

Complex Approach to Hydrocarbon Production Management on the Basis of AVIST OIL & GAS Platform

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The ITPS Group of Companies designed the integrated software platform to manage the production of hydrocarbons (HC) on the basis of methodology of integrated tools and integrated operations. This approach proposed the construction of transparent and inter-related industrial processes, creation and application of integrated models, integrated planning, management of the potentials (search and optimization), and complex operation of choke models. Russian digital package AVIST OIL&GAS (Asset Virtualization System, proprietary design of ITPS) is used as the integrated software platform to consolidate, process and analyze data from various engineering and field systems. In general the application of the above-mentioned methodologies, the set of integrated tools AVIST OIL&GAS platform enables to realize the digital concept of a smart field.

Key words: smart field, integrated operations, integrated simulation, integrated planning, model of limitations, management of potential, center of integrated operations, production control center.

Digital transformation of production is most often associated with a number of technological solutions of the fourth industrial revolution (Industry 4.0). Not so long ago, end-to-end real-time data processing technologies, smart sensors and M2M (Machine-To-Machine) technologies, predictive maintenance and other solutions seemed fantastic. Now they are real. Inventions do not just defeat our stereotypes, they change the principles and approaches to solving production problems, create new trends and markets.

The effects of digitalization are clearly visible in the oil and gas sector. It is a multifaceted, technically complex and highly conservative industry in which any major organizational and technological change is a major challenge. The described approach is effective at any stage of the company's life cycle. Large-scale introduction of Industry 4.0 technologies has recently been increasingly used for the new facilities. At the same time, digital tools of integrated operations are also used more and more actively at the fields of II-IV stages of development, especially by technology leaders, which are always leading in efficiency as well. One of the main tasks digitalization of oil and gas industry enterprises solve is the implementation of the Intelligent Field, Asset of the Future, Digital Field (i-Field) concept. As part of this direction, together with the customers we use a set of interrelated tools: integrated field model, choke model, integrated plan, integrated operations, integrated management, specialized software, including domestic production. The implementation of these tools into production cycles and processes makes it possible to create a qualitatively new model of production management in the company based on technological facilities' potentials and technological system of the field.

INTEGRATED MODELING

Any management process is based on the Deming cycle "Plan - Do - Check - Act". For proper and efficient implementation of each stage of the management cycle, it is necessary to build a model of the managed object. This will help to model planned indicators and scenarios, analyze and compare forecast, plan and actual result, and quickly identify and model the necessary operation changes for the managed object in order to correct unplanned deviations. At oil and gas production enterprises, the managed objects are reservoirs, production and injection wells, production systems, pipelines and reservoir pressure maintenance system facilities, systems for commercial product processing, and oil and gas storage and delivery facilities.

Modelling is done for all managed facilities. Reservoir model describes the dynamics of the distribution of hydrocarbons in the reservoir and the volumes of oil and gas reserves that the reservoir can release to the surface with the help of specific physical-mathematical and physical-chemical equations. Well models describe their design and changing parameters, movement of hydrocarbons from the reservoir to the ground, and the methods used for lifting hydrocarbons to the ground. The pipeline model allows evaluating and predicting how the produced product will be pumped. Processing system models help to assess the possibilities of processing and release of marketable products. To develop intelligent production, it is necessary to build an integrated model (IM) combining the models of all sections of production system: reservoir, well, gathering system, processing system, pumping system, etc. Production planning and management with the help of integrated models is the basis for predictive production control – management of technological modes of production and injection wells, determining the best production type, changing pipeline system throughput characteristics and operating modes of dynamic equipment on the ground, taking into account changes of wells' operation modes and many other parameters.

For effective planning and production management with the help of integrated models and modeling results, the ITPS Group of Companies has developed an innovative digital platform AVIST Oil & Gas, allowing to implement functions uncharacteristic for IM, such as: interaction with information systems, obtaining initial calculations data, reporting and much more. The platform is indispensable at the stages of commissioning and acceptance and quality assessment of developed and updated IMs during interaction of specialists from extractive enterprises with design organizations and contractors.

AVIST Oil & Gas helps creating a reliable picture of the situation at production facilities, provides automatic data exchange between facilities and the solution in real time. In case of changes in the pipeline (for example, in case abnormal or emergency redistribution of flows occurs) that affect the operation of the well and the reservoir, the model will take them into account and set up an action plan to optimize production to fit the current technical conditions.

The use of AVIST Oil & Gas makes production information understandable and quickly available for making informed decisions by all employees of geological engineering and technological services in accordance to their job descriptions.

MANAGEMENT OF POTENTIALS (CHOKE MODEL)

Integrated models help to use the new and effective capacity-based management and planning methodology. The chain of product movement “reservoir - well - gathering system - processing system - sales” in the choke model is represented as a pipe. The performance of the entire chain depends on the performance of its narrowest point. And when there are hundreds and thousands of such places, it becomes impossible to find the bottlenecks manually (Fig. 1).



Fig. 1. Management of production potentials

Each step of production technological system has its own maximum and operational potential, certain design features, operating modes and technical characteristics. Some of them were determined during the design process, while others were implemented in the course of operation. The choke model links them into a unified system, making it possible to perform calculations, determine system potential, and estimate possible losses during planning and plans implementation. Understanding potential losses while analyzing bottlenecks, allows minimizing operating costs when determining activities to increase planned production, as well as when selecting activities to compensate for unplanned deviations in the process of production plan implementation.

Knowing the remaining potential when analyzing bottlenecks allows optimizing capital costs by planning activities aimed at upgrade and reconstruction of technological facilities. Work within the medium and strategic timeframes is used to plan commissioning of new facilities and infrastructure reconstruction. Analysis of the potentials for technological objects of choke model for a daily and monthly timeframes makes it possible to optimally plan and execute the technological modes of equipment operation, and within the annual timeframe – to develop efficient and balanced programs of wellwork and organizational-technical measures.

The unique capabilities of choke model are most effectively used with the tasks of forming production rates and maximizing production. Automated production planning based on potentials in the context of each production facility allows increasing equipment turnaround time and achieve higher values of recoverable reserves.

The functionality of AVIST Oil & Gas makes it possible to assess and predict changes in the potentials of production facilities and the system as a whole at the operational (day, week, month), medium-term (1–5 years) and strategic (until the end of field life) planning levels. The use of AVIST Oil & Gas in combination with integrated modeling tools ensures fewer production shortages (up to complete elimination), reduction in operational planning time, and reduction of the number of bottlenecks, accidents and emergency situations.

INTEGRATED PLANNING

Integrated planning (IP) is an indispensable part of integrated tools. The key task of integrated planning is creation and maintenance of a unified consolidated schedule of production plans consisting of separate functional plans (geological and technical activities, workover plan, research plan, reconstruction and upgrade plan, drilling plan, infrastructure facilities construction plan, preventive maintenance plan, etc.) within various planning timeframes, and also the correlation of integrated plans between timeframes.

ITPS offers its own development AVIST.Planning as a digital tool allowing to create integrated plans and automatically introduce changes in accordance with the daily timeframe in proportion to the consequences of these changes within a monthly, annual or even long-term timeframe.

The use of this tool by the oil and gas companies allows reducing the time needed for decision-making to eliminate deviations not only within the current timeframe, but also strategically. The tool makes it possible to promptly form a plan of compensating activities, which will ensure production plan implementation at the operating well stock even in case of accidents, conflicts between departments, untimely commissioning of the developed area and other emergency situations. And vice versa, the absence of integrated planning, usually leads to unplanned losses.

The use of AVIST.Planning allows putting together a long-term integrated plan and more detailed plans for smaller timeframes on its basis, including:

- Development of a unified plan through consolidation of original production plans.
- Visual analysis of the consolidated plan and its indicators.
- Minimization of risks in the consolidated plan.
- Minimization of conflicts referring to technology, resources, logistics, and finances in the consolidated plan.
- Analysis of readiness for activities implementation in the consolidated plan.
- Optimization (activities, schedule) of the consolidated plan for the selected target functions.
- Forecast of the integrated plan success.

INTEGRATED APPROACH TO MANAGEMENT

An integrated approach is implemented with the help of integrated tools or a unified analysis environment and involves specialists in various areas. This environment is implemented in Integrated Operations Centers and Production Control Centers. The use of integrated tools makes it possible implementing a comprehensive production planning and management model (Fig. 2).

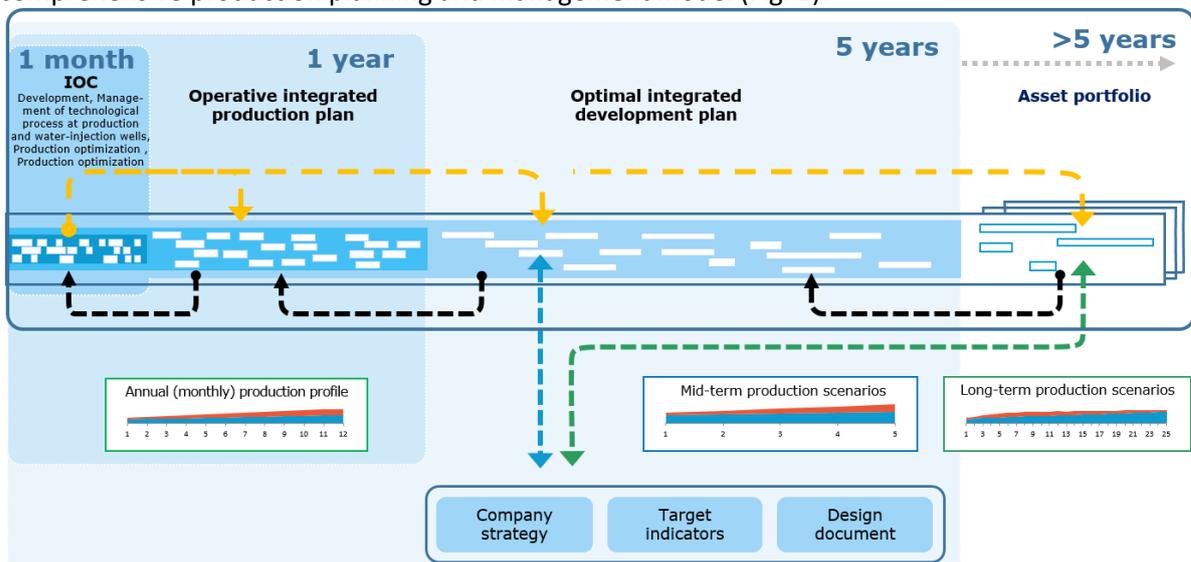


Fig. 2. Production management with the help of integrated solutions

Within the framework of the described model, planning begins with an integrated planning of complete (long-term) development of a production asset, which is calculated in the integrated model and includes analysis of potentials of the development object, ground infrastructure in accordance with the asset development strategy and process engineering documents for development and construction. On the basis of the approved schedule for complete (long-term) development of the asset, an updated medium-term integrated plan of the asset is put together. On the basis of a medium-term integrated plan, a detailed annual integrated production plan calculated in the integrated model is created.

When putting together the annual integrated plan, same as for strategic timeframes, maximum and current potentials of units and the system in general are analyzed, based on the reserves and potentials, geological and technical measures programs, workover plans, drilling schedule and asset development program are created.

Based on the annual integrated plan, monthly integrated work plans are created with detailed breakdown by days and hours. Integrated Operations Center is responsible for the development and efficient implementation of all activities carried out in the field. Production Optimization Center is responsible for optimal production planning and effective management and adjustment of the operating well stock in case of unplanned deviations in wells' operation. Production management is executed on the basis of potential analysis and timely calculations in the integrated model.

Decisions and the adjustments made in the operation of technological assets, and scope and timing of works performed on the asset, are recorded in the monthly integrated plan and, in case of a significant impact on the execution of higher plans, are automatically transferred to the integrated plans of the upper levels. Therefore, all stakeholders can immediately see the forecast for the implementation for a monthly, annual, mid-term and long-term integrated plans.

Implementation of an integrated model, choke model and integrated planning will most likely require a transformation of business processes, which is needed not only to integrate tools into individual functions of currently used business processes, but also to move from the traditional sequential method of solving production tasks to an interdisciplinary one.

The interdisciplinary approach means a group of specialists takes part in solving production tasks in terms of operational management at production, such as: process engineers, downhole pumping equipment specialists, geologists, mechanical engineers, etc. This enhances the quality of decision-making and decreases the time required for solving production tasks, and if authorization is needed, decreases the time of approval, too. Altogether, integrated tools and interdisciplinary approach to operation are usually called integrated operations.

ITPS offers its own software development AVIST Oil & Gas as a basis for the implementation of an integrated approach to oil and gas production management. The platform ensures coordination of joint activities of various disciplines and helps analyzing optimized development options using modeling data and operational production systems. Prompt development of suggestions on adjusting technological regimes might take several days or even several hours. Taken together, all this makes it possible to significantly increase hydrocarbon production and achieve higher oil recovery factors. In the long term, the recovery factor might increase by 1–2%.

During 15 years of active work with oil and gas companies in the digital transformation market, the ITPS Group of Companies has implemented more than 100 projects within the Intelligent Field concept. Our experience demonstrates the payback period for such projects is usually not more than two years. The economic effect is achieved through production increase by 5-10%, reduction of shortages and losses through optimizing technological regimes at the wells (standard shortages and losses are specified as 3%) and reducing capital and operating costs by 5-10%.