High-tech drilling of wells in offshore fields using import-substituting technologies

A G Alekseev¹ and E V Egorova²

¹LUKOIL-Nizhnevolzhskneft LLC, Admiralteyskaya st., Astrakhan, 4140241, Russia
²Astrakhan State Technical University, 16, Tatishcheva st., Astrakhan, 414025, Russia

E-mail: egorova_ev@list.ru

Abstract: The article considers the relevance of increasing the efficiency of development of offshore shelf deposits in the North Caspian, using the example of the oil and gas condensate field named after Y. Korchagin. The development of offshore fields is associated with the use of the latest expensive technologies aimed at highly efficient development of facilities with hard-to-recover hydrocarbon reserves. The involvement of field operators in the development of expensive imported technologies leads to a significant increase in the cost of oil produced. In this regard, there is a need for testing and introducing similar domestic technologies into the offshore field development process to optimize the hydrocarbon production process.

1. Introduction

Currently, as we study new promising areas in terms of oil and gas potential, the complexity of developing deposits located in hard-to-reach areas of the earth’s surface and associated with hard-to-recover reserves is increasing. Such objects include the field them. Yu. Korchagin, located in the Russian part of the Caspian Sea. Effective development of facilities with hard-to-recover oil reserves on the shelf is a daunting task. It can be solved only by using the latest development technologies, for example, such as drilling extended horizontal wells (horizontal wells), branched horizontal wells (BHW), in combination with downhole equipment that allows you to control and regulate fluid flow from different intervals of the reservoir.

When drawing up a technological development scheme in order to increase the efficiency of the development of the oil rim of the Neocomian deposits of the field named after Yu. Korchagin proposes a development system by drilling a long-range horizontal well. Production wells with horizontal shafts up to 5000 m long are evenly distributed over the reservoir area, near the oil-water contact (WOC), parallel to its surface [1]. The length of the wells is determined by the size of the field, their trajectory is less dependent on the characteristics of the geological structure of the formation. Due to the large length of the well, a high density of wells is achieved and oil displacement by gas occurs more evenly.

After a gas breakthrough, the wells are transferred to periodic work or their flow rate is regulated (reduced). Thus, the development of the reservoir is carried out while limiting the gas factor to a value that allows for normal well operation. Breakthrough gas is pumped back into the gas cap to maintain reservoir pressure in it at the initial level, while produced water is transferred to the marginal zone through water-absorbing wells.
However, the use of the described field development system is hindered by the fact that the wells that were drilled had a high complexity of drilling, completion and development, due to the complex profile of the well. The horizontal drift was more than double the depth of the wells vertically.

2. Factors that improve the quality of well drilling
To ensure high-quality well drilling in these conditions, the most important factors are:

1. Conducting high-tech geosteering, providing a high percentage of the reservoir in the horizontal part of the trunk.
2. Consideration of all risks and negative factors of well drilling based on high-quality geomechanical modeling.

In preparation for geosteering and compiling a geomechanical model, factors were noted that increased the degree of uncertainty of the calculations. These factors are primarily associated with a lack of input data [2]. These include:

- High structural uncertainty (especially the northern slope of the structure).
- Weak coverage of the study area with well data.
- Lack of full inversion / interpretation of seismic data reliable impedance and density cubes.
- Incomplete interpretation of acoustic log data for geomechanics.
- Probable differences in the petrophysical interpretation of data by various methods (for example, clay content in exploratory and production wells).
- Lack of knowledge of the Volga layer, namely the lack of results of mechanical core testing, the lack of direct measurements of the minimum horizontal stress.

As a result of the finite element calculation for each cell, Schlumberger specialists determined all the components of the stress tensor acting on it. In general, the direction of stresses is maintained over the entire area and is ~ 150° for the maximum horizontal stress (~ 60° for the minimum). Near the faults, a slight rotation of the vertical stress occurs, while the directions of the horizontal stress practically do not change. Thus, the calculation of the 3D stress state allows one to consider the effect of discontinuous disturbances on the magnitude and stress orientation. In the future, taking into account the influence of the development on reservoir pressures can assess the risks of reactivation of displacements along the fault planes and predict the complications associated with this, as well as plan procedures to avoid such problems or to reduce their impact [3].

3. The results of the use of import-substituting technologies
At present, the LUKOIL-Nizhnevolskneft’s geological service independently conducts geo-navigation of wells using the Russian software PetroInfoComplex.

This software in comparison with both imported and Russian counterparts has several significant advantages in geological support of drilling, namely it allows [4]:

1. Dynamic use of seismic data (2D / 3D) with automated rebuilding of a deep-speed model considering geo-navigation data (Fig. 1). At the same time, deep constructions can be verified using depth anisotropic migration before summation (PSDM) implemented in the PetroInfoComplex ProSystem software.
2. 3D geological modeling, which is one of the layers in the geosteering window (Fig. 2).
3. 1D and 3D geomechanical modeling, including considering seismic data. Risk assessment of well drilling considering the stress-strain state of the medium, calculation and change of the well trajectory considering the above factors.
4. The use of real-time attribute seismic analysis according to the data of acoustic impedance, Hilbert transforms, prediction of fault zones and fractures, etc. Moreover, all attributes are calculated directly in the software during geo-navigation.
5. Opportunities for recording and using other data: 4D seismic exploration (if available), electrical exploration and other geophysical methods for optimizing well drilling and several other software capabilities.
4. Conclusions
Thus, the specialists of the geological service of LUKOIL-Nizhnevolzhskneft LLC are successfully implementing high-tech drilling of wells in offshore fields using import-substituting technologies.

The results show a serious development of domestic technologies that can compete with the technologies of the world's leading oil and gas companies. One of the main factors for the further growth of import substitution during the development of offshore fields is the education and training of highly qualified specialists who can develop and implement this area of the oil and gas sector.

To this end, LUKOIL-Nizhnevolzhskneft LLC actively interacts with Astrakhan universities. Cooperation is actively developing with the Astrakhan State Technical University (ASTU), which graduates specialists in the field of applied geology and oil and gas business. Leading specialists of LUKOIL-Nizhnevolzhskneft LLC are involved in the educational process – they teach basic disciplines, conduct seminars, and participate in conferences. Such cooperation of production workers with the educational institution allows us to transfer tremendous experience and knowledge of high technologies to new generations of oil workers.
Considering the experience gained in the field of geological support for offshore drilling and field development at a high technological level using import-substituting technologies, it is planned to create a basis for training students and graduate students on the basis of ASTU, as well as conduct special advanced training courses for industry specialists. The unique experience of developing offshore fields, which will be passed on to new generations of specialists in the oil and gas industry, will give impetus to the development of this direction for all regions where the development of deposits in offshore and other difficult natural conditions for the development of hydrocarbon deposits is relevant.

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