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Recommendation of Optimal Technological Solutions for the Industrial Development of The Sharkiy Berdakh Gas Condensate Field

Madreimov A.A., Shafiev R.U.

Head of the field "Sharkiy Berdakh", JSC Uzbekneftegaz, Ustyurt GPD, Uzbekistan
Doctor of Technical Sciences, Chief Researcher, JSC "O'ZLITINEFTGAZ", Basic Department of Standardization, Tashkent, Uzbekistan

ABSTRACT: This work presents the results of the analysis and generalization of the results of geological exploration and actual works, materials on the calculation of hydrocarbon reserves, approved by the State Testing Center of the Republic of Uzbekistan (minutes No. 357 dated December 29, 2008), testing of wells, and gas-dynamic research results to determine the most technically and economically justified option for the industrial development of the deposit. The introductory part of the article is devoted to a brief overview of the deposit. Further, the theoretical part provides information on the analysis of gas-dynamic, gas-condensate, and technological methods for developing and proposing a technically and economically efficient regime for the development and operation of deposits. The concluding part provides a brief analysis of the technological indicators of the object under consideration and provides recommendations for improving the effectiveness of the implemented development system.

KEY WORDS: productive horizon, formation, well productivity, well, water saturation, development, exploitation, simultaneous-separate exploitation, pressure, water saturation.

I. INTRODUCTION

Most gas and gas condensate deposits in the Ustyurt region were formed in the Jurassic and Cretaceous periods of the Mesozoic era and consist of several gas-saturated layers, therefore the deposits are mainly multi-layered.
Development tasks are significantly complicated when it is necessary to extract gas from a multi-layer deposit. In this case, it is necessary to consider the development system of each individual layer, the distribution of seizures between them, and the possibilities and methods of their joint exploitation.
Multi-layer deposits can be developed using various methods. The facilities can be operated separately by wells drilled for each horizon and by wells that have uncovered all productive horizons. When operating separately, to save the number of wells, simultaneous-separate operation (SE) is often carried out.
Among the hydrocarbon deposits of the Ustyurt gas region, the Sharkiy Berdakh Gas Condensate Field (GCF) is one of the most complexly constructed objects and has numerous productive layers. The complex structure of this deposit is due to the development of various faciesally unstable lithological types of rocks - sandstones, siltstones, and clays. Collectors are individual layers, lenses of sandstones, which are unevenly distributed both across the area and across the section. Two separate folds have been identified at the deposit, separated by a tectonic fault. The violation is traced to the J31 horizon and essentially divides the structure into two sections, with an amplitude from 20 to 40 m [4].
The industrial gas content of the Sharkiy Berdakh deposit is associated with terrigenous deposits of the Upper and Middle Jurassic, in which 27 independent deposits are identified in the Sharkiy Berdakh section and 19 deposits in the Uchsay section with approved industrial reserves of the C1 category.
The operational object is a part of the productive section of the gas condensate field, which, according to geological and industrial characteristics, is allocated for development by an independent well network. An operating facility can include one layer of sufficient thickness or several layers, or even the entire productive horizon. Horizons with insignificant gas reserves and low well productivity should be developed by connecting them to the operation of the lower layers with a single filter or simultaneously-separately with it, with the aim of reducing capital costs for well drilling.

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The Sharkiy Berdakh deposit has been under development since 2002, during which a deviation of actual indicators from project indicators is observed [4-6; 8]. The reason for these deviations was analyzed in the previous sections of this work. According to the regulatory document [1], East Berdakh and Uchsay are allocated as operational facilities for further development of the Sharkiy Berdak Gas Chemical Complex, comprising 27 and 19 deposits, respectively, with approved industrial gas reserves in accordance with the work [7].

With such a large number of productive layers in one field, the most widely and often used method is ROE, when two or more layers are exploited in one well. The method is efficient and productive, with layers being drilled using a single well grid [7; 9]. The well grid is established when designing the development of deposits. The grid determines the nature of the wells' location at the site, indicating the distances between them. The grid can be triangular, square, and polygonal. As a rule, a triangular grid is preferred, as it can accommodate 15% more wells.

II. SIGNIFICANCE OF THE SYSTEM

The implemented development system at the Sharkiy Berdakh Gas Condensate Field (GCF) is crucial for optimizing gas extraction from its complex multi-layered structure. The use of simultaneous-separate exploitation (SE) technology allows efficient utilization of multiple productive horizons, reducing drilling costs and maximizing well productivity. Proper reservoir pressure management and gas-dynamic investigations (GDI) help maintain stable production levels and prevent premature well shutdowns.

Additionally, monitoring gas-water contact (GWC) movement and implementing enhanced recovery techniques, such as hydraulic fracturing and selective perforation, ensure sustainable field development. By integrating advanced reservoir modeling and digital monitoring systems, production efficiency can be further improved, supporting long-term energy supply and economic feasibility.

III. METHODOLOGY AND DISCUSSION

When implementing a development system with SE technology, it is important to consider the productivity of each selected object, as well as their filtration-capacity properties, thermobaric conditions, and the physicochemical characteristics of the fluids and gas they are saturated with. Therefore, for the correct choice of development system, it is worth relying on the results of GIS obtained during the search and exploration work.

At the Sharkiy Berdakh GCF, gas-dynamic investigations (GDI) were conducted during its exploration and development stages. The results of these studies are presented in Appendix B. As seen from the appendix, GDI was not conducted regularly, particularly during the period from 2011 to 2018, except for the year 2015.

Based on these gas-dynamic investigations (GDI), the average values of filtration resistance coefficients for productive horizons were determined, which are necessary for forecasting their development using the steady-state transition method [10]. The results of these calculations are presented in study [2].

Thus, according to the adopted geological model, 38 productive reservoirs have been identified with commercial category C1 reserves, including 24 in the Sharkiy Berdakh area and 14 in the Uchsay area [3]. In 2009, the «Industrial Development Project of the Sharkiy Berdakh -Uchsay Gas-Condensate Field» was prepared for the approved reserves [9].

During the development of deposits in the Ustyurt region, a number of factors are noted, indicating that the actual geological structure of their productive horizons does not correspond to the approved parameters.

Furthermore, the operation of wells complicates the inflow of reservoir water into their production, which affects well productivity and causes the deviation of reservoir pressure dynamics from the gas pressure line. The noted circumstances complicate the achievement of design development indicators.

From the work [2], it follows that as of 01.01.2022, as a whole, there are 55 wells in the existing field fund, which form 72 well-objects, due to the operation of several horizons by one well with a single filter, i.e., the application of SE technology. At the Sharkiy Berdakh site, 30 wells form 37 well facilities, and at the Uchsay site, 25 wells form 35 operational facilities.

Also, by analyzing the data on the load on the operating well stock of the Sharkiy Berdakh GKM, presented in the work [2], one can observe a high load on the operating well stock. From this table, it can be seen that as of 01.01.2022, the operating factor of the wells in the Sharkiy Berdakh section is 0.972, in the Uchsay section - 0.940, and for the entire field - 0.954, while the project value is 0.959. It is necessary to comply with project constraints, which necessitates the implementation of planned activities for GDI, GKI, etc.

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Despite the correct allocation of facilities for simultaneous separate development, irrational decisions were made to simplify the operating modes of these wells during the operation of wells using SE technology. Consequently, the active influence of residual water saturation, which formed during reservoir formation, was observed on the well's operating life.

The intensity of reservoir water rise depends on the pressure created on the reservoir. Depending on the parameters of the technological operating mode of the wells, the reservoir water is brought to the surface with sufficient reservoir energy. The resulting depression on the reservoir will increase the movement of reservoir water towards the gas production zone, blocking its path to the bottomhole, reducing reservoir pressure and productivity, and ultimately leading to a halt at low working head pressure.

IV. EXPERIMENTAL RESULTS

Figures 1-3 show graphs of the development of the GFC Sharkiy Berdakh as a whole and its sections separately. Based on the graphs presented in Figures 1-3 (not provided), it can be observed that since 2000, the rate of gas production has been gradually decreasing throughout the field, and at the initial stages of development, maximum gas extraction has been achieved. In the Sharkiy Berdakh section, the gas extraction rate is similar to the field, while in the Uchsay section, the decrease rate is more pronounced, which led to a significant rapid decrease in the existing well stock from the same section. The relative decrease in gas production rate is a probable consequence of the active movement of the gas-water contact, which can lead to a sharp decrease in gas phase permeability.

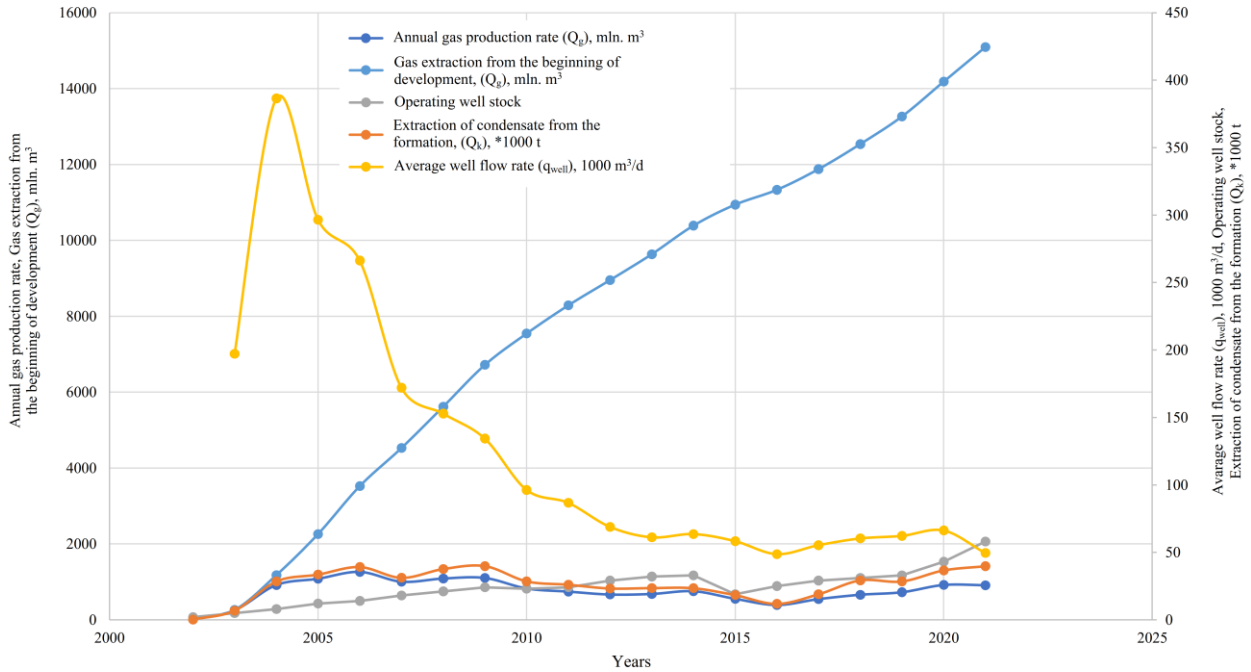

Figure 1. Schedules for the development of the GCF «Sharkiy Berdak» (according to the work [2])

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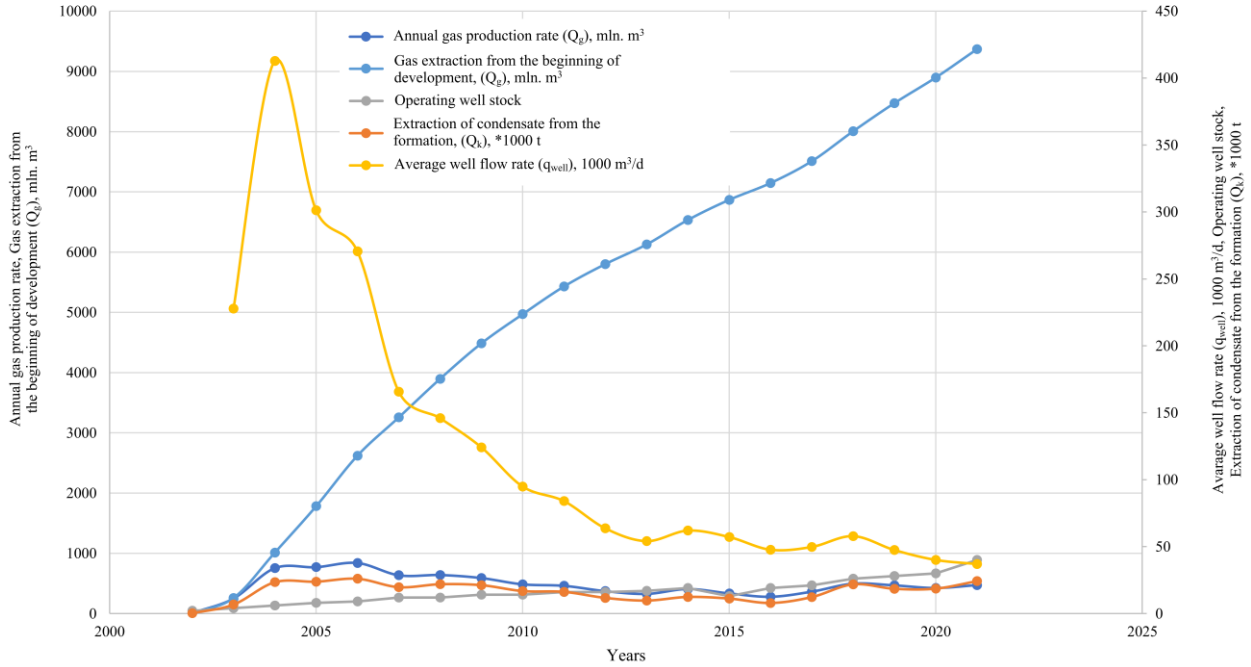

Figure 2. Development schedules of the Sharkiy Berdakh site (according to work [2])

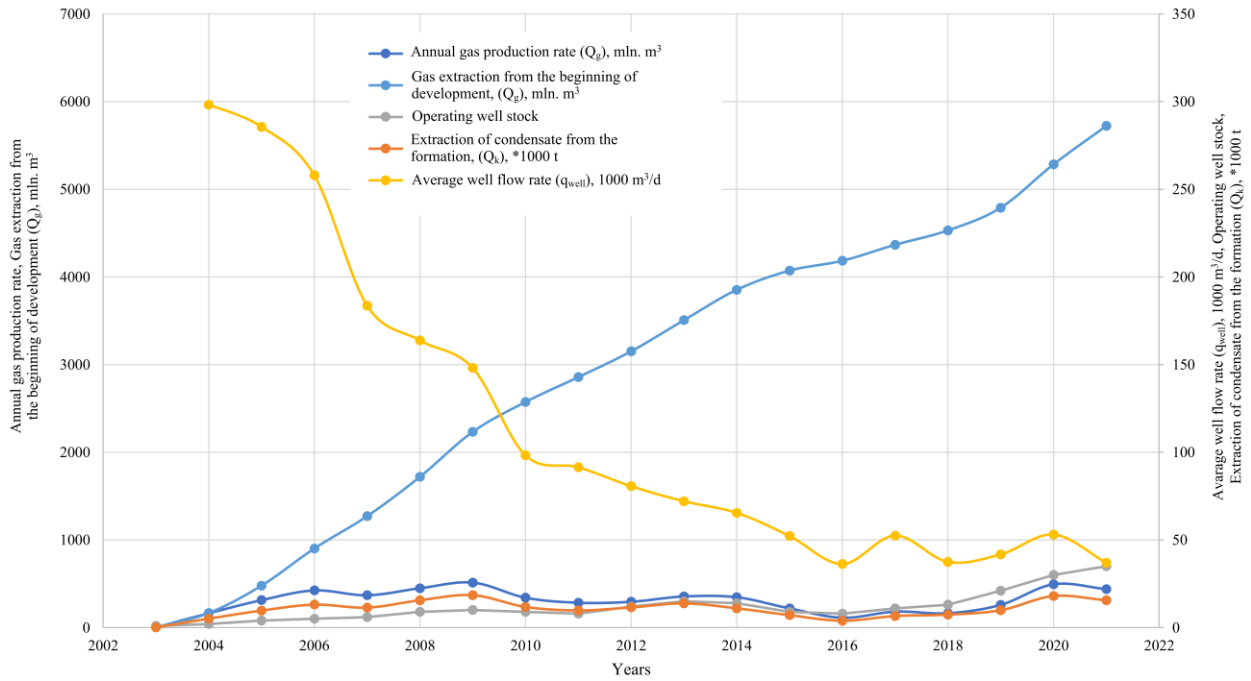

Figure 3. Development schedules of the Uchsay section (according to work [2])

To extend the operation period of wells at a specific site, it is recommended to conduct GDI before commissioning a well at a new site according to recommendation [9] - in 5-7 modes and, based on this, to create a proper technological regime for well operation with minimal fluid discharge from the reservoir. In addition, wells with low working wellhead pressure should be connected to a low-pressure wellhead, which must be introduced as the first stage of compression before

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supplying gas to the existing wellhead. Additionally, to increase the gas recovery factor and maintain production stability, it is recommended to implement methods for intensifying the inflow, such as hydraulic fracturing and additional perforation. Particular attention should be paid to monitoring the movement of the gas-water contact (GWC), especially in the Uchsay section, where a sharp decrease in productivity is observed. This will allow for the timely application of corrective measures and prevent premature waterlogging of wells. Additionally, it is necessary to analyze reservoir conditions and reservoir pressure, as extraction remains more stable in Sharkiy Berdakh, indicating the possibility of extending the operational period of this section when applying an adapted reservoir pressure management strategy.

V. CONCLUSION AND FUTURE WORK

The development of the Sharkiy Berdak Gas Condensate Field (GCF) faces challenges due to its complex multi-layered structure and deviations from project indicators. While simultaneous-separate exploitation (SE) technology has improved well utilization, issues such as reservoir water influence and pressure decline require further optimization. Regular gas-dynamic investigations (GDI) and improved reservoir pressure management are essential for sustaining production efficiency.

Future efforts should focus on refining geological models, enhancing hydraulic fracturing and perforation techniques, and implementing real-time gas-water contact (GWC) monitoring to prevent premature well flooding. Additionally, the use of digital twin technology for predictive reservoir modeling and research on enhanced gas recovery (EGR) methods can further optimize production. These measures will help ensure long-term gas field sustainability and efficiency.

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AUTHOR'S BIOGRAPHY

Full name	**Madreimov Aybek Axmet uli**
Science degree	-
Academic rank	Researcher
Institution	JSC "Uzbekneftegaz"

Full name	**Shafiev Rustam Umarovich**
Science degree	Doctor of Technical Sciences
Academic rank	Chief Scientific Officer
Institution	JSC "O'ZLITINEFTGAZ"