Gazprom strategy of Digital Twin project implementation of the geological and technological model of the Yuzhno-Russkoye field

Deputy Chief of Division PJSC «Gazprom»

Boris Sharipov
Profile of Severneftegazprom OJSC

Company shareholders:

Gazprom
Wintershall
OMV

Development milestones:

1998
Year of company's incorporation

2007
Commissioning of the gas processing facility

2009
Reaching the design capacity (25 bln m³ per year)

2010
Commissioning of the boosting compressor station

2011
Beginning of a pilot operation of the Turonian gas reservoir by starting-up a two-bottom-hole well with flat completion (No. 174)

2014
Start-up of a production well (No. 184) with uphill completion at the Turonian gas deposit

2016
Start-up of a production well with a 4-stage hydraulic fracturing (No. 1902) at the Turonian gas deposit

2018

- Total cumulative production: 250 bln m³
- 25% of total gas reserves
- Industrial commissioning of the Turonian gas deposit in the Yuzhno-Russkoye field

Subjects of patent law, incl. 4 in development of hard-to-recover natural gas reserves


Company shareholders:

Gazprom
Wintershall
OMV
Information Management System (IMS) of the Yuzhno-Russkoye OGCF as a result of the 3rd Industrial Revolution

8 automated process control system (APCS)

75 local automatic control systems for installations on the SIMATIC platform with SIEMENS processes

Thanks to the introduction of minimally manned technologies, integrated automation, improvement of the mathematical apparatus, organization of data transmission and management teams in the gas field of the Yuzhno-Russkoye oil-gas condensate field, Severneftegazprom OJSC has created a reliable, highly automated technological system of gas production and preparation for transportation, which allows operating the gas field production facilities with a minimal headcount.
New stage of development – Digital production transformation within Industry 4.0

- The concept of Industry 4.0 involves a wide use of digital technologies and tools for proactive management of the enterprise and processes throughout the value added chain to maximize business profitability
- One of the elements of the concept is the creation of Digital Twins of production facilities, including those in the oil and gas industry

The Digital Twin allows for a more comprehensive study of the potential of production facilities, finding additional opportunities to increase their efficiency, and optimizing capital and operating costs.
Relevance of introducing the digital technology in the Yuzhno-Russkoye field

Severneftegazprom OJSC was the first subsoil user in 2011 to implement a pilot project for the development of hard-to-recover gas reserves from the Turonian deposits in the north of Western Siberia and received positive results from its implementation.

Development and implementation of the Digital Twin at the Yuzhno-Russkoye field will improve the efficiency of joint operation of Cenomanian and Turonian wells through a single gas collecting system, and optimize capital and operating costs of production.

707.9 bln m$^3$ of gas reserves in the Cenomanian-Turonian gas-bearing facility are listed in the assets of Gazprom PJSC.

“Development of the Turonian deposits contributes to the achievement of the primary goal of Gazprom Group - ensuring stability and continuity of supplies to Europe”

Aleksandr Medvedev
Deputy Chairman of the Management Board
Gazprom PJSC,
Chairman of the Board of Directors
Severneftegazprom OJSC
Strategy of the Digital Twin project implementation was developed.

**Research activity (2019)**
- Stage I Pre-design survey
- Stage II. Development of requirements for the DT operation
- Stage III. Development of a DT preliminary design for the geological and technological model element of the technological chain: productive formation – wells of GWC No. 14, 15, and 17 - GCH No. 3 – SVS
- Stage IV. Registration of RA results

**Development activity (2020)**
- Development of a single-stage design
- Development of estimate documentation

**Introduction of the Digital Twin (2021‒2022)**
- Manufacturing, delivery, and installation of the software and hardware suite of the Digital Twin
- “No-load” and “on-load” start-up and adjustment
- Pilot production
- Acceptance tests
- Industrial commissioning
Within the developed strategy, the RA was initiated for the following topic: Digital Twin of the geological and technological model: productive formation – wells – gas collecting system – switch valve station of the Yuzhno-Russkoye field

<table>
<thead>
<tr>
<th>Characteristic (development prospects)</th>
<th>Productive formation</th>
<th>Wells</th>
<th>Gas collecting system</th>
<th>Switch valve station</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Turon, Т1-2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Formation pressure = 8.85 MPa)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Senoman, PK1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Formation pressure = 5.02 MPa)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26 formations of Lower Cretaceous deposits</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Active</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>142 production wells at the Cenomanian gas deposit, 3 production wells at the Turonian gas deposit</td>
<td></td>
<td></td>
<td></td>
<td>12 flow-lines</td>
</tr>
<tr>
<td>Prospective</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>135 production wells at the Turonian gas deposit</td>
<td></td>
<td></td>
<td></td>
<td>Gas collection header (GCH) No. 13 is planned for the prospective Turonian gas deposit</td>
</tr>
<tr>
<td>Extent</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gas buster station (GBS) 202 km long</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>and an additional GBS since 2022 ca. 14 km loop long</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The RA was initiated for the following topic: Digital Twin of the geological and technological model: productive formation – wells – gas collecting system – switch valve station of the Yuzhno-Russkoye field.
RA goals:

1. Performance of a set of studies to determine the range of objectives achieved with the help of the Digital Twin of the geological and technological model: productive formation – wells – gas collecting system – switch valve station of the Yuzhno-Russkoye field, and assessment of DA profitability and cost-effectiveness on the basis of input data obtained.
2. Determination of an optimal software and hardware architecture of the Digital Twin, taking into account the selected objectives and the need to introduce a new information platform that combines software for geological and technological simulation, automation and dispatch systems.

RA key objectives:

- Making a list of objectives achieved by using the DT
- Making a list of design input and software required for the DT operation
- Definition of a software and hardware architecture of the Digital Twin, taking into account the selected objectives

RA results:

- Development of a feasibility study to implement the Digital Twin
- Drawing up of a technical assignment for the development activity (DA)
List of stages and RA scope

Stage I. Pre-design survey (from 01.02.2019 to 15.03.2019):
• study of the projects: “Construction of the Yuzhno-Russkoye field facilities”, “Flow diagram for the development of the Cenomanian and Turonian gas deposits of the Yuzhno-Russkoye field”, “Construction of field facilities at the Turonian gas deposit of the Yuzhno-Russkoye field. First Phase Commissioning”;
• study of the Schlumberger Oilfield Services report on a pre-design survey of the existing information system for monitoring and optimizing of production at the Yuzhno-Russkoye field in 2012;
• study of software used at the enterprise;
• study of functions of the implemented IMS;
• study of the range of objectives achieved by the Company’s Management Board, and determining of the DT effective application scope.

Stage II. Development of requirements for the DT operation (from 15.03.2019 to 15.05.2019):
• making a list of objectives, approaches and methods to achieve them using the DT;
• making a list of data and software required for the DT;
• determining of appropriate DT operating modes;
• determination of the optimal DT software and hardware architecture, taking into account the objective to maximally integrate the DT with the automation and dispatch systems, and software for geological and technological simulation.

Stage III. Development of a DT preliminary design for the geological and technological model element of the technological chain (from 16.05.2019 to 15.07.2019):
• the preliminary design should enable the definition of progressive input requirements for the DT development in compliance with the global leading-edge level, the reduction of timelines and costs for the DT development and utilization through a detailed preliminary study of key issues and reducing the likelihood of errors during further works.

Stage IV. Registration of RA results (from 16.07.2019 to 30.08.2019):
• feasibility study of the DT implementation with appropriate graphic, computing and analytical materials, assessment of the DT implementation efficiency;
• technical assignment for the development activity in line with the selected variant (or a combination of variants) of the DT development;
• research activity report;
• patent research report.

Implementation of development activity in 2020
Preliminary technical requirements for the Digital Twin

Simulation of physical processes occurring in the elements of the technological chain

- Calculation of an optimal operating mode for the geological and technological model
- Express recalculation of the operating mode of the geological and technological model in case of any emergency
- Forecasting of gas production for the appropriate period based on mathematical models and objectives
- Well flow rate management during joint development of the Cenomanian and Turonian gas deposits
- Management of gas transportation through a single gas collecting system
- Early identifying and informing of any negative changes in the operation of the geological and technological model

Visualization of processes of the geological and technological model (3D animation of the developed facility with the GWC level and well trajectories, indicator diagrams for wells, gas velocity graphs, hydrating points, etc.)

Geological and technological model:
productive formation – wells – gas collecting system – switch valve station

2nd Joint Committee Meeting of Gas Market, Sustainability and E&P Committees
28-30 March 2018, Shenzhen, China
Basic technical requirements for the Digital Twin mathematical and software support

1. Providing input, storage, display, update, and processing of the following data: a layer of regulatory and reference information; a layer of electronic estimate, design, as-built and operational documentation; a graphical presentation layer (including 3D and 2D models, flow diagrams, etc.); a layer of mathematical models; a layer of engineering data containing technical characteristics of technological chain elements; a layer of real-time statistics; and a layer of a field-geologic database

2. Content of appropriate information resources for integrated simulation, forecasting and optimization of technological processes of production and asset management

3. Availability of industrial analytical tools to provide a mechanism for analyzing and forming proposals to optimize the development of the field, dynamical adjustment of technological chain operating modes depending on available resources

4. Tools of the DT mathematical models should enable the simulation of physical and technological processes in various operating modes, including calculations, optimization and auto-adaptation of operating modes of technological chain elements (hydraulic calculation of a stationary mode, simulation of non-stationary modes), taking into account geological and technological limitations
Results of creating and implementing the Digital Twin

Development and implementation of the Digital Twin at Severneftegazprom OJSC will help increase the efficiency of the joint development of the Cenomanian (PK1) and Turonian (T1-2) gas deposits at the multilayer Yuzhno-Russkoye field, taking into account the following indicators:

- **Formation pressure difference** between PK1 and T1-2 during the launch of the unified gas collecting system is up to 4.0 MPa;

- **Difference between allowable draw-down pressures** during the operation of PK1 (0.4 MPa) and T1-2 (2.3 MPa);

- Uneven distribution of natural gas reserves in different zones of deposits at the multilayer field;

- **Wellhead pressure difference** in wells of PK1 and T1-2 is up to 1.5 MPa;

- **Wellhead temperature difference** in wells of PK1 and T1-2 is -2 °C to +9 °C.

The Digital Twin will allow simulating of facilities and technological processes of the Yuzhno-Russkoye field in a digital environment, which is especially relevant for increasing productivity and final gas recovery, optimizing additional capital investments and operating costs while managing the joint development of the Cenomanian and Turonian gas deposits.
THANK YOU FOR YOUR ATTENTION!