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Original Article

Technical Study and Design of Options for Instructive Experience for Stabilizing Oil Production and Controlling Water Cut in Wells of the Horizon-North Deposit of the Zhana-Zhol Field

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Abstract - *Investigating strategies to stabilize oil production rates and control well water cuts is critical to the stability of the energy industry and the economy as a whole. The study aimed to analyze methods for eliminating errors in improving oil production rate stabilization and controlling well water cuts, particularly in the Zhana-Zhol field. This study used a secondary data analysis that included comparative, thematic, and analyses of peer-reviewed studies, technical reports, and industry data. During the research, the peculiarities and differences of project options for instructional experiments were noted, and errors and reasons for errors in improving oil production rate stabilization were analyzed. The analysis of oil production rate stabilization is crucial for evaluating the efficiency of oil extraction, development, and the complexity of operations during oil processing. Issues such as analyzing the functioning of oil extraction mechanisms, the practicality of utilizing well data, the restrictions of the process, the influence of limits on outcomes, and recommendations were offered to assist in establishing an effective regulatory framework. It was determined that implementing oil production rate stabilization and effective control of well water cut at the Horizon-North field are important for ensuring the long-term sustainability of oil extraction. The work's practical significance is from the potential use of the acquired results to address errors in establishing and enhancing oil extraction mechanisms and the general research on the dependability of well applications.*

Keywords - *Energy dependence, Industrial sector, Extraction of raw materials, barrels, Active exploitation.*

1. Introduction

The regulation of oil production rates and managing water cuts are critical for increasing oil output, particularly in regions like Zhana-Zhol. These characteristics improve well-being and contribute to the sustainability of production operations, which is critical for energy security and economic stability in resource-dependent countries. Nonetheless, despite the importance of these processes, significant gaps remain in developing efficient methodologies and procedures for their optimization. Horizontal wells have altered hydrocarbon extraction by enhancing the interface between producing reservoirs and the wellbore, resulting in more efficient oil and gas recovery. As asserted by M.R. Yusupov and K.A. Ihsanov [1], horizontal wells facilitate increased contact with productive reservoirs, leading to more efficient oil or gas extraction. There is a need for improvements in oil pumping mechanisms to address challenges arising during these machines' development and operation stages. These challenges stem from the necessity of determining and optimizing parameters during equipment design, operation, and development. Furthermore, horizontal wells can increase the length of the water-cut zone in the productive reservoir, potentially resulting in higher production. Using horizontal well technology is consistent with the global trend toward increased and sustainable hydrocarbon extraction, according to I.Kh. Khalismatov et al. [2], drilling horizontal wells can reduce overall energy costs and simplify extraction processes compared to vertical wells. This efficiency is significant in mature oilfields, where decreasing reservoir pressure and increased water production create operational challenges. These wells support enhanced oil recovery (EOR) technologies like hydraulic fracturing and water or gas injection, which are critical for stabilizing production rates and increasing final recovery. A.K. Zhakay et al. [3] stated that drilling horizontal wells, such as hydraulic fracturing, can be used for more effective reservoir stimulation. However, they acknowledged the environmental risks of increased well density. To achieve the same production rates with fewer wells, innovations in wellbore design and stimulation techniques are required to lessen environmental problems while increasing output.

According to N.U. Batirova [4], the gas and liquid movement conditions in the wellbore and near-wellbore zone of the reservoir significantly influence the technological regime of oil-producing wells and key development indicators. Efficient regulation of these conditions is critical for increasing output while maintaining reservoir integrity. Furthermore, understanding the interplay of gas and liquid flow dynamics may help operators manage water cut levels, directly impacting economic returns and operational efficiency.

A. Taha et al. [5] noted that ensuring optimal pressure distribution in the near-wellbore zone is key for effectively displing oil and gas from reservoir pores. Nonetheless, water cut management is an understudied subject that warrants further exploration, particularly in horizontal well applications. Elevated water cut levels may significantly reduce production efficiency and increase operating costs, emphasizing the need for effective diagnostic and response procedures. K. Yelemesov et al. [6] stressed that proper flow conditions influence the effectiveness of pressure maintenance methods, such as water or gas injection, affecting the production level. These methods improve reservoir pressure and sweep efficiency, resulting in higher recovery rates. Advances in pump design, flow modeling, and real-time monitoring systems may considerably increase the efficacy of horizontal wells, making them more adaptable to changing reservoir conditions [7, 8].

A major difficulty in oil production is the need for comprehensive solutions to enhance oil production stabilizing devices. Contemporary techniques usually overlook the complex dynamics of gas and liquid interactions in the near-wellbore zone, which can significantly alter water cut levels. Although horizontal well technology has been extensively investigated, its influence on production stability and water cut management warrants more inquiry. This study aims to bridge these gaps by focusing on the Zhana-Zhol field and leveraging automation and mechanization to improve oil production efficiency and sustainability. The originality of this research stems from its tailored integration of current methodologies aimed at addressing specific challenges confronting rising nations. It seeks to increase the economic viability of oil extraction techniques and environmental sustainability in these regions. This study aims to objectively analyse methodologies for identifying problems and errors in improving the quality of oil production rate stabilization and well water cut control. The study is based on data from the Zhana-Zhol field. Special attention is given to evaluating the effectiveness of extraction mechanisms using full automation and mechanization, which are considered key elements for the sustainable development of pumping systems at the current stage of mechanism evolution.

2. Literature Review

Previous research has extensively studied ways for stabilizing oil output, emphasising boosting crude oil recovery and production system efficiency. For example, Olugbenga et al. [9] researched the use of Response Surface Methodology and ASPEN HYSYS software to model and simulate crude oil stabilization processes, indicating energy-saving improvements as a crucial area for optimization in oil production. Their findings indicate that a more sophisticated modeling technique can improve the operating efficiency of stabilizing systems, resulting in greater energy use and cost-effectiveness. Despite these gains, the study identified significant restrictions due to the difficulty of real-time system modifications, mainly when dealing with shifting reservoir levels. This highlights the need for more innovation to address dynamic changes in oil properties during extraction.

Furthermore, research on chemical demulsification and stabilization has helped better understand the complexities of stabilizing crude oil emulsions. Yonguep et al. [10] examined the production and stability of crude oil-in-water emulsions, noting that chemical treatments have proved efficient in demulsification but are not without limits. These procedures frequently need precise management of chemical doses, which can lead to difficulties such as higher costs and the possibility of environmental effects. This study provides insight into the need to improve chemical stabilization processes, implying that more environmentally friendly and cost-effective solutions are required for long-term sustainability in oil production. Pei et al. [11] studied the synergistic stabilization of emulsified solvents using nanobentonite and alkylethoxyglucoside to increase heavy oil recovery. While the results showed a beneficial influence on recovery, the study also highlighted the difficulties of implementing such technologies on a broader scale, as the usefulness of nanomaterials varies depending on the oil's unique qualities and reservoir circumstances. Furthermore, the technique necessitates extreme material handling and dose accuracy, hindering its widespread implementation.

Furthermore, research on sand stabilization approaches, such as Song et al.'s experimental evaluation of chemical sand stabilization [12], shows that chemical treatments can improve sand management in oil wells. While these technologies have shown promise in enhancing production stability by reducing sand generation, they are not universally applicable to all reservoir types, and their efficiency is frequently restricted by the field's unique geological and hydrodynamic features.

Research by Tao et al. [13] on regulating water and stabilizing output in heavy oil reservoirs with edge-bottom water highlights the complicated relationships between water management and production stability. These technologies have been critical for maintaining oil production rates in areas with a high water presence. However, the study admits that while such measures can minimize water cuts and increase output, they confront issues like maintaining long-term reservoir pressure and controlling water injection costs. These prior studies demonstrate the ongoing endeavor to improve oil production stabilization methods while emphasizing the limits of present systems. Despite developments, many technologies still confront cost, scalability, and environmental concerns.

3. Materials and Methods

This study utilized a secondary data analysis strategy, drawing on current research, industry reports, and publicly accessible data to investigate the problems and optimization approaches for horizontal good performance in hydrocarbon reservoirs. The data sources were carefully chosen to guarantee their relevance and dependability, concentrating on peer-reviewed scientific publications, technical reports from oil and gas firms, and industry standards. The major focus was on data from the Horizon-North reservoir of the Zhana-Zhol field, which provides unique issues such as high-viscosity oil, carbonate structures, and increased water cut levels. The main research was chosen for its relevance to oil production stabilization methods, emphasising high-viscosity oil extraction, sulfur compound control, and reservoir pressure optimization. Databases such as ScienceDirect, SpringerLink, and OnePetro were extensively searched for terms such as "oil stabilization", "horizontal wells", and "sulfur management". Statistical summaries of production data, such as flow rates, water cut levels, and sulfur content, were obtained from the literature. To ensure that the study represented current developments, only articles from 2010 and after were considered. The data included information on 20 wells from various sites, each with geological and operating characteristics similar to the Zhana-Zhol field. These wells were chosen based on their relation to the study's goals, which included high-viscosity oil extraction and reservoir pressure maintenance. At the initial stage of the research, a fundamental theoretical foundation was developed, serving as the basis for subsequent analysis and forming the groundwork for concluding.

The current study used a combination of comparative analysis, thematic analysis, and systems analysis to assess the performance and optimization of horizontal wells in hydrocarbon reservoirs. A comparative study determined horizontal and vertical wells' benefits, emphasising criteria such as water cut levels, flow rates, and extraction efficiency. From a systematic evaluation of secondary sources such as peer-reviewed journals and technical reports, thematic analysis was used to uncover repeating patterns and organize data into major topics, including well-watering control, reservoir pressure maintenance, and sulfur management. Furthermore, systems analysis was employed to investigate the relationships between operational mechanisms, reservoir features, and production systems, which allowed for the discovery of interdependencies and optimization potential.

These approaches provided a comprehensive framework for integrating information from many sources and developing practical measures to improve oil production stabilization operations. Using the structural-functional method, trends, factors, and models aimed at improving the control of well water cut in the Horizon-North deposit of the Zhana-Zhol field were analyzed. Effective solutions to problems related to errors in developing and improving oil and gas processing system maintenance and their components were identified. Additionally, improvement methods and innovative mechanisms were studied to reduce inaccuracies in their operation and optimize performance at various stages of development. The deduction method was employed to consider the features of the operation of horizontal wells, which allow for increased contact area between the well and the productive formation, contributing to more effective oil extraction. Characteristics of the length of the horizontal section of these wells are necessary for a comprehensive analysis of their operation and problem-solving in the oil extraction process, particularly in the implementation of oil extraction mechanisms, which were highlighted.

The practical part of the study, using computer modeling methods, involved studying the basic principles of operation and problems in developing and applying mechanisms for oil extraction. Their advantages and disadvantages and interaction with the overall industrial sector were considered. A crucial stage was the examination of the prospects for using horizontal wells on an international level, serving as the basis for creating a standard scheme for hydrodynamic research. The research also included an analysis of the process's activity to improve oil production rate stabilization and its operational mechanisms. The developed methods aim to reduce possible errors in improving well water cut control systems, which is crucial for determining development efficiency and prospects for oil potential. Using a synthesis method, indicators were gathered, evaluated, and derived from theoretical research and practical experience to offer suggestions for overcoming problems and supporting progressive growth. The emphasis was centered on improving the quality of oil industry mechanisms and reducing mistakes. In addition, we provided prediction models and design solutions for the essential components involved. The method of analysis, logical and functional types, allowed us to consider in more detail the concept of "technical study and design options for instructional experience on stabilization of oil production rates and well water cut control in the Horizon-North deposit of the Zhana-Zhol field", which in turn helped to understand the situations in which it is difficult to apply well control. These types of methods allowed for the characterisation of the features and principles of the functioning of oil production stabilization and pumping processes. The operational complexity of mechanisms under specific conditions and their effects on fulfilling the needs of the population and user requirements were analyzed, as well as the climatic conditions under which it is more difficult to apply control and measurement systems and, in general, to carry out oil and gas production based on the characteristics of wells and oil production rates were considered.

4. Results

The use of horizontal wells allows for an increased reservoir contact area. This is achieved by the horizontal section of the well traversing a more significant portion of the reservoir, enhancing hydrocarbon recovery efficiency. The expanded reservoir contact also contributes to a more uniform distribution of production across the field, which can improve overall productivity and economic efficiency. Research in horizontal wells differs from that in vertical wells, primarily due to the complexity of flows in horizontal wells [14]. In horizontal wells, flows have a more intricate structure due to changes in the flow direction [15]. This can impact the distribution of pressure and temperature in the reservoir, requiring more thorough research for accurate interpretation of results. Horizontal wells often penetrate various geological layers, leading to more complex hydrodynamic interactions between different formations, necessitating consideration in research [16-18].

In the case of a group of horizontal wells, more substantial mutual interference may occur, requiring consideration in data analysis. Due to the complexity of flows in horizontal wells, selecting research methods, such as permeability tests, may require additional adaptations and refinements. Research in horizontal wells demands a more meticulous approach to data analysis and consideration of hydrodynamic behavior peculiarities in such wells. Accurately determining horizontal wells' operating modes and technological parameters is crucial [19]. Investigating and analysing data on the performance of horizontal wells become key elements in ensuring optimal field operation and maximizing hydrocarbon recovery. Challenges related to flows in horizontal wells, their interaction with the reservoir, and their impact on productivity emphasize the importance of precisely determining operating modes. This includes determining permeability, production rate, pressure, and temperature.

Table 1. Impact of acidizing treatments on carbonate reservoirs

Parameter	Pre-Treatment	Post-Treatment	% Improvement
Permeability (mD)	80	120	50%
Production Rate (bbl/d)	250	375	50%

Source: [30].

Modern research methods, computer modeling, and the use of advanced technologies in monitoring and managing extraction processes are necessary to address this issue. This can assist field operators in making informed decisions to optimize the operation of horizontal wells and enhance overall hydrocarbon recovery efficiency [20-23]. Acidizing treatments are a technological method of reservoir stimulation to improve permeability, especially in carbonate reservoirs [24]. Carbonate deposits often characterise the Turnayisk formation, and developing such deposits requires specific approaches. High-viscosity oil and difficult-to-recover reserves provide substantial hurdles in several fields, including Zhana-Zhol [25-27]. Case studies such as those by Akhmetov et al. [28] show how ground chain drives for rod pump units can increase extraction efficiency for high-viscosity fluids. Furthermore, as demonstrated by Heng et al. [29], gas injection methods utilised in fractured carbonate reservoirs assist in maintaining reservoir pressure and stabilizing production in difficult conditions. Acidizing treatments in carbonate reservoirs have been shown to increase critical metrics like permeability and production rates significantly. Table 1 shows results from experimental research and field applications on carbonate reservoirs, which included acidizing treatments and measuring permeability and production rates. The findings include samples from comparable formations and field data from oil wells.

As indicated in Table 1, the findings highlight the ability of acidizing treatments to improve hydrocarbon extraction from difficult carbonate deposits greatly. Additional research and development are needed in the application of acidizing treatments to optimize extraction in fields with high-viscosity oil and hard-to-recover reserves in carbonate reservoirs of the Turnayisk formation [31]. The issue of processing crude oil and condensates with high sulphur compound content, such as hydrogen sulphide, mercaptans, disulphides, and sulphides, is becoming increasingly relevant in environmental protection. When burned, sulfur compounds can lead to emissions into the atmosphere, contributing to air pollution and the formation of acid rain. Sulfur compounds, especially hydrogen sulfide and certain mercaptans, are toxic and can negatively impact human health and ecosystems [32, 33]. Sulfur in oil can contribute to equipment corrosion during oil products' extraction, transportation, and processing. Depending on legislation and regulations, many regions require processing facilities to adhere to specific quality standards, including sulfur compound content levels.

Table 2. Reduction in sulphur compound levels after treatment

Sulphur Compound	Before Treat ment (ppm)	After Treatment (ppm)	Reduction (%)
Hydrogen Sulphide	1200	600	50%
Mercaptans	300	150	50%

Source: [35].

In areas such as Zhana-Zhol, the impact of sulfur emissions on public health is a major concern. Aitmaganbet et al. [34] discovered a direct link between sulfur emissions from oil extraction and higher morbidity rates in surrounding communities. These findings highlight the need for enhanced stabilizing and emissions control technology to reduce the negative impact on human health and the environment. However, the efficacy of sulfur compound reduction procedures is crucial in addressing these environmental and operational concerns.

Table 2 displays results from 18-month treatment studies on crude oil and condensates with high sulfur concentrations. Over 20 experiments assessed decreases in hydrogen sulfide and mercaptans before and after therapy. As seen below, processing procedures may dramatically reduce sulfur compounds in crude oil and condensates. These findings emphasize the need to deploy modern treatment techniques to reduce sulfur compounds' negative impacts on equipment, human health, and the environment.

To address these concerns, it is critical to develop and execute effective processing technologies and procedures that reduce sulphur compound concentration while limiting environmental damage [36]. Continued progress in these areas will assure compliance with demanding quality requirements while safeguarding ecosystems and public health. Technical research and design concerns for stabilizing oil output necessitate a methodical approach and extensive analysis. The oil production stabilization method seeks to provide a consistent and optimum oil flow from wells. El-Sadi et al. [37] demonstrated the value of structured technical improvements in horizontal well drilling. New drilling tactics result in a 35% learning curve acceleration and considerable savings in well delivery time. These innovations increase well efficiency and illustrate the need for ongoing learning and technological integration to tackle technical issues in hydrocarbon recovery.

Analysing the chemical composition of oil helps understand its physicochemical properties, which is crucial for developing stabilization methods. Researching temperature, pressure, and gas content can help determine which parameters affect oil production. Developing chemical stabilization methods involves selecting and optimizing oil-stabilising chemical substances, such as anti-icing inhibitors or additives, to reduce viscosity [38].

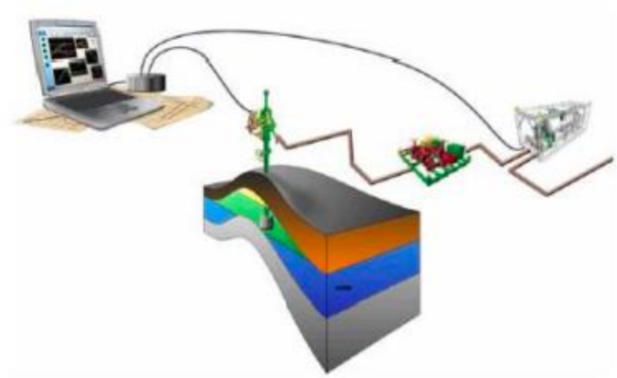

Fig. 1 Typical hydrodynamic study scheme

Source: [39].

Developing a system to control technological parameters in the well is a crucial step in ensuring effective management of the oil production stabilization processes. Effective water cut control is the ability to properly monitor, analyze, and manage the water-to-total liquid volume ratio produced by a well, ensuring maximum oil recovery while minimizing water-related inefficiencies and negative environmental impacts. Identifying key parameters affecting oil production stability, such as pressure, temperature, gas content, and oil viscosity, is necessary. Determining the types of sensors and equipment used to measure and monitor critical parameters is vital. This may include pressure sensors, temperature sensors, level sensors, and gas analysers. Temporary technical equipment for data recording is placed at the bottom of the well and on its surface (Figure 1).

Data on the flow rate from the analysed well and neighbouring wells is required for interpretation. It is also important to record the response time to changes in bottomhole pressure during pressure build-up. It is recommended that the response time be recorded throughout the entire production period. In addition to pressure and flow rate information, data on the physical properties of the reservoir fluid, pressure-flow rate-volume relationship, geological structure, and logging results are also necessary. Water cut in oil production is the percentage ratio of the volume of water to the total liquid volume (oil+water) produced from a well [40]. This indicator plays a crucial role in oil production because the higher the water cut, the more water is extracted from the mixture. Increased water cuts can affect production efficiency, as water, compared to oil, often has a lower value and may require additional efforts for treatment and disposal. Determining and controlling water cuts are essential in managing oil production.

Methods for measuring water cuts may include using special sensors, analysers, and laboratory tests. Knowing the water cut level helps well operators make decisions to optimize production, implement appropriate technologies, and minimize the negative impact of water on the oil production process. To control water cuts in wells at the

Horizon-North reservoir of the Zhana-Zhol field, it is important to apply systems and methods specifically adapted to the characteristics of this reservoir. The placement of sensors and analysers capable of measuring water cut in the liquid stream from each well is necessary. This can be achieved using modern automated systems. Regular data collection on well water cuts is also needed. This may include both continuous monitoring and periodic measurements under various production conditions. An effective water cut control system helps ensure the production process's stability and minimises water's negative impact on the quality of the extracted oil.

Hydrodynamic studies are essential to developing oil and gas fields [41, 42]. They give essential information for project documentation, field development analysis, and geological and technological planning. Recent advances in drilling performance, as proven in the study by El-Sadi et al. [37], show that utilizing operational learnings and current technology may result in efficiency benefits and cost savings in horizontal Enhanced Geothermal System wells. Specifically, consistent drilling rates of 70 feet per hour and drilling time reductions of more than 60% demonstrate the possibility for fast performance improvement via controlled trials and the integration of geology and technical learnings.

These findings highlight the need to enhance hydrodynamic studies to include information from modern drilling technologies for improved production results. Research assists in determining how fluids (oil, gas, water) are distributed within the reservoirs. This may include estimating reserve volumes, their extraction degree, and the potential impact on production. Hydrodynamic analysis can also reveal how fluids migrate within the field, which is important for predicting the movement of production fronts and the efficiency of various extraction methods.

Hydrodynamic studies may include an assessment of reservoir permeability and porosity, which is crucial for determining the feasibility of extraction and selecting optimal reservoir impact methods. Based on the results of hydrodynamic studies, models can forecast production in different scenarios and determine optimal field development strategies. The oil production process in wells requires constant monitoring and management to maintain optimal operation. Important parameters such as pressure, water cut (water content), and flow rate (volume of produced product) can change over time due to various factors such as changes in reservoirs, the environment, or well characteristics. Real-time automated control systems are used to optimize the operation of oil-producing wells and increase their efficiency. These systems are equipped with sensors and tools that continuously monitor well parameters. When changes in pressure, water cut, or flow rate occur, control systems can make instantaneous decisions and implement control actions.

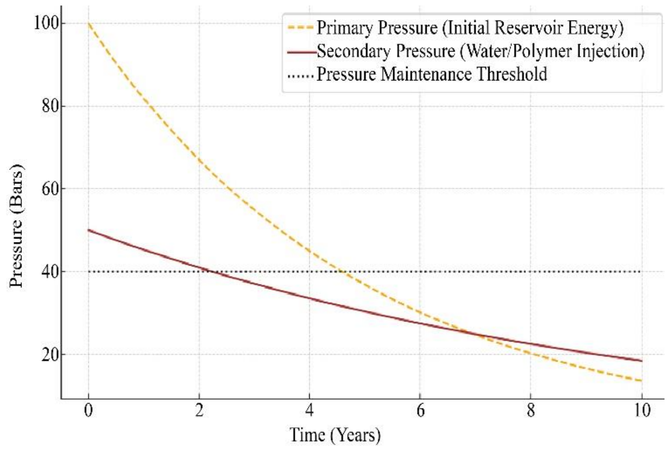

Fig. 2 Reservoir pressure and recovery process stages

Source: [43].

The process of oil extraction relies on the use of natural energy from the reservoir. At the core of this process is the reservoir pressure induced by the presence of hydrocarbons in porous rocks. This natural reservoir energy can push oil from the well to the surface. In the initial production stage, oil can spontaneously flow into the well when the reservoir pressure is sufficiently high. This process is known as primary production and may involve oil and natural gas extraction. Various secondary recovery methods are employed to sustain production when natural pressure declines. A common approach includes pumping water into the reservoir to increase pressure and enable oil displacement from the rock pores. This process may include water, polymer, or surfactant injection. Therefore, leveraging the natural energy of the reservoir is a crucial aspect of oil extraction, and engineers actively research and apply various technologies to optimize this process and enhance production yields. Figure 2 shows the progression of reservoir pressure over the primary and secondary recovery stages, emphasizing the need to maintain optimal pressure rates to maximize recovery rates.

In recent years, oil refining and petroleum manufacturing innovations have become increasingly significant. Advancements in deep oil refining methods allow for the production of higher-quality products, such as motor fuels with improved environmental characteristics and bitumens with enhanced properties. Using new catalysts and catalytic processing technologies improves cracking and hydrofining processes. Purifying oil from sulfur compounds using new technologies enables the production of fuels that comply with stricter sulfur content standards [44, 45]. Gasification and conversion processes can be applied to enhance the utilization of hydrocarbon resources and produce various products, including synthetic fuels [46, 47]. These technologies improve oil and petroleum product quality, reducing environmental impact and compliance with modern safety and sustainability standards. The development of technologies for determining and controlling the water cut level in oil production is an important aspect, as excess moisture can adversely affect the quality and efficiency of extraction. Extending the wellbore horizontally into the reservoir, these wells reach a greater formation volume than conventional vertical wells. This enhanced exposure promotes more effective drainage of hydrocarbons, resulting in elevated production rates. In heavy oil reservoirs, horizontal wells have demonstrated the potential to double oil recovery, increasing from 18% to 35%. [48]. Horizontal well fluid dynamics are complicated, resulting in uneven pressure distribution and changing flow rates that complicate reservoir management. They frequently penetrate geological layers, needing sophisticated modelling and analysis for production optimization [49-51]. Acid treatments increase permeability in carbonate reservoirs by dissolving rock minerals and creating conductive channels. Matrix acidization creates wormholes that circumvent formation degradation, increasing production. Acid composition, injection rates, and reservoir parameters determine efficient techniques. Recent advancements have centered on alternate acids and additions [52].

Horizontal drilling techniques have increased oil and gas production [53-55]. In 2024, US shale businesses considerably increased crude oil output by using longer well extensions and drilling numerous wells per pad, resulting in greater production rates with fewer rigs [56]. Recent technical improvements have considerably increased the efficiency of horizontal drilling, making it quicker, more cost-effective, and more productive [57]. One breakthrough is the capacity to frack numerous wells simultaneously, which improves resource use and decreases total well completion time [58]. This approach enables the fracturing of many wells simultaneously, simplifying the process and reducing downtime between phases. Additionally, using electric pumps has improved the accuracy and control of hydraulic fracturing procedures, lowering operational costs and energy consumption compared to traditional diesel-powered pumps.

This study exceeded cutting-edge methods using advanced hydrodynamic modeling, real-time monitoring, and specific secondary recovery processes. Unlike earlier techniques that depended on broad characteristics, it focused on reservoir-specific factors such as permeability variations, fluid composition, and water cut dynamics. Sophisticated automated control systems permitted continuous data collection and adaptable production adjustments, removing the inefficiencies of old measurement methods. Production mistakes are frequently caused by reservoir heterogeneity, which includes permeability differences and cracks, resulting in unequal water breakthroughs and increased water cuts. For example, incorrect horizontal well placement in fractured carbonate reservoirs can aggravate water intrusion and lower production [59]. Addressing distinct geological features requires tailored techniques. Stabilization relies heavily on the accuracy of monitoring systems and the dependability of manufacturing equipment. Inadequate sensor calibration, delayed anomaly detection, and poor real-time data integration can all cause errors. Outdated water cut measurement devices may fail to detect slow changes in water content, delaying correction operations. Advanced technologies like automated control systems and AI-powered models are critical for improving accuracy. Improper well spacing, poor completion techniques, and insufficient maintenance are common causes of operational problems. In conclusion, integrating horizontal drilling, advanced acidizing treatments, effective sulfur management, and real-time monitoring systems has substantially enhanced oil recovery and production efficiency. These technological advancements address the complexities associated with modern oil extraction, leading to more sustainable and economically viable operations.

5. Discussion

Pressure build-up curve analysis entails temporarily shutting down a well to record pressure variations in the reservoir, which provides critical data on features such as permeability and volumetric coefficients for efficient oil production management. However, this technology has certain disadvantages, including temporary output loss and increased expenses owing to resource needs. To reduce oil losses and save money, new technologies, such as non-contact approaches and improved computational data processing that do not necessitate total well shutdowns, are emerging. Adjusting downhole pump operating modes is one innovative strategy for increasing oil production rates, reducing water cuts, and improving overall efficiency. Operators can use variable-frequency drives to dynamically modify pump rotation speeds to match extraction requirements, maximizing fluid flow into the well. Furthermore, monitoring pump vibration and wear improves operating dependability while lowering maintenance costs. These innovations improve response to geological changes and production dynamics, producing optimal well performance. Oil recovery is an important measure, defined as the percentage of recovered oil compared to total reservoir volume. Current oil recovery measures the amount of oil extracted at a given moment, whereas predicted ultimate oil recovery calculates the projected extraction percentage from the total accessible oil. On average, this anticipated final recovery is about 15%, implying that around 15% of the total oil volume may be retrieved using various factors and technology. A thorough examination of the reservoir's unique physical and technical features is required to further understand how this recovery is accomplished, including the technologies utilized and the contributing variables.

The sono-catalytic oxidative desulphurization of oil is a technology applied for the deep processing of crude oil to enhance its quality and reduce sulphur content [60-63]. Using sono-catalysts (substances capable of enhancing the efficiency of catalytic processes under the influence of ultrasound) with oxidative reagents allows for more intensive and controlled oxidation and desulphurization processes. The Zhana-Zhol field is the subject of such research. Ultrasound waves generated by sono-catalysts stimulate oxidative reactions, contributing to the improvement of oil quality. The process aims to reduce the sulfur content in the oil, which is crucial for environmental reasons, as sulfur in oil can lead to the formation of sulfur oxides during combustion, contributing to air pollution. After desulfurization, processes for the regeneration and recovery of the sono-catalyst are necessary for reuse. These technologies aim to produce cleaner petroleum products that align with modern quality and environmental safety requirements. However, the methods and process characteristics of sono-catalytic desulfurization may vary depending on the catalysts, reagents, and technological conditions.

According to A. Mustafa et al. [64], hydrodynamic well studies involve comprehensive investigations conducted on shut-in and producing wells to measure various parameters, such as pressure, temperature, liquid level, and flow rate. These studies provide crucial data on the dynamics of well operation and reservoir properties. The results enable engineers and geologists to more accurately determine reservoir characteristics, optimize well operation, and make informed decisions regarding oil production. It is noteworthy that there is a similarity between this work and the researchers' work. However, the author's work does not mention that hydrodynamic well studies are integral to oil production control and management.

Referring to the definition by N. Tahouni et al. [65], it is essential to develop efficient management systems to optimise the operation of oil-producing wells. These systems should be equipped with modern measurement systems capable of providing sufficient data for analysis and informed managerial decision-making. A key component is functional control algorithms capable of adapting to changes in well-operating conditions and ensuring optimal operation modes to maximize production with minimal losses and risks. This confirms that the author's work is consistent with current developments in designing and modelling approaches that enhance oil production processes. Currently, there is a strong emphasis on accounting for all elements that influence the quality of these efforts to maximize the potential of the industrial sector. However, this work does not consider that such systems contribute to increasing the efficiency and reliability of oil production processes.

Researchers D. Poungui et al. [66] determined that the indicator diagram is a graphical method for analyzing flow regimes in wells. It is based on the idea that pressure and liquid flow rate changes in the well reflect the system's state (e.g., reservoir and well). It also allows for evaluating reservoir characteristics, determining flow mechanisms, and identifying potential issues in the production system. However, the analysis of production, which includes monitoring and analyzing production processes, such as changes in flow rate, pressure, and temperature, enabling the assessment of production efficiency and the identification of changes in reservoir, well, or production system conditions, was not mentioned. The distinction of this study lies in the authors not highlighting the importance of the specific use of these two methods, which are essential tools for engineers and geologists in the oil and gas industry. It can be noted that indicator diagrams can be constructed based on flow rate and pressure data, while production analysis may involve evaluating flow rate curves and pressure changes. These methods not only help understand the current state of the production system but also aid in decision-making to optimize processes, improve efficiency, and identify potential issues such as well blockages and changes in reservoir properties.

T. Harding [67] notes that production analysis is an important part of engineering and geological studies in the oil and gas industry. It is conducted when pressure and flow rate parameters are known, and a more in-depth understanding of production processes and well and reservoir characteristics is required. Data on oil or gas pressure and flow rate from the well must be available, and these parameters are measured and monitored throughout the entire operation. The results of this study, specifically regarding oil production rates and pressure, have been further analyzed in detail. It is crucial to emphasize the goal of production analysis, which includes identifying changes in well or reservoir conditions, determining production efficiency, and detecting potential problems or unusual events.

Z. Wang et al. [68] demonstrated through their work that automation systems are designed to control the processes of oil and gas production from wells. These systems comprise various components and technologies for monitoring and managing operations in the field. Rod pumps are common equipment for oil production. However, it was not specified or addressed in this work that, at present, it is claimed that these modern automation systems lack the means to perform technical control of parameters (such as pressure, temperature, and liquid level) directly inside the well. It can also be noted that the absence of control means inside the well may hinder precise monitoring of production process parameters and timely problem detection, thus creating a distinction between this work and the author's work.

As noted by Y. Zhang et al. [69], dynamometer sensors measure the mechanical load on rods. They can be used to evaluate the characteristics of rod movement and diagnose the well and pump equipment's condition. Wattmeters are designed to measure the pump system's electrical power consumed by motors. This data can be useful for assessing pump efficiency and identifying anomalies. It is also necessary to amend the study to mention that measuring pressure in the discharge line can provide information about pump operation, the condition of the production system, and overall pressure parameters in the well. Wellbore water cut is measured as the proportion of water in the total volume of extracted fluid. Regulating this parameter is important for optimizing hydrocarbon production. The current study's limitations come from its focus on horizontal well operations and acidizing treatments, which may not encompass all reservoir conditions and technologies. Further research is needed on the long-term effects of technical advancements such as automated control systems and deep oil refining on production efficiency and environmental sustainability.

6. Conclusion

The research has indicated that solutions for stabilizing oil production rates and controlling well water cuts must be economical and profitable. The obtained results suggest that as the water content in the extracted oil increases, there may be a need for more effective methods of water and oil separation to maintain a stable oil production rate. Moreover, numerous social and technological adaptations are required for areas that cannot be addressed solely through technical means. This study has examined recommendations for eliminating errors in oil extraction mechanisms' design and implementation processes.

A thorough analysis of the functioning of these mechanisms during production, considering potential well water cuts, has been conducted. Special attention has been given to analyzing technological processes and identifying errors and issues that arise during the stabilization of oil production rates. The implementation of efficient tools will effectively address these issues and prevent potential errors in the future. Mechanisms and automation systems that expand this resource base through introduction have been explored to improve well water cut control.

The analysis demonstrates that managing oil production rate stabilization effectively is crucial in ensuring sustainable and efficient hydrocarbon extraction.

It has been observed that the efficiency of machinery, mechanisms, and units in the oil industry can be enhanced through the implementation of automation systems. If a well traverses multiple reservoirs, water contamination from isolation or intermediate reservoirs can lead to water production.

The research has successfully achieved its goal by analyzing methods to rectify errors in stabilizing oil production rates and addressing issues in enhancing oil industry mechanisms. Methods have also been developed to improve the functioning of mechanism processes, specifically identifying and proposing effective ways to rectify errors while enhancing the efficiency of these complex machines.

All these steps aim to enhance the potential, competitiveness, and quality of services the oil industry provides. The reviewed modern approaches to the issues of stabilizing oil production rates aim to meet contemporary needs for the further prospective use of oil extraction mechanisms. Future research should focus on developing and implementing innovative mechanisms in the oil industry complex to advance the energy sector.

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