INTEGRATED SOLUTIONS FOR EFFECTIVE DEVELOPMENT AND EXPLOITATION OF URENGOY OIL, GAS, CONDENSATE FIELD. CREATION AND INDUSTRIAL INTRODUCTION OF NEW INFORMATION TECHNOLOGIES FOR OIL, GAS, CONDENSATE FIELD DEVELOPMENT MANAGEMENT

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For more than 30 years Gazprom dobycha Urengoy LLC develops Urengoy field - one of the world's largest oil, gas, condensate fields, where more than 2.5 thousand of gas, gas condensate and oil wells are currently in operation. Hydrocarbons are treated in twenty-one complex gas treatment facilities (UKPG), thirty-one workshops of booster stations (DKS), two oil gathering stations.

Urengoy oil, gas, condensate field is unique not only for the initial geological reserves exceeding 12 trillion cubic meters of gas, but also for the diversity of the reservoir fluid and the conditions of the development of hydrocarbon deposits (Fig. 1).

Geological cross-section of Urengoy field

There are three gas, oil bearing layers in cross-section of Big Urengoy:

1 layer - deep submerged Jurassic and Achimov gas, condensate, and oil deposits,
2 layer - Neokomian gas, condensate, and oil formations,
3 layer - Cenomanian-Albian gas formations

Fig. 1 - Geological cross-section of Urengoy field

To date, the depletion of gas reserves in the Cenomanian productive horizon exceeded 65% of their initial value.
Extracted reserves of Valanginian complex gas-condensate and gas-oil deposits make up about 36% of gas separation, and 30% of gas condensate (Fig. 2).
Currently, for the Cenomanian and Valanginian horizons of Urengoy field, which are at a late stage of development, the time of «easy gas» is over. The main tasks are the maintenance of current levels of production and provision of design coefficients of extraction of gas, condensate and oil. The pressure drop in the Cenomanian and Valanginian deposits is accompanied by a selective and focal watering, ingress of water and sand and paraffin and hydrate building in wells and gathering systems, it also complicates the process of extracted production treatment (Fig. 3).
The main bulk of natural gas is extracted from the Cenomanian horizon. A significant reduction in reservoir pressure in the Cenomanian horizon led to the intense and selective water intrusion, accompanied by ingress of water and sand in wells, leading to abrasion of wellhead equipment and the formation of sand plugs in wells. Also hydro-abrasive wear of valves occurs in the systems of products gathering and treatment, water and sand accumulate in the lower parts of gas pipelines and hydrate develops.

To reduce the negative impact of these geological and technical factors on the quality of commercial hydrocarbons treatment, the development of a comprehensive solution of problems encountered was required due to the lack of development experience of such large fields with complex geological structure in the extreme conditions of the Far North.

To prevent and eliminate these complications technology of repair and insulation work (RIR) was developed aimed at the elimination or restriction of water inflow to the wells and the strengthening of bottomhole reservoir (PZP). In the initial period of operation while maintaining high energy potential of large hydrocarbon deposits and due to the significant speed of product in tubing string (NCP) a stable work of wells was maintained with the withdrawal of sand and water. Since then, in connection with the lowering of the energy potential of gas deposits removal of mechanical impurities decreased, which led to the formation of sand plugs, reducing the rate up to stop of individual wells. Since the early introduction of effective technologies to enhance the RIR for PZP strengthening significantly decreased the number of wells with the restrictions on ingress of water and sand. More than 200 idle wells were returned to production stock throughout all the years.

During the period of production decline in the system of gas gathering and UKPG treatment one of the main objectives is to optimize the thermobaric parameters of gas drying process. An integrated approach to solving the problems of the standard quality of gas supply in the gas main was shown also in the improvement of technological schemes of dehydration, in the industrial treatment units' modernization and automation of technological processes.

Implementing these solutions will help to provide the required gas quality while minimizing energy costs and environmental pressures on the environment up to the end of the field development.

The production problems on Neokomian gas deposits are similar to problems that arose during the Cenomanian gas production, but have their own features – paraffin building, retrograde processes, etc. (Fig. 4).
Ensuring a stable inflow of reservoir fluid into a well with a permanent reduction in the energy capacity of the reservoir is achieved through different ways of intensification. Among the original and adapted to the conditions of Urengoy NGKM, ways of intensifying is the reservoir hydrofracturing (GRP). As a result of the use of GRP to Neokomian gas condensate and oil wells reached fold increase in production rate.

For reliable technology of low-temperature separation (NTS) on UKPG Company specialists developed the original scheme for cyclical use of methanol and its automatic supply. These technologies have reduced the content of methanol in the wastewater of up to 3% and reduce the consumption of the inhibitor by 20-30%. As a result, eco-efficiency is achieved not only through the preservation of the environment, but also by reducing the harmful effects on the sites of production and storage of methanol, as well as during its transportation.

As the formation pressure declines initial project flow chart of Neokomian gas treatment may not provide optimal working conditions of low temperature separation plant. New technical solutions were required to be developed to further the effective operation of Neokomian gas. At present, low temperature separation plant is optimized with the help of a latest technology, which includes the joint operation of the Cenomanian and Neokomian UKPGs. The new scheme provides an efficient work of low-temperature separation units while the formation pressure declines due to gas separation supply at stage I or II of Cenomanian DKS. At the same time, energy efficiency of Cenomanian DKS is increased, which work with the optimal load. As a result, specific fuel gas consumption reduced by half and air emissions of harmful substances are reduced by 700 tons per year. The complex of these solutions ensures stable operation of the gas condensate wells stock, and effective treatment of hydrocarbons to the moment of commissioning of Neokomian DKS and the construction of a pump workshop for inter-field unstable condensate transporting.

During operation on oil fringes of Urengoy field one of the most urgent challenges is to increase the rate of utilization of associated petroleum gas (PNG). Integrated solution to this problem provides for the treatment and compressing of the gas, followed by feeding it into inter-field collector, as well as satisfying the needs of oil facilities in gaslift gas. The implementation of the decisions would bring the level of utilization of associated gas in the Urengoy field up to 95%. At the same time, emissions to the atmosphere of PNG combustion products will significantly shrink, which is particularly significant in the framework of the Kyoto Protocol realization.

Gazprom dobcha Urengoy LLC, together with specialists from the IM Gubkina State University of Oil and Gas and Ufa State Oil Technical University, developed and implemented modern information-
measuring systems (IIS) to determine the parameters of a multiphase flow (well flow rate on gas, liquid and mechanical impurities), the pressure and temperature on the hole, and the IIS for the measurement of pressure and temperature at the wellhead, designed for operation in harsh climatic conditions of the Far North.

Currently, the wells UNGKK apply information-measuring system, a series of «flow» and appliances a new generation of RTP, AMT, PGA.

Potok series information-measuring systems

On the basis of the developed new no-separation method, employees of GANG-Neftegazavtomatika, Scientific and Technical Center of IM Gubkina RGU of Oil and Gas, developed and implemented Potok series system of monitoring the wells operation, designed for different operating conditions of wells in the UNGKK field.

The Potok working method is based on information technology, implementing the patented spectrometric method for the measurement of the phase discharge of complex mixture high-speed flow. This method allows to calculate the phase discharge (gas, liquid and solid - sand) on the basis of spectral analysis of fluctuation (pressure fluctuations), initiated by the motion of multiphase flow through a pipeline through the orifice device of a special form (Fig. 5).

Fig. 5 - Borehole measurement module: Potok - 4

RTP, AMT, PGA types devices

IIS developed and implemented on Urengoy field for pressure and temperature measurements on the borehole and on the wellhead of AMT and PGA types.

Autonomous manometers - thermometers of AMT series and depth autonomous measuring transducers of PHO series are designated for the registration of pressure and temperature on the hole and (or) their measurement in time at any point.

This information is derived from devices directly to your computer through standard serial ports, and recorded on the hard disk. Figures of the wells may be rendered in the form of tables or graphs on a computer screen fully, as well as detailed fragments.

To control the parameters of pressure and temperature of hydrocarbons at the wellhead and gas gathering pipelines a wireless self-powered control system is implemented based on sensors of process parameters registration (RTP). RTP-4 device is a universal manometer - thermometer with radio interface for data transfer and control with a wide range of operating temperatures from -55 to +85°C (Fig. 6)
RTP-4 devices are the basis of the data collection system, similar to the cellular network, in which the parameters of the wells obtained through the device are transmitted to the remote UKPG operator via a separate radio channel.

The reliability and measurement accuracy of the IIS created is up to the world standards, while winning due to its value.

These systems, which allow for the receipt of geological and commercial information of a higher quality, increased the efficiency of management decisions on the rational development of hydrocarbons reserves.

Newly designed and implemented energy and resource saving technical solutions and methods create major techno-economic and environmental effects for the company.

Thus, implemented in the Gazprom dobycha Urengoy LLC systematic and large-scale work on a comprehensive solution of problems of effective development and operation of Urengoy oil and gas fields through the introduction of innovative technology allows for a stable and reliable extraction of hydrocarbons with the preservation of vulnerable nature of the Far North.