



Future Challenges in Water Control to Ensure the Long-term Development of Oilfield Assets

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Abstract. High water cut in production wells is one of the main challenges in the development of mature oil fields. This study examines the impact of increasing water production on the performance of the Bibiheybat and Gunashli fields operated by SOCAR “Azneft” Production Unit. Field production data, well stock distribution, and water cut levels were analyzed to understand their influence on well productivity and the efficiency of production infrastructure. The results show that excessive water production leads to lower oil output, higher operating costs, and faster deterioration of downhole equipment. The performance of traditional water isolation methods, particularly cement-based treatments, was also evaluated. Although these methods can temporarily block water channels, they may reduce reservoir permeability and limit oil production. The study highlights the advantages of selective water shutoff technologies, especially chemical treatments that target water-saturated zones while preserving oil-bearing intervals. The findings suggest that applying selective and field-specific technologies can improve production efficiency and extend the operating life of wells in mature fields.

Keywords: water shutoff, formation water, chemical methods, bottom hole zone, onshore and offshore oil reservoir, permeability.

1 Introduction

In mature oil fields, the improvement of production technologies and the implementation of integrated measures aimed at increasing oil recovery remain consistently relevant. Scientific research and analytical studies focused on enhancing the economic value of existing oilfield assets and ensuring the profitability of investments hold particular importance in this context. Since oil reservoirs are exhaustible natural and economic resources, their development must be carried out within a limited timeframe and with the maximum possible recovery factor.

Over time, the operation of mature oil fields is accompanied by various complications arising from physicochemical changes occurring within the reservoir and wells,

as well as technological and geological influences. Under such conditions, it becomes necessary to apply comprehensive, dynamic, and integrated approaches to the “reservoir-well-gathering” system.

During the development of oil fields, an increase in the water content of well production—that is, well watering or water cut and the complications associated with it affect all stages of this system [1,2]. This leads to significant technical, economic, and environmental challenges.

Currently, in SOCAR “Azneft” Production Unit (“Azneft” PU), the water cut in wells of long-term producing, i.e., mature oil fields, is a characteristic feature across all production facilities and is observed to increase over time due to natural causes. This phenomenon leads to a reduction in the operational life of oilfield assets and an increase in production costs within the oil and gas industry.

Although numerous scientific studies have been conducted in this area, the changing geological characteristics of reservoirs, variations in well operational regimes, and current production requirements specific to individual fields and well stocks keep the issue of water control and management constantly relevant.

Thus, the implementation of new technologies for water control, and the selection of innovative and technically economic efficient chemical and physical methods have become one of the main research and development directions in modern petroleum engineering.

2 Current Production Conditions and Challenges

Currently, “Azneft” PU operates 16 onshore and 13 offshore oil fields. In this article, the research and analyses were primarily conducted on the “Bibiheybat” and “Gunashli” fields.

The Gunashli field is characterized by a complex tectonic structure, which results in its division into separate tectonic blocks that differ from each other in terms of geological-lithological, geological, and hydrogeochemical properties due to longitudinal and transverse faults. In cross-section, 11 productive operating objects are distinguished.

The Bibiheybat field, similar to other fields of the Absheron Peninsula in terms of the lithofacies of sediments, consists of alternating layers of sand, clay, and sandstone of varying thicknesses, and is distinguished by 29 independently producing horizons.

Both onshore and offshore, the formation water plays a particularly significant role as a primary source of water cut. During long-term reservoir operation, water tongues forming within the reservoir and moving toward the wellbore facilitate the entry of formation water into oil-bearing zones and compartments of the rock, a process that is accompanied by severe water breakthrough.

As a result, unexploited oil zones are created, which leads to a reduction in the overall recovery factor and production performance of the field. Additionally, in the near-wellbore zone, the reservoir properties of the rocks deteriorate, the filtration pro-

cess slows down, and phase permeability for oil worsens. As water production continues to increase, the destruction of the near-wellbore skeleton intensifies, leading to sand production [3,4].

An increase in water and mechanical mixtures in the wellbore adversely affects downhole equipment and further stimulates pulsations in well operations. These conditions disrupt the technological operating regimes of wells, ultimately reducing well flow rates. In some cases, water cut can even lead to the complete abandonment of the well in a short period.

Such phenomena negatively impact the long-term development of existing infrastructure and oilfield assets. Therefore, the efficient development of assets and the implementation of economically effective oil and gas operations are only possible by preventing these production-technological complications and challenges.

In onshore fields, water cut is generally field-wide and affects the entire production area of the reservoir. In the Bibiheybat field, which has the highest production share among these fields, operational experience has shown that over time, an increase in water content in well production creates a series of technological problems in wells and production-collection systems.

Severe water cut negatively impacts the performance characteristics of the main artificial lift methods used in the field, namely rod (sucker rod) pumps and electric submersible pumps (ESP). As a result, the technological operating regimes of wells are disrupted, and downhole equipment—particularly pumps—suffers from corrosion and scale deposition, which reduces well workover interval.

Additionally, the tubings of wells wear and damage due to erosion of threads and surfaces, leading to an increased number of repairs. The presence of various salts in produced water frequently causes deposits in well flowlines, which creates operational difficulties and negatively affects the ability to maintain reliable, uninterrupted production [5-7].

Under conditions of 90% water cut in a field, the periodic increase in water volumes necessitates the implementation of comprehensive measures to ensure ecological safety and maintain the efficiency of the production system. These measures include the upgrading of water injection infrastructure, increasing the number of injector and production wells, and enhancing their injectivity and productivity. When combined with the challenge of maintaining emulsion stability within the production system, these measures lead to increased economic costs and significant energy consumption.

The above-mentioned factors are particularly critical for offshore fields, where a substantial portion of oil production is obtained. For example, the Gunashli field provides more than 60% of the total oil production of the PU, with a water cut exceeding 30%. The dynamics of oil production, water production, water cut percentage, and the active well stock in the Gunashli field over the past ten years are presented in Figure 1.

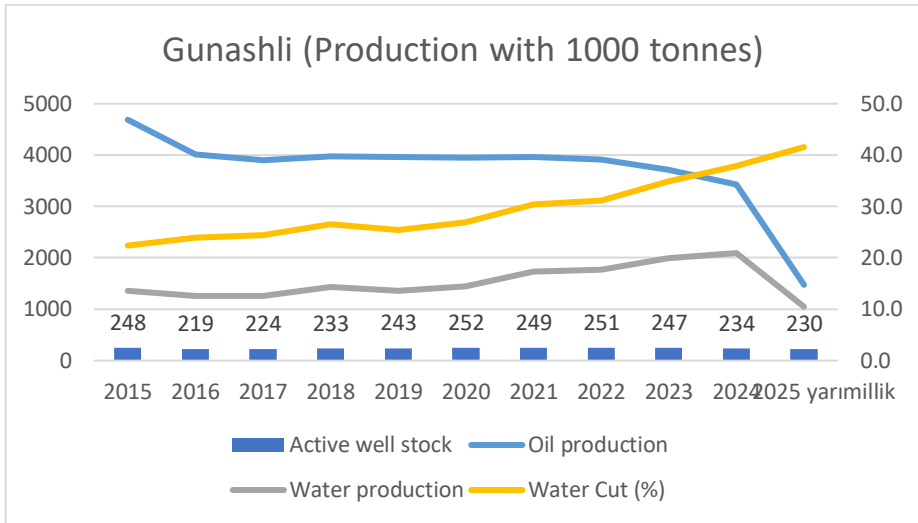


Fig. 1. Dynamics of oil production, water production, water cut (WC), and active well stock in the **Gunashli field** from 2015 to 2025.

As shown in the figure, in recent years there has been an increase in the volume of produced formation water. Managing and disposing of increasing formation water volumes in offshore environments, while protecting the ecological condition of the marine area, is accompanied by characteristic infrastructure challenges. In the figure, oil production in the Gunashli field remained relatively stable until 2022. The increase in the active well stock-through the commissioning of new wells and implementation of geological and technical measures-played a significant role in maintaining this stability. After 2022, the sharp increase in water cut and the corresponding decrease in production indicate that the reduction in the number of operating wells and production volumes aligns with the rise in water cut. Thus, in recent years, water cut in well production has had a significant impact on overall oil output.

Specifically, the complexity of offshore production infrastructure and technological limitations, the loading of oil gathering and processing equipment, the rise in operating pressures in transportation collectors, and the associated increase in energy consumption highlight the need for systematic and effective management of these issues. Thus, particularly in offshore oilfield facilities, it has become necessary to develop energy-efficient, technologically robust, and environmentally safe industrial solutions to control well water cut and efficiently manage formation water.

Factors that accelerate well water cut include the multilayer nature of the reservoir, heterogeneity of the rocks in terms of permeability and oil saturation, and high liquid production rates. These characteristics complicate the optimization of selected chemical formulations and the assurance of their efficiency. Therefore, scientific research conducted under such conditions requires a highly integrated and comprehensive approach.

The changes observed in the active well stock as a result of increasing water cut are presented Figure 2. As can be seen from the figure, due to the annual increase in water

cut and the associated technological complications in wells, changes in the active well stock are inevitable.

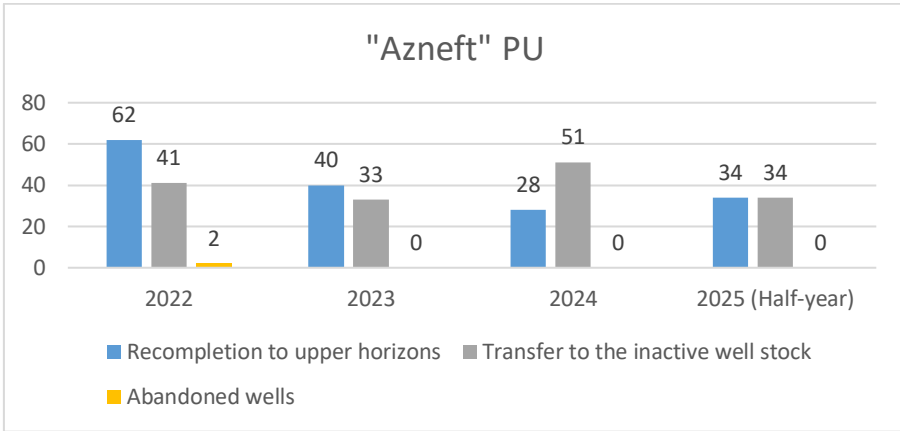


Fig. 2. Annual dynamics of well stock distribution in “Azneft” PU from 2022 to 2025.

Although various water sources-such as injected water reaching the wellbore, the activity of bottom and top waters, and behind-barrier leakage-manifest in the production system, the impact of formation water is the primary reason for wells being withdrawn from active operation.

The data indicate that in recent years, the number of wells in “Azneft” PU that were placed into inactive stock for maintenance or were forcibly returned to upper horizons due to water cut has been quite significant. For example, in 2024, the number of wells placed into inactive stock was 2 in the Gunashli field and 6 in the Bibiheybat field, while the number of wells recompleted to upper horizons was 2 and 12, respectively.

During the maintenance period, production losses occur. Additionally, during the well return operations, residual oil volumes in the lower horizons are necessarily left behind, and these horizons are consequently abandoned.

In Figures 3 and 4, the distribution of wells in the producing stock according to water cut is presented as of October 1, 2025. The analysis is based on the results of separate studies conducted for the Bibiheybat and Gunashli fields. Considering the active well stock and water cut, the impact of well water cut on the production system is clearly evident.

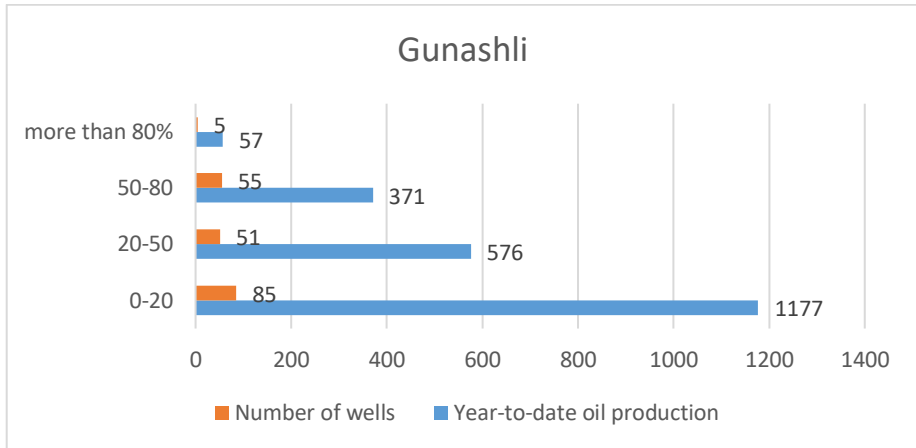


Fig. 3. Water cut (WC) in the producing well stock as of October 1, 2025.

As shown in Figure 3, in the Gunashli field, wells with a water cut (WC) of up to 20% produced over 1,100 thousand tons of oil since the beginning of the year. The figure, based on conducted studies, also shows that there is a significant number of wells with water cut exceeding 50% in the field.

The well stock mainly consists of wells operated using the gas-lift method. Considering the high production rates of gas-lift wells, it should be noted that an increase in the water fraction in well production raises the hydrostatic pressure in the wellbore, which, in turn, increases the bottom-hole pressure.

As shown in Figure 4, a large portion of the producing well stock consists of wells with water cut (WC) exceeding 80%, and the production volumes from these wells are correspondingly high. This indicates that it is necessary to reduce the impact of formation water in both low and high water cut wells, extend the operational life of wells, and implement modern technological approaches.

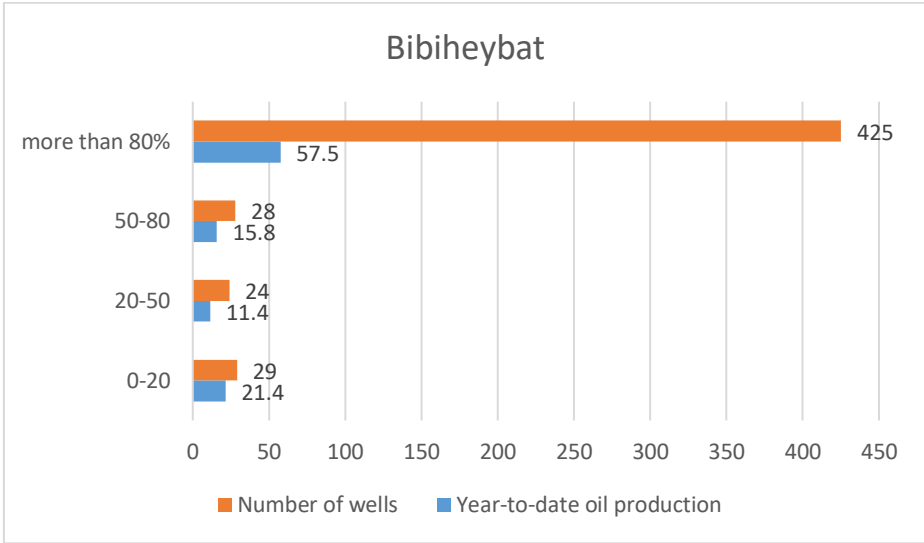


Fig. 4. Water cut (WC) in the producing well stock as of October 1, 2025.

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Information on the application of cement slurry for water isolation in the near-wellbore zone to prevent water cut is presented separately for the Gunashli and Bibiheybat fields in the following figures (Figures 5 and 6).

Cementing is one of the simplest and most widely used methods. By pumping cement slurry into the near-wellbore zone, water tongues are blocked, and this method is regularly applied during production operations .

Based on the figures, comparing production before and after cementing applications shows a significant difference, which can be explained by the successful and high-quality implementation of the method, despite its non-selective nature. It should be noted that although this method is economically favorable, technically simple, and supported by extensive engineering experience, the cement slurry penetrates the formation pores along the near-wellbore zone, sharply reducing permeability and deteriorating the reservoir properties of the rock. This limits the maximum achievable oil recovery.

Such non-selective methods create a non-degradable screen around the near-wellbore area over time, which necessitates re-perforation of the wells [6,7]. Analysis shows that in the Gunashli field, water tongues at the well bottom are effectively blocked during applications, allowing oil-bearing sections in the near-wellbore zone to be brought under depressurization and resulting in high post-treatment production.

In contrast, in the Bibiheybat field, due to field-wide water cut, formation pressure decline, and deterioration of the near-wellbore skeleton reservoir properties, blocking the well bottom zone with cement does not lead to a significant increase in production.

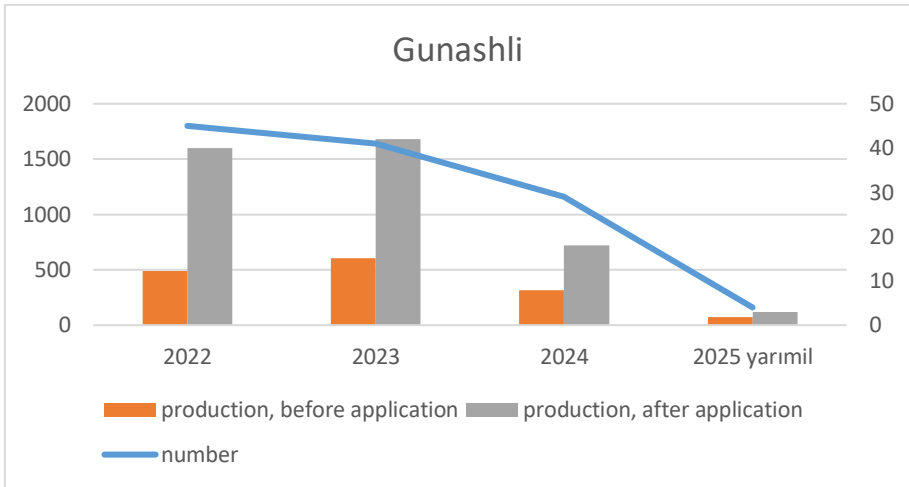


Fig. 5. Application of cement slurry for water isolation in the Gunashli field

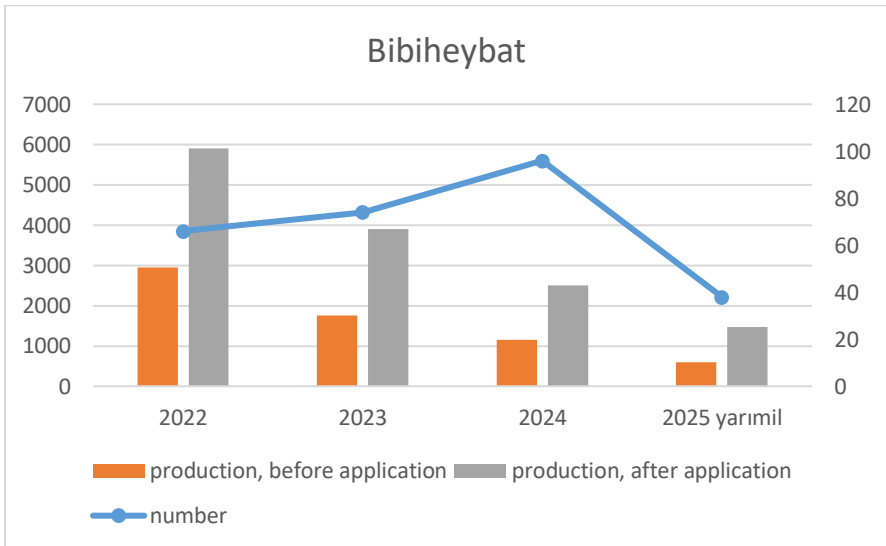


Fig. 6. Application of cement slurry for water isolation in the Bibiheybat field

The selection of methods and technologies to mitigate water cut is one of the key factors determining the success of water isolation measures. The effectiveness of geological interventions and remedial isolation work can be significantly enhanced by accurately determining the geological and physical properties of the reservoir layers in

the respective fields. Based on the data and analyses presented above, the application of selective methods is considered more feasible and promising.

The use of selective methods is particularly important, as the injected material only creates flow resistance in the water-saturated zone of the layer, leaving the oil-bearing zone unaffected. Selective methods are especially effective in layers exhibiting high anisotropy. The main requirements for choosing such methods include:

- Ensuring selective penetration of the isolating material into the water-saturated zone to the required depth and direction.
- The ability to adjust the physical-chemical and rheological properties of the material over a wide range.
- Availability of the material and economic feasibility.
- Non-toxicity and safety of the material during handling.

In global practice, chemical methods are widely applied for this purpose. These include gelling systems, foam systems, precipitation-forming reagents, and polymer-based compositions. Based on the analyses above, the pilot application of chemical methods shows clear potential in both the Bibiheybat and Gunashli fields.

3 Conclusion

The water cut process in wells has a multifaceted and significant negative impact on the production system and the overall petroleum infrastructure. This effect is particularly pronounced in mature, late-stage reservoirs. To ensure the long-term and sustainable development of oilfield assets, it is necessary to develop comprehensive, scientifically justified, and practically applicable approaches to mitigate water cut in the active well stock. Considering the typical geological and production characteristics of the fields, selective treatment technologies have significant potential as a promising direction for future research and practical applications. In selecting compositions for water cut mitigation, accurate evaluation of geological and technical parameters and comparative analyses are of decisive importance for determining the appropriate type of chemical method.

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