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# NEW ASPECTS OF HYDRATE CONTROL AT NORTHERN GAS AND GAS CONDENSATE FIELDS OF NOVATEK

**Rauf Yunusov, Vladimir Istomin*, Dmitry Gritsishin, Stanislav Shevkunov**
**NOVATEK JSC**
**8, 2-nd Brestskaya str., Moscow, 125047**
**RUSSIA**

**ABSTRACT**

A thermodynamic inhibitor - methanol is used for hydrates control both at gas-gathering pipelines and gas conditioning / treatment field plants of Novatek JSC. Due to severe climate conditions and absence of serious infrastructure high operation costs for hydrate control take place. For reducing inhibitor losses some new technological solutions were proposed including recycling and regeneration of saturated methanol. A small module for producing methanol at field conditions was designed. Technological schemes for methanol injection and recirculation are discussed. These technologies reduce methanol losses.

Small methanol-producing plant at Yurkharovskoe gas-condensate field (12.5 million ton methanol per year) integrated with field gas treatment plant is presented. The technology includes producing converted gas (syngas) from natural gas, catalytic process for raw methanol synthesis and rectification of raw methanol at final stage. Some particularities of the integrated technology are as follows. Not needs for preliminary purification of required raw materials (natural gas and water). Dried natural gas after conditioning (without any traces of sulfuric compounds) and pure water from simplified water treatment block are used. Rectification of raw methanol is combined with rectification of saturated methanol from gas treatment plant. Economic estimations show that the integrated methanol-producing technology and optimization of methanol circulation in technological processes essentially reduce capital and operational costs for hydrate control at northern gas and gas-condensate fields.

*Keywords*: natural gas, gas hydrates, methanol, low-temperature separation

## INTRODUCTION

Novatek JSC is Russia's largest independent natural gas producer and the second-largest producer of natural gas in Russia after Gazprom. In terms of proved natural gas reserves, we are the fourth largest holder of natural gas resources in Russia after Gazprom, Rosneft and LUKOIL. Company NOVATEK is engaged in the exploration, production and processing of natural gas and liquid hydrocarbons and it's proved reserves include more than 650 bcm of natural gas. The Company's upstream activities are concentrated in the Yamal-Nenets Region of Russia. Now a three core gas-condensate fields - Yurkharovskoye, East Tarkosalinskoye and Khancheyskoye are under development. At present approximately 30 mmcm of natural gas and 2.5 mmt of liquid hydrocarbons per year are produced at these three fields. Also two new fields (Sterkhovoye and Termokarstovoye) are both in the early stages of development.

All of these fields are multilayer gas and gas-condensate productive horizons, so low temperature separation method is applied for gas and gas-condensate treatment at daily surface. Methanol is used for hydrate control both at gas gathering systems and at low-temperature conditioning units.

* Corresponding author: Phone: +7 495 730 6000 add. 15180 E-mail: istomin@novatek.ru

The most interesting field is Yurkharovskoye gas-condensate field. The Yurkharovskoye field, discovered in 1970, is a natural gas and gas condensate field situated inside the Arctic Circle, in the south-eastern part of the Tazov Peninsula.
This field lies 50 km east of Gazprom's Yamburgskoye field and approximately 300 km north of Gazprom's Urengoiskoye field. The western part of the field lies on the Tazov Peninsula, while the central and eastern parts of the field are situated on the shelf of Tazov Bay where water depths average four meters. Development drilling at the field commenced in May 2002. The field is being developed from an onshore location, through a combination of directional and horizontal wells. Natural gas is transported via our own pipeline to an injection point into a Unified Gas Supply System feeder pipeline, whereas unstable gas-condensate is transported by two of our own pipelines to Gazprom's gas condensate pipeline network.

Currently Yurharovskoe field production from Valanzhin and Cenomanian deposits amounting to 9.5 billion $m^3$ of gas per year, and in the nearest future the production may be increased up to 40 billion $m^3$ per year.

Thus, main features of Yurharovskoe gas-condensate field are as follows:

- Location large part of the pool is under Tazov bay, so this field is considered partly as offshore field.
- A serious environmental requirements for the deposit's territory due to a very high sensitivity of Acrtic nature to industrial influence. Also it should be pointed out that Tazov bay is a fish spawning area.
- Applications of highly produced onshore wells with large deviations from the vertical and with horizontal endings.
- Multilayer horizons with highly different productivities and condensate characteristics, hence the need to find appropriate solutions for the preparation of a joint recovery of different productive horizons.
- The development is realized mainly from Valanzhin deposits in comparison to the another West Siberia fields (like Urengoyskoe or Yamburgskoe), where main productive horizon is Cenomanian.

Yurharovskoe field is used by NOVATEK JSC as a place for testing of some innovation technologies which may be applied in future on another northern gas condensate fields. In general such technologies are: ultrasonic gas dynamic separation for application on small condensate fields, new turbo-expansion technique for gas treatment at large gas-condensate fields, small methanol plans for producing concentrated methanol on-site, improved approach for hydrate control at gas gathering systems and at low temperature units by using different thermodynamic inhibitors, etc.
The main paper's purpose is to discuss how to reduce exploration costs for hydrate control by producing methanol on-site from natural gas on Yurharovskoe field.

## CURRENT TECHNOLOGY FOR GAS TREATMENT ON YURKHAROVSKOE GAS AND GAS CONDENSATE FIELD

Commercial gas treatment at first stage of the Yurkharov project is realized at a single gas conditioning unit (named in Russian: "Unit for Complex Preparing of Gas", UCPG 1).
On this gas conditioning unit Valangin gas is treated by two-stage low-temperature separation at three technological lines. According to the project, separation temperature is minus 30 $^oC$ and separation pressure is ~7.5 MPa at an initial stage of the field development. The technology includes (Fig. 1) two-stage separation with inlet separator (2), low-temperature separator (6) and gas-gas heat exchanger (8), gas-condensate heat exchanger (4) for cold recuperation. Isoenthalpy expansion of the raw gas stream carried out on the ejector (5) and it gives possibility to utilize low-pressure gases from the buffer capacity (10).
Methanol with a concentration of 95-98 mass% is applied as hydrate formation inhibitor. For reducing methanol losses a technology of its spent solution recirculation has been introduced. Saturated water-methanol solution (70-75 mass%) from the low-temperature separator is used as inhibitor for inlet separator and for a heat exchanger (8). Water phase from the three phase divider-separator (9), containing low concentration of methanol, utilized by combustion method.
Cenomanian gas conditioning process is also realized on UCPG 1 currently on the method of low-temperature separation (Fig. 1), including inlet separator (12), throttle (13) and with the mixture of both Cenomanian and Valagin streams before the low-temperature separator (6).

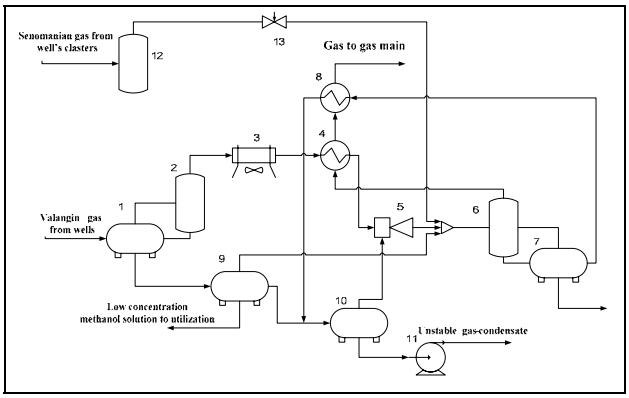


Figure 1 - The basic technological scheme of senomanian and valangin gases treatment on Yurkharovskoe field (the first stage of the project)
1, 2, 12 – inlet separators; 3 – air cooling unit; 4 – "gas-gas" heat-exchanger; 5 – ejector; 6 – low-temperature separator; 7, 9 – three phase dividers (separators); 8 – "gas-condensate" heat-exchanger; 10 – buffer capacity; 11 – pumps of external transport; 13 – throttle.

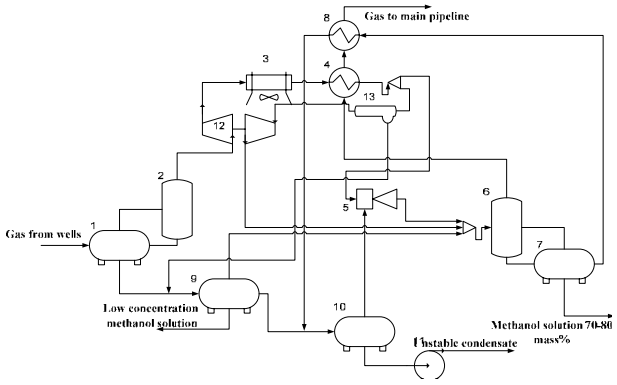


Figure 2 – Enhanced technological scheme of valangin gases treatment with turbo-expander-compressor block on Yurkharovskoe field (the second stage of the project)
1, 2 – inlet separators; 3 – air cooling unit; 4 – heat exchanger "gas-gas"; 5 – ejector; 6 – low temperature separator; 7 – low temperature three phase divider; 8 – heat exchanger "gas-condensate"; 9 – inlet three phase divider; 10 – buffer capacity; 11 - pumps of external transport; 12 – turbo-expander-compressor; 13 – in-tube separator.

## ENHANCED TECHNOLOGY OF GAS CONDITIONIBG ON YURKHAROVSKOE GAS-CONDENSATE FIELD

At present the second stage of the Yurkharov project is under realizing. At this stage of the field development we need to improve the technological scheme in two aspects:

- providing outlet gas temperature at the level of zero degrees centigrade (due to Gazprom's requirements on gas temperature in main pipelines for a permafrost Arctic zone);
- prolonging the period of conditioning unit's exploitation without buster station at the head of technological process.

Analyzing the problem we had considered some suggested approaches for gas cooling systems, but all of these solutions are not effective from the capital costs. As a result a new technological scheme was proposed by using turbo-expander-compressor block (Fig. 2). This scheme will be used both for reconstructions of first stage conditioning unit and for designing the new second stage of the project.
The advantages of proposed technology are:

- the required negative temperatures (minus 2 – 0 $^{o}$C) of gas and condensate to pipelines;
- increasing of output $C_{3+}$ ;
- prolonging the recovery time without compressor station;
- low capital and exploration costs.

At the second stage of the project methanol injection technology on Yurkharovskoe gas-condensate field is also reconstracted. For reducing methanol losses a technology of methanol solution recirculation has been improved (new approach for methanol recirculation were proposed especially for this scheme). These technologies significantly reduce methanol losses. The most important technical solution is a novel technology of methanol producing from natural gas directly at field conditions (presented below). For reducing capital and exploration costs the technology is incorporated into gas conditioning and treatment unit (UCPG 1).

## METHANOL TECHNOLOGY ON YURKHAROVSKOE FIELD

At present the price of methanol is significantly increasing. Also there are some difficult transport problems of delivery methanol from southern methanol producing plants to Yurharovskoe gas-condensate field. It seems that the research activity on reducing amount of methanol and organization of its own production directly in field conditions should be very important. Now specific amount of methanol to Valanzhin gas on 1000 m$^3$ of gas is ~1.2 kg, and for Cenomanian gas deposits is ~0.3 kg/1000 m$^3$. It should be pointed out that

recirculation of methanol solutions from low-temperature separator to the first stage of gas separation was installed by project design. Analyses show that such technology not so effective in practice in comparison with project data. It would be more effective to change methanol recirculation technology and to use methanol solutions (from low-temperature separator) directly to well clusters for evaporation of methanol to compressed gas phase (also for inhibiting gas and gas condensate gathering pipelines, if needed). Estimates [1] show that this approach can reduce the consumption of methanol amount about 15 % (and not need a special column for desorption methanol from water solutions).

More radical approach for reducing exploration costs is to develop the methanol production from natural gas on site at field conditions. Possible approaches for such field technologies from theoretical point of view were discussed early [1-3]. The main economical and scientific problem which was solved at this direction is how to reduce capital cost for designing methanol-producing unit by it's deeply integration with gas conditioning unit.

The developed scheme of small methanol production plant at field conditions is presented in Fig. 3. Environmental aspects of the technology under consideration have recently reviewed in [3]. Below we briefly describe the basis of the methanol production on-site from natural gas.

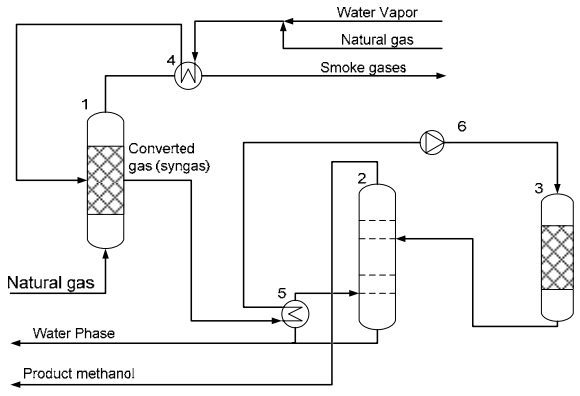


Figure 3 – The technological scheme for methanol production (installation on Yurharovskoe field)
1 – reforming reactor; 2 – rectification column;
3 – synthesis reactor; 4.5 – heat exchangers;
6 – compressor

The raw material for the production of methanol is purified natural gas. The technology based on the following processes:

- catalytic conversion under pressure 2.2 MPa and temperature of 850 $^{o}$C on nickel catalyst of water vapor - methane gas mixture to converted gas (like syngas);
- heat recovery of converted gas with elaborate of a water vapor for technological needs;
- cooling and drying of converted gas;
- compressing converted gas up to 5.0 MPa;
- methanol synthesis from converted gas at low-temperature cupper catalyst (220-280 °C);
- rectification of raw methanol to obtain the final product - methanol of 93 mass % .

This methanol unit was installed on-site at Yurkharovskoe field (12.5 million ton methanol per year).

## CONCLUSIONS

For the second stage of Yurharovskoe field development an energy and resource-saving gas conditioning technology was proposed. Technological losses of methanol as hydrate inhibitor were reduced on gas and gas-condensate low-temperatures conditioning units.

An integrated technology of methanol producing from natural gas directly at field condition was developed. The small methanol unit was installed on-site at Yurkharovskoe field. This unit since the midst of 2007 is in operation. It includes reforming of natural gas - water mixture to converted gas, catalytic synthesis of raw methanol and it's rectification. The special attention is given to the complex decision the problem of recycling low-potential sources of heat. Also ecological risks were estimated and ecological safety of methanol production was provided.

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