
0.95	0.1255	2.28×10^7	

AGITATION RATE = 1260 RPM RESIDENCE TIME = 170 secs.

SUPERSATURATION	GROWTH RATE	NUCLEATION RATE	TEMPERATURE
0.70	0.0963	1.0125×10^7	15°C
0.823	0.10135	1.1×10^7	
0.95	0.1057	1.23125×10^7	
0.70	0.0981	1.09375×10^7	20°C
0.823	0.10528	1.245×10^7	
0.95	0.1133	1.43125×10^7	
0.70	0.1015	1.2000×10^7	25°C
0.823	0.11048	1.3875×10^7	
0.95	0.1206	1.65×10^7	
0.70	0.10306	1.3125×10^7	35°C
0.823	0.1142	1.505×10^7	
0.95	0.12525	1.925×10^7	

AGITATION RATE = 2466 RPM RESIDENCE TIME = 235 secs.

SUPERSATURATION	GROWTH RATE	NUCLEATION RATE	TEMPERATURE
0.70	0.066	0.66875×10^7	15°C
0.823	0.07225	0.8×10^7	
0.95	0.0781	1.0375×10^7	
0.70	0.06735	0.875×10^7	20°C
0.823	0.0769	1×10^7	
0.95	0.086	1.18125×10^7	
0.70	0.0727	0.98375×10^7	25°C
0.823	0.08135	1.15625×10^7	
0.95	0.0915	1.41875×10^7	
0.70	0.07495	1.0825×10^7	35°C
0.823	0.0857	1.3125×10^7	
0.95	0.09615	1.6375×10^7	

AGITATION RATE = 1926 RPM RESIDENCE TIME = 235 secs.

SUPERSATURATION	GROWTH RATE	NUCLEATION RATE	TEMPERATURE
0.70	0.0727	0.830625×10^7	15°C
0.823	0.0763	0.9125×10^7	
0.95	0.0784	1.0625×10^7	
0.70	0.0742	0.875×10^7	20°C
0.823	0.0784	1.01875×10^7	
0.95	0.0842	1.19375×10^7	
0.70	0.07525	0.95625×10^7	25°C
0.823	0.0827	1.125×10^7	
0.95	0.0887	1.4×10^7	
0.70	0.0772	1.0375×10^7	35°C
0.823	0.08495	1.2925×10^7	
0.95	0.09369	1.61875×10^7	

AGITATION RATE = 1260 RPM RESIDENCE TIME = 235 secs.

SUPERSATURATION	GROWTH RATE	NUCLEATION RATE	TEMPERATURE
0.70	0.07425	1×10^7	15°C
0.823	0.0765	1.07×10^7	
0.95	0.08025	1.21875×10^7	
0.70	0.0755	1.14125×10^7	20°C
0.823	0.0791	1.2325×10^7	
0.95	0.0845	1.4375×10^7	
0.70	0.07725	1.2625×10^7	25°C
0.823	0.08195	1.41875×10^7	
0.95	0.0869	1.65375×10^7	
0.70	0.07875	1.425×10^7	35°C
0.823	0.08435	1.575×10^7	
0.95	0.0903	1.86625×10^7	

AGITATION RATE = 2466 RPM RESIDENCE TIME = 380 secs.

SUPERSATURATION	GROWTH RATE	NUCLEATION RATE	TEMPERATURE
0.70	0.0414	0.45×10^7	15°C
0.823	0.0431	0.5075×10^7	
0.95	0.0451	0.575×10^7	
0.70	0.0433	0.5×10^7	20°C
0.823	0.046	0.6×10^7	
0.95	0.04865	0.75625×10^7	
0.70	0.04475	0.5375×10^7	25°C
0.823	0.0489	0.69375×10^7	
0.95	0.053	0.89375×10^7	
0.70	0.0472	0.6125×10^7	35°C
0.823	0.05175	0.79×10^7	
0.95	0.0573	1.1×10^7	

AGITATION RATE = 1926 RPM RESIDENCE TIME = 380 secs.

SUPERSATURATION	GROWTH RATE	NUCLEATION RATE	TEMPERATURE
0.70	0.041	0.3375×10^7	15°C
0.823	0.0435	0.3875×10^7	
0.95	0.0451	0.43125×10^7	
0.70	0.0425	0.6875×10^7	20°C
0.823	0.0462	0.8×10^7	
0.95	0.050	0.96625×10^7	
0.70	0.0435	0.8×10^7	25°C
0.823	0.0486	0.9275×10^7	
0.95	0.0535	1.125×10^7	
0.70	0.04475	0.90625×10^7	35°C
0.823	0.05057	1.0625×10^7	
0.95	0.057	1.3125×10^7	

AGITATION RATE = 1260 RPM RESIDENCE TIME = 380 secs.

SUPERSATURATION	GROWTH RATE	NUCLEATION RATE	TEMPERATURE
0.70	0.044	0.48125×10^7	15°C
0.823	0.0475	0.5175×10^7	
0.95	0.05125	0.6875×10^7	
0.70	0.04575	0.505625×10^7	20°C
0.823	0.0501	0.6375×10^7	
0.95	0.05515	0.875×10^7	
0.70	0.047	0.645×10^7	25°C
0.823	0.0530	0.8125×10^7	
0.95	0.05865	1.08125×10^7	
0.70	0.04865	0.7375×10^7	35°C
0.823	0.05565	0.9425×10^7	
0.95	0.06245	1.2825×10^7	

APPENDIX 3

MEAN SIZE AND COEFFICIENT OF VARIATION (CV)

SUPERSATURATION = 0.95 TEMPERATURE = 15°C AGITATION RATE = 2466 RPM

MEAN SIZE (mm)	COEFFICIENT OF VARIATION (C.V)%	RESIDENCE TIME (secs)
0.1001	31.2	170
0.1006	45	235
0.1009	48	380

SUPERSATURATION = 0.95 TEMPERATURE = 20°C AGITATION RATE = 2466 RPM

MEAN SIZE (mm)	COEFFICIENT OF VARIATION (C.V)%	RESIDENCE TIME (secs)
0.1003	33	170
0.1007	49	235
0.101	51	380

SUPERSATURATION = 0.95 TEMPERATURE = 25°C AGITATION RATE = 2466 RPM

MEAN SIZE (mm)	COEFFICIENT OF VARIATION (C.V)%	RESIDENCE TIME (secs)
0.1004	32	170
0.1008	46	235
0.1009	52	380

SUPERSATURATION = 0.95 TEMPERATURE = 35°C AGITATION RATE = 2466 RPM

MEAN SIZE (mm)	COEFFICIENT OF VARIATION (C.V)%	RESIDENCE TIME (secs)
0.1002	28	170
0.1009	42	235
0.1007	43	380

SUPERSATURATION = 0.823 TEMPERATURE = 15°C AGITATION RATE = 1926 RPM

MEAN SIZE (mm)	COEFFICIENT OF VARIATION (C.V)%	RESIDENCE TIME (secs)
0.100	39	170
0.1003	46	235
0.100	52	380

SUPERSATURATION= 0.823 TEMPERATURE = 20°C AGITATION RATE = 1926 RPM

MEAN SIZE (mm)	COEFFICIENT OF VARIATION (C.V)%	RESIDENCE TIME (secs)
0.1002	29	170
0.1001	47	235
0.1005	43	380

SUPERSATURATION = 0.823 TEMPERATURE = 25°C AGITATION RATE = 1926 RPM

MEAN SIZE (mm)	COEFFICIENT OF VARIATION (C.V)%	RESIDENCE TIME (secs)
0.1001	33	170
0.1003	40	235
0.1007	42	380

SUPERSATURATION = 0.823 TEMPERATURE = 35°C RESIDENCE TIME (secs)

MEAN SIZE (mm)	COEFFICIENT OF VARIATION (C.V)%	RESIDENCE TIME (secs)
0.1003	31	170
0.1002	39	235
0.1008	38	380

SUPERSATURATION = 0.70 TEMPERATURE = 15°C AGITATION RATE = 1260 RPM

MEAN SIZE (mm)	COEFFICIENT OF VARIATION (C.V)%	RESIDENCE TIME (secs)
0.100	35	170
0.1001	37	235
0.1001	38	380

SUPERSATURATION = 0.70 TEMPERATURE = 20°C AGITATION RATE = 1260

MEAN SIZE (mm)	COEFFICIENT OF VARIATION (C.V)%	RESIDENCE TIME (secs)
0.1001	32	170
0.10015	33	235
0.100	40	380

SUPERSATURATION = 0.70 TEMPERATURE = 25°C AGITAION RATE = 1260

MEAN SIZE (mm)	COEFFICIENT OF VARIATION (C.V)%	RESIDENCE TIME (secs)
0.1001	32	170
0.1002	32.4	235
0.1003	31.5	380

SUPERSATURATION = 0.70 TEMPERATURE = 35°C AGITATION RATE = 1260 RPM

MEAN SIZE (mm)	COEFFICIENT OF VARIATION (C.V)%	RESIDENCE TIME (secs)
0.100	34	170
0.1001	33.6	235
0.1002	36	380

APPENDIX 4

GROWTH AND NUCLEATION RATE CONSTANTS WITH CALCULATED ACTIVATION ENERGY AT VARIOUS CONDITIONS

VARIOUS CONDITIONS

AGITATION RATE - 2466 RPM RESIDENCE TIME = 170 secs.

GROWTH CONSTANT	ACTIVATION ENERGY	1.T°K	NUCLEATION CONSTANT	ACTIVATION ENERGY
2.996		0.0032468	0.819	
1.8807	14.5kcal/mol	0.0033557	0.424474	15 kcal/mol
1.4550		0.003413	0.30573	
1.13029		0.0034720	0.212556	

AGITATION RATE = 1926 RPM RESIDENCE TIME = 170 secs.

GROWTH CONSTANT	ACTIVATION ENERGY	1/T°K	NUCLEATION CONSTANT	ACTIVATION ENERGY
1.9		0.0032468	0.49	
1.453	14.4kcal/mol	0.0033557	0.383864	14.8 kcal/mol
1.30		0.003413	0.34432	
1.12		0.0034722	0.30	

AGITATION RATE = 1260 RPM RESIDENCE TIME = 170 secs.

GROWTH CONSTANT	ACTIVATION ENERGY	1/T°K	NUCLEATION CONSTANT	ACTIVATION ENERGY
2.295		0.0032468	0.4244748	
1.50	15kcal/mol	0.0033557	0.3057307	14.5kcal/mol
1.15		0.003413	0.2308682	
0.9		0.0034722	0.185	

AGITATION RATE = 2466 RPM RESIDENCE TIME = 235 secs.

GROWTH CONSTANT	ACTIVATION ENERGY	1/T°K	NUCLEATION CONSTANT	ACTIVATION ENERGY
2.2		0.0032468	0.3443276	
1.48	14.6kcal/mol	o.oo33557	0.2867454	13 kcal/mol
1.18		0.003413	0.2567	
0.94896		0.0034722	0.230	

AGITATION RATE = 1926 RPM RESIDENCE TIME = 235 secs.

GROWTH CONSTANT	ACTIVATION ENERGY	1/T°K	NUCLEATION CONSTANT	ACTIVATION ENERGY
1.326	13kcal/mol	0.0032468	0.381	13.8 kcal/mol
1.07236		0.0033557	0.30573	
0.90		0.003413	0.270	
0.799		0.0034722	0.240	

AGITATION RATE = 1260 RPM RESIDENCE TIME = 235 secs.

GROWTH CONSTANT	ACTIVATION ENERGY	1/T°K	NUCLEATION CONSTANT	ACTIVATION ENERGY
0.9004	13.2kcal/mol	0.0032468	0.301	13 kcal/mol
0.767327		0.0033557	0.256	
0.692		0.003413	0.2056	
0.4578357		0.0034722	0.17	

AGITATION RATE = 2466 RPM RESIDENCE TIME = 380 secs.

GROWTH CONSTANT	ACTIVATION ENERGY	1/T°K	NUCLEATION CONSTANT	ACTIVATION ENERGY
1.32	14.6kcal/mol	0.0032468	0.32491	13 kcal/mol
0.6494067		0.0033557	0.21	
0.4244748		0.003413	0.173	
0.2981129		0.0034722	0.135	

AGITATION RATE = 1926 RPM RESIDENCE TIME = 380 secs.

GROWTH CONSTANT	ACTIVATION ENERGY	1/T°K	NUCLEATION CONSTANT	ACTIVATION ENERGY
1.00	14kcal/mol	0.0032468	0.323	12.6kcal/mol
0.7		0.0033557	0.2308	
0.54		0.003413	0.1853	
0.4		0.0034722	0.155	

AGITATION RATE = 1260 RPM RESIDENCE TIME = 380 secs.

GROWTH CONSTANT	ACTIVATION ENERGY	1/T°K	NUCLEATION CONSTANT	ACTIVATION ENERGY
1.4	14.2kcal/mol	0.0032468	0.44	14.6 kcal/mol
0.932515		0.0033557	0.3038	
0.753554		0.003413	0.24	
0.57735		0.0034722	0.19	

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APPENDIX 5

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CCCCCCCCCCCC  00000000000  GGGGGGGGGGGG  BBBBBBBBBBBB
CC         CC  00        00  GG        GG  BB        BB
CC             00        00  GG            BB        BB
CC             00        00  GG            BB       BB
CC             00        00  GG            BBBBBBBBBB
CC             00        00  GG     GGGGG  BBBBBBBBBB
CC             00        00  GG     GGGGG  BB        BB
CC             00        00  GG        GG  BB        BB
CC         CC  00        00  GG        GG  BB        BB
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 CCCCCCCCCC    0000000000    GGGGGGGGGG    BBBBBBBBBBB


              SSSSSSSSSS   PPPPPPPPPPP   EEEEEEEEEEEE   CCCCCCCCCC
**    **    **  SSSSSSSSSSS  PPPPPPPPPPPP  EEEEEEEEEEEE  CCCCCCCCCCCC  **    *
 **   **   **   SS         SS  PP         PP  EE            CC        CC   **   *
  **  ** **     SS             PP         PP  EE            CC              ** *
   ******       SSS           PP         PP  EE            CC                ***
************    SSSSSSSSS    PPPPPPPPPPPP  EEEEEEEE      CC              ******
************     SSSSSSSSS   PPPPPPPPPPP   EEEEEEEE      CC              ******
   ******              SSS  PP            EE            CC                **
  ** ** **               SS  PP            EE            CC              ** *
 **   **   **   SS         SS  PP            EE            CC        CC   **   *
**    **    **  SSSSSSSSSSS  PP            EEEEEEEEEEEE  CCCCCCCCCCCC  **    *
              SSSSSSSSSS   PP            EEEEEEEEEEEE   CCCCCCCCCC


**Last signon was: 14:01:49   Tue Jun 10/80
 User "COGB" signed on at  01:09:35 on Wed Jun 11/80
$RUN SJUT:QUERY
Execution Begins   01:09:36

***SECURE QUERY:  EXECUTION OK'D BY OPERATOR
Execution Terminated   01:09:44  T=0.002  RC=0       $.00


$COPY    PROJECT  *SINK*
          PROJECT:                    PROC OPTIONS(MAIN);
            /*RESULTS AND ANALYSIS OF RESULTS */;
   /* DECLARATION STATEMENTS */;
        DCL (GRV(3,3,3,4),NRV(3,3,3,4),DAT(3,3,3,4,6)) FLOAT(16);
        DCL (TEMP(4),AGIT(3),RES(3),SUPSAT(3)) FLOAT(16);
        DCL (LN,LAD,I,J,K,L,IA,M,JA) FIXED;
        DCL (AD(*),X(*),CW(*),N(*),D(*),Z(*)) FLOAT(16) CTL;
        DCL (SUM_X,SMD,CUM_X,AS,DEN,DIFF) FLOAT(16);
        DCL (SUM_D,SUM_N,SUM_ND,SUN2_D,V,RHO) FLOAT(16);
        DCL (RHO_G,KV,C,G,MD) FLOAT(16), (NO(3,3,3,4)) FLOAT(16);
        DCL (RTEMP(27,2),RAGIT(36,2),RRES(36,2),RSUPSAT(36,2)) FLOAT(16);
        DCL (SUM_G,SUM_S,SUM_SG,SUM2_S,DS,KSG,PSG) FLOAT(16);
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```
      DCL (SUM_NR,SUM_SN,KSN,PSN,KAG,PAG,DA,SUM_A,SUM_AG) FLOAT(16);
      DCL (SUM_AN,KAN,PAN,SUM_R,SUM_RG,SUM2_R,DR) FLOAT(16);
      DCL (NO,KRG,PRG,SUM_RN,SUM_T,SUM_TG,DT) FLOAT(16);
      DCL (KTG,PTG,SUM_TN,KTN,PTN,KRN,DG) FLOAT(16);
         PUT PAGE LINE(3) EDIT('ANALYSIS RESULTS')(COL(26),A);
             PUT SKIP(0) EDIT((18)'_')(COL(26),A);
          /* INPUT  STATEMENTS */;
      GET LIST (KV,V,RHO_G,LAD);
       ALLOCATE AD(LAD),X(LAD),CW(LAD);
      GET LIST ((AD(JA) DO JA=1 TO LAD));
LB1:  DO L=1 TO 4;
      DO K=1 TO 3;
      DO J=1 TO 3;
      DO I=1 TO 3;
      GET LIST (SUPSAT(I),AGIT(J),RES(K),TEMP(L),(DAT(I,J,K,L,M) DO M=1
      TO 6));
END LB1;
/* POPULATION DENSITY COUNT FROM SCREEN WEIGHTS */;
LB2:  DO L=1 TO 4;
      DO K=1 TO 3;
      DO J=1 TO 3;
      DO I=1 TO 3;
      DO M=1 TO 5;
      X(M)=DAT(I,J,K,L,M);
      END;
      RHO=DAT(I,J,K,L,6);
      SUM_X=SUM(X);
      CUM_X=0;
       DO JA=1 TO LAD;
      CUM_X=CUM_X+X(JA);
      CW(JA)=100*CUM_X/SUM_X;
       END;
      DIFF=(AD(LAD)-AD(1))/0.005;
      LN=TRUNC(DIFF);
      ALLOCATE D(LN),Z(LN),N(LN);
       DO IA=1 TO LN-1;
      AS=AD(1)+0.005*(IA-1);
        DO JA=1 TO LAD-1;
      IF(AS>=AD(JA))& (AS<AD(JA+1))| (AS=AD(LAD)) THEN GO TO LB3;
        END;
LB3:    Z(IA)=CW(JA)+(CW(JA+1)-CW(JA))*(AS-AD(JA))/(AD(JA+1)-AD(JA));
      D(IA)=SQRT((AS-.025)*(AS+.025));
    N(IA)=(RHO*V*(Z(IA+1)-Z(IA)))/(RHO_G*KV*D(IA)**3*(D(IA+1)-D(IA)));
END;
             D(LN)=1;
      N(LN)=1;
      SUM_D=SUM(D)-D(LN);
      SUM_N=SUM(LOG(N));
      SUM_ND=SUM((D)*LOG(N));
      SUM2_D=SUM(D**2)-D(LN)**2;
      DEN=SUM_D**2-(LN-1)*SUM2_D;
      DG=(SUM_D*SUM_N-(LN-1)*SUM_ND)/DEN;
      C=(SUM_D*SUM_ND-SUM_N*SUM2_D)/DEN;
            G=-(1/RES(K)*DG);
       NO(I,J,K,L)=EXP(C);
     NRV(I,J,K,L)=NO(I,J,K,L)*G;
      GRV(I,J,K,L)=G;
          PUT SKIP(4) EDIT((68)'_')(COL(4),A);
  PUT SKIP EDIT('TEMPERATURE','RESIDENCE TIME','AGITATION RATE'
      ,'SUPERSATURATION')(COL(6),A,X(6),A,X(3),A,X(3),A);
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      PUT SKIP(0) EDIT((11)'_',(14)'_',(14)'_',(15)'_') (COL(6),A,
            X(6),A,X(3),A,X(3),A);
          PUT SKIP(2) EDIT(TEMP(L),RES(K),AGIT(J),SUPSAT(I)) (COL(6),
          E(10,3),X(6),E(10,3),X(8),E(10,3),X(8),E(10,3));
           PUT SKIP(2) EDIT('POP. AT 0') (COL(13),A);
           PUT SKIP(0) EDIT((9)'_') (COL(13),A);
           PUT SKIP EDIT(NO(I,J,K,L)) (COL(13),E(10,3));
     PUT SKIP(2) EDIT('WEIGHT X','SCREEN SIZE AD','% CUMULATIVE WEIGHT
           ') (COL(6),A,X(6),A,X(4),A);
        PUT SKIP(0) EDIT((8)'_',(14)'_',(19)'_') (COL(6),A,X(6),A,X(4),
           A);
           DO JA=1 TO 5;
  PUT SKIP(2) EDIT(X(JA),AD(JA),CW(JA)) (COL(6),E(10,3),
           X(6),E(10,3),X(6),E(10,3));
           END;
        PUT SKIP(2) EDIT('CRYSTAL SIZE','POPULATION DENSITY',
      'CRYSTAL SIZE','POPULATION DENSITY')
           (COL(6),A,X(2),A,X(4),A,X(2),A);
           PUT SKIP(0) EDIT((12)'_',(18)'_',(12)'_',(18)'_') (COL(6),
             A,X(2),A,X(4),A,X(2),A);
           DO IA=1 TO LN-1 BY 2;
PUT SKIP(2) EDIT(D(IA),N(IA),D(IA+1),N(IA+1))
   (COL(7),E(10,3),X(7),E(10,3),X(9),E(10,3),X(7),E(10,3));
           END;
 END LB2;
/* SUPERSATURATION,GROWTH AND NUCLEATION RATES RELATIONSHIP */;
   PUT PAGE EDIT('SUPERSATURATION,GROWTH AND NUCLEATION RATE RELATION')
           (COL(4),A);
           PUT SKIP(0) EDIT((68)'_') (COL(4),A);
LB4: DO L=1 TO 4;
     DO K=1 TO 3;
     DO J=1 TO 3;
     SUM_G=SUM(LOG(GRV(*,J,K,L)));
     SUM_S=SUM(LOG(SUPSAT));
     SUM_SG=SUM(LOG(SUPSAT)*LOG(GRV(*,J,K,L)));
     SUM2_S=SUM((LOG(SUPSAT))**2);
     DS=SUM_S**2-3*SUM2_S;
     KSG=EXP((SUM_G*SUM_S-3*SUM_SG)/DS);
     PSG=(SUM_S*SUM_SG-SUM_G*SUM2_S)/DS;
     SUM_NR=SUM(LOG(NRV(*,J,K,L)));
     SUM_SN=SUM(LOG(SUPSAT)*LOG(NRV(*,J,K,L)));
     KSN=EXP((SUM_NR*SUM_S-3*SUM_SN)/DS);
     PSN=(SUM_S*SUM_SN-SUM_NR*SUM2_S)/DS;
    PUT SKIP(2) EDIT('TEMPERATURE','RESIDENCE TIME','AGITATION')
           (COL(6),A,X(7),A,X(8),A);
     PUT SKIP(0) EDIT((11)'_',(14)'_',(9)'_') (COL(6),A,X(7),A,X(8),A);
           PUT SKIP EDIT(TEMP(L),RES(K),AGIT(J)) (COL(6),E(10,3),X(9),
           E(10,3),X(13),E(10,3));
    PUT SKIP(2) EDIT('GROWTH CONSTANT','GROWTH ORDER','NUC_CONSTANT',
           'NUCLEATION ORDER') (COL(4),A,X(2),A,X(5),A,X(5),A);
           PUT SKIP(0) EDIT((15)'_',(12)'_',(12)'_',(16)'_')
           (COL(4),A,X(2),A,X(5),A,X(5),A);
      PUT SKIP EDIT(KSG,PSG,KSN,PSN) (COL(4),E(10,3),X(8),E(10,3),X(8),
           E(10,3),X(8),E(10,3));
END LB4;
/* AGITATION,GROWTH AND NUCLEATION RATES RELATIONSHIP */;
   PUT PAGE EDIT('AGITATION,GROWTH AND NUCLEATION RATES RELATION')
         (COL(4),A);
         PUT SKIP(0) EDIT((68)'_') (COL(4),A);
LB5: DO L=1 TO 4;
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```
      DO K=1 TO 3;
      DO I=1 TO 3;
      SUM_A=SUM(LOG(AGIT));
      SUM_G=SUM(LOG(GRV(I,*,K,L)));
      SUM_AG=SUM(LOG(AGIT)*LOG(GRV(I,*,K,L)));
      SUM2_A=SUM((LOG(AGIT))**2);
      DA=SUM_A**2-3*SUM2_A;
      KAG=EXP((SUM_A*SUM_G-3*SUM_AG)/DA);
      PAG=(SUM_A*SUM_AG-SUM_G*SUM2_G)/DA;
      SUM_NR=SUM(LOG(NRV(I,*,K,L)));
      SUM_AN=SUM(LOG(AGIT)*LOG(NRV(I,*,K,L)));
      KAN=EXP((SUM_NR*SUM_A-3*SUM_AN)/DA);
      PAN=(SUM_A*SUM_AN-SUM_NR*SUM2_A)/DA;
     PUT SKIP(2) EDIT('TEMPERATURE','RESIDENCE TIME','SUPERSATURATION')
           (COL(6),A,X(9),A,X(10),A);
    PUT SKIP(0) EDIT((11)'_',(14)'_',(15)'_') (COL(6),A,X(9),A,X(10),A);
      PUT SKIP EDIT(TEMP(L),RES(K),SUPSAT(I)) (COL(6),E(10,3),X(11),
           E(10,3),X(15),E(10,3));
     PUT SKIP(2) EDIT('GROWTH CONSTANT','GROWTH ORDER','NUC_CONSTANT',
           'NUCLEATION ORDER') (COL(4),A,X(2),A,X(5),A,X(5),A);
      PUT SKIP(0) EDIT((15)'_',(12)'_',(12)'_',(17)'_') (COL(4),A,X(2),
           A,X(5),A,X(5),A);
   PUT SKIP EDIT(KAG,PAG,KAN,PAN) (COL(5),E(10,3),X(7),E(10,3),X(8),
           E(10,3),X(8),E(10,3));
END LB5;
/* RESIDENCE TIME,GROWTH AND NUCLEATION RATES */;
   PUT PAGE EDIT('RESIDENCE TIME,GROWTH RATE AND NUCLEATION RELATION')
        (COL(4),A);
       PUT SKIP(0) EDIT((68)'_') (COL(4),A);
LB6: DO L=1 TO 4;
      DO J=1 TO 3;
      DO I=1 TO 3;
      SUM_R=SUM(LOG(RES));
      SUM_G=SUM(LOG(GRV(I,J,*,L)));
      SUM_RG=SUM(LOG(RES)*LOG(GRV(I,J,*,L)));
      SUM2_R=SUM((LOG(RES))**2);
      DR=SUM_R**2-3*SUM2_R;
      KRG=EXP((SUM_G*SUM_R-3*SUM_RG)/DR);
      PRG=(SUM_R*SUM_RG-SUM_G*SUM2_R)/DR;
      SUM_NR=SUM(LOG(NRV(I,J,*,L)));
      SUM_RN=SUM(LOG(RES)*LOG(NRV(I,J,*,L)));
      KRN=EXP((SUM_NR*SUM_R-3*SUM_RN)/DR);
      PRN=(SUM_R*SUM_RN-SUM_NR*SUM2_R)/DR;
        PUT SKIP(2) EDIT('TEMPERATURE','AGITATION','SUPERSATURATION')
        (COL(6),A,X(9),A,X(12),A);
        PUT SKIP(0) EDIT((11)'_',(9)'_',(15)'_') (COL(6),A,X(9),A,
        X(12),A);
        PUT SKIP EDIT(TEMP(L),AGIT(J),SUPSAT(I)) (COL(7),E(10,3),X(10),
        E(10,3),X(15),E(10,3));
   PUT SKIP(2) EDIT('GROWTH CONSTANT','GROWTH ORDER','NUC_CONSTANT',
        'NUCLEATION ORDER') (COL(4),A,X(2),A,X(5),A,X(5),A);
    PUT SKIP(0) EDIT((15)'_',(12)'_',(12)'_',(16)'_') (COL(4),A,X(2),
        A,X(5),A,X(5),A);
        PUT SKIP EDIT(KRG,PRG,KRN,PRN) (COL(5),E(10,3),X(7),E(10,3),
        X(8),E(10,3),X(8),E(10,3));
END LB6;
/* TEMPERATURE,GROWTH AND NUCLEATION RATES */;
        PUT PAGE EDIT('TEMPERATURE,GROWTH AND NUCLEATION RELATION')
        (COL(4),A);
        PUT SKIP(0) EDIT((68)'_') (COL(4),A);
```

```
LB7: DO K=1 TO 3;
     DO J=1 TO 3;
     DO I=1 TO 3;
     SUM_T=SUM(LOG(TEMP));
     SUM_G=SUM(LOG(GRV(I,J,K,*)));
     SUM_TG=SUM(LOG(TEMP)*LOG(GRV(I,J,K,*)));
     SUM2_T=SUM((LOG(TEMP))**2);
     DT=SUM_T**2-4*SUM2_T;
     KTG=EXP((SUM_G*SUM_T-4*SUM_TG)/DT);
     PTG=(SUM_T*SUM_TG-SUM_G*SUM2_T)/DT;
     SUM_NR=SUM(LOG(NRV(I,J,K,*)));
     SUM_TN=SUM(LOG(TEMP)*LOG(NRV(I,J,K,*)));
     KTN=EXP((SUM_NR*SUM_T-4*SUM_TN)/DT);
     PTN=(SUM_T*SUM_TN-SUM_NR*SUM2_T)/DT;
   PUT SKIP(2) EDIT('RESIDENCE TIME','AGITATION','SUPERSATURATION')
       (COL(6),A,X(8),A,X(12),A);
  PUT SKIP(0) EDIT((14)'_',(9)'_',(15)'_') (COL(6),A,X(8),A,X(12),A);
       PUT SKIP EDIT(RES(K),AGIT(J),SUPSAT(I)) (COL(7),E(10,3),X(12),
       E(10,3),X(12),E(10,3));
  PUT SKIP(2) EDIT('GROWTH CONSTANT','GROWTH ORDER','NUC_CONSTANT',
      'NUCLEATION ORDER') (COL(4),A,X(2),A,X(5),A,X(5),A);
      PUT SKIP(0) EDIT((15)'_',(12)'_',(12)'_',(16)'_') (COL(4),A,X(2),
      A,X(5),A,X(5),A);
      PUT SKIP EDIT(KTG,PTG,KTN,PTN) (COL(5),E(10,3),X(7),E(10,3),X(8),
      E(10,3),X(8),E(10,3));
END LB7;
  RETURN;
END PROJECT;
```

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ANALYSIS RESULTS

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
1.500E+01	1.700E+02	2.466E+03	9.500E-01

POP. AT 0
1.829E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
4.647E-01	1.060E-01	5.673E+01
2.451E-01	1.500E-01	8.665E+01
3.320E-02	1.800E-01	9.070E+01
3.950E-02	2.500E-01	9.552E+01
3.670E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	2.810E+07	1.081E-01	2.451E+07
1.133E-01	2.152E+07	1.184E-01	1.900E+07

1.235E-01	1.686E+07	1.286E-01	5.669E+51
1.337E-01	1.445E+52	1.388E-01	9.971E+45
1.438E-01	1.093E+07	1.489E-01	9.841E+06
1.540E-01	8.675E+06	1.590E-01	7.681E+06
1.641E-01	6.829E+06	1.692E-01	6.094E+06
1.742E-01	5.458E+06	1.793E-01	4.901E+06
1.843E-01	4.403E+06	1.894E-01	3.967E+06
1.944E-01	3.585E+06	1.994E-01	3.248E+06
2.045E-01	2.950E+06	2.095E-01	2.687E+06
2.145E-01	2.452E+06	2.196E-01	2.243E+06
2.246E-01	2.057E+06	2.296E-01	1.889E+06
2.347E-01	1.739E+06	2.397E-01	1.603E+06
2.447E-01	1.481E+06	2.498E-01	1.370E+06
2.548E-01	1.272E+06	2.598E-01	1.182E+06

2.648E-01	1.100E+06	2.698E-01	1.026E+06
2.749E-01	9.575E+05	2.799E-01	8.949E+05
2.849E-01	8.375E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
1.500E+01	1.700E+02	2.466E+03	8.230E-01

POP. AT 0
1.408E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
6.149E-01	1.060E-01	4.080E+01
7.894E-01	1.500E-01	9.318E+01
3.950E-02	1.800E-01	9.580E+01
4.730E-02	2.500E-01	9.894E+01
1.600E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	1.899E+07	1.081E-01	1.791E+07
1.133E-01	1.678E+07	1.184E-01	1.565E+07
1.235E-01	1.456E+07	1.286E-01	1.353E+07
1.337E-01	1.256E+07	1.388E-01	1.166E+07
1.438E-01	1.083E+07	1.489E-01	9.941E+06
1.540E-01	8.736E+06	1.590E-01	7.711E+06
1.641E-01	6.835E+06	1.692E-01	6.082E+06
1.742E-01	5.431E+06	1.793E-01	4.865E+06
1.843E-01	4.363E+06	1.894E-01	3.926E+06
1.944E-01	3.542E+06	1.994E-01	3.205E+06
2.045E-01	2.907E+06	2.095E-01	2.644E+06
2.145E-01	2.410E+06	2.196E-01	2.201E+06
2.246E-01	2.015E+06	2.296E-01	1.849E+06
2.347E-01	1.699E+06	2.397E-01	1.564E+06
2.447E-01	1.443E+06	2.498E-01	1.333E+06

2.548E-01	1.232E+06	2.598E-01	1.141E+06
2.648E-01	1.058E+06	2.698E-01	9.827E+05
2.749E-01	9.139E+05	2.799E-01	8.511E+05
2.849E-01	7.935E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
1.500E+01	1.700E+02	2.466E+03	7.000E-01

POP. AT 0
8.528E+07

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
3.619E-01	1.060E-01	2.840E+01
5.469E-01	1.500E-01	7.131E+01
1.418E-01	1.800E-01	8.243E+01
1.790E-01	2.500E-01	9.648E+01
4.490E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	1.383E+07	1.081E-01	1.334E+07
1.133E-01	1.271E+07	1.184E-01	1.201E+07
1.235E-01	1.130E+07	1.286E-01	1.059E+07
1.337E-01	9.901E+06	1.388E-01	9.250E+06
1.438E-01	8.636E+06	1.489E-01	7.994E+06
1.540E-01	7.174E+06	1.590E-01	6.462E+06
1.641E-01	5.841E+06	1.692E-01	5.298E+06
1.742E-01	4.820E+06	1.793E-01	4.389E+06
1.843E-01	3.975E+06	1.894E-01	3.611E+06
1.944E-01	3.289E+06	1.994E-01	3.004E+06
2.045E-01	2.750E+06	2.095E-01	2.524E+06
2.145E-01	2.321E+06	2.196E-01	2.139E+06
2.246E-01	1.975E+06	2.296E-01	1.828E+06
2.347E-01	1.694E+06	2.397E-01	1.573E+06

2.447E-01	1.463E+06	2.498E-01	1.361E+06
2.548E-01	1.262E+06	2.598E-01	1.171E+06
2.648E-01	1.089E+06	2.698E-01	1.014E+06
2.749E-01	9.458E+05	2.799E-01	8.831E+05
2.849E-01	8.256E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
1.500E+01	1.700E+02	1.926E+03	9.500E-01

POP. AT 0
1.475E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
2.780E-01	1.060E-01	4.078E+01
3.393E-01	1.500E-01	9.055E+01
2.000E-02	1.800E-01	9.349E+01
2.960E-02	2.500E-01	9.783E+01
1.480E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	2.050E+07	1.081E-01	1.922E+07
1.133E-01	1.791E+07	1.184E-01	1.664E+07
1.235E-01	1.543E+07	1.286E-01	1.430E+07
1.337E-01	1.324E+07	1.388E-01	1.227E+07
1.438E-01	1.138E+07	1.489E-01	1.044E+07
1.540E-01	9.177E+06	1.590E-01	8.107E+06
1.641E-01	7.190E+06	1.692E-01	6.402E+06
1.742E-01	5.721E+06	1.793E-01	5.128E+06
1.843E-01	4.604E+06	1.894E-01	4.147E+06
1.944E-01	3.745E+06	1.994E-01	3.392E+06
2.045E-01	3.080E+06	2.095E-01	2.803E+06
2.145E-01	2.557E+06	2.196E-01	2.338E+06
2.246E-01	2.143E+06	2.296E-01	1.967E+06

2.347E-01	1.810E+06	2.397E-01	1.668E+06
2.447E-01	1.540E+06	2.498E-01	1.424E+06
2.548E-01	1.318E+06	2.598E-01	1.222E+06
2.648E-01	1.135E+06	2.698E-01	1.055E+06
2.749E-01	9.822E+05	2.799E-01	9.157E+05
2.849E-01	8.549E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
1.500E+01	1.700E+02	1.926E+03	8.230E-01

POP. AT 0
9.628E+07

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
3.898E-01	1.060E-01	2.593E+01
8.605E-01	1.500E-01	8.318E+01
1.678E-01	1.800E-01	9.435E+01
8.150E-02	2.500E-01	9.977E+01
3.500E-03	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	1.243E+07	1.081E-01	1.280E+07
1.133E-01	1.277E+07	1.184E-01	1.249E+07
1.235E-01	1.206E+07	1.286E-01	1.154E+07
1.337E-01	1.098E+07	1.388E-01	1.040E+07
1.438E-01	9.831E+06	1.489E-01	9.171E+06
1.540E-01	8.201E+06	1.590E-01	7.362E+06
1.641E-01	6.634E+06	1.692E-01	5.998E+06
1.742E-01	5.441E+06	1.793E-01	4.935E+06
1.843E-01	4.435E+06	1.894E-01	3.997E+06
1.944E-01	3.613E+06	1.994E-01	3.274E+06
2.045E-01	2.975E+06	2.095E-01	2.710E+06
2.145E-01	2.474E+06	2.196E-01	2.264E+06

2.246E-01	2.076E+06	2.296E-01	1.908E+06
2.347E-01	1.756E+06	2.397E-01	1.620E+06
2.447E-01	1.497E+06	2.498E-01	1.384E+06
2.548E-01	1.278E+06	2.598E-01	1.183E+06
2.648E-01	1.096E+06	2.698E-01	1.017E+06
2.749E-01	9.447E+05	2.799E-01	8.789E+05
2.849E-01	8.188E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
1.500E+01	1.700E+02	1.926E+03	7.000E-01

POP. AT 0
2.249E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
1.534E+00	1.060E-01	6.839E+01
5.226E-01	1.500E-01	9.169E+01
6.690E-02	1.800E-01	9.468E+01
6.350E-02	2.500E-01	9.751E+01
5.590E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	3.578E+07	1.081E-01	3.059E+07
1.133E-01	2.636E+07	1.184E-01	2.289E+07
1.235E-01	2.000E+07	1.286E-01	1.758E+07
1.337E-01	1.554E+07	1.388E-01	1.381E+07
1.438E-01	1.232E+07	1.489E-01	1.099E+07
1.540E-01	9.669E+06	1.590E-01	8.541E+06
1.641E-01	7.576E+06	1.692E-01	6.746E+06
1.742E-01	6.029E+06	1.793E-01	5.402E+06
1.843E-01	4.845E+06	1.894E-01	4.358E+06
1.944E-01	3.932E+06	1.994E-01	3.557E+06
2.045E-01	3.226E+06	2.095E-01	2.933E+06

2.145E-01	2.672E+06	2.196E-01	2.441E+06
2.246E-01	2.234E+06	2.296E-01	2.049E+06
2.347E-01	1.883E+06	2.397E-01	1.733E+06
2.447E-01	1.599E+06	2.498E-01	1.477E+06
2.548E-01	1.368E+06	2.598E-01	1.268E+06
2.648E-01	1.178E+06	2.698E-01	1.096E+06
2.749E-01	1.020E+06	2.799E-01	9.517E+05
2.849E-01	8.888E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
1.500E+01	1.700E+02	1.260E+03	9.500E-01

POP. AT 0
1.807E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
4.365E-01	1.060E-01	6.476E+01
1.182E-01	1.500E-01	8.230E+01
2.940E-02	1.800E-01	8.666E+01
4.830E-02	2.500E-01	9.383E+01
4.160E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	3.152E+07	1.081E-01	2.674E+07
1.133E-01	2.288E+07	1.184E-01	1.973E+07
1.235E-01	1.714E+07	1.286E-01	1.498E+07
1.337E-01	1.316E+07	1.388E-01	1.163E+07
1.438E-01	1.033E+07	1.489E-01	9.187E+06
1.540E-01	8.107E+06	1.590E-01	7.185E+06
1.641E-01	6.394E+06	1.692E-01	5.712E+06
1.742E-01	5.121E+06	1.793E-01	4.604E+06
1.843E-01	4.144E+06	1.894E-01	3.742E+06
1.944E-01	3.388E+06	1.994E-01	3.076E+06

2.045E-01	2.800E+06	2.095E-01	2.555E+06
2.145E-01	2.337E+06	2.196E-01	2.142E+06
2.246E-01	1.967E+06	2.296E-01	1.810E+06
2.347E-01	1.669E+06	2.397E-01	1.542E+06
2.447E-01	1.427E+06	2.498E-01	1.323E+06
2.548E-01	1.231E+06	2.598E-01	1.146E+06
2.648E-01	1.069E+06	2.698E-01	9.982E+05
2.749E-01	9.336E+05	2.799E-01	8.742E+05
2.849E-01	8.197E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
1.500E+01	1.700E+02	1.260E+03	8.230E-01

POP. AT 0
1.490E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
4.266E-01	1.060E-01	4.350E+01
4.713E-01	1.500E-01	9.155E+01
3.200E-02	1.800E-01	9.481E+01
3.670E-02	2.500E-01	9.855E+01
1.420E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	2.096E+07	1.081E-01	1.941E+07
1.133E-01	1.793E+07	1.184E-01	1.653E+07
1.235E-01	1.524E+07	1.286E-01	1.404E+07
1.337E-01	1.295E+07	1.388E-01	1.196E+07
1.438E-01	1.105E+07	1.489E-01	1.011E+07
1.540E-01	8.896E+06	1.590E-01	7.862E+06
1.641E-01	6.977E+06	1.692E-01	6.216E+06
1.742E-01	5.557E+06	1.793E-01	4.983E+06
1.843E-01	4.472E+06	1.894E-01	4.025E+06

1.944E-01	3.634E+06	1.994E-01	3.289E+06
2.045E-01	2.985E+06	2.095E-01	2.716E+06
2.145E-01	2.477E+06	2.196E-01	2.263E+06
2.246E-01	2.073E+06	2.296E-01	1.902E+06
2.347E-01	1.749E+06	2.397E-01	1.612E+06
2.447E-01	1.487E+06	2.498E-01	1.374E+06
2.548E-01	1.271E+06	2.598E-01	1.178E+06
2.648E-01	1.092E+06	2.698E-01	1.015E+06
2.749E-01	9.442E+05	2.799E-01	8.796E+05
2.849E-01	8.205E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
1.500E+01	1.700E+02	1.260E+03	7.000E-01

POP. AT 0
8.383E+07

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
3.619E-01	1.060E-01	2.826E+01
5.469E-01	1.500E-01	7.096E+01
1.480E-01	1.800E-01	8.252E+01
1.790E-01	2.500E-01	9.649E+01
4.490E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	1.364E+07	1.081E-01	1.316E+07
1.133E-01	1.253E+07	1.184E-01	1.185E+07
1.235E-01	1.114E+07	1.286E-01	1.044E+07
1.337E-01	9.764E+06	1.388E-01	9.122E+06
1.438E-01	8.516E+06	1.489E-01	7.886E+06
1.540E-01	7.084E+06	1.590E-01	6.388E+06
1.641E-01	5.780E+06	1.692E-01	5.247E+06
1.742E-01	4.778E+06	1.793E-01	4.354E+06

1.843E-01	3.943E+06	1.894E-01	3.581E+06
1.944E-01	3.262E+06	1.994E-01	2.979E+06
2.045E-01	2.727E+06	2.095E-01	2.502E+06
2.145E-01	2.301E+06	2.196E-01	2.121E+06
2.246E-01	1.958E+06	2.296E-01	1.812E+06
2.347E-01	1.679E+06	2.397E-01	1.559E+06
2.447E-01	1.450E+06	2.498E-01	1.349E+06
2.548E-01	1.251E+06	2.598E-01	1.161E+06
2.648E-01	1.080E+06	2.698E-01	1.005E+06
2.749E-01	9.373E+05	2.799E-01	8.752E+05
2.849E-01	8.182E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
1.500E+01	2.350E+02	2.466E+03	9.500E-01

POP. AT 0
1.186E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
4.684E-01	1.060E-01	4.668E+01
2.472E-01	1.500E-01	7.131E+01
9.090E-02	1.800E-01	8.037E+01
1.549E-01	2.500E-01	9.580E+01
4.210E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	2.269E+07	1.081E-01	1.979E+07
1.133E-01	1.738E+07	1.184E-01	1.534E+07
1.235E-01	1.362E+07	1.286E-01	1.214E+07
1.337E-01	1.088E+07	1.388E-01	9.781E+06
1.438E-01	8.829E+06	1.489E-01	7.969E+06
1.540E-01	7.118E+06	1.590E-01	6.383E+06
1.641E-01	5.745E+06	1.692E-01	5.189E+06

1.742E-01	4.703E+06	1.793E-01	4.270E+06
1.843E-01	3.874E+06	1.894E-01	3.524E+06
1.944E-01	3.215E+06	1.994E-01	2.940E+06
2.045E-01	2.695E+06	2.095E-01	2.477E+06
2.145E-01	2.281E+06	2.196E-01	2.105E+06
2.246E-01	1.946E+06	2.296E-01	1.803E+06
2.347E-01	1.673E+06	2.397E-01	1.555E+06
2.447E-01	1.448E+06	2.498E-01	1.349E+06
2.548E-01	1.251E+06	2.598E-01	1.163E+06
2.648E-01	1.082E+06	2.698E-01	1.008E+06
2.749E-01	9.408E+05	2.799E-01	8.790E+05
2.849E-01	8.224E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
1.500E+01	2.350E+02	2.466E+03	8.230E-01

POP. AT 0
1.923E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
2.290E-01	1.060E-01	6.174E+01
1.060E-01	1.500E-01	9.032E+01
1.450E-02	1.800E-01	9.423E+01
1.570E-02	2.500E-01	9.846E+01
5.700E-03	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	3.048E+07	1.081E-01	2.641E+07
1.133E-01	2.304E+07	1.184E-01	2.023E+07
1.235E-01	1.786E+07	1.286E-01	1.585E+07
1.337E-01	1.414E+07	1.388E-01	1.266E+07
1.438E-01	1.139E+07	1.489E-01	1.022E+07
1.540E-01	9.008E+06	1.590E-01	7.971E+06

1.641E-01	7.083E+06	1.692E-01	6.317E+06
1.742E-01	5.655E+06	1.793E-01	5.076E+06
1.843E-01	4.557E+06	1.894E-01	4.103E+06
1.944E-01	3.706E+06	1.994E-01	3.356E+06
2.045E-01	3.046E+06	2.095E-01	2.773E+06
2.145E-01	2.529E+06	2.196E-01	2.313E+06
2.246E-01	2.119E+06	2.296E-01	1.945E+06
2.347E-01	1.789E+06	2.397E-01	1.649E+06
2.447E-01	1.522E+06	2.498E-01	1.407E+06
2.548E-01	1.302E+06	2.598E-01	1.206E+06
2.648E-01	1.119E+06	2.698E-01	1.040E+06
2.749E-01	9.672E+05	2.799E-01	9.012E+05
2.849E-01	8.407E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
1.500E+01	2.350E+02	2.466E+03	7.000E-01

POP. AT 0
8.651E+07

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
1.793E-01	1.060E-01	2.129E+01
4.400E-01	1.500E-01	7.354E+01
1.778E-01	1.800E-01	9.466E+01
3.610E-02	2.500E-01	9.894E+01
8.900E-03	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	1.170E+07	1.081E-01	1.232E+07
1.133E-01	1.246E+07	1.184E-01	1.232E+07
1.235E-01	1.198E+07	1.286E-01	1.153E+07
1.337E-01	1.103E+07	1.388E-01	1.049E+07
1.438E-01	9.941E+06	1.489E-01	9.341E+06

1.540E-01	8.558E+06	1.590E-01	7.859E+06
1.641E-01	7.234E+06	1.692E-01	6.673E+06
1.742E-01	6.168E+06	1.793E-01	5.674E+06
1.843E-01	5.094E+06	1.894E-01	4.588E+06
1.944E-01	4.143E+06	1.994E-01	3.752E+06
2.045E-01	3.406E+06	2.095E-01	3.100E+06
2.145E-01	2.828E+06	2.196E-01	2.586E+06
2.246E-01	2.369E+06	2.296E-01	2.175E+06
2.347E-01	2.001E+06	2.397E-01	1.844E+06
2.447E-01	1.702E+06	2.498E-01	1.574E+06
2.548E-01	1.455E+06	2.598E-01	1.347E+06
2.648E-01	1.249E+06	2.698E-01	1.160E+06
2.749E-01	1.079E+06	2.799E-01	1.005E+06
2.849E-01	9.367E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
1.500E+01	2.350E+02	1.926E+03	9.500E-01

POP. AT 0
1.390E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
5.350E-01	1.060E-01	3.889E+01
6.580E-01	1.500E-01	8.673E+01
6.960E-02	1.800E-01	9.179E+01
5.050E-02	2.500E-01	9.546E+01
6.250E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	1.969E+07	1.081E-01	1.848E+07
1.133E-01	1.723E+07	1.184E-01	1.602E+07
1.235E-01	1.486E+07	1.286E-01	1.378E+07
1.337E-01	1.277E+07	1.388E-01	1.183E+07

1.438E-01	1.097E+07	1.489E-01	1.007E+07
1.540E-01	8.898E+06	1.590E-01	7.893E+06
1.641E-01	7.030E+06	1.692E-01	6.285E+06
1.742E-01	5.639E+06	1.793E-01	5.070E+06
1.843E-01	4.550E+06	1.894E-01	4.096E+06
1.944E-01	3.698E+06	1.994E-01	3.347E+06
2.045E-01	3.038E+06	2.095E-01	2.764E+06
2.145E-01	2.521E+06	2.196E-01	2.304E+06
2.246E-01	2.110E+06	2.296E-01	1.937E+06
2.347E-01	1.781E+06	2.397E-01	1.641E+06
2.447E-01	1.514E+06	2.498E-01	1.400E+06
2.548E-01	1.300E+06	2.598E-01	1.208E+06
2.648E-01	1.125E+06	2.698E-01	1.048E+06
2.749E-01	9.786E+05	2.799E-01	9.148E+05
2.849E-01	8.562E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
1.500E+01	2.350E+02	1.926E+03	8.230E-01

POP. AT 0
1.088E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
1.820E-01	1.060E-01	2.693E+01
4.104E-01	1.500E-01	8.766E+01
4.900E-02	1.800E-01	9.491E+01
2.800E-02	2.500E-01	9.905E+01
6.400E-03	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	1.337E+07	1.081E-01	1.382E+07
1.133E-01	1.383E+07	1.184E-01	1.355E+07
1.235E-01	1.311E+07	1.286E-01	1.256E+07

1.337E-01	1.196E+07	1.388E-01	1.134E+07
1.438E-01	1.072E+07	1.489E-01	9.991E+06
1.540E-01	8.860E+06	1.590E-01	7.890E+06
1.641E-01	7.054E+06	1.692E-01	6.330E+06
1.742E-01	5.701E+06	1.793E-01	5.140E+06
1.843E-01	4.614E+06	1.894E-01	4.155E+06
1.944E-01	3.752E+06	1.994E-01	3.397E+06
2.045E-01	3.084E+06	2.095E-01	2.807E+06
2.145E-01	2.560E+06	2.196E-01	2.340E+06
2.246E-01	2.144E+06	2.296E-01	1.968E+06
2.347E-01	1.810E+06	2.397E-01	1.668E+06
2.447E-01	1.540E+06	2.498E-01	1.423E+06
2.548E-01	1.316E+06	2.598E-01	1.218E+06
2.648E-01	1.129E+06	2.698E-01	1.049E+06
2.749E-01	9.752E+05	2.799E-01	9.080E+05
2.849E-01	8.465E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
1.500E+01	2.350E+02	1.926E+03	7.000E-01

POP. AT 0
1.475E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
3.269E-01	1.060E-01	3.843E+01
4.554E-01	1.500E-01	9.196E+01
3.440E-02	1.800E-01	9.600E+01
2.300E-02	2.500E-01	9.871E+01
1.100E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	1.969E+07	1.081E-01	1.878E+07
1.133E-01	1.773E+07	1.184E-01	1.665E+07

1.235E-01	1.557E+07	1.286E-01	1.453E+07
1.337E-01	1.354E+07	1.388E-01	1.261E+07
1.438E-01	1.174E+07	1.489E-01	1.081E+07
1.540E-01	9.522E+06	1.590E-01	8.427E+06
1.641E-01	7.488E+06	1.692E-01	6.680E+06
1.742E-01	5.980E+06	1.793E-01	5.367E+06
1.843E-01	4.812E+06	1.894E-01	4.328E+06
1.944E-01	3.904E+06	1.994E-01	3.531E+06
2.045E-01	3.202E+06	2.095E-01	2.911E+06
2.145E-01	2.653E+06	2.196E-01	2.422E+06
2.246E-01	2.217E+06	2.296E-01	2.033E+06
2.347E-01	1.868E+06	2.397E-01	1.719E+06
2.447E-01	1.586E+06	2.498E-01	1.464E+06
2.548E-01	1.354E+06	2.598E-01	1.254E+06
2.648E-01	1.163E+06	2.698E-01	1.081E+06
2.749E-01	1.005E+06	2.799E-01	9.362E+05
2.849E-01	8.732E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
1.500E+01	2.350E+02	1.260E+03	9.500E-01

POP. AT 0
2.014E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
6.903E-01	1.060E-01	6.154E+01
3.640E-01	1.500E-01	9.399E+01
2.700E-02	1.800E-01	9.640E+01
2.660E-02	2.500E-01	9.877E+01
1.380E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	3.053E+07	1.081E-01	2.664E+07

1.133E-01	2.338E+07	1.184E-01	2.065E+07
1.235E-01	1.832E+07	1.286E-01	1.634E+07
1.337E-01	1.463E+07	1.388E-01	1.316E+07
1.438E-01	1.188E+07	1.489E-01	1.069E+07
1.540E-01	9.387E+06	1.590E-01	8.283E+06
1.641E-01	7.339E+06	1.692E-01	6.527E+06
1.742E-01	5.827E+06	1.793E-01	5.216E+06
1.843E-01	4.676E+06	1.894E-01	4.205E+06
1.944E-01	3.792E+06	1.994E-01	3.429E+06
2.045E-01	3.109E+06	2.095E-01	2.825E+06
2.145E-01	2.574E+06	2.196E-01	2.350E+06
2.246E-01	2.150E+06	2.296E-01	1.971E+06
2.347E-01	1.811E+06	2.397E-01	1.666E+06
2.447E-01	1.536E+06	2.498E-01	1.419E+06
2.548E-01	1.312E+06	2.598E-01	1.215E+06
2.648E-01	1.127E+06	2.698E-01	1.046E+06
2.749E-01	9.733E+05	2.799E-01	9.066E+05
2.849E-01	8.454E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
1.500E+01	2.350E+02	1.260E+03	8.230E-01

POP. AT 0
1.658E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
4.203E-01	1.060E-01	4.648E+01
4.064E-01	1.500E-01	9.143E+01
4.810E-02	1.800E-01	9.675E+01
2.200E-02	2.500E-01	9.918E+01
7.400E-03	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY

1.030E-01	2.381E+07	1.081E-01	2.175E+07
1.133E-01	1.986E+07	1.184E-01	1.814E+07
1.235E-01	1.659E+07	1.286E-01	1.519E+07
1.337E-01	1.393E+07	1.388E-01	1.279E+07
1.438E-01	1.177E+07	1.489E-01	1.074E+07
1.540E-01	9.488E+06	1.590E-01	8.416E+06
1.641E-01	7.496E+06	1.692E-01	6.701E+06
1.742E-01	6.013E+06	1.793E-01	5.405E+06
1.843E-01	4.845E+06	1.894E-01	4.357E+06
1.944E-01	3.929E+06	1.994E-01	3.553E+06
2.045E-01	3.222E+06	2.095E-01	2.928E+06
2.145E-01	2.667E+06	2.196E-01	2.435E+06
2.246E-01	2.228E+06	2.296E-01	2.043E+06
2.347E-01	1.877E+06	2.397E-01	1.727E+06
2.447E-01	1.592E+06	2.498E-01	1.470E+06
2.548E-01	1.359E+06	2.598E-01	1.258E+06
2.648E-01	1.166E+06	2.698E-01	1.083E+06
2.749E-01	1.007E+06	2.799E-01	9.372E+05
2.849E-01	8.736E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
1.500E+01	2.350E+02	1.260E+03	7.000E-01

POP. AT 0
1.251E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
1.858E-01	1.060E-01	4.233E+01
1.548E-01	1.500E-01	7.760E+01
3.190E-02	1.800E-01	8.487E+01
5.490E-02	2.500E-01	9.738E+01
1.150E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	2.125E+07	1.081E-01	1.915E+07
1.133E-01	1.728E+07	1.184E-01	1.564E+07
1.235E-01	1.418E+07	1.286E-01	1.289E+07
1.337E-01	1.175E+07	1.388E-01	1.073E+07
1.438E-01	9.822E+06	1.489E-01	8.947E+06
1.540E-01	7.948E+06	1.590E-01	7.090E+06
1.641E-01	6.349E+06	1.692E-01	5.707E+06
1.742E-01	5.148E+06	1.793E-01	4.655E+06
1.843E-01	4.209E+06	1.894E-01	3.817E+06
1.944E-01	3.472E+06	1.994E-01	3.166E+06
2.045E-01	2.894E+06	2.095E-01	2.652E+06
2.145E-01	2.435E+06	2.196E-01	2.241E+06
2.246E-01	2.067E+06	2.296E-01	1.910E+06
2.347E-01	1.768E+06	2.397E-01	1.640E+06
2.447E-01	1.523E+06	2.498E-01	1.415E+06
2.548E-01	1.311E+06	2.598E-01	1.216E+06
2.648E-01	1.129E+06	2.698E-01	1.051E+06
2.749E-01	9.786E+05	2.799E-01	9.128E+05
2.849E-01	8.525E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
1.500E+01	3.800E+02	2.466E+03	9.500E-01

POP. AT 0
1.443E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
3.537E-01	1.060E-01	4.881E+01
2.463E-01	1.500E-01	8.279E+01
4.320E-02	1.800E-01	8.875E+01
6.040E-02	2.500E-01	9.709E+01

2.110E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	2.358E+07	1.081E-01	2.094E+07
1.133E-01	1.868E+07	1.184E-01	1.672E+07
1.235E-01	1.503E+07	1.286E-01	1.355E+07
1.337E-01	1.226E+07	1.388E-01	1.113E+07
1.438E-01	1.013E+07	1.489E-01	9.180E+06
1.540E-01	8.126E+06	1.590E-01	7.224E+06
1.641E-01	6.448E+06	1.692E-01	5.777E+06
1.742E-01	5.194E+06	1.793E-01	4.681E+06
1.843E-01	4.217E+06	1.894E-01	3.811E+06
1.944E-01	3.453E+06	1.994E-01	3.138E+06
2.045E-01	2.858E+06	2.095E-01	2.610E+06
2.145E-01	2.389E+06	2.196E-01	2.191E+06
2.246E-01	2.014E+06	2.296E-01	1.855E+06
2.347E-01	1.712E+06	2.397E-01	1.582E+06
2.447E-01	1.465E+06	2.498E-01	1.358E+06
2.548E-01	1.258E+06	2.598E-01	1.167E+06
2.648E-01	1.085E+06	2.698E-01	1.009E+06
2.749E-01	9.406E+05	2.799E-01	8.777E+05
2.849E-01	8.200E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
1.500E+01	3.800E+02	2.466E+03	8.230E-01

POP. AT 0
1.078E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
1.540E-01	1.060E-01	2.383E+01
4.264E-01	1.500E-01	8.982E+01
4.330E-02	1.800E-01	9.652E+01

1.280E-02	2.500E-01	9.850E+01
9.700E-03	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	1.209E+07	1.081E-01	1.309E+07
1.133E-01	1.348E+07	1.184E-01	1.347E+07
1.235E-01	1.322E+07	1.286E-01	1.281E+07
1.337E-01	1.231E+07	1.388E-01	1.176E+07
1.438E-01	1.119E+07	1.489E-01	1.046E+07
1.540E-01	9.264E+06	1.590E-01	8.239E+06
1.641E-01	7.357E+06	1.692E-01	6.594E+06
1.742E-01	5.931E+06	1.793E-01	5.342E+06
1.843E-01	4.787E+06	1.894E-01	4.303E+06
1.944E-01	3.880E+06	1.994E-01	3.507E+06
2.045E-01	3.179E+06	2.095E-01	2.888E+06
2.145E-01	2.630E+06	2.196E-01	2.401E+06
2.246E-01	2.196E+06	2.296E-01	2.013E+06
2.347E-01	1.848E+06	2.397E-01	1.700E+06
2.447E-01	1.567E+06	2.498E-01	1.447E+06
2.548E-01	1.338E+06	2.598E-01	1.240E+06
2.648E-01	1.150E+06	2.698E-01	1.069E+06
2.749E-01	9.943E+05	2.799E-01	9.263E+05
2.849E-01	8.641E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
1.500E+01	3.800E+02	2.466E+03	7.000E-01

POP. AT 0
1.462E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
6.483E-01	1.060E-01	4.156E+01
7.694E-01	1.500E-01	9.088E+01

3.520E-02	1.800E-01	9.314E+01
4.620E-02	2.500E-01	9.610E+01
6.080E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	2.018E+07	1.081E-01	1.885E+07
1.133E-01	1.752E+07	1.184E-01	1.625E+07
1.235E-01	1.504E+07	1.286E-01	1.391E+07
1.337E-01	1.287E+07	1.388E-01	1.191E+07
1.438E-01	1.103E+07	1.489E-01	1.011E+07
1.540E-01	8.882E+06	1.590E-01	7.836E+06
1.641E-01	6.942E+06	1.692E-01	6.173E+06
1.742E-01	5.510E+06	1.793E-01	4.933E+06
1.843E-01	4.425E+06	1.894E-01	3.981E+06
1.944E-01	3.592E+06	1.994E-01	3.249E+06
2.045E-01	2.947E+06	2.095E-01	2.680E+06
2.145E-01	2.443E+06	2.196E-01	2.231E+06
2.246E-01	2.042E+06	2.296E-01	1.873E+06
2.347E-01	1.722E+06	2.397E-01	1.585E+06
2.447E-01	1.462E+06	2.498E-01	1.352E+06
2.548E-01	1.253E+06	2.598E-01	1.164E+06
2.648E-01	1.083E+06	2.698E-01	1.009E+06
2.749E-01	9.412E+05	2.799E-01	8.791E+05
2.849E-01	8.222E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
1.500E+01	3.800E+02	1.926E+03	9.500E-01

POP. AT 0
1.259E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
2.094E-01	1.060E-01	4.826E+01

9.050E-02	1.500E-01	6.912E+01
3.600E-02	1.800E-01	7.741E+01
5.470E-02	2.500E-01	9.002E+01
4.330E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	2.434E+07	1.081E-01	2.102E+07
1.133E-01	1.828E+07	1.184E-01	1.601E+07
1.235E-01	1.410E+07	1.286E-01	1.249E+07
1.337E-01	1.111E+07	1.388E-01	9.933E+06
1.438E-01	8.918E+06	1.489E-01	8.014E+06
1.540E-01	7.150E+06	1.590E-01	6.405E+06
1.641E-01	5.759E+06	1.692E-01	5.197E+06
1.742E-01	4.705E+06	1.793E-01	4.267E+06
1.843E-01	3.863E+06	1.894E-01	3.507E+06
1.944E-01	3.193E+06	1.994E-01	2.915E+06
2.045E-01	2.667E+06	2.095E-01	2.446E+06
2.145E-01	2.249E+06	2.196E-01	2.072E+06
2.246E-01	1.912E+06	2.296E-01	1.768E+06
2.347E-01	1.639E+06	2.397E-01	1.521E+06
2.447E-01	1.414E+06	2.498E-01	1.317E+06
2.548E-01	1.231E+06	2.598E-01	1.151E+06
2.648E-01	1.079E+06	2.698E-01	1.012E+06
2.749E-01	9.506E+05	2.799E-01	8.941E+05
2.849E-01	8.419E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
1.500E+01	3.800E+02	1.926E+03	8.230E-01

POP. AT 0
9.349E+07

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT

3.494E-01	1.060E-01	2.463E+01
7.317E-01	1.500E-01	7.620E+01
2.677E-01	1.800E-01	9.507E+01
5.960E-02	2.500E-01	9.927E+01
1.030E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	1.295E+07	1.081E-01	1.319E+07
1.133E-01	1.307E+07	1.184E-01	1.272E+07
1.235E-01	1.223E+07	1.286E-01	1.167E+07
1.337E-01	1.108E+07	1.388E-01	1.048E+07
1.438E-01	9.887E+06	1.489E-01	9.247E+06
1.540E-01	8.420E+06	1.590E-01	7.689E+06
1.641E-01	7.040E+06	1.692E-01	6.463E+06
1.742E-01	5.947E+06	1.793E-01	5.452E+06
1.843E-01	4.895E+06	1.894E-01	4.407E+06
1.944E-01	3.980E+06	1.994E-01	3.604E+06
2.045E-01	3.272E+06	2.095E-01	2.978E+06
2.145E-01	2.716E+06	2.196E-01	2.483E+06
2.246E-01	2.275E+06	2.296E-01	2.089E+06
2.347E-01	1.921E+06	2.397E-01	1.770E+06
2.447E-01	1.634E+06	2.498E-01	1.510E+06
2.548E-01	1.396E+06	2.598E-01	1.292E+06
2.648E-01	1.198E+06	2.698E-01	1.112E+06
2.749E-01	1.034E+06	2.799E-01	9.622E+05
2.849E-01	8.968E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
1.500E+01	3.800E+02	1.926E+03	7.000E-01

POP. AT 0
1.209E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
5.085E-01	1.060E-01	3.014E+01
9.436E-01	1.500E-01	8.607E+01
1.910E-01	1.800E-01	9.739E+01
3.880E-02	2.500E-01	9.969E+01
5.200E-03	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	1.583E+07	1.081E-01	1.578E+07
1.133E-01	1.539E+07	1.184E-01	1.481E+07
1.235E-01	1.413E+07	1.286E-01	1.339E+07
1.337E-01	1.264E+07	1.388E-01	1.190E+07
1.438E-01	1.119E+07	1.489E-01	1.039E+07
1.540E-01	9.291E+06	1.590E-01	8.337E+06
1.641E-01	7.510E+06	1.692E-01	6.788E+06
1.742E-01	6.155E+06	1.793E-01	5.578E+06
1.843E-01	5.000E+06	1.894E-01	4.496E+06
1.944E-01	4.054E+06	1.994E-01	3.666E+06
2.045E-01	3.323E+06	2.095E-01	3.020E+06
2.145E-01	2.751E+06	2.196E-01	2.511E+06
2.246E-01	2.298E+06	2.296E-01	2.106E+06
2.347E-01	1.935E+06	2.397E-01	1.780E+06
2.447E-01	1.641E+06	2.498E-01	1.515E+06
2.548E-01	1.400E+06	2.598E-01	1.295E+06
2.648E-01	1.200E+06	2.698E-01	1.113E+06
2.749E-01	1.035E+06	2.799E-01	9.626E+05
2.849E-01	8.968E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
1.500E+01	3.800E+02	1.260E+03	9.500E-01

POP. AT 0

1.969E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
5.864E-01	1.060E-01	5.874E+01
3.510E-01	1.500E-01	9.390E+01
3.700E-02	1.800E-01	9.761E+01
7.700E-03	2.500E-01	9.838E+01
1.620E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	2.930E+07	1.081E-01	2.576E+07
1.133E-01	2.277E+07	1.184E-01	2.022E+07
1.235E-01	1.804E+07	1.286E-01	1.617E+07
1.337E-01	1.455E+07	1.388E-01	1.313E+07
1.438E-01	1.190E+07	1.489E-01	1.074E+07
1.540E-01	9.455E+06	1.590E-01	8.361E+06
1.641E-01	7.425E+06	1.692E-01	6.619E+06
1.742E-01	5.921E+06	1.793E-01	5.309E+06
1.843E-01	4.754E+06	1.894E-01	4.269E+06
1.944E-01	3.846E+06	1.994E-01	3.473E+06
2.045E-01	3.145E+06	2.095E-01	2.855E+06
2.145E-01	2.598E+06	2.196E-01	2.369E+06
2.246E-01	2.165E+06	2.296E-01	1.983E+06
2.347E-01	1.819E+06	2.397E-01	1.672E+06
2.447E-01	1.540E+06	2.498E-01	1.421E+06
2.548E-01	1.314E+06	2.598E-01	1.218E+06
2.648E-01	1.130E+06	2.698E-01	1.050E+06
2.749E-01	9.769E+05	2.799E-01	9.102E+05
2.849E-01	8.492E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
1.500E+01	3.800E+02	1.260E+03	8.230E-01

POP. AT 0
3.244E+07

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
1.720E-01	1.060E-01	1.236E+01
4.736E-01	1.500E-01	4.639E+01
4.152E-01	1.800E-01	7.623E+01
3.192E-01	2.500E-01	9.917E+01
1.160E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	6.228E+06	1.081E-01	6.730E+06
1.133E-01	6.925E+06	1.184E-01	6.921E+06
1.235E-01	6.788E+06	1.286E-01	6.577E+06
1.337E-01	6.318E+06	1.388E-01	6.034E+06
1.438E-01	5.738E+06	1.489E-01	5.467E+06
1.540E-01	5.284E+06	1.590E-01	5.084E+06
1.641E-01	4.874E+06	1.692E-01	4.661E+06
1.742E-01	4.450E+06	1.793E-01	4.206E+06
1.843E-01	3.844E+06	1.894E-01	3.523E+06
1.944E-01	3.237E+06	1.994E-01	2.980E+06
2.045E-01	2.751E+06	2.095E-01	2.544E+06
2.145E-01	2.357E+06	2.196E-01	2.188E+06
2.246E-01	2.035E+06	2.296E-01	1.896E+06
2.347E-01	1.769E+06	2.397E-01	1.654E+06
2.447E-01	1.548E+06	2.498E-01	1.446E+06
2.548E-01	1.337E+06	2.598E-01	1.237E+06
2.648E-01	1.147E+06	2.698E-01	1.065E+06
2.749E-01	9.903E+05	2.799E-01	9.220E+05
2.849E-01	8.594E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION

1.500E+01	3.800E+02	1.260E+03	7.000E-01

POP. AT 0
1.017E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
3.301E-01	1.060E-01	2.780E+01
6.148E-01	1.500E-01	7.957E+01
2.031E-01	1.800E-01	9.668E+01
3.850E-02	2.500E-01	9.992E+01
9.400E-04	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	1.410E+07	1.081E-01	1.406E+07
1.133E-01	1.373E+07	1.184E-01	1.322E+07
1.235E-01	1.261E+07	1.286E-01	1.195E+07
1.337E-01	1.129E+07	1.388E-01	1.063E+07
1.438E-01	9.989E+06	1.489E-01	9.309E+06
1.540E-01	8.432E+06	1.590E-01	7.663E+06
1.641E-01	6.985E+06	1.692E-01	6.386E+06
1.742E-01	5.853E+06	1.793E-01	5.350E+06
1.843E-01	4.799E+06	1.894E-01	4.318E+06
1.944E-01	3.896E+06	1.994E-01	3.525E+06
2.045E-01	3.198E+06	2.095E-01	2.908E+06
2.145E-01	2.651E+06	2.196E-01	2.422E+06
2.246E-01	2.217E+06	2.296E-01	2.034E+06
2.347E-01	1.870E+06	2.397E-01	1.722E+06
2.447E-01	1.588E+06	2.498E-01	1.467E+06
2.548E-01	1.355E+06	2.598E-01	1.253E+06
2.648E-01	1.161E+06	2.698E-01	1.077E+06
2.749E-01	1.000E+06	2.799E-01	9.306E+05
2.849E-01	8.668E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
2.000E+01	1.700E+02	2.466E+03	9.500E-01

POP. AT 0
2.318E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
7.765E-01	1.060E-01	6.955E+01
2.722E-01	1.500E-01	9.393E+01
2.570E-02	1.800E-01	9.623E+01
2.900E-02	2.500E-01	9.883E+01
1.310E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	3.633E+07	1.081E-01	3.109E+07
1.133E-01	2.682E+07	1.184E-01	2.331E+07
1.235E-01	2.039E+07	1.286E-01	1.794E+07
1.337E-01	1.587E+07	1.388E-01	1.411E+07
1.438E-01	1.260E+07	1.489E-01	1.124E+07
1.540E-01	9.874E+06	1.590E-01	8.711E+06
1.641E-01	7.716E+06	1.692E-01	6.862E+06
1.742E-01	6.124E+06	1.793E-01	5.482E+06
1.843E-01	4.915E+06	1.894E-01	4.421E+06
1.944E-01	3.987E+06	1.994E-01	3.606E+06
2.045E-01	3.270E+06	2.095E-01	2.972E+06
2.145E-01	2.708E+06	2.196E-01	2.473E+06
2.246E-01	2.263E+06	2.296E-01	2.075E+06
2.347E-01	1.906E+06	2.397E-01	1.755E+06
2.447E-01	1.618E+06	2.498E-01	1.494E+06
2.548E-01	1.382E+06	2.598E-01	1.279E+06
2.648E-01	1.187E+06	2.698E-01	1.102E+06
2.749E-01	1.025E+06	2.799E-01	9.546E+05
2.849E-01	8.902E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
2.000E+01	1.700E+02	2.466E+03	8.230E-01

POP. AT 0
2.370E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
1.119E+00	1.060E-01	7.911E+01
1.707E-01	1.500E-01	9.117E+01
4.070E-02	1.800E-01	9.405E+01
4.560E-02	2.500E-01	9.727E+01
3.860E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	3.918E+07	1.081E-01	3.280E+07
1.133E-01	2.772E+07	1.184E-01	2.362E+07
1.235E-01	2.028E+07	1.286E-01	1.753E+07
1.337E-01	1.525E+07	1.388E-01	1.334E+07
1.438E-01	1.173E+07	1.489E-01	1.035E+07
1.540E-01	9.100E+06	1.590E-01	8.037E+06
1.641E-01	7.128E+06	1.692E-01	6.346E+06
1.742E-01	5.670E+06	1.793E-01	5.081E+06
1.843E-01	4.558E+06	1.894E-01	4.101E+06
1.944E-01	3.701E+06	1.994E-01	3.349E+06
2.045E-01	3.038E+06	2.095E-01	2.763E+06
2.145E-01	2.519E+06	2.196E-01	2.301E+06
2.246E-01	2.107E+06	2.296E-01	1.933E+06
2.347E-01	1.777E+06	2.397E-01	1.636E+06
2.447E-01	1.509E+06	2.498E-01	1.395E+06
2.548E-01	1.292E+06	2.598E-01	1.198E+06
2.648E-01	1.113E+06	2.698E-01	1.036E+06
2.749E-01	9.650E+05	2.799E-01	9.003E+05
2.849E-01	8.409E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
2.000E+01	1.700E+02	2.466E+03	7.000E-01

POP. AT 0
4.571E+07

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
6.130E-02	1.060E-01	1.722E+01
1.210E-01	1.500E-01	5.122E+01
1.135E-01	1.800E-01	8.311E+01
3.230E-02	2.500E-01	9.219E+01
2.780E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	8.410E+06	1.081E-01	8.474E+06
1.133E-01	8.331E+06	1.184E-01	8.063E+06
1.235E-01	7.723E+06	1.286E-01	7.346E+06
1.337E-01	6.955E+06	1.388E-01	6.563E+06
1.438E-01	6.181E+06	1.489E-01	5.845E+06
1.540E-01	5.632E+06	1.590E-01	5.405E+06
1.641E-01	5.172E+06	1.692E-01	4.937E+06
1.742E-01	4.706E+06	1.793E-01	4.431E+06
1.843E-01	3.996E+06	1.894E-01	3.615E+06
1.944E-01	3.279E+06	1.994E-01	2.983E+06
2.045E-01	2.720E+06	2.095E-01	2.486E+06
2.145E-01	2.277E+06	2.196E-01	2.091E+06
2.246E-01	1.924E+06	2.296E-01	1.774E+06
2.347E-01	1.638E+06	2.397E-01	1.516E+06
2.447E-01	1.405E+06	2.498E-01	1.305E+06
2.548E-01	1.216E+06	2.598E-01	1.135E+06
2.648E-01	1.060E+06	2.698E-01	9.920E+05
2.749E-01	9.295E+05	2.799E-01	8.720E+05
2.849E-01	8.191E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
2.000E+01	1.700E+02	1.926E+03	9.500E-01

POP. AT 0
1.815E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
8.288E-01	1.060E-01	5.384E+01
5.762E-01	1.500E-01	9.128E+01
6.430E-02	1.800E-01	9.545E+01
5.020E-02	2.500E-01	9.871E+01
1.980E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	2.735E+07	1.081E-01	2.429E+07
1.133E-01	2.166E+07	1.184E-01	1.939E+07
1.235E-01	1.742E+07	1.286E-01	1.571E+07
1.337E-01	1.421E+07	1.388E-01	1.290E+07
1.438E-01	1.174E+07	1.489E-01	1.063E+07
1.540E-01	9.370E+06	1.590E-01	8.295E+06
1.641E-01	7.373E+06	1.692E-01	6.579E+06
1.742E-01	5.892E+06	1.793E-01	5.289E+06
1.843E-01	4.744E+06	1.894E-01	4.269E+06
1.944E-01	3.852E+06	1.994E-01	3.486E+06
2.045E-01	3.162E+06	2.095E-01	2.876E+06
2.145E-01	2.622E+06	2.196E-01	2.395E+06
2.246E-01	2.193E+06	2.296E-01	2.012E+06
2.347E-01	1.849E+06	2.397E-01	1.703E+06
2.447E-01	1.571E+06	2.498E-01	1.451E+06
2.548E-01	1.342E+06	2.598E-01	1.243E+06
2.648E-01	1.153E+06	2.698E-01	1.071E+06
2.749E-01	9.962E+05	2.799E-01	9.279E+05
2.849E-01	8.654E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
2.000E+01	1.700E+02	1.926E+03	8.230E-01

POP. AT 0
2.147E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
1.015E+00	1.060E-01	6.736E+01
4.074E-01	1.500E-01	9.440E+01
2.180E-02	1.800E-01	9.585E+01
3.420E-02	2.500E-01	9.812E+01
2.830E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	3.310E+07	1.081E-01	2.849E+07
1.133E-01	2.471E+07	1.184E-01	2.157E+07
1.235E-01	1.895E+07	1.286E-01	1.674E+07
1.337E-01	1.487E+07	1.388E-01	1.326E+07
1.438E-01	1.188E+07	1.489E-01	1.063E+07
1.540E-01	9.320E+06	1.590E-01	8.209E+06
1.641E-01	7.261E+06	1.692E-01	6.448E+06
1.742E-01	5.746E+06	1.793E-01	5.138E+06
1.843E-01	4.605E+06	1.894E-01	4.141E+06
1.944E-01	3.734E+06	1.994E-01	3.376E+06
2.045E-01	3.061E+06	2.095E-01	2.781E+06
2.145E-01	2.534E+06	2.196E-01	2.313E+06
2.246E-01	2.116E+06	2.296E-01	1.940E+06
2.347E-01	1.782E+06	2.397E-01	1.640E+06
2.447E-01	1.512E+06	2.498E-01	1.396E+06
2.548E-01	1.292E+06	2.598E-01	1.197E+06
2.648E-01	1.111E+06	2.698E-01	1.033E+06
2.749E-01	9.613E+05	2.799E-01	8.960E+05
2.849E-01	8.361E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
2.000E+01	1.700E+02	1.926E+03	7.000E-01

POP. AT 0
1.768E+07

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
7.240E-02	1.060E-01	1.366E+01
6.090E-02	1.500E-01	2.516E+01
1.842E-01	1.800E-01	5.992E+01
1.382E-01	2.500E-01	8.600E+01
7.420E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	6.643E+06	1.081E-01	5.990E+06
1.133E-01	5.411E+06	1.184E-01	4.899E+06
1.235E-01	4.445E+06	1.286E-01	4.043E+06
1.337E-01	3.685E+06	1.388E-01	3.367E+06
1.438E-01	3.083E+06	1.489E-01	2.929E+06
1.540E-01	3.126E+06	1.590E-01	3.242E+06
1.641E-01	3.298E+06	1.692E-01	3.308E+06
1.742E-01	3.285E+06	1.793E-01	3.196E+06
1.843E-01	2.948E+06	1.894E-01	2.726E+06
1.944E-01	2.525E+06	1.994E-01	2.344E+06
2.045E-01	2.180E+06	2.095E-01	2.030E+06
2.145E-01	1.895E+06	2.196E-01	1.771E+06
2.246E-01	1.657E+06	2.296E-01	1.553E+06
2.347E-01	1.458E+06	2.397E-01	1.370E+06
2.447E-01	1.290E+06	2.498E-01	1.214E+06
2.548E-01	1.141E+06	2.598E-01	1.073E+06
2.648E-01	1.010E+06	2.698E-01	9.525E+05
2.749E-01	8.990E+05	2.799E-01	8.495E+05
2.849E-01	8.036E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
2.000E+01	1.700E+02	1.260E+03	9.500E-01

POP. AT 0
2.126E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
1.334E+00	1.060E-01	6.476E+01
5.279E-01	1.500E-01	9.038E+01
8.920E-02	1.800E-01	9.471E+01
7.480E-02	2.500E-01	9.834E+01
3.420E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	3.401E+07	1.081E-01	2.925E+07
1.133E-01	2.535E+07	1.184E-01	2.212E+07
1.235E-01	1.942E+07	1.286E-01	1.715E+07
1.337E-01	1.522E+07	1.388E-01	1.358E+07
1.438E-01	1.216E+07	1.489E-01	1.088E+07
1.540E-01	9.597E+06	1.590E-01	8.499E+06
1.641E-01	7.557E+06	1.692E-01	6.745E+06
1.742E-01	6.042E+06	1.793E-01	5.426E+06
1.843E-01	4.869E+06	1.894E-01	4.382E+06
1.944E-01	3.956E+06	1.994E-01	3.580E+06
2.045E-01	3.249E+06	2.095E-01	2.956E+06
2.145E-01	2.695E+06	2.196E-01	2.463E+06
2.246E-01	2.256E+06	2.296E-01	2.070E+06
2.347E-01	1.903E+06	2.397E-01	1.753E+06
2.447E-01	1.618E+06	2.498E-01	1.495E+06
2.548E-01	1.383E+06	2.598E-01	1.281E+06
2.648E-01	1.189E+06	2.698E-01	1.105E+06
2.749E-01	1.028E+06	2.799E-01	9.582E+05
2.849E-01	8.940E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
2.000E+01	1.700E+02	1.260E+03	8.230E-01

POP. AT 0
2.423E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
8.937E-01	1.060E-01	8.319E+01
1.119E-01	1.500E-01	9.361E+01
2.530E-02	1.800E-01	9.596E+01
2.400E-02	2.500E-01	9.819E+01
1.940E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	3.950E+07	1.081E-01	3.298E+07
1.133E-01	2.778E+07	1.184E-01	2.361E+07
1.235E-01	2.021E+07	1.286E-01	1.742E+07
1.337E-01	1.512E+07	1.388E-01	1.319E+07
1.438E-01	1.157E+07	1.489E-01	1.018E+07
1.540E-01	8.946E+06	1.590E-01	7.893E+06
1.641E-01	6.993E+06	1.692E-01	6.219E+06
1.742E-01	5.551E+06	1.793E-01	4.970E+06
1.843E-01	4.455E+06	1.894E-01	4.005E+06
1.944E-01	3.611E+06	1.994E-01	3.265E+06
2.045E-01	2.960E+06	2.095E-01	2.690E+06
2.145E-01	2.450E+06	2.196E-01	2.237E+06
2.246E-01	2.046E+06	2.296E-01	1.876E+06
2.347E-01	1.723E+06	2.397E-01	1.586E+06
2.447E-01	1.462E+06	2.498E-01	1.350E+06
2.548E-01	1.249E+06	2.598E-01	1.157E+06
2.648E-01	1.074E+06	2.698E-01	9.983E+05
2.749E-01	9.291E+05	2.799E-01	8.659E+05
2.849E-01	8.080E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
2.000E+01	1.700E+02	1.260E+03	7.000E-01

POP. AT 0
1.872E+07

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
1.088E-01	1.060E-01	1.388E+01
9.820E-02	1.500E-01	2.641E+01
2.351E-01	1.800E-01	5.640E+01
2.867E-01	2.500E-01	9.298E+01
5.500E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	7.262E+06	1.081E-01	6.590E+06
1.133E-01	5.985E+06	1.184E-01	5.443E+06
1.235E-01	4.958E+06	1.286E-01	4.524E+06
1.337E-01	4.136E+06	1.388E-01	3.788E+06
1.438E-01	3.477E+06	1.489E-01	3.283E+06
1.540E-01	3.396E+06	1.590E-01	3.444E+06
1.641E-01	3.444E+06	1.692E-01	3.410E+06
1.742E-01	3.351E+06	1.793E-01	3.247E+06
1.843E-01	3.039E+06	1.894E-01	2.848E+06
1.944E-01	2.671E+06	1.994E-01	2.509E+06
2.045E-01	2.358E+06	2.095E-01	2.219E+06
2.145E-01	2.091E+06	2.196E-01	1.972E+06
2.246E-01	1.862E+06	2.296E-01	1.759E+06
2.347E-01	1.664E+06	2.397E-01	1.575E+06
2.447E-01	1.493E+06	2.498E-01	1.410E+06
2.548E-01	1.312E+06	2.598E-01	1.223E+06
2.648E-01	1.142E+06	2.698E-01	1.068E+06
2.749E-01	9.996E+05	2.799E-01	9.370E+05
2.849E-01	8.793E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
2.000E+01	2.350E+02	2.466E+03	9.500E-01

POP. AT 0
4.560E+07

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
1.424E-01	1.060E-01	2.665E+01
7.800E-02	1.500E-01	4.125E+01
1.811E-01	1.800E-01	7.515E+01
1.041E-01	2.500E-01	9.463E+01
2.870E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	1.277E+07	1.081E-01	1.117E+07
1.133E-01	9.824E+06	1.184E-01	8.689E+06
1.235E-01	7.723E+06	1.286E-01	6.897E+06
1.337E-01	6.185E+06	1.388E-01	5.569E+06
1.438E-01	5.032E+06	1.489E-01	4.651E+06
1.540E-01	4.610E+06	1.590E-01	4.527E+06
1.641E-01	4.414E+06	1.692E-01	4.282E+06
1.742E-01	4.137E+06	1.793E-01	3.941E+06
1.843E-01	3.592E+06	1.894E-01	3.283E+06
1.944E-01	3.008E+06	1.994E-01	2.763E+06
2.045E-01	2.543E+06	2.095E-01	2.346E+06
2.145E-01	2.169E+06	2.196E-01	2.009E+06
2.246E-01	1.865E+06	2.296E-01	1.734E+06
2.347E-01	1.614E+06	2.397E-01	1.506E+06
2.447E-01	1.407E+06	2.498E-01	1.314E+06
2.548E-01	1.221E+06	2.598E-01	1.136E+06
2.648E-01	1.058E+06	2.698E-01	9.876E+05
2.749E-01	9.228E+05	2.799E-01	8.633E+05
2.849E-01	8.088E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
2.000E+01	2.350E+02	2.466E+03	8.230E-01

POP. AT 0
1.940E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
1.141E+00	1.060E-01	5.933E+01
6.744E-01	1.500E-01	9.441E+01
4.720E-02	1.800E-01	9.686E+01
3.810E-02	2.500E-01	9.885E+01
2.220E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	2.897E+07	1.081E-01	2.544E+07
1.133E-01	2.247E+07	1.184E-01	1.995E+07
1.235E-01	1.779E+07	1.286E-01	1.593E+07
1.337E-01	1.433E+07	1.388E-01	1.293E+07
1.438E-01	1.171E+07	1.489E-01	1.056E+07
1.540E-01	9.279E+06	1.590E-01	8.187E+06
1.641E-01	7.255E+06	1.692E-01	6.453E+06
1.742E-01	5.761E+06	1.793E-01	5.157E+06
1.843E-01	4.622E+06	1.894E-01	4.155E+06
1.944E-01	3.746E+06	1.994E-01	3.386E+06
2.045E-01	3.069E+06	2.095E-01	2.788E+06
2.145E-01	2.539E+06	2.196E-01	2.318E+06
2.246E-01	2.120E+06	2.296E-01	1.943E+06
2.347E-01	1.784E+06	2.397E-01	1.642E+06
2.447E-01	1.513E+06	2.498E-01	1.397E+06
2.548E-01	1.291E+06	2.598E-01	1.196E+06
2.648E-01	1.109E+06	2.698E-01	1.030E+06
2.749E-01	9.581E+05	2.799E-01	8.923E+05
2.849E-01	8.320E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
2.000E+01	2.350E+02	2.466E+03	7.000E-01

POP. AT 0
1.589E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
8.050E-01	1.060E-01	4.534E+01
7.618E-01	1.500E-01	8.825E+01
1.106E-01	1.800E-01	9.447E+01
6.280E-02	2.500E-01	9.801E+01
3.530E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	2.348E+07	1.081E-01	2.140E+07
1.133E-01	1.951E+07	1.184E-01	1.780E+07
1.235E-01	1.625E+07	1.286E-01	1.486E+07
1.337E-01	1.362E+07	1.388E-01	1.249E+07
1.438E-01	1.149E+07	1.489E-01	1.049E+07
1.540E-01	9.280E+06	1.590E-01	8.248E+06
1.641E-01	7.360E+06	1.692E-01	6.593E+06
1.742E-01	5.927E+06	1.793E-01	5.336E+06
1.843E-01	4.788E+06	1.894E-01	4.309E+06
1.944E-01	3.890E+06	1.994E-01	3.520E+06
2.045E-01	3.194E+06	2.095E-01	2.906E+06
2.145E-01	2.649E+06	2.196E-01	2.421E+06
2.246E-01	2.217E+06	2.296E-01	2.034E+06
2.347E-01	1.870E+06	2.397E-01	1.723E+06
2.447E-01	1.590E+06	2.498E-01	1.469E+06
2.548E-01	1.360E+06	2.598E-01	1.260E+06
2.648E-01	1.170E+06	2.698E-01	1.087E+06
2.749E-01	1.012E+06	2.799E-01	9.436E+05
2.849E-01	8.807E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
2.000E+01	2.350E+02	1.926E+03	9.500E-01

POP. AT 0
4.507E+07

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
1.339E-01	1.060E-01	2.140E+01
1.405E-01	1.500E-01	4.386E+01
2.593E-01	1.800E-01	8.531E+01
6.730E-02	2.500E-01	9.607E+01
2.460E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	1.073E+07	1.081E-01	9.886E+06
1.133E-01	9.089E+06	1.184E-01	8.351E+06
1.235E-01	7.672E+06	1.286E-01	7.053E+06
1.337E-01	6.490E+06	1.388E-01	5.978E+06
1.438E-01	5.514E+06	1.489E-01	5.194E+06
1.540E-01	5.237E+06	1.590E-01	5.210E+06
1.641E-01	5.135E+06	1.692E-01	5.024E+06
1.742E-01	4.889E+06	1.793E-01	4.672E+06
1.843E-01	4.218E+06	1.894E-01	3.820E+06
1.944E-01	3.469E+06	1.994E-01	3.159E+06
2.045E-01	2.884E+06	2.095E-01	2.639E+06
2.145E-01	2.420E+06	2.196E-01	2.225E+06
2.246E-01	2.049E+06	2.296E-01	1.891E+06
2.347E-01	1.748E+06	2.397E-01	1.619E+06
2.447E-01	1.502E+06	2.498E-01	1.395E+06
2.548E-01	1.294E+06	2.598E-01	1.202E+06
2.648E-01	1.118E+06	2.698E-01	1.042E+06
2.749E-01	9.716E+05	2.799E-01	9.076E+05
2.849E-01	8.489E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
2.000E+01	2.350E+02	1.926E+03	8.230E-01

POP. AT 0
1.610E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
8.907E-01	1.060E-01	4.794E+01
7.979E-01	1.500E-01	9.088E+01
7.260E-02	1.800E-01	9.479E+01
6.950E-02	2.500E-01	9.853E+01
2.730E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	2.355E+07	1.081E-01	2.136E+07
1.133E-01	1.938E+07	1.184E-01	1.762E+07
1.235E-01	1.604E+07	1.286E-01	1.463E+07
1.337E-01	1.337E+07	1.388E-01	1.225E+07
1.438E-01	1.124E+07	1.489E-01	1.024E+07
1.540E-01	9.018E+06	1.590E-01	7.980E+06
1.641E-01	7.090E+06	1.692E-01	6.323E+06
1.742E-01	5.660E+06	1.793E-01	5.080E+06
1.843E-01	4.559E+06	1.894E-01	4.103E+06
1.944E-01	3.704E+06	1.994E-01	3.353E+06
2.045E-01	3.043E+06	2.095E-01	2.769E+06
2.145E-01	2.525E+06	2.196E-01	2.307E+06
2.246E-01	2.113E+06	2.296E-01	1.939E+06
2.347E-01	1.783E+06	2.397E-01	1.643E+06
2.447E-01	1.516E+06	2.498E-01	1.401E+06
2.548E-01	1.296E+06	2.598E-01	1.200E+06
2.648E-01	1.114E+06	2.698E-01	1.035E+06
2.749E-01	9.627E+05	2.799E-01	8.968E+05
2.849E-01	8.366E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
2.000E+01	2.350E+02	1.926E+03	7.000E-01

POP. AT 0
1.849E+07

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
6.180E-02	1.060E-01	1.034E+01
1.113E-01	1.500E-01	2.898E+01
2.311E-01	1.800E-01	6.766E+01
1.026E-01	2.500E-01	8.483E+01
9.060E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	5.171E+06	1.081E-01	5.127E+06
1.133E-01	4.984E+06	1.184E-01	4.783E+06
1.235E-01	4.552E+06	1.286E-01	4.308E+06
1.337E-01	4.062E+06	1.388E-01	3.820E+06
1.438E-01	3.587E+06	1.489E-01	3.464E+06
1.540E-01	3.675E+06	1.590E-01	3.796E+06
1.641E-01	3.849E+06	1.692E-01	3.853E+06
1.742E-01	3.819E+06	1.793E-01	3.701E+06
1.843E-01	3.372E+06	1.894E-01	3.080E+06
1.944E-01	2.821E+06	1.994E-01	2.590E+06
2.045E-01	2.384E+06	2.095E-01	2.198E+06
2.145E-01	2.032E+06	2.196E-01	1.882E+06
2.246E-01	1.746E+06	2.296E-01	1.622E+06
2.347E-01	1.511E+06	2.397E-01	1.409E+06
2.447E-01	1.316E+06	2.498E-01	1.232E+06
2.548E-01	1.159E+06	2.598E-01	1.092E+06
2.648E-01	1.030E+06	2.698E-01	9.724E+05
2.749E-01	9.192E+05	2.799E-01	8.698E+05
2.849E-01	8.239E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
2.000E+01	2.350E+02	1.260E+03	9.500E-01

POP. AT 0
2.931E+06

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
2.860E-02	1.060E-01	4.556E+00
3.400E-02	1.500E-01	9.973E+00
1.656E-01	1.800E-01	3.635E+01
2.521E-01	2.500E-01	7.652E+01
1.474E-01	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	2.100E+06	1.081E-01	1.962E+06
1.133E-01	1.824E+06	1.184E-01	1.691E+06
1.235E-01	1.566E+06	1.286E-01	1.449E+06
1.337E-01	1.340E+06	1.388E-01	1.241E+06
1.438E-01	1.149E+06	1.489E-01	1.145E+06
1.540E-01	1.407E+06	1.590E-01	1.593E+06
1.641E-01	1.720E+06	1.692E-01	1.802E+06
1.742E-01	1.850E+06	1.793E-01	1.856E+06
1.843E-01	1.789E+06	1.894E-01	1.722E+06
1.944E-01	1.654E+06	1.994E-01	1.588E+06
2.045E-01	1.522E+06	2.095E-01	1.458E+06
2.145E-01	1.396E+06	2.196E-01	1.337E+06
2.246E-01	1.279E+06	2.296E-01	1.224E+06
2.347E-01	1.172E+06	2.397E-01	1.122E+06
2.447E-01	1.074E+06	2.498E-01	1.027E+06
2.548E-01	9.793E+05	2.598E-01	9.341E+05
2.648E-01	8.916E+05	2.698E-01	8.515E+05
2.749E-01	8.137E+05	2.799E-01	7.780E+05
2.849E-01	7.443E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
2.000E+01	2.350E+02	1.260E+03	8.230E-01

POP. AT 0
6.982E+07

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
3.690E-01	1.060E-01	3.377E+01
2.183E-01	1.500E-01	5.375E+01
4.459E-01	1.800E-01	9.456E+01
3.920E-02	2.500E-01	9.815E+01
2.020E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	1.535E+07	1.081E-01	1.348E+07
1.133E-01	1.191E+07	1.184E-01	1.057E+07
1.235E-01	9.428E+06	1.286E-01	8.445E+06
1.337E-01	7.594E+06	1.388E-01	6.854E+06
1.438E-01	6.208E+06	1.489E-01	5.735E+06
1.540E-01	5.635E+06	1.590E-01	5.495E+06
1.641E-01	5.328E+06	1.692E-01	5.144E+06
1.742E-01	4.951E+06	1.793E-01	4.688E+06
1.843E-01	4.207E+06	1.894E-01	3.786E+06
1.944E-01	3.418E+06	1.994E-01	3.093E+06
2.045E-01	2.807E+06	2.095E-01	2.554E+06
2.145E-01	2.328E+06	2.196E-01	2.128E+06
2.246E-01	1.949E+06	2.296E-01	1.788E+06
2.347E-01	1.644E+06	2.397E-01	1.514E+06
2.447E-01	1.397E+06	2.498E-01	1.291E+06
2.548E-01	1.195E+06	2.598E-01	1.107E+06
2.648E-01	1.028E+06	2.698E-01	9.552E+05
2.749E-01	8.891E+05	2.799E-01	8.286E+05
2.849E-01	7.733E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
2.000E+01	2.350E+02	1.260E+03	7.000E-01

POP. AT 0
2.173E+06

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
2.570E-02	1.060E-01	4.116E+00
2.090E-02	1.500E-01	7.463E+00
9.870E-02	1.800E-01	2.327E+01
2.220E-01	2.500E-01	5.882E+01
2.571E-01	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	2.039E+06	1.081E-01	1.833E+06
1.133E-01	1.652E+06	1.184E-01	1.492E+06
1.235E-01	1.352E+06	1.286E-01	1.227E+06
1.337E-01	1.117E+06	1.388E-01	1.019E+06
1.438E-01	9.325E+05	1.489E-01	9.061E+05
1.540E-01	1.054E+06	1.590E-01	1.156E+06
1.641E-01	1.222E+06	1.692E-01	1.262E+06
1.742E-01	1.281E+06	1.793E-01	1.284E+06
1.843E-01	1.272E+06	1.894E-01	1.252E+06
1.944E-01	1.226E+06	1.994E-01	1.196E+06
2.045E-01	1.164E+06	2.095E-01	1.129E+06
2.145E-01	1.094E+06	2.196E-01	1.058E+06
2.246E-01	1.022E+06	2.296E-01	9.861E+05
2.347E-01	9.509E+05	2.397E-01	9.165E+05
2.447E-01	8.830E+05	2.498E-01	8.557E+05
2.548E-01	8.482E+05	2.598E-01	8.381E+05
2.648E-01	8.259E+05	2.698E-01	8.122E+05
2.749E-01	7.973E+05	2.799E-01	7.814E+05
2.849E-01	7.648E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
2.000E+01	3.800E+02	2.466E+03	9.500E-01

POP. AT 0
5.550E+07

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
2.752E-01	1.060E-01	2.069E+01
4.519E-01	1.500E-01	5.467E+01
4.070E-01	1.800E-01	8.528E+01
1.793E-01	2.500E-01	9.876E+01
1.650E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	1.062E+07	1.081E-01	1.037E+07
1.133E-01	9.970E+06	1.184E-01	9.491E+06
1.235E-01	8.975E+06	1.286E-01	8.450E+06
1.337E-01	7.933E+06	1.388E-01	7.434E+06
1.438E-01	6.960E+06	1.489E-01	6.542E+06
1.540E-01	6.246E+06	1.590E-01	5.948E+06
1.641E-01	5.654E+06	1.692E-01	5.368E+06
1.742E-01	5.092E+06	1.793E-01	4.781E+06
1.843E-01	4.326E+06	1.894E-01	3.927E+06
1.944E-01	3.574E+06	1.994E-01	3.261E+06
2.045E-01	2.983E+06	2.095E-01	2.735E+06
2.145E-01	2.514E+06	2.196E-01	2.315E+06
2.246E-01	2.136E+06	2.296E-01	1.975E+06
2.347E-01	1.830E+06	2.397E-01	1.698E+06
2.447E-01	1.578E+06	2.498E-01	1.467E+06
2.548E-01	1.356E+06	2.598E-01	1.256E+06
2.648E-01	1.165E+06	2.698E-01	1.082E+06
2.749E-01	1.006E+06	2.799E-01	9.373E+05
2.849E-01	8.742E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
2.000E+01	3.800E+02	2.466E+03	8.230E-01

POP. AT 0
2.158E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
1.435E+00	1.060E-01	6.357E+01
7.460E-01	1.500E-01	9.662E+01
2.840E-02	1.800E-01	9.788E+01
2.250E-02	2.500E-01	9.887E+01
2.540E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	3.200E+07	1.081E-01	2.790E+07
1.133E-01	2.447E+07	1.184E-01	2.159E+07
1.235E-01	1.915E+07	1.286E-01	1.707E+07
1.337E-01	1.528E+07	1.388E-01	1.374E+07
1.438E-01	1.239E+07	1.489E-01	1.114E+07
1.540E-01	9.766E+06	1.590E-01	8.599E+06
1.641E-01	7.603E+06	1.692E-01	6.749E+06
1.742E-01	6.012E+06	1.793E-01	5.373E+06
1.843E-01	4.811E+06	1.894E-01	4.322E+06
1.944E-01	3.894E+06	1.994E-01	3.517E+06
2.045E-01	3.185E+06	2.095E-01	2.892E+06
2.145E-01	2.632E+06	2.196E-01	2.401E+06
2.246E-01	2.194E+06	2.296E-01	2.010E+06
2.347E-01	1.844E+06	2.397E-01	1.695E+06
2.447E-01	1.562E+06	2.498E-01	1.441E+06
2.548E-01	1.332E+06	2.598E-01	1.233E+06
2.648E-01	1.144E+06	2.698E-01	1.062E+06
2.749E-01	9.880E+05	2.799E-01	9.201E+05
2.849E-01	8.580E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
2.000E+01	3.800E+02	2.466E+03	7.000E-01

POP. AT 0
1.082E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
5.046E-01	1.060E-01	2.893E+01
8.462E-01	1.500E-01	7.745E+01
2.358E-01	1.800E-01	9.097E+01
1.298E-01	2.500E-01	9.841E+01
2.770E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	1.585E+07	1.081E-01	1.554E+07
1.133E-01	1.497E+07	1.184E-01	1.428E+07
1.235E-01	1.352E+07	1.286E-01	1.275E+07
1.337E-01	1.198E+07	1.388E-01	1.124E+07
1.438E-01	1.053E+07	1.489E-01	9.773E+06
1.540E-01	8.796E+06	1.590E-01	7.946E+06
1.641E-01	7.202E+06	1.692E-01	6.548E+06
1.742E-01	5.972E+06	1.793E-01	5.441E+06
1.843E-01	4.898E+06	1.894E-01	4.422E+06
1.944E-01	4.003E+06	1.994E-01	3.635E+06
2.045E-01	3.308E+06	2.095E-01	3.018E+06
2.145E-01	2.760E+06	2.196E-01	2.530E+06
2.246E-01	2.324E+06	2.296E-01	2.138E+06
2.347E-01	1.972E+06	2.397E-01	1.821E+06
2.447E-01	1.685E+06	2.498E-01	1.561E+06
2.548E-01	1.444E+06	2.598E-01	1.338E+06
2.648E-01	1.241E+06	2.698E-01	1.153E+06
2.749E-01	1.073E+06	2.799E-01	1.000E+06
2.849E-01	9.329E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
2.000E+01	3.800E+02	1.926E+03	9.500E-01

POP. AT 0
1.773E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
9.037E-01	1.060E-01	5.068E+01
7.132E-01	1.500E-01	9.068E+01
1.398E-01	1.800E-01	9.852E+01
1.820E-02	2.500E-01	9.955E+01
8.100E-03	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	2.630E+07	1.081E-01	2.358E+07
1.133E-01	2.121E+07	1.184E-01	1.913E+07
1.235E-01	1.730E+07	1.286E-01	1.568E+07
1.337E-01	1.426E+07	1.388E-01	1.300E+07
1.438E-01	1.188E+07	1.489E-01	1.080E+07
1.540E-01	9.585E+06	1.590E-01	8.541E+06
1.641E-01	7.640E+06	1.692E-01	6.860E+06
1.742E-01	6.181E+06	1.793E-01	5.574E+06
1.843E-01	4.991E+06	1.894E-01	4.484E+06
1.944E-01	4.039E+06	1.994E-01	3.649E+06
2.045E-01	3.305E+06	2.095E-01	3.001E+06
2.145E-01	2.731E+06	2.196E-01	2.491E+06
2.246E-01	2.277E+06	2.296E-01	2.085E+06
2.347E-01	1.913E+06	2.397E-01	1.759E+06
2.447E-01	1.620E+06	2.498E-01	1.495E+06
2.548E-01	1.381E+06	2.598E-01	1.278E+06
2.648E-01	1.184E+06	2.698E-01	1.099E+06
2.749E-01	1.021E+06	2.799E-01	9.504E+05
2.849E-01	8.856E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
2.000E+01	3.800E+02	1.926E+03	8.230E-01

POP. AT 0
1.977E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
1.281E+00	1.060E-01	5.842E+01
8.215E-01	1.500E-01	9.589E+01
4.620E-02	1.800E-01	9.800E+01
2.470E-02	2.500E-01	9.912E+01
1.920E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	2.889E+07	1.081E-01	2.551E+07
1.133E-01	2.264E+07	1.184E-01	2.018E+07
1.235E-01	1.806E+07	1.286E-01	1.623E+07
1.337E-01	1.464E+07	1.388E-01	1.325E+07
1.438E-01	1.203E+07	1.489E-01	1.086E+07
1.540E-01	9.538E+06	1.590E-01	8.411E+06
1.641E-01	7.447E+06	1.692E-01	6.620E+06
1.742E-01	5.906E+06	1.793E-01	5.284E+06
1.843E-01	4.733E+06	1.894E-01	4.252E+06
1.944E-01	3.830E+06	1.994E-01	3.461E+06
2.045E-01	3.134E+06	2.095E-01	2.846E+06
2.145E-01	2.590E+06	2.196E-01	2.363E+06
2.246E-01	2.160E+06	2.296E-01	1.978E+06
2.347E-01	1.816E+06	2.397E-01	1.669E+06
2.447E-01	1.538E+06	2.498E-01	1.419E+06
2.548E-01	1.311E+06	2.598E-01	1.214E+06
2.648E-01	1.125E+06	2.698E-01	1.045E+06
2.749E-01	9.716E+05	2.799E-01	9.046E+05
2.849E-01	8.433E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
2.000E+01	3.800E+02	1.926E+03	7.000E-01

POP. AT 0
1.523E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
8.559E-01	1.060E-01	4.398E+01
7.458E-01	1.500E-01	8.230E+01
1.980E-01	1.800E-01	9.247E+01
9.640E-02	2.500E-01	9.743E+01
5.010E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	2.399E+07	1.081E-01	2.170E+07
1.133E-01	1.965E+07	1.184E-01	1.783E+07
1.235E-01	1.621E+07	1.286E-01	1.477E+07
1.337E-01	1.348E+07	1.388E-01	1.233E+07
1.438E-01	1.131E+07	1.489E-01	1.032E+07
1.540E-01	9.212E+06	1.590E-01	8.257E+06
1.641E-01	7.428E+06	1.692E-01	6.706E+06
1.742E-01	6.074E+06	1.793E-01	5.503E+06
1.843E-01	4.944E+06	1.894E-01	4.454E+06
1.944E-01	4.025E+06	1.994E-01	3.647E+06
2.045E-01	3.313E+06	2.095E-01	3.017E+06
2.145E-01	2.754E+06	2.196E-01	2.519E+06
2.246E-01	2.310E+06	2.296E-01	2.122E+06
2.347E-01	1.953E+06	2.397E-01	1.801E+06
2.447E-01	1.663E+06	2.498E-01	1.539E+06
2.548E-01	1.425E+06	2.598E-01	1.321E+06
2.648E-01	1.227E+06	2.698E-01	1.142E+06
2.749E-01	1.064E+06	2.799E-01	9.920E+05
2.849E-01	9.265E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
2.000E+01	3.800E+02	1.260E+03	9.500E-01

POP. AT 0
9.812E+07

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
6.440E-01	1.060E-01	2.895E+01
9.898E-01	1.500E-01	7.344E+01
2.862E-01	1.800E-01	8.630E+01
2.577E-01	2.500E-01	9.788E+01
4.710E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	1.544E+07	1.081E-01	1.493E+07
1.133E-01	1.425E+07	1.184E-01	1.349E+07
1.235E-01	1.270E+07	1.286E-01	1.191E+07
1.337E-01	1.115E+07	1.388E-01	1.042E+07
1.438E-01	9.737E+06	1.489E-01	9.023E+06
1.540E-01	8.122E+06	1.590E-01	7.337E+06
1.641E-01	6.651E+06	1.692E-01	6.048E+06
1.742E-01	5.516E+06	1.793E-01	5.030E+06
1.843E-01	4.544E+06	1.894E-01	4.117E+06
1.944E-01	3.741E+06	1.994E-01	3.409E+06
2.045E-01	3.113E+06	2.095E-01	2.850E+06
2.145E-01	2.616E+06	2.196E-01	2.405E+06
2.246E-01	2.216E+06	2.296E-01	2.046E+06
2.347E-01	1.893E+06	2.397E-01	1.754E+06
2.447E-01	1.628E+06	2.498E-01	1.512E+06
2.548E-01	1.399E+06	2.598E-01	1.297E+06
2.648E-01	1.204E+06	2.698E-01	1.120E+06
2.749E-01	1.042E+06	2.799E-01	9.719E+05
2.849E-01	9.072E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
2.000E+01	3.800E+02	1.260E+03	8.230E-01

POP. AT 0
1.978E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
1.335E+00	1.060E-01	6.233E+01
6.370E-01	1.500E-01	9.206E+01
7.150E-02	1.800E-01	9.540E+01
5.300E-02	2.500E-01	9.788E+01
4.550E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	3.062E+07	1.081E-01	2.657E+07
1.133E-01	2.321E+07	1.184E-01	2.040E+07
1.235E-01	1.804E+07	1.286E-01	1.603E+07
1.337E-01	1.431E+07	1.388E-01	1.283E+07
1.438E-01	1.155E+07	1.489E-01	1.037E+07
1.540E-01	9.123E+06	1.590E-01	8.064E+06
1.641E-01	7.157E+06	1.692E-01	6.376E+06
1.742E-01	5.702E+06	1.793E-01	5.112E+06
1.843E-01	4.583E+06	1.894E-01	4.121E+06
1.944E-01	3.717E+06	1.994E-01	3.361E+06
2.045E-01	3.048E+06	2.095E-01	2.770E+06
2.145E-01	2.524E+06	2.196E-01	2.304E+06
2.246E-01	2.108E+06	2.296E-01	1.933E+06
2.347E-01	1.776E+06	2.397E-01	1.635E+06
2.447E-01	1.507E+06	2.498E-01	1.392E+06
2.548E-01	1.288E+06	2.598E-01	1.194E+06
2.648E-01	1.109E+06	2.698E-01	1.031E+06
2.749E-01	9.598E+05	2.799E-01	8.948E+05
2.849E-01	8.353E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
2.000E+01	3.800E+02	1.260E+03	7.000E-01

POP. AT 0
8.386E+07

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
4.612E-01	1.060E-01	2.925E+01
5.336E-01	1.500E-01	6.310E+01
3.055E-01	1.800E-01	8.248E+01
2.142E-01	2.500E-01	9.607E+01
6.200E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	1.559E+07	1.081E-01	1.452E+07
1.133E-01	1.346E+07	1.184E-01	1.246E+07
1.235E-01	1.151E+07	1.286E-01	1.064E+07
1.337E-01	9.830E+06	1.388E-01	9.089E+06
1.438E-01	8.411E+06	1.489E-01	7.776E+06
1.540E-01	7.146E+06	1.590E-01	6.582E+06
1.641E-01	6.074E+06	1.692E-01	5.616E+06
1.742E-01	5.203E+06	1.793E-01	4.802E+06
1.843E-01	4.348E+06	1.894E-01	3.948E+06
1.944E-01	3.595E+06	1.994E-01	3.282E+06
2.045E-01	3.003E+06	2.095E-01	2.755E+06
2.145E-01	2.533E+06	2.196E-01	2.334E+06
2.246E-01	2.154E+06	2.296E-01	1.993E+06
2.347E-01	1.846E+06	2.397E-01	1.714E+06
2.447E-01	1.594E+06	2.498E-01	1.482E+06
2.548E-01	1.375E+06	2.598E-01	1.277E+06
2.648E-01	1.188E+06	2.698E-01	1.107E+06
2.749E-01	1.032E+06	2.799E-01	9.645E+05
2.849E-01	9.021E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
2.500E+01	1.700E+02	2.466E+03	9.500E-01

POP. AT 0
2.273E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
1.451E+00	1.060E-01	6.901E+01
5.430E-01	1.500E-01	9.483E+01
3.400E-02	1.800E-01	9.645E+01
4.110E-02	2.500E-01	9.841E+01
3.350E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	3.510E+07	1.081E-01	3.012E+07
1.133E-01	2.605E+07	1.184E-01	2.268E+07
1.235E-01	1.988E+07	1.286E-01	1.753E+07
1.337E-01	1.553E+07	1.388E-01	1.383E+07
1.438E-01	1.237E+07	1.489E-01	1.105E+07
1.540E-01	9.693E+06	1.590E-01	8.540E+06
1.641E-01	7.556E+06	1.692E-01	6.711E+06
1.742E-01	5.983E+06	1.793E-01	5.350E+06
1.843E-01	4.795E+06	1.894E-01	4.310E+06
1.944E-01	3.886E+06	1.994E-01	3.512E+06
2.045E-01	3.183E+06	2.095E-01	2.892E+06
2.145E-01	2.634E+06	2.196E-01	2.404E+06
2.246E-01	2.199E+06	2.296E-01	2.015E+06
2.347E-01	1.851E+06	2.397E-01	1.703E+06
2.447E-01	1.569E+06	2.498E-01	1.449E+06
2.548E-01	1.340E+06	2.598E-01	1.242E+06
2.648E-01	1.152E+06	2.698E-01	1.071E+06
2.749E-01	9.961E+05	2.799E-01	9.282E+05
2.849E-01	8.659E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
2.500E+01	1.700E+02	2.466E+03	8.230E-01

POP. AT 0
2.278E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
8.052E-01	1.060E-01	7.871E+01
1.582E-01	1.500E-01	9.417E+01
2.480E-02	1.800E-01	9.660E+01
1.980E-02	2.500E-01	9.853E+01
1.500E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	3.651E+07	1.081E-01	3.072E+07
1.133E-01	2.608E+07	1.184E-01	2.233E+07
1.235E-01	1.925E+07	1.286E-01	1.671E+07
1.337E-01	1.460E+07	1.388E-01	1.282E+07
1.438E-01	1.132E+07	1.489E-01	1.001E+07
1.540E-01	8.794E+06	1.590E-01	7.759E+06
1.641E-01	6.875E+06	1.692E-01	6.115E+06
1.742E-01	5.459E+06	1.793E-01	4.887E+06
1.843E-01	4.379E+06	1.894E-01	3.937E+06
1.944E-01	3.549E+06	1.994E-01	3.208E+06
2.045E-01	2.907E+06	2.095E-01	2.642E+06
2.145E-01	2.406E+06	2.196E-01	2.196E+06
2.246E-01	2.008E+06	2.296E-01	1.841E+06
2.347E-01	1.690E+06	2.397E-01	1.555E+06
2.447E-01	1.433E+06	2.498E-01	1.323E+06
2.548E-01	1.224E+06	2.598E-01	1.134E+06
2.648E-01	1.052E+06	2.698E-01	9.770E+05
2.749E-01	9.090E+05	2.799E-01	8.469E+05
2.849E-01	7.900E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
2.500E+01	1.700E+02	2.466E+03	7.000E-01

POP. AT 0
1.614E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
4.747E-01	1.060E-01	5.297E+01
2.284E-01	1.500E-01	7.845E+01
6.220E-02	1.800E-01	8.539E+01
7.580E-02	2.500E-01	9.385E+01
5.510E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	2.818E+07	1.081E-01	2.446E+07
1.133E-01	2.138E+07	1.184E-01	1.880E+07
1.235E-01	1.663E+07	1.286E-01	1.478E+07
1.337E-01	1.320E+07	1.388E-01	1.183E+07
1.438E-01	1.065E+07	1.489E-01	9.585E+06
1.540E-01	8.508E+06	1.590E-01	7.583E+06
1.641E-01	6.786E+06	1.692E-01	6.095E+06
1.742E-01	5.493E+06	1.793E-01	4.961E+06
1.843E-01	4.471E+06	1.894E-01	4.041E+06
1.944E-01	3.663E+06	1.994E-01	3.330E+06
2.045E-01	3.034E+06	2.095E-01	2.771E+06
2.145E-01	2.537E+06	2.196E-01	2.328E+06
2.246E-01	2.141E+06	2.296E-01	1.972E+06
2.347E-01	1.820E+06	2.397E-01	1.683E+06
2.447E-01	1.559E+06	2.498E-01	1.447E+06
2.548E-01	1.346E+06	2.598E-01	1.253E+06
2.648E-01	1.169E+06	2.698E-01	1.091E+06
2.749E-01	1.021E+06	2.799E-01	9.558E+05
2.849E-01	8.962E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
2.500E+01	1.700E+02	1.926E+03	9.500E-01

POP. AT 0
2.326E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
1.447E+00	1.060E-01	6.926E+01
5.321E-01	1.500E-01	9.473E+01
4.130E-02	1.800E-01	9.670E+01
3.830E-02	2.500E-01	9.854E+01
3.060E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	3.600E+07	1.081E-01	3.087E+07
1.133E-01	2.668E+07	1.184E-01	2.322E+07
1.235E-01	2.034E+07	1.286E-01	1.792E+07
1.337E-01	1.587E+07	1.388E-01	1.413E+07
1.438E-01	1.263E+07	1.489E-01	1.128E+07
1.540E-01	9.901E+06	1.590E-01	8.730E+06
1.641E-01	7.728E+06	1.692E-01	6.869E+06
1.742E-01	6.127E+06	1.793E-01	5.481E+06
1.843E-01	4.912E+06	1.894E-01	4.415E+06
1.944E-01	3.980E+06	1.994E-01	3.597E+06
2.045E-01	3.260E+06	2.095E-01	2.962E+06
2.145E-01	2.697E+06	2.196E-01	2.461E+06
2.246E-01	2.251E+06	2.296E-01	2.063E+06
2.347E-01	1.894E+06	2.397E-01	1.743E+06
2.447E-01	1.606E+06	2.498E-01	1.483E+06
2.548E-01	1.371E+06	2.598E-01	1.270E+06
2.648E-01	1.178E+06	2.698E-01	1.095E+06
2.749E-01	1.019E+06	2.799E-01	9.489E+05
2.849E-01	8.852E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
2.500E+01	1.700E+02	1.926E+03	8.230E-01

POP. AT 0
2.260E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
1.188E+00	1.060E-01	7.304E+01
3.350E-01	1.500E-01	9.365E+01
4.850E-02	1.800E-01	9.663E+01
3.840E-02	2.500E-01	9.899E+01
1.640E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	3.592E+07	1.081E-01	3.051E+07
1.133E-01	2.614E+07	1.184E-01	2.257E+07
1.235E-01	1.962E+07	1.286E-01	1.716E+07
1.337E-01	1.510E+07	1.388E-01	1.335E+07
1.438E-01	1.187E+07	1.489E-01	1.055E+07
1.540E-01	9.281E+06	1.590E-01	8.198E+06
1.641E-01	7.271E+06	1.692E-01	6.473E+06
1.742E-01	5.784E+06	1.793E-01	5.183E+06
1.843E-01	4.646E+06	1.894E-01	4.177E+06
1.944E-01	3.767E+06	1.994E-01	3.406E+06
2.045E-01	3.088E+06	2.095E-01	2.807E+06
2.145E-01	2.557E+06	2.196E-01	2.334E+06
2.246E-01	2.136E+06	2.296E-01	1.958E+06
2.347E-01	1.799E+06	2.397E-01	1.655E+06
2.447E-01	1.526E+06	2.498E-01	1.409E+06
2.548E-01	1.303E+06	2.598E-01	1.206E+06
2.648E-01	1.118E+06	2.698E-01	1.038E+06
2.749E-01	9.657E+05	2.799E-01	8.992E+05
2.849E-01	8.384E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
2.500E+01	1.700E+02	1.926E+03	7.000E-01

POP. AT 0
8.942E+07

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
4.174E-01	1.060E-01	2.637E+01
6.836E-01	1.500E-01	6.955E+01
2.915E-01	1.800E-01	8.796E+01
1.321E-01	2.500E-01	9.630E+01
5.850E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	1.415E+07	1.081E-01	1.382E+07
1.133E-01	1.328E+07	1.184E-01	1.264E+07
1.235E-01	1.195E+07	1.286E-01	1.125E+07
1.337E-01	1.056E+07	1.388E-01	9.897E+06
1.438E-01	9.265E+06	1.489E-01	8.623E+06
1.540E-01	7.873E+06	1.590E-01	7.207E+06
1.641E-01	6.614E+06	1.692E-01	6.085E+06
1.742E-01	5.610E+06	1.793E-01	5.155E+06
1.843E-01	4.644E+06	1.894E-01	4.197E+06
1.944E-01	3.803E+06	1.994E-01	3.456E+06
2.045E-01	3.148E+06	2.095E-01	2.875E+06
2.145E-01	2.632E+06	2.196E-01	2.414E+06
2.246E-01	2.219E+06	2.296E-01	2.044E+06
2.347E-01	1.886E+06	2.397E-01	1.744E+06
2.447E-01	1.615E+06	2.498E-01	1.497E+06
2.548E-01	1.388E+06	2.598E-01	1.289E+06
2.648E-01	1.199E+06	2.698E-01	1.117E+06
2.749E-01	1.041E+06	2.799E-01	9.726E+05
2.849E-01	9.094E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
2.500E+01	1.700E+02	1.260E+03	9.500E-01

POP. AT 0
2.012E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
7.016E-01	1.060E-01	6.566E+01
2.616E-01	1.500E-01	9.014E+01
3.570E-02	1.800E-01	9.348E+01
4.000E-02	2.500E-01	9.722E+01
2.970E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	3.229E+07	1.081E-01	2.770E+07
1.133E-01	2.395E+07	1.184E-01	2.086E+07
1.235E-01	1.828E+07	1.286E-01	1.611E+07
1.337E-01	1.428E+07	1.388E-01	1.271E+07
1.438E-01	1.137E+07	1.489E-01	1.016E+07
1.540E-01	8.943E+06	1.590E-01	7.905E+06
1.641E-01	7.017E+06	1.692E-01	6.253E+06
1.742E-01	5.592E+06	1.793E-01	5.015E+06
1.843E-01	4.500E+06	1.894E-01	4.051E+06
1.944E-01	3.657E+06	1.994E-01	3.311E+06
2.045E-01	3.005E+06	2.095E-01	2.734E+06
2.145E-01	2.493E+06	2.196E-01	2.279E+06
2.246E-01	2.087E+06	2.296E-01	1.915E+06
2.347E-01	1.761E+06	2.397E-01	1.623E+06
2.447E-01	1.497E+06	2.498E-01	1.384E+06
2.548E-01	1.282E+06	2.598E-01	1.189E+06
2.648E-01	1.105E+06	2.698E-01	1.028E+06
2.749E-01	9.580E+05	2.799E-01	8.937E+05
2.849E-01	8.349E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
2.500E+01	1.700E+02	1.260E+03	8.230E-01

POP. AT 0
1.079E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
5.581E-01	1.060E-01	4.813E+01
2.131E-01	1.500E-01	6.651E+01
1.965E-01	1.800E-01	8.346E+01
1.585E-01	2.500E-01	9.713E+01
3.330E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	2.214E+07	1.081E-01	1.901E+07
1.133E-01	1.646E+07	1.184E-01	1.434E+07
1.235E-01	1.258E+07	1.286E-01	1.109E+07
1.337E-01	9.838E+06	1.388E-01	8.765E+06
1.438E-01	7.844E+06	1.489E-01	7.064E+06
1.540E-01	6.440E+06	1.590E-01	5.886E+06
1.641E-01	5.395E+06	1.692E-01	4.957E+06
1.742E-01	4.565E+06	1.793E-01	4.195E+06
1.843E-01	3.798E+06	1.894E-01	3.449E+06
1.944E-01	3.140E+06	1.994E-01	2.866E+06
2.045E-01	2.623E+06	2.095E-01	2.406E+06
2.145E-01	2.212E+06	2.196E-01	2.038E+06
2.246E-01	1.881E+06	2.296E-01	1.740E+06
2.347E-01	1.612E+06	2.397E-01	1.496E+06
2.447E-01	1.391E+06	2.498E-01	1.294E+06
2.548E-01	1.198E+06	2.598E-01	1.112E+06
2.648E-01	1.033E+06	2.698E-01	9.613E+05
2.749E-01	8.957E+05	2.799E-01	8.358E+05
2.849E-01	7.808E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
2.500E+01	1.700E+02	1.260E+03	7.000E-01

POP. AT 0
1.945E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
1.158E+00	1.060E-01	5.852E+01
6.348E-01	1.500E-01	9.061E+01
8.300E-02	1.800E-01	9.481E+01
6.440E-02	2.500E-01	9.806E+01
3.830E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	3.017E+07	1.081E-01	2.638E+07
1.133E-01	2.321E+07	1.184E-01	2.053E+07
1.235E-01	1.825E+07	1.286E-01	1.629E+07
1.337E-01	1.461E+07	1.388E-01	1.316E+07
1.438E-01	1.189E+07	1.489E-01	1.071E+07
1.540E-01	9.443E+06	1.590E-01	8.360E+06
1.641E-01	7.431E+06	1.692E-01	6.632E+06
1.742E-01	5.939E+06	1.793E-01	5.332E+06
1.843E-01	4.783E+06	1.894E-01	4.304E+06
1.944E-01	3.884E+06	1.994E-01	3.514E+06
2.045E-01	3.188E+06	2.095E-01	2.900E+06
2.145E-01	2.643E+06	2.196E-01	2.415E+06
2.246E-01	2.211E+06	2.296E-01	2.028E+06
2.347E-01	1.865E+06	2.397E-01	1.717E+06
2.447E-01	1.584E+06	2.498E-01	1.464E+06
2.548E-01	1.354E+06	2.598E-01	1.255E+06
2.648E-01	1.165E+06	2.698E-01	1.083E+06
2.749E-01	1.008E+06	2.799E-01	9.397E+05
2.849E-01	8.770E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
2.500E+01	2.350E+02	2.466E+03	9.500E-01

POP. AT 0
2.467E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
2.008E+00	1.060E-01	7.224E+01
6.669E-01	1.500E-01	9.624E+01
4.580E-02	1.800E-01	9.788E+01
4.450E-02	2.500E-01	9.949E+01
1.430E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	3.808E+07	1.081E-01	3.253E+07
1.133E-01	2.801E+07	1.184E-01	2.430E+07
1.235E-01	2.122E+07	1.286E-01	1.864E+07
1.337E-01	1.647E+07	1.388E-01	1.462E+07
1.438E-01	1.304E+07	1.489E-01	1.162E+07
1.540E-01	1.019E+07	1.590E-01	8.983E+06
1.641E-01	7.948E+06	1.692E-01	7.059E+06
1.742E-01	6.293E+06	1.793E-01	5.627E+06
1.843E-01	5.041E+06	1.894E-01	4.531E+06
1.944E-01	4.083E+06	1.994E-01	3.690E+06
2.045E-01	3.344E+06	2.095E-01	3.037E+06
2.145E-01	2.765E+06	2.196E-01	2.523E+06
2.246E-01	2.307E+06	2.296E-01	2.114E+06
2.347E-01	1.941E+06	2.397E-01	1.785E+06
2.447E-01	1.645E+06	2.498E-01	1.518E+06
2.548E-01	1.402E+06	2.598E-01	1.298E+06
2.648E-01	1.203E+06	2.698E-01	1.116E+06
2.749E-01	1.037E+06	2.799E-01	9.655E+05
2.849E-01	8.998E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
2.500E+01	2.350E+02	2.466E+03	8.230E-01

POP. AT 0
1.535E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
1.181E+00	1.060E-01	5.414E+01
5.916E-01	1.500E-01	8.127E+01
2.331E-01	1.800E-01	9.196E+01
1.366E-01	2.500E-01	9.822E+01
3.880E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	2.619E+07	1.081E-01	2.278E+07
1.133E-01	1.995E+07	1.184E-01	1.757E+07
1.235E-01	1.556E+07	1.286E-01	1.385E+07
1.337E-01	1.239E+07	1.388E-01	1.112E+07
1.438E-01	1.002E+07	1.489E-01	9.039E+06
1.540E-01	8.079E+06	1.590E-01	7.250E+06
1.641E-01	6.530E+06	1.692E-01	5.902E+06
1.742E-01	5.352E+06	1.793E-01	4.854E+06
1.843E-01	4.365E+06	1.894E-01	3.937E+06
1.944E-01	3.561E+06	1.994E-01	3.230E+06
2.045E-01	2.937E+06	2.095E-01	2.677E+06
2.145E-01	2.446E+06	2.196E-01	2.240E+06
2.246E-01	2.055E+06	2.296E-01	1.890E+06
2.347E-01	1.741E+06	2.397E-01	1.607E+06
2.447E-01	1.486E+06	2.498E-01	1.375E+06
2.548E-01	1.272E+06	2.598E-01	1.179E+06
2.648E-01	1.094E+06	2.698E-01	1.017E+06
2.749E-01	9.465E+05	2.799E-01	8.820E+05
2.849E-01	8.231E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
2.500E+01	2.350E+02	2.466E+03	7.000E-01

POP. AT 0
1.213E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
7.856E-01	1.060E-01	2.845E+01
1.596E+00	1.500E-01	8.623E+01
2.318E-01	1.800E-01	9.463E+01
1.203E-01	2.500E-01	9.898E+01
2.810E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	1.555E+07	1.081E-01	1.575E+07
1.133E-01	1.554E+07	1.184E-01	1.508E+07
1.235E-01	1.447E+07	1.286E-01	1.379E+07
1.337E-01	1.307E+07	1.388E-01	1.235E+07
1.438E-01	1.164E+07	1.489E-01	1.082E+07
1.540E-01	9.621E+06	1.590E-01	8.587E+06
1.641E-01	7.695E+06	1.692E-01	6.921E+06
1.742E-01	6.245E+06	1.793E-01	5.641E+06
1.843E-01	5.065E+06	1.894E-01	4.561E+06
1.944E-01	4.120E+06	1.994E-01	3.731E+06
2.045E-01	3.387E+06	2.095E-01	3.083E+06
2.145E-01	2.813E+06	2.196E-01	2.572E+06
2.246E-01	2.357E+06	2.296E-01	2.164E+06
2.347E-01	1.990E+06	2.397E-01	1.834E+06
2.447E-01	1.694E+06	2.498E-01	1.566E+06
2.548E-01	1.447E+06	2.598E-01	1.340E+06
2.648E-01	1.243E+06	2.698E-01	1.154E+06
2.749E-01	1.073E+06	2.799E-01	9.992E+05
2.849E-01	9.316E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
2.500E+01	2.350E+02	1.926E+03	9.500E-01

POP. AT 0
1.963E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
1.581E+00	1.060E-01	5.630E+01
1.026E+00	1.500E-01	9.285E+01
7.380E-02	1.800E-01	9.548E+01
8.090E-02	2.500E-01	9.836E+01
4.600E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	2.940E+07	1.081E-01	2.598E+07
1.133E-01	2.307E+07	1.184E-01	2.058E+07
1.235E-01	1.843E+07	1.286E-01	1.657E+07
1.337E-01	1.495E+07	1.388E-01	1.354E+07
1.438E-01	1.230E+07	1.489E-01	1.111E+07
1.540E-01	9.766E+06	1.590E-01	8.621E+06
1.641E-01	7.642E+06	1.692E-01	6.800E+06
1.742E-01	6.072E+06	1.793E-01	5.439E+06
1.843E-01	4.878E+06	1.894E-01	4.388E+06
1.944E-01	3.958E+06	1.994E-01	3.581E+06
2.045E-01	3.248E+06	2.095E-01	2.953E+06
2.145E-01	2.691E+06	2.196E-01	2.458E+06
2.246E-01	2.250E+06	2.296E-01	2.063E+06
2.347E-01	1.896E+06	2.397E-01	1.745E+06
2.447E-01	1.610E+06	2.498E-01	1.487E+06
2.548E-01	1.376E+06	2.598E-01	1.275E+06
2.648E-01	1.183E+06	2.698E-01	1.099E+06
2.749E-01	1.023E+06	2.799E-01	9.529E+05
2.849E-01	8.890E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
2.500E+01	2.350E+02	1.926E+03	8.230E-01

POP. AT 0
1.972E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
1.540E+00	1.060E-01	6.155E+01
7.957E-01	1.500E-01	9.335E+01
8.640E-02	1.800E-01	9.680E+01
5.560E-02	2.500E-01	9.902E+01
2.450E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	3.011E+07	1.081E-01	2.624E+07
1.133E-01	2.301E+07	1.184E-01	2.029E+07
1.235E-01	1.800E+07	1.286E-01	1.604E+07
1.337E-01	1.435E+07	1.388E-01	1.290E+07
1.438E-01	1.164E+07	1.489E-01	1.047E+07
1.540E-01	9.212E+06	1.590E-01	8.143E+06
1.641E-01	7.228E+06	1.692E-01	6.440E+06
1.742E-01	5.760E+06	1.793E-01	5.164E+06
1.843E-01	4.629E+06	1.894E-01	4.161E+06
1.944E-01	3.752E+06	1.994E-01	3.393E+06
2.045E-01	3.075E+06	2.095E-01	2.795E+06
2.145E-01	2.546E+06	2.196E-01	2.324E+06
2.246E-01	2.126E+06	2.296E-01	1.949E+06
2.347E-01	1.790E+06	2.397E-01	1.647E+06
2.447E-01	1.518E+06	2.498E-01	1.402E+06
2.548E-01	1.296E+06	2.598E-01	1.200E+06
2.648E-01	1.112E+06	2.698E-01	1.033E+06
2.749E-01	9.606E+05	2.799E-01	8.945E+05
2.849E-01	8.339E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
2.500E+01	2.350E+02	1.926E+03	7.000E-01

POP. AT 0
1.001E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
6.981E-01	1.060E-01	2.865E+01
1.117E+00	1.500E-01	7.448E+01
3.950E-01	1.800E-01	9.068E+01
1.935E-01	2.500E-01	9.863E+01
3.350E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	1.528E+07	1.081E-01	1.486E+07
1.133E-01	1.425E+07	1.184E-01	1.353E+07
1.235E-01	1.277E+07	1.286E-01	1.201E+07
1.337E-01	1.126E+07	1.388E-01	1.054E+07
1.438E-01	9.861E+06	1.489E-01	9.159E+06
1.540E-01	8.300E+06	1.590E-01	7.546E+06
1.641E-01	6.881E+06	1.692E-01	6.293E+06
1.742E-01	5.770E+06	1.793E-01	5.279E+06
1.843E-01	4.754E+06	1.894E-01	4.294E+06
1.944E-01	3.889E+06	1.994E-01	3.532E+06
2.045E-01	3.216E+06	2.095E-01	2.935E+06
2.145E-01	2.686E+06	2.196E-01	2.462E+06
2.246E-01	2.262E+06	2.296E-01	2.083E+06
2.347E-01	1.921E+06	2.397E-01	1.775E+06
2.447E-01	1.643E+06	2.498E-01	1.522E+06
2.548E-01	1.408E+06	2.598E-01	1.304E+06
2.648E-01	1.210E+06	2.698E-01	1.124E+06
2.749E-01	1.045E+06	2.799E-01	9.739E+05
2.849E-01	9.084E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
2.500E+01	2.350E+02	1.260E+03	9.500E-01

POP. AT 0
1.373E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
5.990E-01	1.060E-01	3.901E+01
7.863E-01	1.500E-01	9.021E+01
8.810E-02	1.800E-01	9.594E+01
4.800E-02	2.500E-01	9.907E+01
1.430E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	1.886E+07	1.081E-01	1.784E+07
1.133E-01	1.675E+07	1.184E-01	1.565E+07
1.235E-01	1.458E+07	1.286E-01	1.356E+07
1.337E-01	1.260E+07	1.388E-01	1.171E+07
1.438E-01	1.088E+07	1.489E-01	1.001E+07
1.540E-01	8.849E+06	1.590E-01	7.856E+06
1.641E-01	7.003E+06	1.692E-01	6.266E+06
1.742E-01	5.627E+06	1.793E-01	5.062E+06
1.843E-01	4.540E+06	1.894E-01	4.085E+06
1.944E-01	3.686E+06	1.994E-01	3.335E+06
2.045E-01	3.025E+06	2.095E-01	2.751E+06
2.145E-01	2.507E+06	2.196E-01	2.290E+06
2.246E-01	2.097E+06	2.296E-01	1.923E+06
2.347E-01	1.768E+06	2.397E-01	1.628E+06
2.447E-01	1.501E+06	2.498E-01	1.387E+06
2.548E-01	1.282E+06	2.598E-01	1.187E+06
2.648E-01	1.100E+06	2.698E-01	1.022E+06
2.749E-01	9.501E+05	2.799E-01	8.846E+05
2.849E-01	8.247E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
2.500E+01	2.350E+02	1.260E+03	8.230E-01

POP. AT 0
2.027E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
8.211E-01	1.060E-01	6.443E+01
3.717E-01	1.500E-01	9.359E+01
3.620E-02	1.800E-01	9.643E+01
2.910E-02	2.500E-01	9.871E+01
1.640E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	3.122E+07	1.081E-01	2.702E+07
1.133E-01	2.355E+07	1.184E-01	2.066E+07
1.235E-01	1.823E+07	1.286E-01	1.616E+07
1.337E-01	1.441E+07	1.388E-01	1.290E+07
1.438E-01	1.159E+07	1.489E-01	1.040E+07
1.540E-01	9.139E+06	1.590E-01	8.070E+06
1.641E-01	7.156E+06	1.692E-01	6.369E+06
1.742E-01	5.690E+06	1.793E-01	5.097E+06
1.843E-01	4.569E+06	1.894E-01	4.108E+06
1.944E-01	3.705E+06	1.994E-01	3.350E+06
2.045E-01	3.037E+06	2.095E-01	2.760E+06
2.145E-01	2.514E+06	2.196E-01	2.295E+06
2.246E-01	2.100E+06	2.296E-01	1.925E+06
2.347E-01	1.768E+06	2.397E-01	1.627E+06
2.447E-01	1.500E+06	2.498E-01	1.385E+06
2.548E-01	1.281E+06	2.598E-01	1.186E+06
2.648E-01	1.100E+06	2.698E-01	1.022E+06
2.749E-01	9.505E+05	2.799E-01	8.854E+05
2.849E-01	8.257E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
2.500E+01	2.350E+02	1.260E+03	7.000E-01

POP. AT 0
1.058E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
6.314E-01	1.060E-01	2.819E+01
1.187E+00	1.500E-01	8.118E+01
2.178E-01	1.800E-01	9.090E+01
1.595E-01	2.500E-01	9.803E+01
4.420E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	1.455E+07	1.081E-01	1.453E+07
1.133E-01	1.420E+07	1.184E-01	1.368E+07
1.235E-01	1.306E+07	1.286E-01	1.239E+07
1.337E-01	1.170E+07	1.388E-01	1.102E+07
1.438E-01	1.036E+07	1.489E-01	9.630E+06
1.540E-01	8.591E+06	1.590E-01	7.695E+06
1.641E-01	6.919E+06	1.692E-01	6.243E+06
1.742E-01	5.652E+06	1.793E-01	5.120E+06
1.843E-01	4.608E+06	1.894E-01	4.159E+06
1.944E-01	3.765E+06	1.994E-01	3.417E+06
2.045E-01	3.109E+06	2.095E-01	2.836E+06
2.145E-01	2.593E+06	2.196E-01	2.376E+06
2.246E-01	2.182E+06	2.296E-01	2.008E+06
2.347E-01	1.851E+06	2.397E-01	1.709E+06
2.447E-01	1.581E+06	2.498E-01	1.465E+06
2.548E-01	1.355E+06	2.598E-01	1.256E+06
2.648E-01	1.166E+06	2.698E-01	1.084E+06
2.749E-01	1.009E+06	2.799E-01	9.405E+05
2.849E-01	8.778E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
2.500E+01	3.800E+02	2.466E+03	9.500E-01

POP. AT 0
2.000E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
8.966E-01	1.060E-01	5.712E+01
6.313E-01	1.500E-01	9.733E+01
1.870E-02	1.800E-01	9.852E+01
1.580E-02	2.500E-01	9.953E+01
7.400E-03	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	2.864E+07	1.081E-01	2.546E+07
1.133E-01	2.272E+07	1.184E-01	2.035E+07
1.235E-01	1.830E+07	1.286E-01	1.651E+07
1.337E-01	1.494E+07	1.388E-01	1.357E+07
1.438E-01	1.235E+07	1.489E-01	1.118E+07
1.540E-01	9.797E+06	1.590E-01	8.625E+06
1.641E-01	7.625E+06	1.692E-01	6.767E+06
1.742E-01	6.028E+06	1.793E-01	5.386E+06
1.843E-01	4.824E+06	1.894E-01	4.333E+06
1.944E-01	3.903E+06	1.994E-01	3.526E+06
2.045E-01	3.194E+06	2.095E-01	2.900E+06
2.145E-01	2.639E+06	2.196E-01	2.407E+06
2.246E-01	2.200E+06	2.296E-01	2.015E+06
2.347E-01	1.849E+06	2.397E-01	1.700E+06
2.447E-01	1.566E+06	2.498E-01	1.444E+06
2.548E-01	1.334E+06	2.598E-01	1.235E+06
2.648E-01	1.144E+06	2.698E-01	1.062E+06
2.749E-01	9.869E+05	2.799E-01	9.185E+05
2.849E-01	8.559E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
2.500E+01	3.800E+02	2.466E+03	8.230E-01

POP. AT 0
1.778E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
9.379E-01	1.060E-01	5.769E+01
5.983E-01	1.500E-01	9.449E+01
4.410E-02	1.800E-01	9.721E+01
2.820E-02	2.500E-01	9.894E+01
1.720E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	2.630E+07	1.081E-01	2.321E+07
1.133E-01	2.059E+07	1.184E-01	1.835E+07
1.235E-01	1.642E+07	1.286E-01	1.475E+07
1.337E-01	1.330E+07	1.388E-01	1.204E+07
1.438E-01	1.093E+07	1.489E-01	9.871E+06
1.540E-01	8.675E+06	1.590E-01	7.658E+06
1.641E-01	6.789E+06	1.692E-01	6.041E+06
1.742E-01	5.395E+06	1.793E-01	4.832E+06
1.843E-01	4.329E+06	1.894E-01	3.891E+06
1.944E-01	3.507E+06	1.994E-01	3.170E+06
2.045E-01	2.873E+06	2.095E-01	2.609E+06
2.145E-01	2.376E+06	2.196E-01	2.168E+06
2.246E-01	1.983E+06	2.296E-01	1.817E+06
2.347E-01	1.668E+06	2.397E-01	1.535E+06
2.447E-01	1.414E+06	2.498E-01	1.305E+06
2.548E-01	1.207E+06	2.598E-01	1.117E+06
2.648E-01	1.036E+06	2.698E-01	9.622E+05
2.749E-01	8.948E+05	2.799E-01	8.333E+05
2.849E-01	7.770E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
2.500E+01	3.800E+02	2.466E+03	7.000E-01

POP. AT 0
1.880E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
1.044E+00	1.060E-01	5.214E+01
9.049E-01	1.500E-01	9.732E+01
1.920E-02	1.800E-01	9.828E+01
1.910E-02	2.500E-01	9.923E+01
1.540E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	2.615E+07	1.081E-01	2.364E+07
1.133E-01	2.141E+07	1.184E-01	1.942E+07
1.235E-01	1.764E+07	1.286E-01	1.607E+07
1.337E-01	1.467E+07	1.388E-01	1.341E+07
1.438E-01	1.229E+07	1.489E-01	1.118E+07
1.540E-01	9.794E+06	1.590E-01	8.619E+06
1.641E-01	7.617E+06	1.692E-01	6.757E+06
1.742E-01	6.017E+06	1.793E-01	5.375E+06
1.843E-01	4.813E+06	1.894E-01	4.323E+06
1.944E-01	3.894E+06	1.994E-01	3.518E+06
2.045E-01	3.186E+06	2.095E-01	2.893E+06
2.145E-01	2.632E+06	2.196E-01	2.401E+06
2.246E-01	2.194E+06	2.296E-01	2.010E+06
2.347E-01	1.844E+06	2.397E-01	1.695E+06
2.447E-01	1.561E+06	2.498E-01	1.440E+06
2.548E-01	1.331E+06	2.598E-01	1.232E+06
2.648E-01	1.142E+06	2.698E-01	1.060E+06
2.749E-01	9.859E+05	2.799E-01	9.178E+05
2.849E-01	8.555E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
2.500E+01	3.800E+02	1.926E+03	9.500E-01

POP. AT 0
1.635E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
7.958E-01	1.060E-01	4.430E+01
9.584E-01	1.500E-01	9.765E+01
1.170E-02	1.800E-01	9.830E+01
1.400E-02	2.500E-01	9.908E+01
1.650E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	2.145E+07	1.081E-01	2.007E+07
1.133E-01	1.868E+07	1.184E-01	1.734E+07
1.235E-01	1.607E+07	1.286E-01	1.487E+07
1.337E-01	1.377E+07	1.388E-01	1.275E+07
1.438E-01	1.182E+07	1.489E-01	1.083E+07
1.540E-01	9.481E+06	1.590E-01	8.339E+06
1.641E-01	7.366E+06	1.692E-01	6.531E+06
1.742E-01	5.812E+06	1.793E-01	5.190E+06
1.843E-01	4.647E+06	1.894E-01	4.173E+06
1.944E-01	3.759E+06	1.994E-01	3.395E+06
2.045E-01	3.074E+06	2.095E-01	2.791E+06
2.145E-01	2.539E+06	2.196E-01	2.316E+06
2.246E-01	2.116E+06	2.296E-01	1.938E+06
2.347E-01	1.778E+06	2.397E-01	1.635E+06
2.447E-01	1.505E+06	2.498E-01	1.388E+06
2.548E-01	1.283E+06	2.598E-01	1.188E+06
2.648E-01	1.102E+06	2.698E-01	1.023E+06
2.749E-01	9.511E+05	2.799E-01	8.856E+05
2.849E-01	8.256E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
2.500E+01	3.800E+02	1.926E+03	8.230E-01

POP. AT 0
2.078E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
1.061E+00	1.060E-01	7.004E+01
3.542E-01	1.500E-01	9.342E+01
5.020E-02	1.800E-01	9.674E+01
3.560E-02	2.500E-01	9.909E+01
1.380E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	3.278E+07	1.081E-01	2.800E+07
1.133E-01	2.412E+07	1.184E-01	2.092E+07
1.235E-01	1.827E+07	1.286E-01	1.606E+07
1.337E-01	1.419E+07	1.388E-01	1.260E+07
1.438E-01	1.124E+07	1.489E-01	1.002E+07
1.540E-01	8.818E+06	1.590E-01	7.793E+06
1.641E-01	6.915E+06	1.692E-01	6.160E+06
1.742E-01	5.508E+06	1.793E-01	4.937E+06
1.843E-01	4.426E+06	1.894E-01	3.980E+06
1.944E-01	3.589E+06	1.994E-01	3.245E+06
2.045E-01	2.942E+06	2.095E-01	2.674E+06
2.145E-01	2.436E+06	2.196E-01	2.224E+06
2.246E-01	2.034E+06	2.296E-01	1.865E+06
2.347E-01	1.713E+06	2.397E-01	1.577E+06
2.447E-01	1.454E+06	2.498E-01	1.342E+06
2.548E-01	1.241E+06	2.598E-01	1.148E+06
2.648E-01	1.065E+06	2.698E-01	9.887E+05
2.749E-01	9.193E+05	2.799E-01	8.559E+05
2.849E-01	7.980E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
2.500E+01	3.800E+02	1.926E+03	7.000E-01

POP. AT 0
2.455E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
1.296E+00	1.060E-01	7.425E+01
4.162E-01	1.500E-01	9.810E+01
1.450E-02	1.800E-01	9.893E+01
1.290E-02	2.500E-01	9.967E+01
5.800E-03	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	3.738E+07	1.081E-01	3.189E+07
1.133E-01	2.743E+07	1.184E-01	2.377E+07
1.235E-01	2.074E+07	1.286E-01	1.820E+07
1.337E-01	1.606E+07	1.388E-01	1.425E+07
1.438E-01	1.270E+07	1.489E-01	1.131E+07
1.540E-01	9.907E+06	1.590E-01	8.716E+06
1.641E-01	7.701E+06	1.692E-01	6.830E+06
1.742E-01	6.080E+06	1.793E-01	5.430E+06
1.843E-01	4.862E+06	1.894E-01	4.367E+06
1.944E-01	3.933E+06	1.994E-01	3.552E+06
2.045E-01	3.216E+06	2.095E-01	2.920E+06
2.145E-01	2.657E+06	2.196E-01	2.423E+06
2.246E-01	2.214E+06	2.296E-01	2.027E+06
2.347E-01	1.860E+06	2.397E-01	1.710E+06
2.447E-01	1.574E+06	2.498E-01	1.452E+06
2.548E-01	1.341E+06	2.598E-01	1.241E+06
2.648E-01	1.150E+06	2.698E-01	1.067E+06
2.749E-01	9.915E+05	2.799E-01	9.226E+05
2.849E-01	8.596E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
2.500E+01	3.800E+02	1.260E+03	9.500E-01

POP. AT 0
1.869E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
6.047E-01	1.060E-01	5.483E+01
4.481E-01	1.500E-01	9.546E+01
2.280E-02	1.800E-01	9.752E+01
2.080E-02	2.500E-01	9.941E+01
6.500E-03	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	2.702E+07	1.081E-01	2.411E+07
1.133E-01	2.159E+07	1.184E-01	1.940E+07
1.235E-01	1.748E+07	1.286E-01	1.581E+07
1.337E-01	1.434E+07	1.388E-01	1.304E+07
1.438E-01	1.189E+07	1.489E-01	1.078E+07
1.540E-01	9.461E+06	1.590E-01	8.343E+06
1.641E-01	7.387E+06	1.692E-01	6.566E+06
1.742E-01	5.857E+06	1.793E-01	5.241E+06
1.843E-01	4.697E+06	1.894E-01	4.221E+06
1.944E-01	3.805E+06	1.994E-01	3.440E+06
2.045E-01	3.117E+06	2.095E-01	2.832E+06
2.145E-01	2.579E+06	2.196E-01	2.354E+06
2.246E-01	2.153E+06	2.296E-01	1.973E+06
2.347E-01	1.812E+06	2.397E-01	1.667E+06
2.447E-01	1.536E+06	2.498E-01	1.418E+06
2.548E-01	1.310E+06	2.598E-01	1.212E+06
2.648E-01	1.124E+06	2.698E-01	1.043E+06
2.749E-01	9.695E+05	2.799E-01	9.023E+05
2.849E-01	8.409E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
2.500E+01	3.800E+02	1.260E+03	8.230E-01

POP. AT 0
2.096E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
1.046E+00	1.060E-01	6.631E+01
4.460E-01	1.500E-01	9.458E+01
2.880E-02	1.800E-01	9.640E+01
4.170E-02	2.500E-01	9.904E+01
1.510E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	3.227E+07	1.081E-01	2.785E+07
1.133E-01	2.421E+07	1.184E-01	2.119E+07
1.235E-01	1.865E+07	1.286E-01	1.651E+07
1.337E-01	1.468E+07	1.388E-01	1.312E+07
1.438E-01	1.178E+07	1.489E-01	1.055E+07
1.540E-01	9.254E+06	1.590E-01	8.157E+06
1.641E-01	7.219E+06	1.692E-01	6.414E+06
1.742E-01	5.720E+06	1.793E-01	5.117E+06
1.843E-01	4.588E+06	1.894E-01	4.127E+06
1.944E-01	3.722E+06	1.994E-01	3.366E+06
2.045E-01	3.053E+06	2.095E-01	2.775E+06
2.145E-01	2.528E+06	2.196E-01	2.309E+06
2.246E-01	2.113E+06	2.296E-01	1.937E+06
2.347E-01	1.780E+06	2.397E-01	1.638E+06
2.447E-01	1.511E+06	2.498E-01	1.395E+06
2.548E-01	1.290E+06	2.598E-01	1.194E+06
2.648E-01	1.107E+06	2.698E-01	1.028E+06
2.749E-01	9.559E+05	2.799E-01	8.901E+05
2.849E-01	8.298E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
2.500E+01	3.800E+02	1.260E+03	7.000E-01

POP. AT 0
1.536E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
8.665E-01	1.060E-01	4.299E+01
1.018E+00	1.500E-01	9.348E+01
9.100E-02	1.800E-01	9.799E+01
2.820E-02	2.500E-01	9.939E+01
1.230E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	2.094E+07	1.081E-01	1.954E+07
1.133E-01	1.815E+07	1.184E-01	1.681E+07
1.235E-01	1.555E+07	1.286E-01	1.438E+07
1.337E-01	1.330E+07	1.388E-01	1.230E+07
1.438E-01	1.139E+07	1.489E-01	1.044E+07
1.540E-01	9.209E+06	1.590E-01	8.155E+06
1.641E-01	7.252E+06	1.692E-01	6.474E+06
1.742E-01	5.799E+06	1.793E-01	5.206E+06
1.843E-01	4.664E+06	1.894E-01	4.190E+06
1.944E-01	3.776E+06	1.994E-01	3.412E+06
2.045E-01	3.091E+06	2.095E-01	2.807E+06
2.145E-01	2.556E+06	2.196E-01	2.332E+06
2.246E-01	2.132E+06	2.296E-01	1.953E+06
2.347E-01	1.793E+06	2.397E-01	1.649E+06
2.447E-01	1.519E+06	2.498E-01	1.401E+06
2.548E-01	1.295E+06	2.598E-01	1.198E+06
2.648E-01	1.111E+06	2.698E-01	1.031E+06
2.749E-01	9.584E+05	2.799E-01	8.921E+05
2.849E-01	8.314E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
3.500E+01	1.700E+02	2.466E+03	9.500E-01

POP. AT 0
1.972E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
6.229E-01	1.060E-01	5.636E+01
3.689E-01	1.500E-01	8.974E+01
5.810E-02	1.800E-01	9.500E+01
4.220E-02	2.500E-01	9.881E+01
1.310E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	3.068E+07	1.081E-01	2.696E+07
1.133E-01	2.381E+07	1.184E-01	2.114E+07
1.235E-01	1.885E+07	1.286E-01	1.689E+07
1.337E-01	1.519E+07	1.388E-01	1.371E+07
1.438E-01	1.241E+07	1.489E-01	1.121E+07
1.540E-01	9.899E+06	1.590E-01	8.781E+06
1.641E-01	7.822E+06	1.692E-01	6.993E+06
1.742E-01	6.275E+06	1.793E-01	5.642E+06
1.843E-01	5.063E+06	1.894E-01	4.558E+06
1.944E-01	4.115E+06	1.994E-01	3.725E+06
2.045E-01	3.381E+06	2.095E-01	3.076E+06
2.145E-01	2.805E+06	2.196E-01	2.564E+06
2.246E-01	2.348E+06	2.296E-01	2.155E+06
2.347E-01	1.982E+06	2.397E-01	1.826E+06
2.447E-01	1.685E+06	2.498E-01	1.557E+06
2.548E-01	1.440E+06	2.598E-01	1.333E+06
2.648E-01	1.237E+06	2.698E-01	1.149E+06
2.749E-01	1.068E+06	2.799E-01	9.949E+05
2.849E-01	9.278E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
3.500E+01	1.700E+02	2.466E+03	8.230E-01

POP. AT 0
2.043E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
6.955E-01	1.060E-01	6.034E+01
3.770E-01	1.500E-01	9.305E+01
2.960E-02	1.800E-01	9.562E+01
3.160E-02	2.500E-01	9.836E+01
1.890E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	3.111E+07	1.081E-01	2.718E+07
1.133E-01	2.390E+07	1.184E-01	2.113E+07
1.235E-01	1.877E+07	1.286E-01	1.676E+07
1.337E-01	1.502E+07	1.388E-01	1.352E+07
1.438E-01	1.221E+07	1.489E-01	1.099E+07
1.540E-01	9.661E+06	1.590E-01	8.527E+06
1.641E-01	7.557E+06	1.692E-01	6.724E+06
1.742E-01	6.004E+06	1.793E-01	5.377E+06
1.843E-01	4.822E+06	1.894E-01	4.337E+06
1.944E-01	3.912E+06	1.994E-01	3.538E+06
2.045E-01	3.209E+06	2.095E-01	2.917E+06
2.145E-01	2.658E+06	2.196E-01	2.428E+06
2.246E-01	2.222E+06	2.296E-01	2.038E+06
2.347E-01	1.872E+06	2.397E-01	1.723E+06
2.447E-01	1.589E+06	2.498E-01	1.468E+06
2.548E-01	1.358E+06	2.598E-01	1.258E+06
2.648E-01	1.167E+06	2.698E-01	1.085E+06
2.749E-01	1.010E+06	2.799E-01	9.407E+05
2.849E-01	8.776E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
3.500E+01	1.700E+02	2.466E+03	7.000E-01

POP. AT 0
1.239E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
5.737E-01	1.060E-01	4.455E+01
3.325E-01	1.500E-01	7.037E+01
1.498E-01	1.800E-01	8.201E+01
2.079E-01	2.500E-01	9.815E+01
2.380E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	2.392E+07	1.081E-01	2.098E+07
1.133E-01	1.851E+07	1.184E-01	1.642E+07
1.235E-01	1.463E+07	1.286E-01	1.309E+07
1.337E-01	1.176E+07	1.388E-01	1.061E+07
1.438E-01	9.604E+06	1.489E-01	8.697E+06
1.540E-01	7.816E+06	1.590E-01	7.050E+06
1.641E-01	6.382E+06	1.692E-01	5.796E+06
1.742E-01	5.279E+06	1.793E-01	4.813E+06
1.843E-01	4.368E+06	1.894E-01	3.975E+06
1.944E-01	3.627E+06	1.994E-01	3.318E+06
2.045E-01	3.043E+06	2.095E-01	2.797E+06
2.145E-01	2.576E+06	2.196E-01	2.378E+06
2.246E-01	2.199E+06	2.296E-01	2.038E+06
2.347E-01	1.892E+06	2.397E-01	1.759E+06
2.447E-01	1.638E+06	2.498E-01	1.525E+06
2.548E-01	1.411E+06	2.598E-01	1.308E+06
2.648E-01	1.214E+06	2.698E-01	1.128E+06
2.749E-01	1.050E+06	2.799E-01	9.788E+05
2.849E-01	9.134E+05	1.000E+00	1.000E+00

TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
3.500E+01	1.700E+02	1.926E+03	9.500E-01

POP. AT 0
1.742E+08

WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
5.683E-01	1.060E-01	4.603E+01
5.525E-01	1.500E-01	9.079E+01
5.470E-02	1.800E-01	9.522E+01
4.050E-02	2.500E-01	9.850E+01
1.850E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	2.513E+07	1.081E-01	2.297E+07
1.133E-01	2.099E+07	1.184E-01	1.918E+07
1.235E-01	1.754E+07	1.286E-01	1.607E+07
1.337E-01	1.473E+07	1.388E-01	1.353E+07
1.438E-01	1.245E+07	1.489E-01	1.137E+07
1.540E-01	1.002E+07	1.590E-01	8.878E+06
1.641E-01	7.895E+06	1.692E-01	7.048E+06
1.742E-01	6.315E+06	1.793E-01	5.671E+06
1.843E-01	5.087E+06	1.894E-01	4.577E+06
1.944E-01	4.131E+06	1.994E-01	3.738E+06
2.045E-01	3.391E+06	2.095E-01	3.084E+06
2.145E-01	2.811E+06	2.196E-01	2.569E+06
2.246E-01	2.352E+06	2.296E-01	2.157E+06
2.347E-01	1.983E+06	2.397E-01	1.826E+06
2.447E-01	1.685E+06	2.498E-01	1.557E+06
2.548E-01	1.440E+06	2.598E-01	1.334E+06
2.648E-01	1.237E+06	2.698E-01	1.150E+06
2.749E-01	1.070E+06	2.799E-01	9.966E+05
2.849E-01	9.297E+05	1.000E+00	1.000E+00

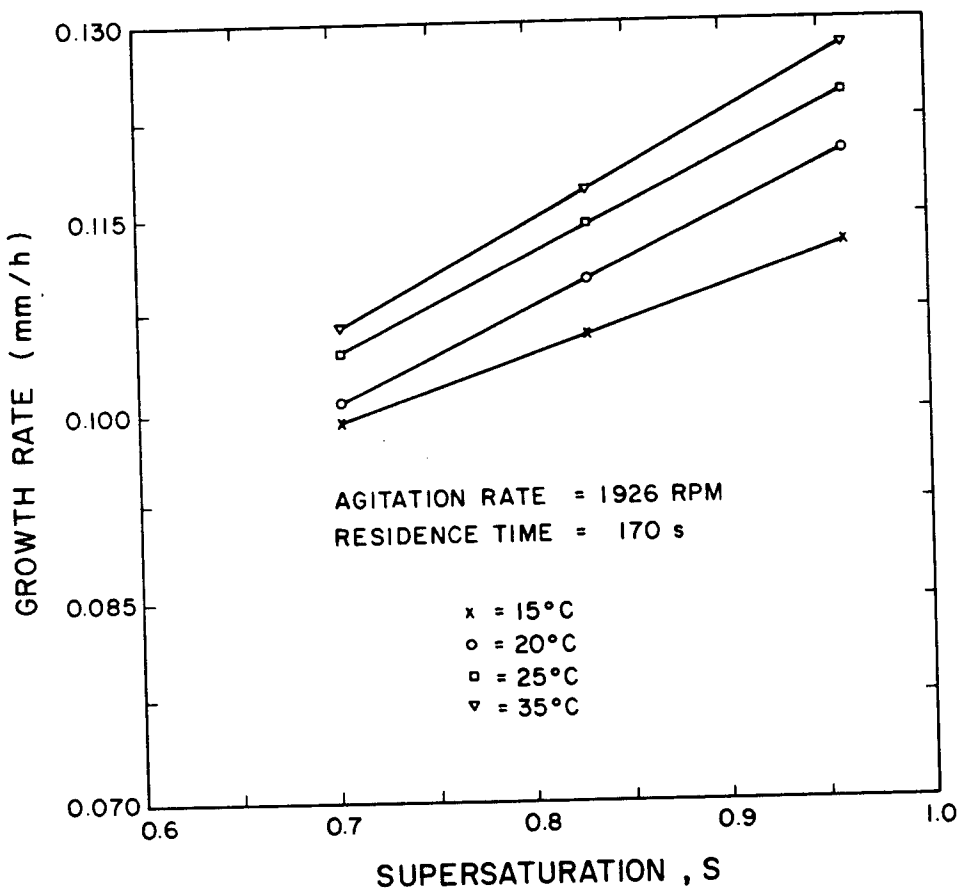
TEMPERATURE	RESIDENCE TIME	AGITATION RATE	SUPERSATURATION
3.500E+01	1.700E+02	1.926E+03	8.230E-01

POP. AT 0
1.865E+08

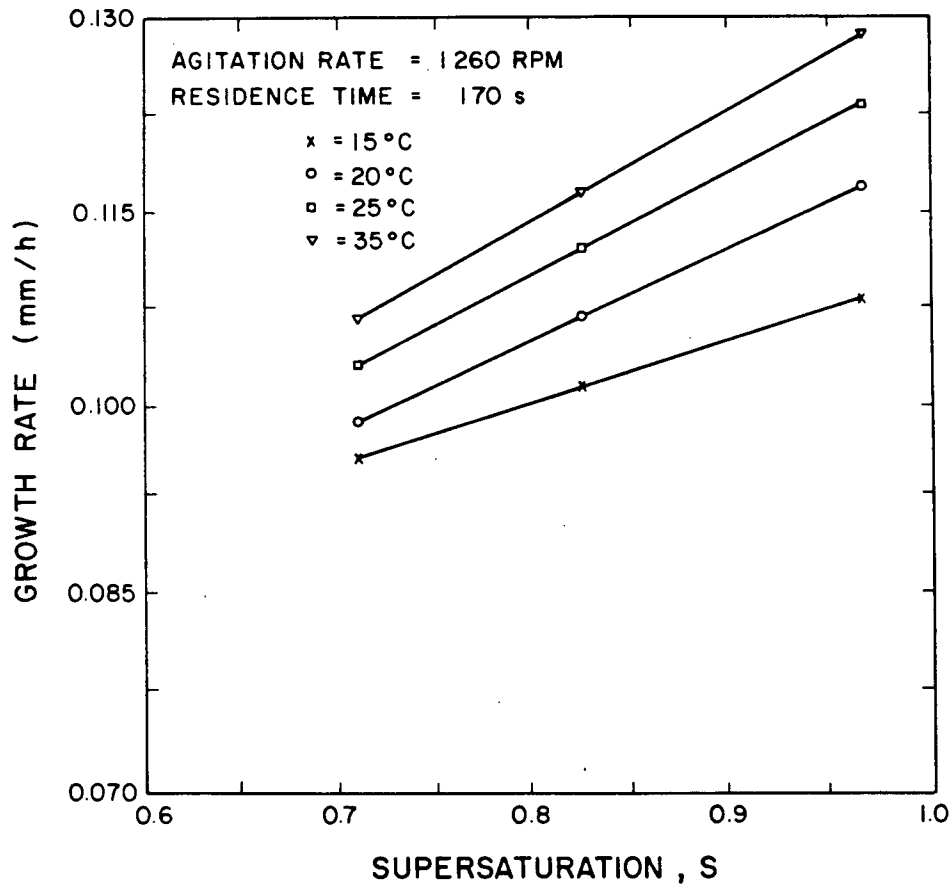
WEIGHT X	SCREEN SIZE AD	% CUMULATIVE WEIGHT
5.445E-01	1.060E-01	5.737E+01
3.136E-01	1.500E-01	9.041E+01
4.620E-02	1.800E-01	9.528E+01
3.100E-02	2.500E-01	9.855E+01
1.380E-02	2.970E-01	1.000E+02

CRYSTAL SIZE	POPULATION DENSITY	CRYSTAL SIZE	POPULATION DENSITY
1.030E-01	2.888E+07	1.081E-01	2.533E+07
1.133E-01	2.234E+07	1.184E-01	1.980E+07
1.235E-01	1.764E+07	1.286E-01	1.578E+07
1.337E-01	1.418E+07	1.388E-01	1.279E+07
1.438E-01	1.157E+07	1.489E-01	1.044E+07
1.540E-01	9.213E+06	1.590E-01	8.167E+06
1.641E-01	7.269E+06	1.692E-01	6.494E+06
1.742E-01	5.823E+06	1.793E-01	5.232E+06
1.843E-01	4.693E+06	1.894E-01	4.223E+06
1.944E-01	3.811E+06	1.994E-01	3.449E+06
2.045E-01	3.129E+06	2.095E-01	2.845E+06
2.145E-01	2.594E+06	2.196E-01	2.370E+06
2.246E-01	2.170E+06	2.296E-01	1.990E+06
2.347E-01	1.830E+06	2.397E-01	1.685E+06
2.447E-01	1.554E+06	2.498E-01	1.436E+06
2.548E-01	1.328E+06	2.598E-01	1.230E+06
2.648E-01	1.141E+06	2.698E-01	1.060E+06
2.749E-01	9.866E+05	2.799E-01	9.191E+05
2.849E-01	8.573E+05	1.000E+00	1.000E+00

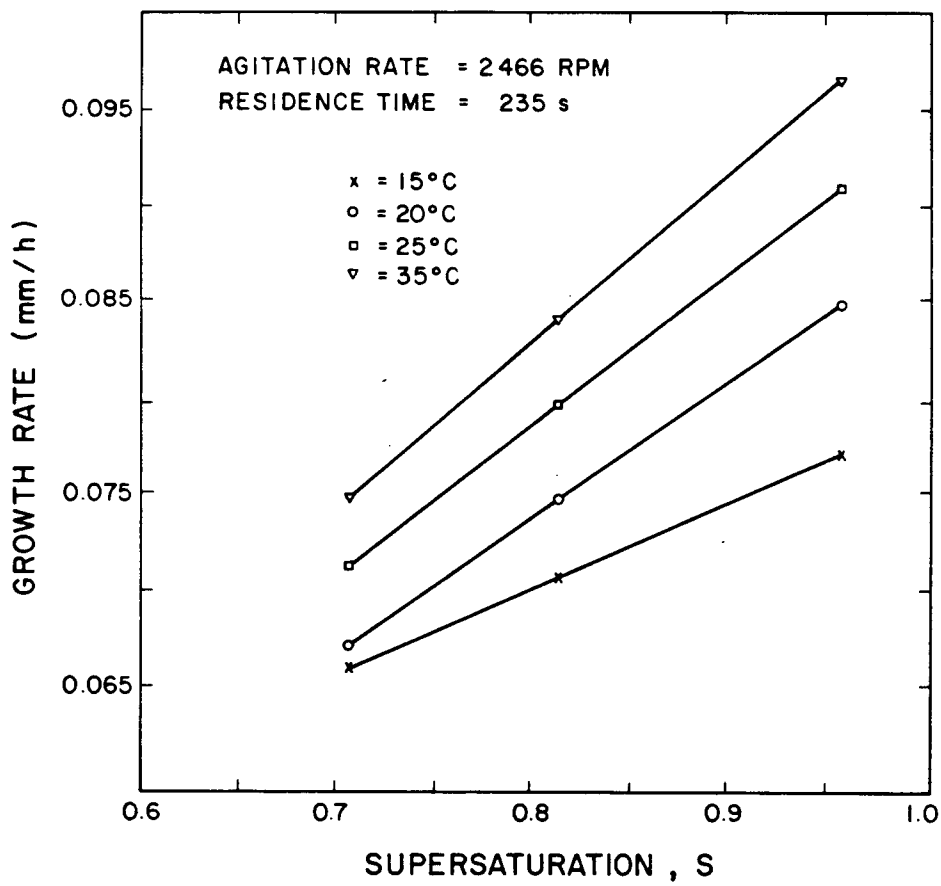
APPENDIX 7



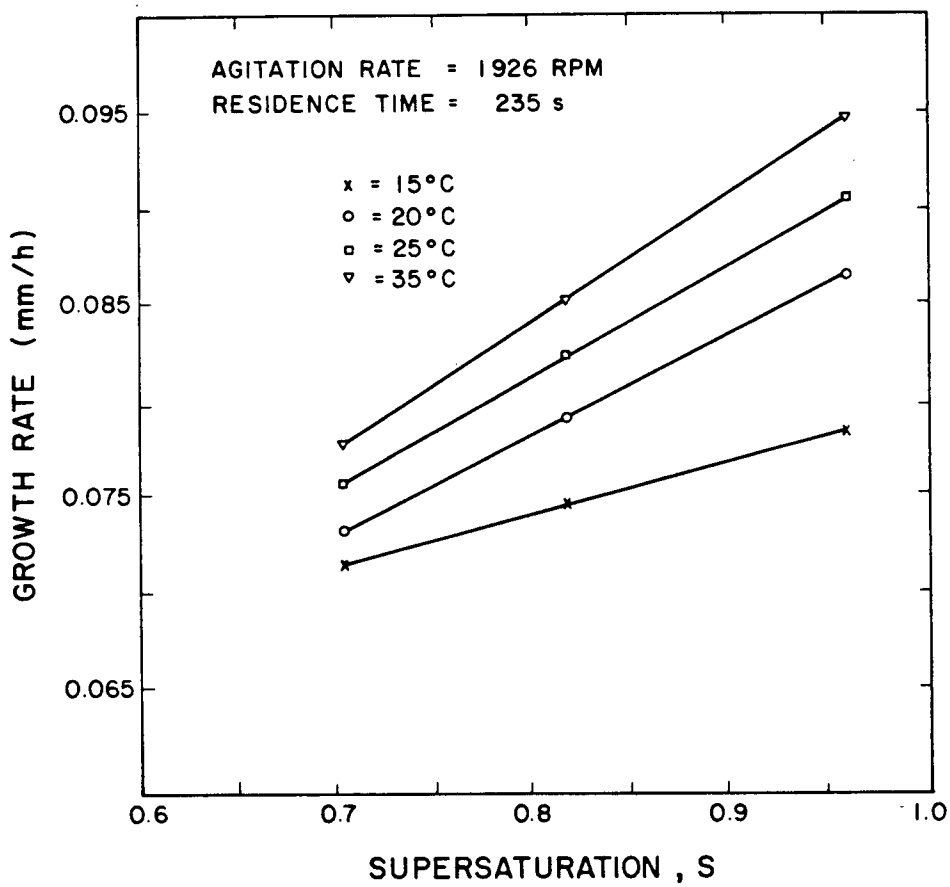
GROWTH RATE VERSUS SUPERSATURATION, TEMPERATURE AS PARAMETER



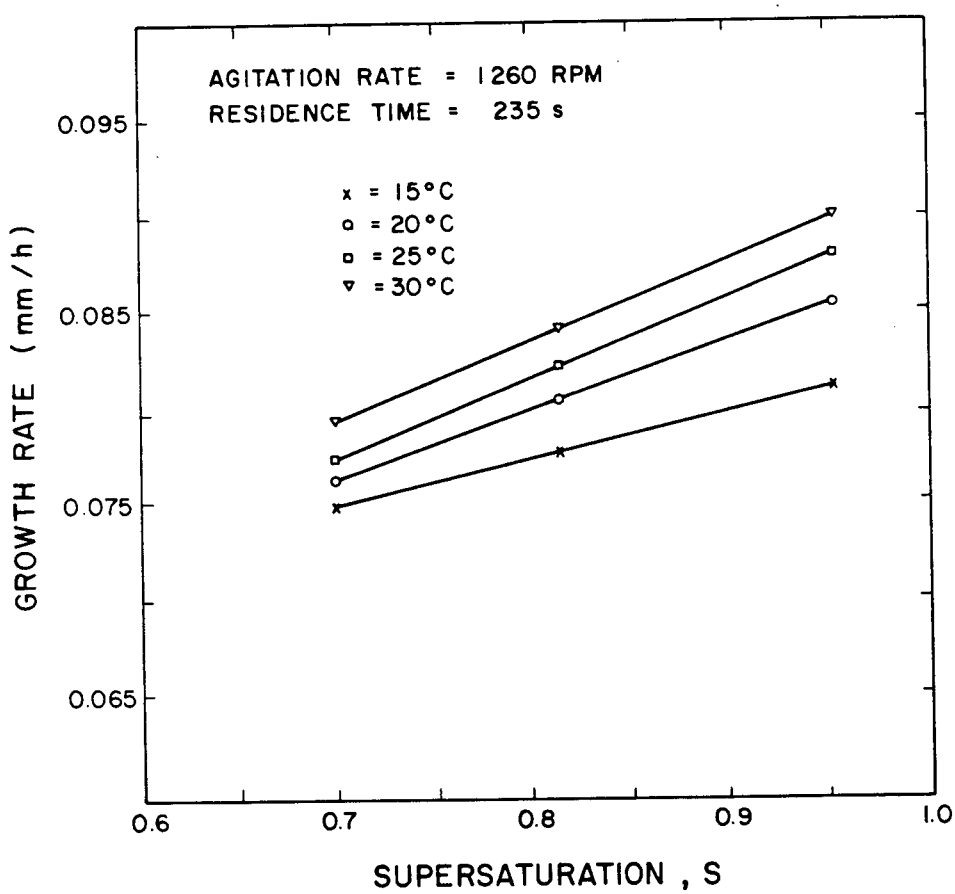
GROWTH RATE VERSUS SUPERSATURATION, TEMPERATURE AS PARAMETER



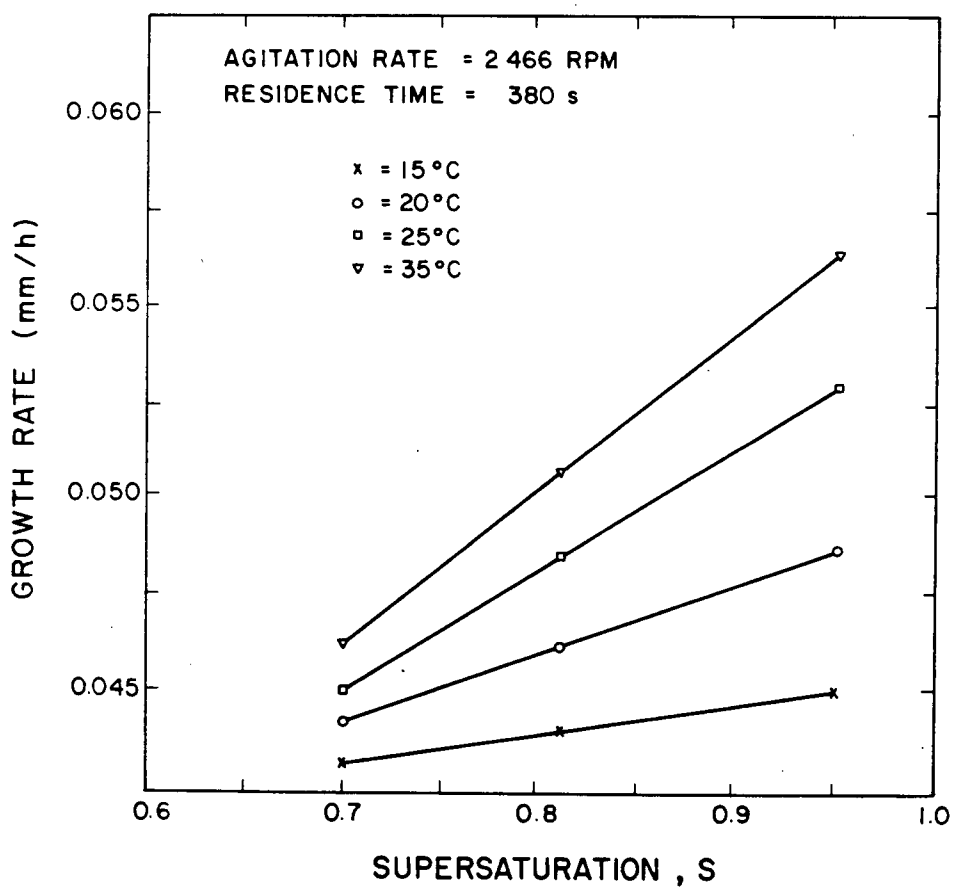
GROWTH RATE VERSUS SUPERSATURATION, TEMPERATURE AS PARAMETER



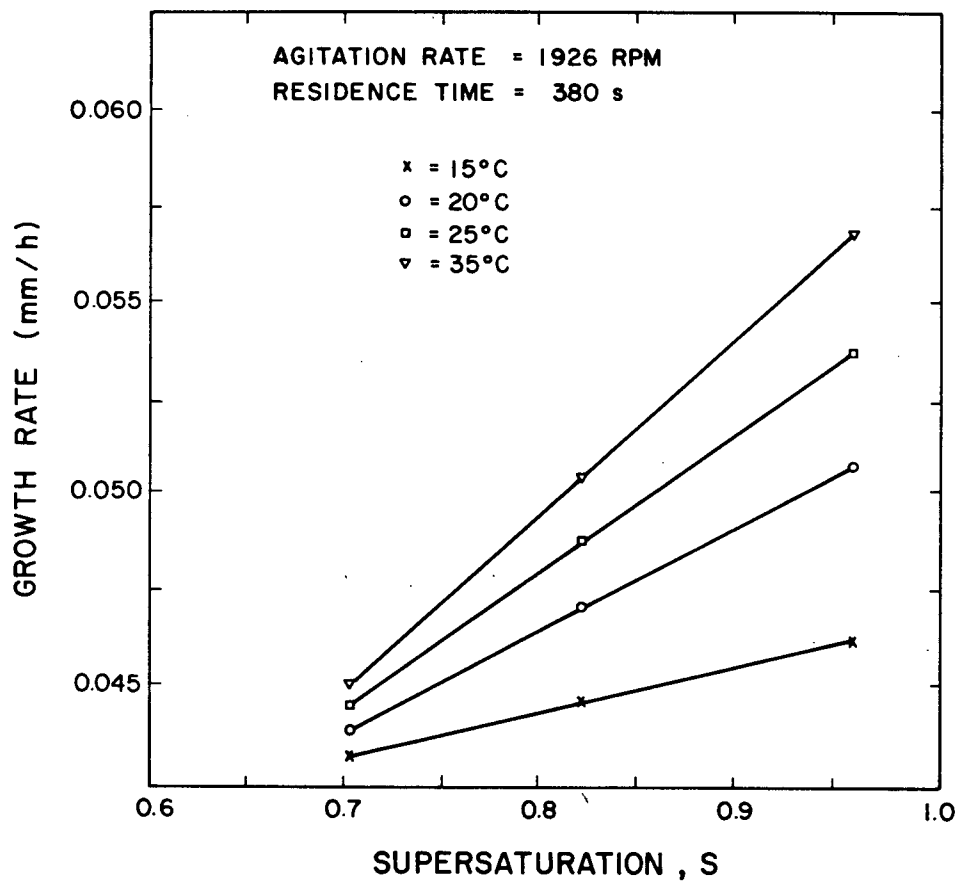
GROWTH RATE VERSUS SUPERSATURATION, TEMPERATURE AS PARAMETER



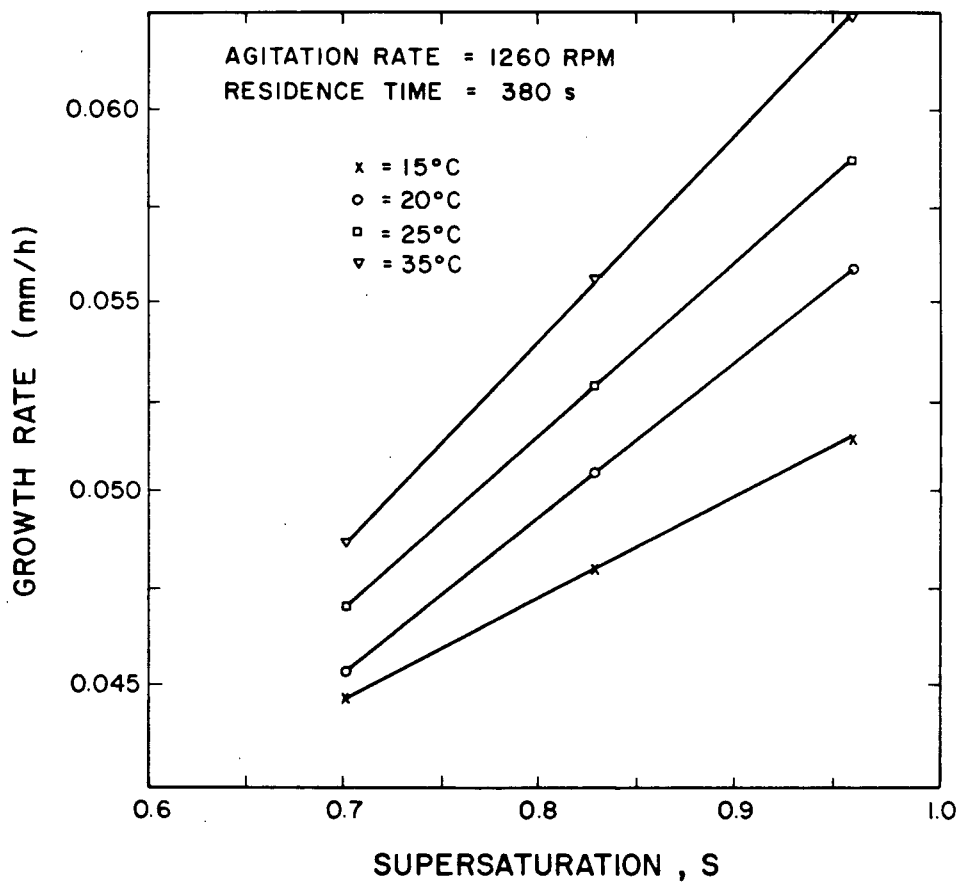
GROWTH RATE VERSUS SUPERSATURATION, TEMPERATURE AS PARAMETER



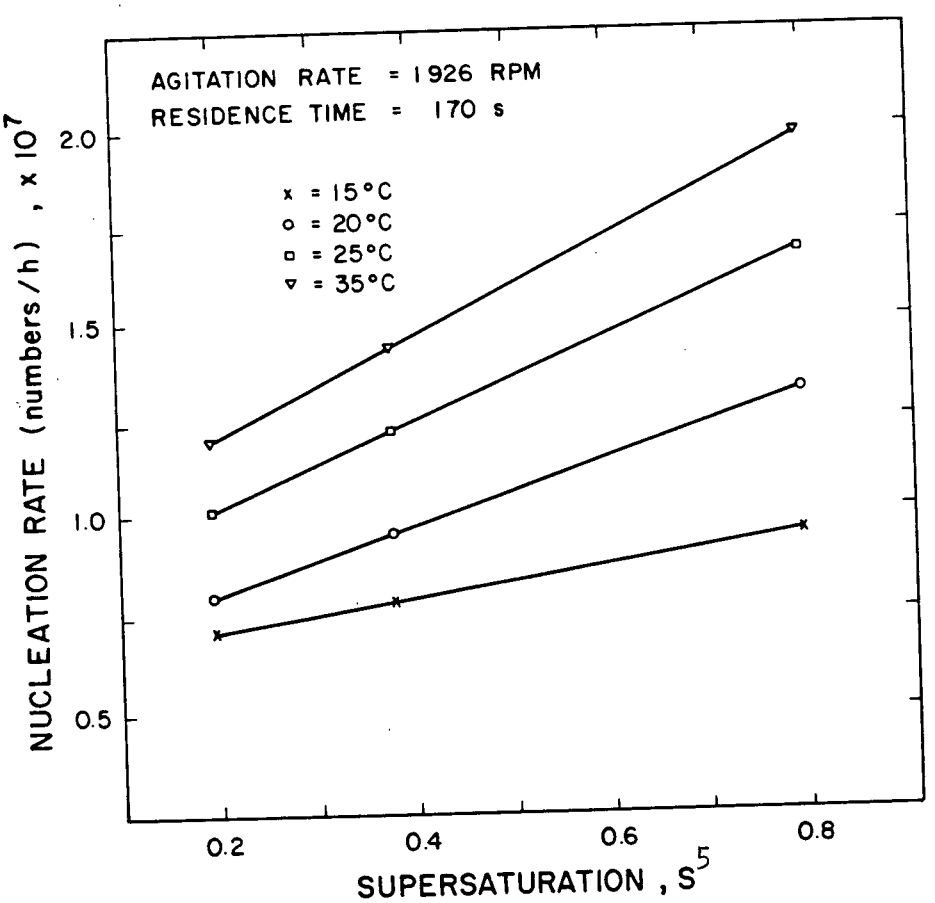
GROWTH RATE VERSUS SUPERSATURATION, TEMPERATURE AS PARAMETER



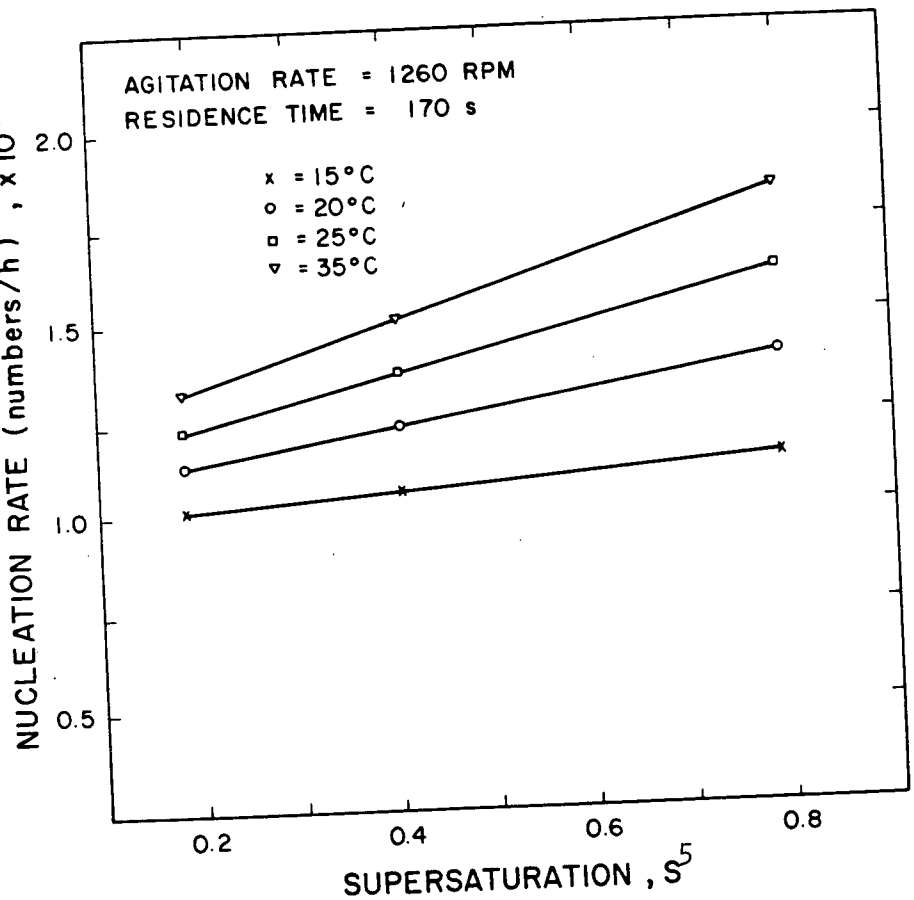
GROWTH RATE VERSUS SUPERSATURATION, TEMPERATURE AS PARAMETER



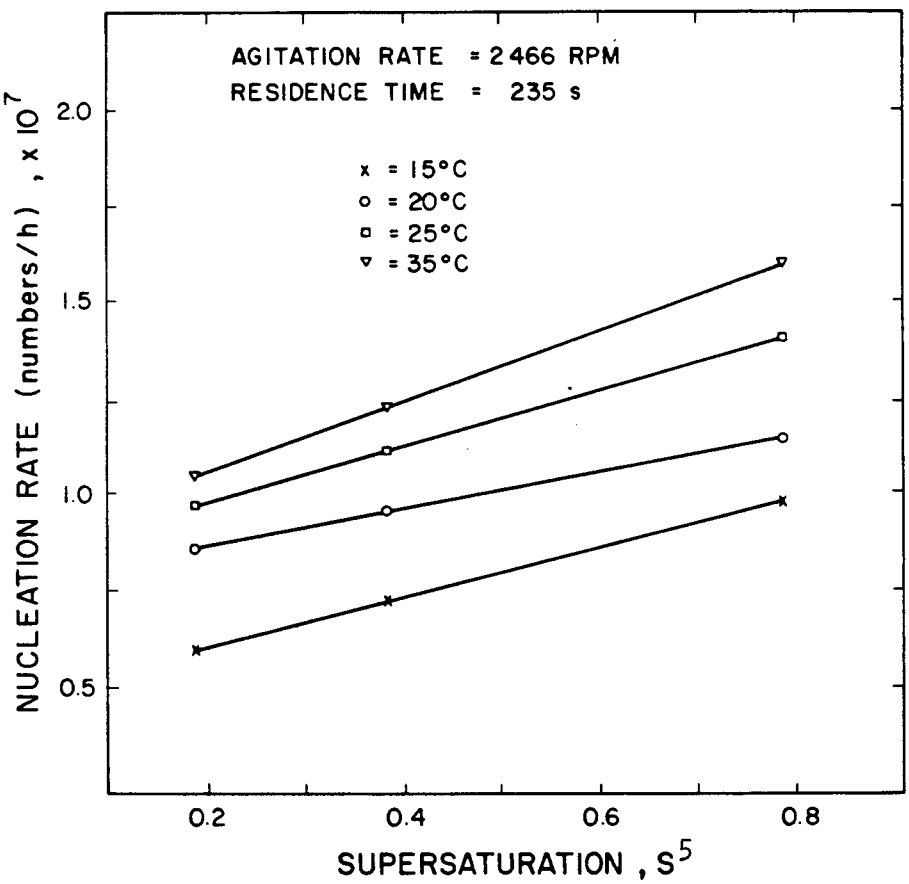
GROWTH RATE VERSUS SUPERSATURATION, TEMPERATURE AS PARAMETER



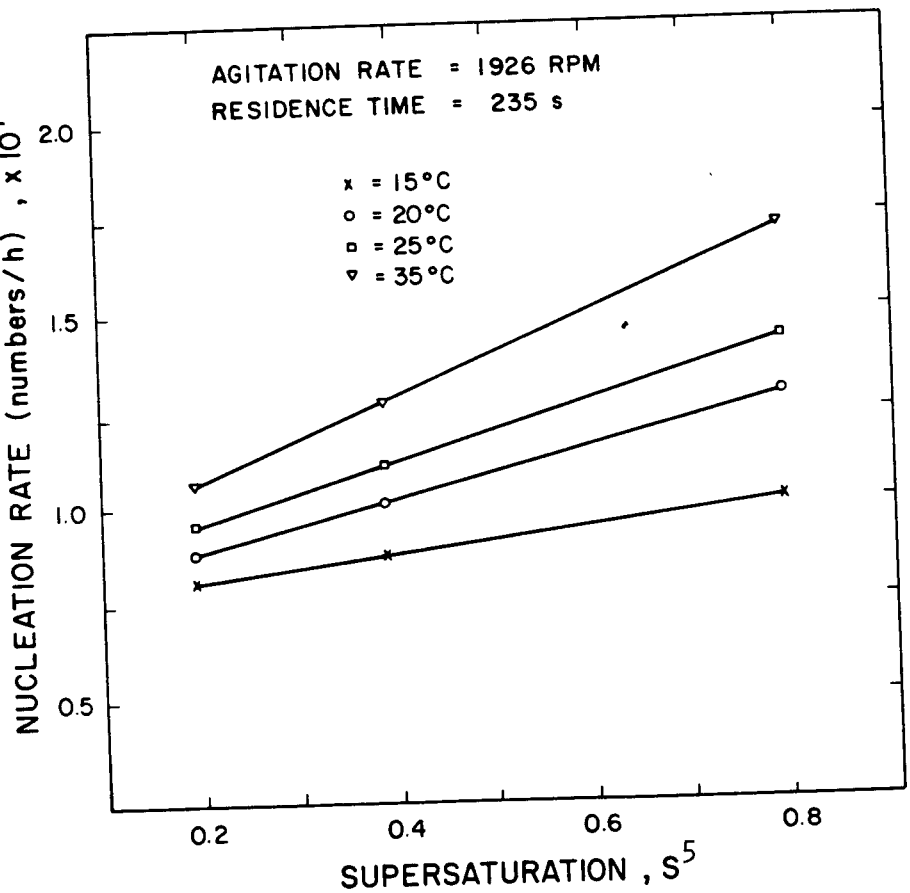
NUCLEATION RATE VS SUPERSATURATION, TEMPERATURE AS PARAMETER



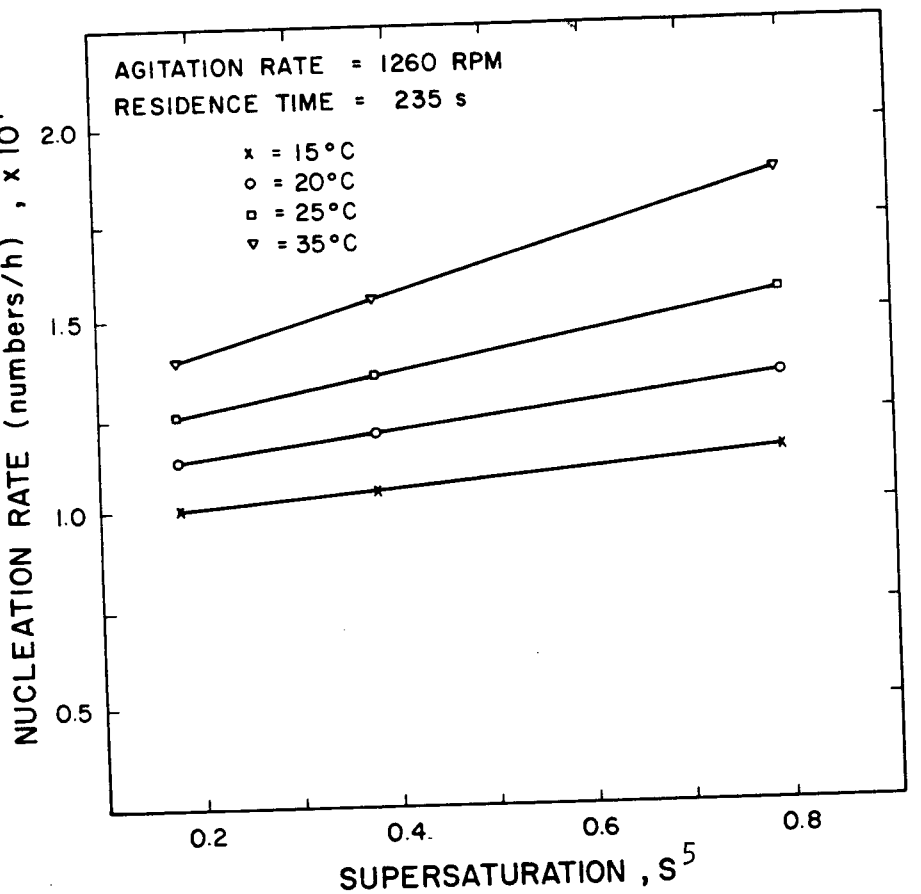
NUCLEATION RATE VS SUPERSATURATION, TEMPERATURE AS PARAMETER



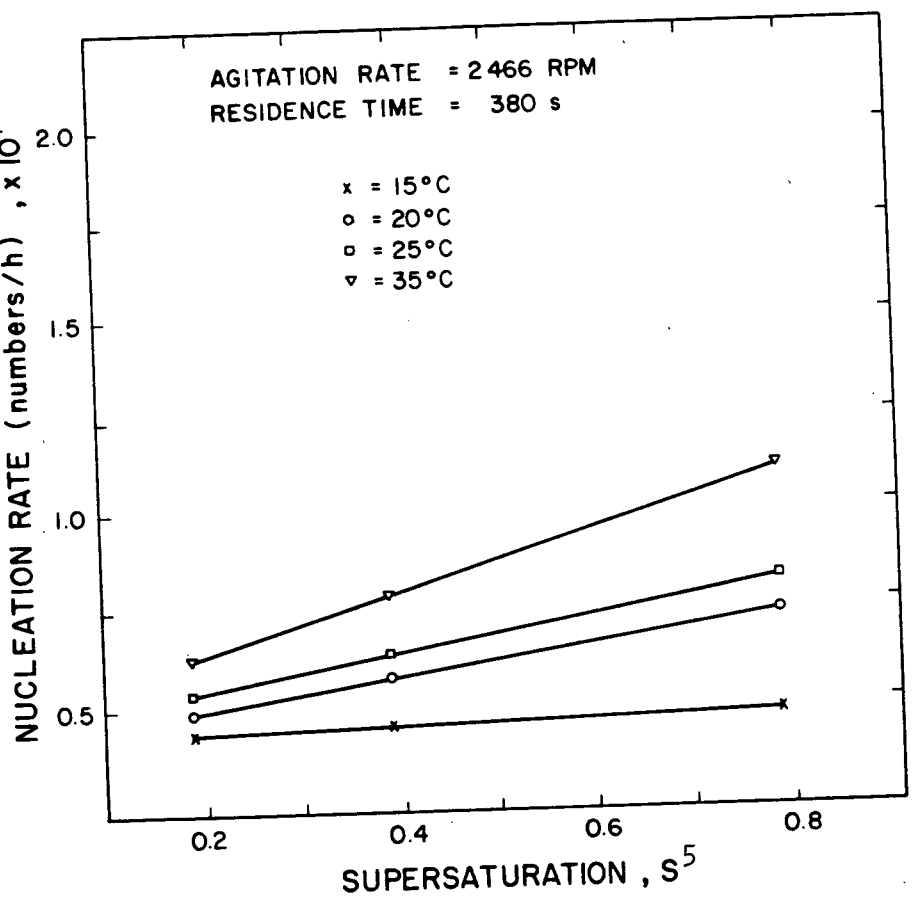
NUCLEATION RATE VS SUPERSATURATION, TEMPERATURE AS PARAMETER



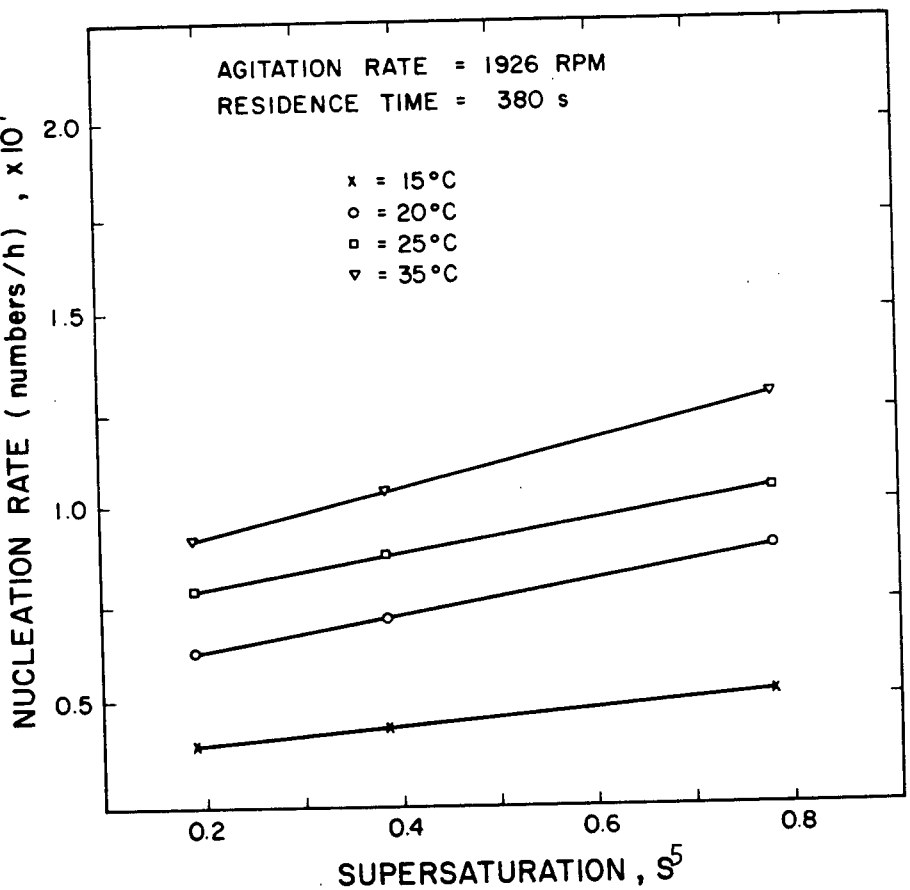
NUCLEATION RATE VS SUPERSATURATION, TEMPERATURE AS PARAMETER



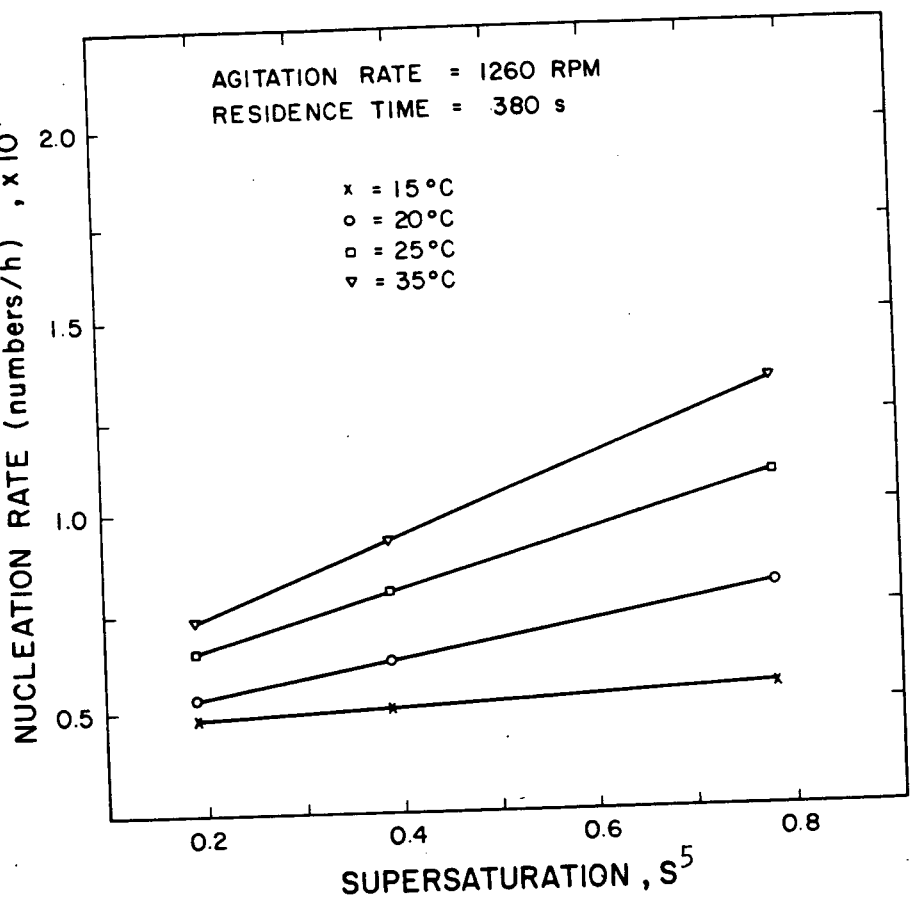
NUCLEATION RATE VS SUPERSATURATION, TEMPERATURE AS PARAMETER



NUCLEATION RATE VS SUPERSATURATION, TEMPERATURE AS PARAMETER



NUCLEATION RATE VS SUPERSATURATION, TEMPERATURE AS PARAMETER



NUCLEATION RATE VS SUPERSATURATION, TEMPERATURE AS PARAMETER

APPENDIX 8

EQUIPMENT LIST

1.	Sartorius balance	CH.E	1518
2.	Lauda-Thermostat (constant temp. bath)	CH.E	2862
3.	Wild Microscope	CH.E	2967
4.	Camera (Pentax 35 mm)	CH.E	2652

APPENDIX 9

```
**Last signon was: 09:40:20
 User "COGB" signed on at  10:32:26 on Thu May 01/80
$LIST  PF
     1              IMPLICIT  REAL*8 (A-H,O-Z)
     2              DIMENSION A(200,5),P(2),PLB(2),PUB(2)
     3              EXTERNAL  AUX
     4              READ (5,10) N,M,NV,NCON
     5      10      FORMAT(5I3)
     6              READ (5,20) ((A(I,J),J=1,NV),I=1,N)
     7      20      FORMAT(5G10.0)
     8              READ (5,20)  (P(I),I=1,M)
     9              IF(NCON.EQ.0) READ(5,20) (PLB(I),I=1,M),(PUB(I),I=1,M)
    10              LOG=10
    11              EPS1=1.D-4
    12              EPS2=1.D-4
    13              IT=500
    14              CALL CLQF(M,N,NV,LOG,A,P,PLB,PUB,EPS1,EPS2,IT,IERR,NCON,AUX
    15              IF (IERR.EQ.0) WRITE(6,40) IT
    16      40      FORMAT('ERROR RETURN',I2)
    17              STOP
    18              END
    19              SUBROUTINE AUX (M,A,P,F,D,IND,L,LS)
    20              IMPLICIT REAL*8 (A-H,O-Z)
```

```
     21              DIMENSION A(200,1),P(1),D(1)
     22              IF (IND.EQ.3) RETURN
     23              Z=DLOG(A(L,5))
     24              FE=DLOG(P(1))+DLOG(A(L,1))+P(2)*DLOG(A(L,3))-14166.67/(1.9
     25              F=FE-Z
     26              IF(IND.EQ.1) RETURN
     27               D(1)=1/P(1)
     28              D(2)=DLOG(A(L,3))
     29              RETURN
     30              END
     31              SUBROUTINE LIMIT (P,DUB,IND,L,C)
     32              IMPLICIT REAL*8 (A-H,O-Z)
     33              DIMENSION P(1),DUB(1)
     34              RETURN
     35              END
End of File


$LIST  POT
      1      108  2  5  0
      2      0.7          2466.0      170.0       15.0        0.081
      3      0.823        2466.0      170.0       15.0        0.088
      4      0.95         2466.0      170.0       15.0        0.095
      5      0.7          1926.0      170.0       15.0        0.0995
      6      0.823        1926.0      170.0       15.0        0.1058
      7      0.95         1926.0      170.0       15.0        0.1132
      8      0.7          1260.0      170.0       15.0        0.0963
      9      0.823        1260.0      170.0       15.0        0.10135
     10      0.95         1260.0      170.0       15.0        0.1057
     11      0.7          2466.0      235.0       15.0        0.066
     12      0.823        2466.0      235.0       15.0        0.07225
     13      0.95         2466.0      235.0       15.0        0.0781
     14      0.7          1926.0      235.0       15.0        0.0727
     15      0.823        1926.0      235.0       15.0        0.0763
     16      0.95         1926.0      235.0       15.0        0.0784
     17      0.7          1260.0      235.0       15.0        0.07425
     18      0.823        1260.0      235.0       15.0        0.0765
     19      0.95         1260.0      235.0       15.0        0.08025
     20      0.7          2466.0      380.0       15.0        0.0414
     21      0.823        2466.0      380.0       15.0        0.0431
     22      0.95         2466.0      380.0       15.0        0.0451
     23      0.7          1926.0      380.0       15.0        0.041
     24      0.823        1926.0      380.0       15.0        0.0435
     25      0.95          1926.0      380.0       15.0        0.0451
     26      0.7          1260.0      380.0       15.0        0.044
     27      0.823        1260.0      380.0       15.0        0.0475
     28      0.95         1260.0      380.0       15.0        0.05125
     29      0.7          2466.0      170.0       20.0        0.0822
     30      0.823        2466.0      170.0       20.0        0.0912
     31      0.95         2466.0      170.0       20.0        0.10
     32      0.7          1926.0      170.0       20.0        0.10075
     33      0.823        1926.0      170.0       20.0        0.1085
     34      0.95         1926.0      170.0       20.0        0.1175
     35      0.7          1260.0      170.0       20.0        0.0981
     36      0.823        1260.0      170.0       20.0        0.10528
     37      0.95         1260.0      170.0       20.0        0.1133
     38      0.7          2466.0      235.0       20.0        0.06735
     39      0.823        2466.0      235.0       20.0        0.0769
     40      0.95         2466.0      235.0       20.0        0.086
```

41	0.7	1926.0	235.0	20.0	0.0742
42	0.823	1926.0	235.0	20.0	0.0784
43	0.95	1926.0	235.0	20.0	0.0842
44	0.7	1260.0	235.0	20.0	0.0755
45	0.823	1260.0	235.0	20.0	0.0791
46	0.95	1260.0	235.0	20.0	0.0841
47	0.7	2466.0	380.0	20.0	0.0433
48	0.823	2466.0	380.0	20.0	0.046
49	0.95	2466.0	380.0	20.0	0.04865
50	0.7	1926.0	380.0	20.0	0.0425
51	0.823	1926.0	380.0	20.0	0.0462
52	0.95	1926.0	380.0	20.0	0.05
53	0.7	1260.0	380.0	20.0	0.04575
54	0.823	1260.0	380.0	20.0	0.0501
55	0.95	1260.0	380.0	20.0	0.05515
56	0.7	2466.0	170.0	25.0	0.0838
57	0.823	2466.0	170.0	25.0	0.095
58	0.95	2466.0	170.0	25.0	0.1066
59	0.7	1926.0	170.0	25.0	0.10325
60	0.823	1926.0	170.0	25.0	0.1115
61	0.95	1926.0	170.0	25.0	0.12075
62	0.7	1260.0	170.0	25.0	0.1015
63	0.823	1260.0	170.0	25.0	0.11048
64	0.95	1260.0	170.0	25.0	0.1206
65	0.7	2466.0	235.0	25.0	0.0727
66	0.823	2466.0	235.0	25.0	0.08135
67	0.95	2466.0	235.0	25.0	0.0915
68	0.7	1926.0	235.0	25.0	0.07525
69	0.823	1926.0	235.0	25.0	0.0827
70	0.95	1926.0	235.0	25.0	0.0887
71	0.7	1260.0	235.0	25.0	0.07725
72	0.823	1260.0	235.0	25.0	0.08195
73	0.95	1260.0	235.0	25.0	0.0869
74	0.7	2466.0	380.0	25.0	0.04475
75	0.823	2466.0	380.0	25.0	0.046
76	0.95	2466.0	380.0	25.0	0.04865
77	0.7	1926.0	380.0	25.0	0.0435
78	0.823	1926.0	380.0	25.0	0.0486
79	0.95	1926.0	380.0	25.0	0.0535
80	0.7	1260.0	380.0	25.0	0.047
81	0.823	1260.0	380.0	25.0	0.053
82	0.95	1260.0	380.0	25.0	0.05865
83	0.7	2466.0	170.0	35.0	0.08835
84	0.823	2466.0	170.0	35.0	0.1005
85	0.95	2466.0	170.0	35.0	0.1134
86	0.7	1926.0	170.0	35.0	0.1045
87	0.823	1926.0	170.0	35.0	0.1145
88	0.95	1926.0	170.0	35.0	0.1255
89	0.7	1260.0	170.0	35.0	0.10306
90	0.823	1260.0	170.0	35.0	0.1142
91	.95	1260.0	170.0	35.0	0.12525
92	0.7	2466.0	235.0	35.0	0.07495
93	0.823	2466.0	235.0	35.0	0.0857
94	0.95	2466.0	235.0	35.0	0.09615
95	0.7	1926.0	235.0	35.0	0.0772
96	0.823	1926.0	235.0	35.0	0.08495
97	0.95	1926.0	235.0	35.0	0.09369
98	0.7	1260.0	235.0	35.0	0.07875
99	0.823	1260.0	235.0	35.0	0.08435
100	0.95	1260.0	235.0	35.0	0.0903

```
   101      0.7          2466.0       380.0        35.0         0.0472
   102      0.823        2466.0       380.0        35.0         0.05175
   103      0.95         2466.0       380.0        35.0         0.0573
   104      0.7          1926.0       380.0        35.0         0.04475
   105      0.823        1926.0       380.0        35.0         0.05075
   106      0.95         1926.0       380.0        35.0         0.057
   107      0.7          1260.0       380.0        35.0         0.04865
   108      0.823        1260.0       380.0        35.0         0.05565
   109      0.95         1260.0       380.0        35.0         0.06245
   110      1.0          1.0          1.0          1.0          1.0
   111      0.00001     -1000.0       -1000.0       -1000.0      -1000.0
   112      1000.0       1000.0       1000.0       1000.0       1000.0
End of File


$R  *FTN  SCARDS=PF  PAR=NOSOURCE
Execution Begins    10:32:39
No errors in MAIN
No errors in AUX
No errors in LIMIT


NAME       NUMBER OF ERRORS/WARNINGS  SEVERITY

MAIN                    0                   0
AUX                     0                   0
LIMIT                   0                   0
Execution Terminated    10:32:42  T=0.285  RC=0       $.07


$R  -LOAD+*NUMLIB  5=POT
 ==> *NUMLIB IS NOW INCORPORATED IN *LIBRARY -- 2 APRIL 1979
    *LIBRARY IS SEARCHED AUTOMATICALLY. ALL REFERENCES TO *NUMLIB
    SHOULD BE DELETED FROM YOUR FILES. IT WILL DISAPPEAR.
Execution Begins    10:32:43

ITERATION     10

FUNCTION     -19421.16        EVALUATION     28
PARAMETERS
     99.97456         0.6602989

FUNCTION     -224.8909        EVALUATION     29
PARAMETERS
     99.97602         3.074756

FUNCTION EVALUATIONS     34    DERIVATIVE EVALUATIONS    13

 PARAMETERS
   100.000          3.07471

 RESIDUALS
    -2.20292        -2.12394        -2.05697        -2.40863        -2.30815
    -2.26469        -2.16370        -1.00258       -0.930487       -0.865531
   -0.869365        -1.11969       -0.988337       -0.892064        0.941460
    0.951168         1.05386         1.16346        0.880551        0.965887
    -1.73720        -1.68581        -1.99817        -1.91089        -1.84708
    -1.81068       -0.599628       -0.571098       -0.539434       -0.697232
```

-0.714601	-0.599305	-0.517093	1.31904	1.42043
1.41609	1.48055	1.26510	1.33505	1.38343
-1.34144	-1.61441	-1.52989	-1.46567	-1.59780
-0.268531	-0.218460	-0.193147	-0.302341	-0.235534
-0.225813	-0.141566	1.69550	1.82871	1.91723
1.82117	1.64533	1.68706	1.73012	-0.681693
-0.850140	-0.779652	-0.727877	-0.835682	-0.777029
0.505622	0.534591	0.448199	0.515001	0.560950
0.596843	2.41787	2.48868	2.52934	2.47229
2.38864	2.41595	2.44408		

SUM OF SQUARES OF RESIDUALS 224.8826

STANDARD DEVIATION 1.456549

##
##

WARNING OUTPUT FIELD WIDTH TOO SMALL. CONDITION OCCURRED DURING A FORMA
SINK. THE WRITE IS SEQUENTIAL AT RECORD NUMBER 30. FOR THIS A
FIELD OF *'S WILL BE WRITTEN.

##
##

ERROR RETURN**
Execution Terminated 10:32:45 T=0.625 RC=0 $.20

$SIG

```
**Last signon was: 16:51:50   Mon Apr 28/80
 User "COGB" signed on at  09:40:20 on Thu May 01/80
$LIST  PF
     1              IMPLICIT  REAL*8 (A-H,O-Z)
     2              DIMENSION A(200,5),P(2),PLB(2),PUB(2)
     3              EXTERNAL  AUX
     4              READ (5,10) N,M,NV,NCON
     5        10    FORMAT(5I3)
     6              READ (5,20) ((A(I,J),J=1,NV),I=1,N)
     7        20    FORMAT(5G10.0)
     8              READ (5,20)  (P(I),I=1,M)
     9              IF(NCON.EQ.0) READ(5,20) (PLB(I),I=1,M),(PUB(I),I=1,M)
    10              LOG=10
    11              EPS1=1.D-4
    12              EPS2=1.D-4
    13              IT=500
    14              CALL CLQP(M,N,NV,LOG,A,P,PLB,PUB,EPS1,EPS2,IT,IERR,NCON,AU
    15              IF (IERR.EQ.0) WRITE(6,40) IT
    16        40    FORMAT('ERROR RETURN',I2)
    17              STOP
    18              END
    19              SUBROUTINE AUX (M,A,P,F,D,IND,L,LS)
    20              IMPLICIT REAL*8 (A-H,O-Z)
```

```
     DIMENSION A(200,1),P(1),D(1)
     IF (IND.EQ.3) RETURN
     Z=DLOG(A(L,5))
     FE=DLOG(P(1))+5*DLOG(A(L,1))+P(2)*DLOG(A(L,3))-13811.11/(1.
     F=FE-Z
     IF(IND.EQ.1) RETURN
      D(1)=1/P(1)
     D(2)=DLOG(A(L,3))
     RETURN
     END
     SUBROUTINE LIMIT (P,DUB,IND,L,C)
     IMPLICIT REAL*8 (A-H,O-Z)
     DIMENSION P(1),DUB(1)
     RETURN
     END
End of File
```

```
$LIST  POT
     1      108  2  5  0
     2      0.7          2466.0      170.0       15.0        0.7075E7
     3      0.823        2466.0      170.0       15.0        0.82E7
     4      0.95         2466.0      170.0       15.0        0.9825E7
     5      0.7          1926.0      170.0       15.0        1.1E7
     6      0.823        1926.0      170.0       15.0        1.2375E7
     7      0.95         1926.0      170.0       15.0        1.44375E7
     8      0.7          1260.0      170.0       15.0        1.0125E7
     9      0.823        1260.0      170.0       15.0        1.1E7
    10      0.95         1260.0      170.0       15.0        1.23125E7
    11      0.7          2466.0      235.0       15.0        0.66875E7
    12      0.823        2466.0      235.0       15.0        0.8E7
    13      0.95         2466.0      235.0       15.0        1.0375E7
    14      0.7          1926.0      235.0       15.0        0.830625E7
    15      0.823        1926.0      235.0       15.0        0.9125E7
    16      0.95         1926.0      235.0       15.0        1.0625E7
    17      0.7          1260.0      235.0       15.0        1.0E7
    18      0.823        1260.0      235.0       15.0        1.07E7
    19      0.95         1260.0      235.0       15.0        1.21875E7
    20      0.7          2466.0      380.0       15.0        0.45E7
    21      0.823        2466.0      380.0       15.0        0.5075E7
    22      0.95         2466.0      380.0       15.0        0.575E7
    23      0.7          1926.0      380.0       15.0        0.3375E7
    24      0.823        1926.0      380.0       15.0        0.3875E7
    25      0.95          1926.0      380.0       15.0         0.43125E7
    26      0.7          1260.0      380.0       15.0        0.48125E7
    27      0.823        1260.0      380.0       15.0        0.5175E7
    28      0.95         1260.0      380.0       15.0        0.6875E7
    29      0.7          2466.0      170.0       20.0        0.88E7
    30      0.823        2466.0      170.0       20.0        0.9725E7
    31      0.95         2466.0      170.0       20.0        1.3E7
    32      0.7          1926.0      170.0       20.0        1.20375E7
    33      0.823        1926.0      170.0       20.0        1.3725E7
    34      0.95         1926.0      170.0       20.0        1.675E7
    35      0.7          1260.0      170.0       20.0        1.09375E7
    36      0.823        1260.0      170.0       20.0        1.245E7
    37      0.95         1260.0      170.0       20.0        1.43125E7
    38      0.7          2466.0      235.0       20.0        0.875E7
    39      0.823        2466.0      235.0       20.0        1.0E7
    40      0.95         2466.0      235.0       20.0        1.18125E7
```

41	0.7	1926.0	235.0	20.0	0.875E7
42	0.823	1926.0	235.0	20.0	1.01875E7
43	0.95	1926.0	235.0	20.0	1.19375E7
44	0.7	1260.0	235.0	20.0	1.14125E7
45	0.823	1260.0	235.0	20.0	1.2325E7
46	0.95	1260.0	235.0	20.0	1.4375E7
47	0.7	2466.0	380.0	20.0	0.5E7
48	0.823	2466.0	380.0	20.0	0.6E7
49	0.95	2466.0	380.0	20.0	0.75625E7
50	0.7	1926.0	380.0	20.0	0.6875E7
51	0.823	1926.0	380.0	20.0	0.8E7
52	0.95	1926.0	380.0	20.0	0.96625E7
53	0.7	1260.0	380.0	20.0	0.505625E7
54	0.823	1260.0	380.0	20.0	0.6375E7
55	0.95	1260.0	380.0	20.0	0.875E7
56	0.7	2466.0	170.0	25.0	1.08E7
57	0.823	2466.0	170.0	25.0	1.3E7
58	0.95	2466.0	170.0	25.0	1.675E7
59	0.7	1926.0	170.0	25.0	1.3125E7
60	0.823	1926.0	170.0	25.0	1.5075E7
61	0.95	1926.0	170.0	25.0	1.975E7
62	0.7	1260.0	170.0	25.0	1.2E7
63	0.823	1260.0	170.0	25.0	1.3875E7
64	0.95	1260.0	170.0	25.0	1.65E7
65	0.7	2466.0	235.0	25.0	0.98375E7
66	0.823	2466.0	235.0	25.0	1.15625E7
67	0.95	2466.0	235.0	25.0	1.41875E7
68	0.7	1926.0	235.0	25.0	0.95625E7
69	0.823	1926.0	235.0	25.0	1.125E7
70	0.95	1926.0	235.0	25.0	1.4E7
71	0.7	1260.0	235.0	25.0	1.2625E7
72	0.823	1260.0	235.0	25.0	1.41875E7
73	0.95	1260.0	235.0	25.0	1.65375E7
74	0.7	2466.0	380.0	25.0	0.5375E7
75	0.823	2466.0	380.0	25.0	0.69375E7
76	0.95	2466.0	380.0	25.0	0.89375E7
77	0.7	1926.0	380.0	25.0	0.8E7
78	0.823	1926.0	380.0	25.0	0.9275E7
79	0.95	1926.0	380.0	25.0	1.125E7
80	0.7	1260.0	380.0	25.0	0.645E7
81	0.823	1260.0	380.0	25.0	0.8125E7
82	0.95	1260.0	380.0	25.0	1.08125E7
83	0.7	2466.0	170.0	35.0	1.2125E7
84	0.823	2466.0	170.0	35.0	1.4975E7
85	0.95	2466.0	170.0	35.0	1.9875E7
86	0.7	1926.0	170.0	35.0	1.42875E7
87	0.823	1926.0	170.0	35.0	1.7225E7
88	0.95	1926.0	170.0	35.0	2.28E7
89	0.7	1260.0	170.0	35.0	1.3125E7
90	0.823	1260.0	170.0	35.0	1.505E7
91	.95	1260.0	170.0	35.0	1.925E7
92	0.7	2466.0	235.0	35.0	1.0825E7
93	0.823	2466.0	235.0	35.0	1.3125E7
94	0.95	2466.0	235.0	35.0	1.6375E7
95	0.7	1926.0	235.0	35.0	1.0375E7
96	0.823	1926.0	235.0	35.0	1.2925E7
97	0.95	1926.0	235.0	35.0	1.6875E7
98	0.7	1260.0	235.0	35.0	1.425E7
99	0.823	1260.0	235.0	35.0	1.575E7
100	0.95	1260.0	235.0	35.0	1.86625E7

```
 101      0.7          2466.0          380.0          35.0          0.61225E7
 102      0.823        2466.0          380.0          35.0          0.79E7
 103      0.95         2466.0          380.0          35.0          1.1E7
 104      0.7          1926.0          380.0          35.0          0.90625E7
 105      0.823        1926.0          380.0          35.0          1.0625E7
 106      0.95         1926.0          380.0          35.0          1.3125E7
 107      0.7          1260.0          380.0          35.0          0.7375E7
 108      0.823        1260.0          380.0          35.0          0.9425E7
 109      0.95         1260.0          380.0          35.0          1.2825E7
 110      1.0          1.0             1.0            1.0           1.0
 111      0.00001      -1000.0         -1000.0        -1000.0       -1000.0
 112      1000.0       1000.0          1000.0         1000.0        1000.0
End of File


$R  *FTN  SCARDS=PF  PAR=NOSOURCE
Execution Begins   09:40:25
No errors in MAIN
No errors in AUX
No errors in LIMIT


NAME       NUMBER OF ERRORS/WARNINGS  SEVERITY

MAIN                    0                 0
AUX                     0                 0
LIMIT                   0                 0
Execution Terminated   09:40:27  T=0.253  RC=0      $.06


$R  -LOAD+*NUMLIB  5=POT
 ==> *NUMLIB IS NOW INCORPORATED IN *LIBRARY -- 2 APRIL 1979
   *LIBRARY IS SEARCHED AUTOMATICALLY. ALL REFERENCES TO *NUMLIB
   SHOULD BE DELETED FROM YOUR FILES. IT WILL DISAPPEAR.
Execution Begins   09:40:29

ITERATION     10

FUNCTION     -315637.2        EVALUATION     28
PARAMETERS
    99.99357          7.238774

FUNCTION     -315258.2        EVALUATION     29
PARAMETERS
    99.99088          7.578023

FUNCTION EVALUATIONS     32   DERIVATIVE EVALUATIONS    12

PARAMETERS
   100.000          7.57801

RESIDUALS
     17.9524        2.49614        19.1510       -143.670        18.2027
    -142.860        18.9253        20.4625       -140.088        21.5502
     21.5264       -141.121        4.68369        21.3892        8.38236
     24.7881        25.4594        26.0705        24.4334        25.1701
     18.8555       -141.898        17.8329        18.5110        19.0294
     19.1867        20.6055       -139.900        21.8323        20.6055
```

20.3398	21.0723	21.6359	-136.374	-135.747
-136.035	25.6751	24.7958	25.3734	25.7742
19.4274	18.1444	18.8152	19.2626	-142.947
20.8864	21.5342	22.0471	20.9147	21.5615
21.3296	21.8938	25.1327	25.6869	26.1511
25.9210	24.9503	25.5289	25.9607	18.9809
18.8168	19.4392	3.75822	18.9016	19.5742
22.1647	22.6610	21.5904	22.1800	22.6309
22.5302	25.7598	10.1961	-134.480	25.3676
25.5736	26.1377	26.5472		

SUM OF SQUARES OF RESIDUALS 315258.2

STANDARD DEVIATION 54.53562

##
##

WARNING OUTPUT FIELD WIDTH TOO SMALL. CONDITION OCCURRED DURING A FORMAT
SINK. THE WRITE IS SEQUENTIAL AT RECORD NUMBER 30. FOR THIS AN
FIELD OF *'S WILL BE WRITTEN.

##
##

ERROR RETURN**
Execution Terminated 09:40:31 T=0.613 RC=0 $.20

$SIG