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Experience in the Application of Integrated Modeling Technologies in a Field with a Gas Lift Well Stock

I.A. Lomukhin, A.I. Kiyan (Gazpromneft-Orenburg) I.M. Galyautdinov (Gazprom Neft) A.S. Ovchinnikov, A.S. Krokhalev (ITPS)

The Orenburgskoye oil and gas condensate field is the largest field in terms of oil and gas reserves in the Orenburg region. The main type of arificial lift at the Eastern area is gas lift. The field is at the stage of pressure depletion performance. The main difficulties in this area are: "bottlenecks", process chains, wells surge, hydrate formation in the gas lift gas supply system and paraffin deposit in the oil production system. Therefore, maintaining hydrocarbon production and increasing the profitability of the producing enterprise are not the easy and require the involvement of modern technologies and complexes. To solve the above problems, Gazpromneft-Orenburg created a comprehensive management system for forecasting and production optimization tools at Orenburg based on a full-scale digital integrated field model, including component models: a geological and hydrodynamic model of a field, wells, a production system, a gas lift gas supply system, a flood pattern, oil and gas processing system, financial and economic model. Currently, Gazpromneft-Orenburg is implementing an integrated approach to activity management by creating a development support system based on an integrated model. This approach allows you to maximize the effect of optimization decisions, given the interaction of all models-components in a single system.

The Eastern section of the Orenburg oil and gas condensate field is the largest in terms of oil and gas reserves in the Orenburg region (Fig. 1). Gaslift is the main type of artificial lift in the Eastern area.

The Eastern sector of the Orenburg oil and gas condensate field is developed by natural pressure depletion. The specified development regime is applied due to the low permeability, preventing the use of water displacement methods and the implementation of a full-fledged reservoir pressure maintenance system.

The geological structure of the deposit is complex:

- reservoir type – carbonate, fractured-porous;
- average depth of occurrence ~ 1900 m;
- high heterogeneity in the area and section – the average number of permeable intervals ~ 19-38 units;
- fault tectonics – 20 fault blocks with different GOC/OWC have been identified;
- 31 – low reservoir properties – fractional porosity 11%, permeability coefficient ~ 0.4 mD;
- hydrocarbon saturation – 82%;
- gascap presence – coiled tubing av. 17.2 m, max. 70 m;
- net oil thickness av. 25.8 m, max. 79 m;
- high H_2S content - 1.9%.

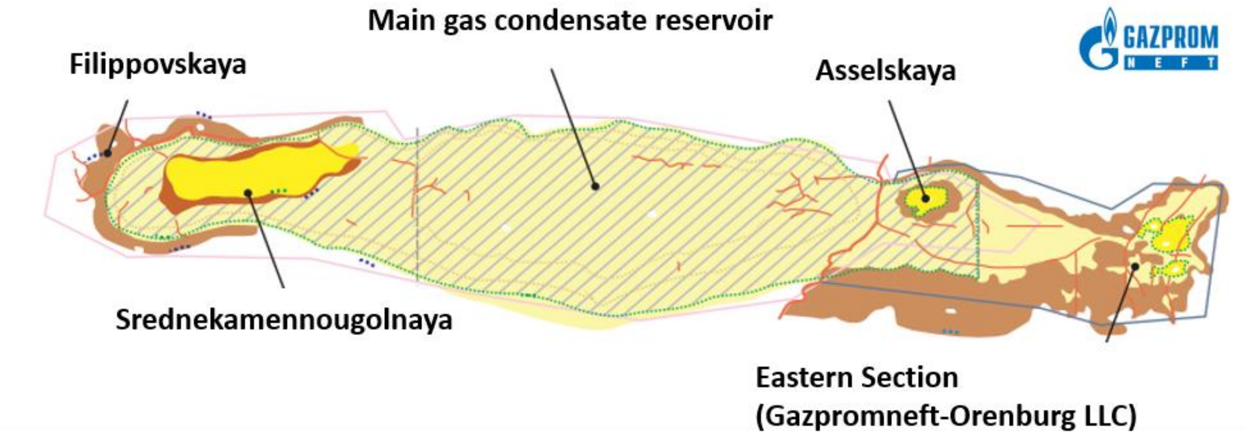

Fig. 1. Eastern Section of the Orenburg Oil and Gas Condensate Field

The Eastern Section of the Orenburg Oil and Gas Condensate Field is characterized by high gas content in oil and high saturation pressure (higher than the actual reservoir pressure), which, together with gas breakthrough from the gascap, leads to very high GOR values and significant gas production rates.

The gas-lift method of operation is used due to the high content of gas in the product. The presence of a large amount of gas in the field creates problems for the operation of downhole pumps, but acts as an advantage when using the gas-lift method of operation. Problems arise when putting down pumps with a large deviation of the wellbore, where the gas lift system can work effectively.

The simplicity of the equipment put down the well and the longer turnaround time are one more advantage of the gas-lift method; this factor becomes especially important with the high H2S content at the field. Thus, taking into account the characteristics of the Eastern Section of the Orenburg Oil and Gas Condensate Field, it can be concluded that gas lift is the most optimal method of oil production at the facility.

The main challenges in this area are the following: process chain bottlenecks, wells surge, hydrate formation in the gas lift gas supply system and paraffin deposits in the oil gathering system.

Therefore, maintaining hydrocarbon production and increasing the profitability of the producing enterprise are not easy and require involvement of modern technologies and equipment.

To solve the above mentioned issues, Gazpromneft-Orenburg created a comprehensive management system for forecasting and production optimization tools at Orenburg based on a full-scale digital integrated field model, including component models: a geological and hydrodynamic model of the field, wells, gathering system, gas lift gas supply system, flood pattern, oil and gas processing system, financial and economic model.

The integrated system is based on asset management through the creation of an information system to support field development based on an integrated model, and is being implemented with the help of systematic approach to digital transformation of the unified development and production management system at the Eastern Section of the Orenburg Oil and Gas Condensate Field, considering such aspects of the integrated solution as: Processes, Information, People, Organization, Technology.

An integrated model (IM) of an asset is a unified digital model of a field, consisting of related reservoir models, wells and a detailed model of the ground infrastructure, and is designed to optimize each facility separately, be it a reservoir or ground infrastructure, and takes into account the mutual data interference (Fig. 2).

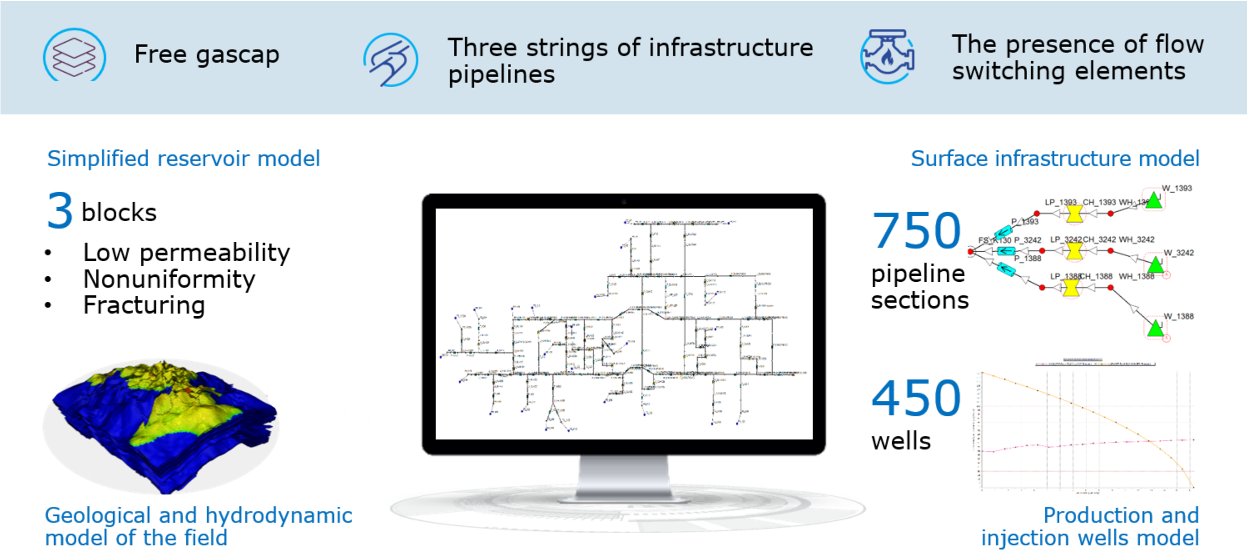

Fig. 2. Composition of the integrated model

Currently, the project of integrated management and production system development at the Eastern Section of the Orenburg Oil and Gas Condensate Field has passed through the stages of identifying bottlenecks in the field, defining management concept based on integrated models, and creating pilot integrated model of the Eastern section. Now the project is at the stage of retrospective analysis of the model and analysis of the model sensitivity to initial data, as well as performing short-term forecast calculations and optimization calculations both on the full integrated model and on its components. Further plans include development of a full-scale integrated model of the entire asset, organization of high-tech production control centers and launching processes based on IM in the asset production control center.

4 stages of integrated model development at the Eastern Section of the Orenburg Oil and Gas Condensate Field (Fig. 3) are:

- Collection of initial data
- Development and adjustment of component models
- Assembling and adjustment of IM
- Operation

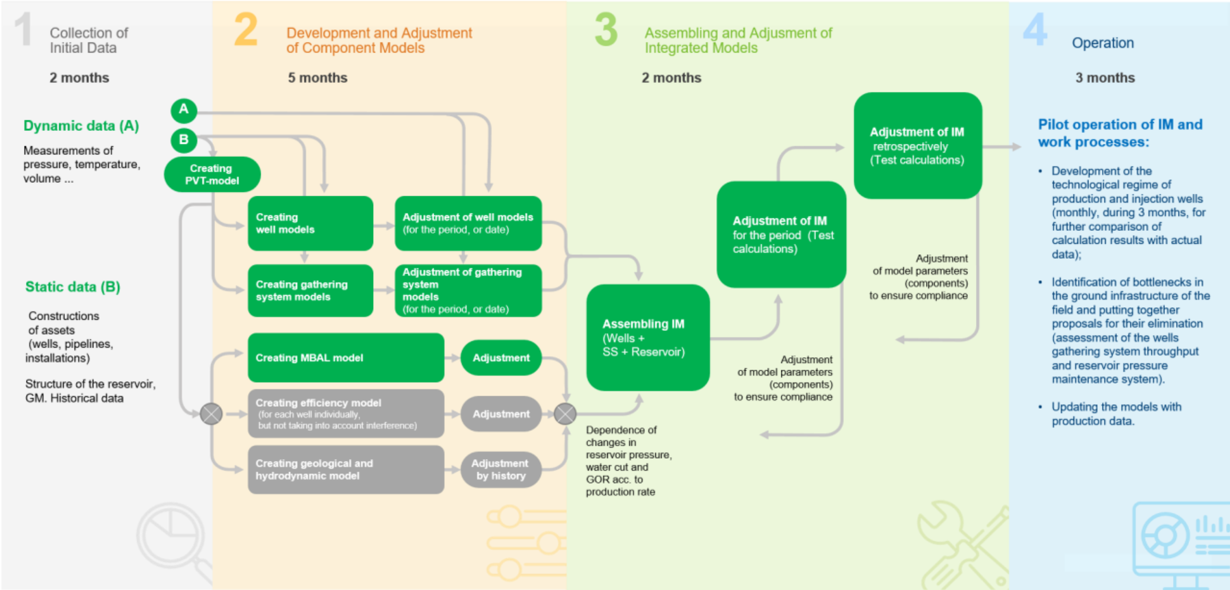

Fig. 3. Integrated model technology development

Integrated Model of the Eastern Section of the Orenburg Oil and Gas Condensate Field is one of the largest and most complex field models created and comprises 450 wells, 750 pipe sections 3 strings of infrastructure pipelines, stream switchover elements, complex geological and hydrokinetic field model due to the gascap, low permeability and inhomogeneous fracture formation.

The following business cases have been implemented at the Eastern Section of the Orenburg Oil and Gas Condensate Field with the help of the integrated model:

- Optimization (redistribution) of gas-lift gas consumption to increase production.
- Calculation of oil gathering system throughput.
- Calculation of optimal and critical well operation mode.
- Optimization (reduction) of gas-lift gas consumption while maintaining current production level at the production line and at the well stock.
- Production changes calculation when new pipelines are commissioned.
- Calculation of the gas-lift gas distribution system capacity.
- We would like to present the results of calculating optimization (redistribution) of the gas-lift gas consumption to increase the production level of the IM pilot area as a successful example of IM application, (Fig. 4).

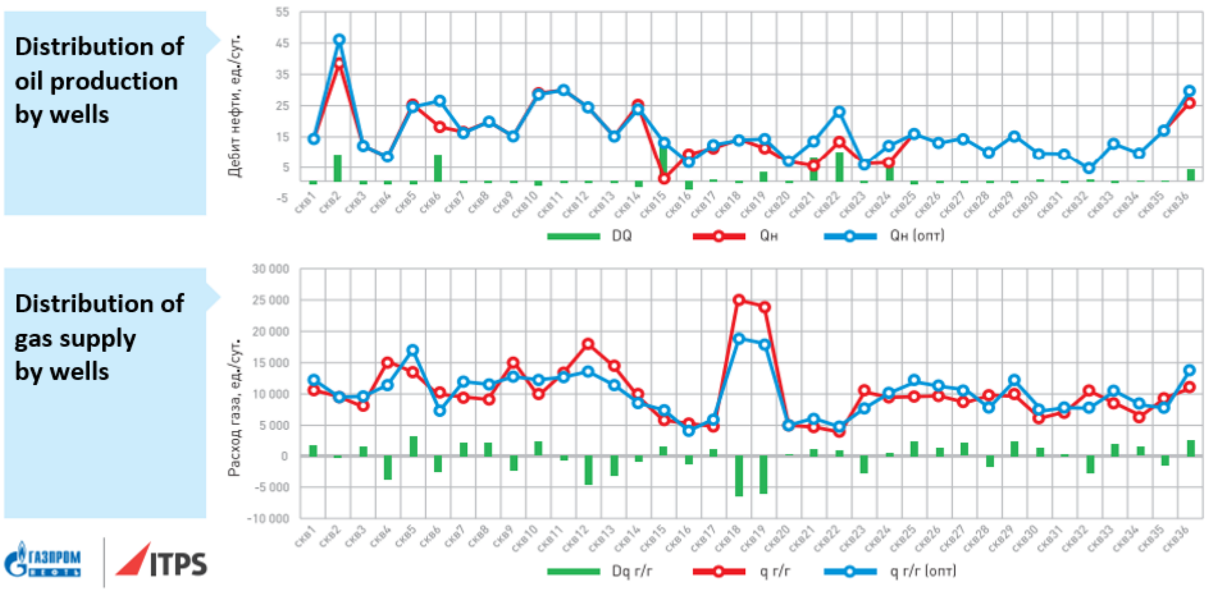

Fig. 4. Optimization calculation results with integrated model for redistribution of gas-lift gas consumption to increase production level

Calculation conditions and initial data:

- the calculation is performed for 48 wells of the test area of the the Eastern Section of the Orenburg Oil and Gas Condensate Field;
- the current technological wells' operation mode;
- only gas-lift wells are involved in optimization (36 wells);
- the calculation is performed for the data as off 06/01/2019;
- total oil production from 48 wells: 843.8 units/day;
- fixed consumption of gas-lift gas: 390 units/day;
- specific consumption of gas-lift gas: 463 units.

Calculation results and conclusions:

- total oil production from 48 wells: 891.3 units/day;
- fixed consumption of gas-lift gas: 388 units/day;
- specific consumption of gas-lift gas: 435.41 units. (-5.9%);
- increase in production amounted to 47.4 units/day. (+ 5.6%).

Not only the use of an integrated model in solving production tasks, but the very process of IM development entails obtaining effects at the asset. The key effects are: identification of inadequate initial data and reasonable planning of necessary research and measurements, demolition of the boundaries between various departments, systematic approach to creating a new complex system based on digital solutions. The expected quantitative effect is the fulfillment of the business plan with a deviation of no more than 5%.

Therefore, we have arrived at the conclusion on the necessity and importance of using and implementing IM in development management processes, which helps to achieve the following results:

- Maximizing productivity of oil and gas production asset and maintaining continuous efficiency in terms of the final volume of crude hydrocarbons extraction, the rate of crude hydrocarbons collection and operational activities in the field, taking into account operation of all systems together.
- Integration of basic production elements.
- Visualization of a holistic picture of asset development.

- Automation of processes in terms of collection, storage and processing of production information.
- Increase in oil production due to reduction of losses between shifts and effective selection of technological modes of well operation.
- Decrease of capital and operating costs.
- Improving the quality of production indicators forecasting and increasing the speed of taking management decisions.
- Improving efficiency of geological and technical measures taking into account infrastructure restrictions.
- Ensuring effective interaction between production and organizational elements of the company.