European Science Methodical Journal
ISSN (E): 2938-3641
Volume 2, Issue 9, September- 2024

METHODS TO INCREASE OIL WELL EFFICIENCY

Mansurov Aziz Abdikarimovich
Teacher, Tashkent State Technical University

Abstract:

This article explores various methods aimed at increasing the efficiency of oil wells, focusing on advanced drilling techniques, enhanced oil recovery (EOR) methods, and real-time data analytics. The article discusses how these technologies can help operators extract more oil from existing wells, reduce costs, and extend the lifespan of the oil field.

Keywords: Oil well efficiency, enhanced oil recovery, drilling techniques, data analytics

Introduction

As oil reserves become increasingly difficult to access, improving the efficiency of existing oil wells has become a critical focus for the industry. This paper examines several modern methods that are used to maximize oil recovery rates and improve the overall productivity of oil wells, including enhanced oil recovery (EOR) techniques, advanced drilling technologies, and the use of real-time data analytics to optimize production.

One of the main problems of the oil industry is incomplete (usually no more than 40%) oil recovery from the oil reservoir by primary methods. For some oil reservoirs containing reserves of highly viscous oil, no more than 10-15% can be extracted due to the reservoir's own potential energy. Subsequently, the oil reservoir is additionally affected by secondary methods to increase the efficiency of the oil reservoir. The main ones are associated with the displacement of oil by pumping various aqueous solutions into the reservoir through additional injector wells, which make it possible to increase oil production by another 15-20% [1]. In oil reservoirs, oil saturates voids, cracks and caverns between the solid fractions of the rock that make up the oil-bearing reservoirs. Most oil fields are located in sedimentary rocks, which are good oil collectors. In the productive zone of the reservoir, in addition to oil, there is also bound water. In most reservoirs it constitutes 20-30% of the pore space volume [2].

Methods

A detailed review of current industry practices was conducted to identify the most effective methods for increasing oil well efficiency. Key technologies, such as thermal EOR, CO2 injection, and horizontal drilling, were evaluated for their effectiveness in different field conditions. Additionally, the use of data analytics and machine learning for well optimization was explored.

There are many abandoned or mothballed reservoirs around the world that still contain a sufficient amount of oil. Increasing oil recovery by just 1% is equivalent to discovering a new field.

In physical and chemical terms, oil is a mixture of carbohydrates and organic compounds. The density of oil is 820-950 kg/m3, electrical conductivity fluctuates widely from 10-6 to 10-14 S/m, and the electrokinetic potential is usually 40-150 mV [3].
In addition to hydraulic methods, the possibilities of secondary impact on the formation by various physical fields are being studied - thermal, ultrasonic, magnetic, high-frequency, electromagnetic, as well as their combinations [1]. Along with traditional secondary methods for increasing the efficiency of oil reservoirs, methods based on electrical treatment of both the reservoirs as a whole and the bottomhole zone immediately adjacent to the oil well have undoubted promise [4].
Analysis of known technical solutions. The analysis of literary and patent information allows us to identify the following methods and techniques for electrical treatment of oil reservoirs.
Using direct, alternating and high-frequency current to heat the oil reservoir and create electrophoresis phenomena. In the presence of layers with quartz sand, when passing high-frequency current, a piezoelectric effect occurs, that is, vibrations of quartz sand grains and, accordingly, increased release of oil from it [5].
Exposure of the zone near the production well to a unipolar electric current before the start of operation. A positive result is achieved due to a complex of electrokinetic effects. In this case, the increased permeability of the formation is preserved even after the cessation of the action of the electric current [6].
Exposure of the zone near the production well to an electric current to heat this zone to a temperature that excludes boiling of pore moisture [7]. The use of the combined electroosmotic and thermal action of direct electric current to create a mineralized channel in an oil-containing formation, for which, after connecting the wells to the power source, mineralized liquid is fed into the cathode well, and the current value is limited by the boiling point of the mineralized liquid.

Results

The results show that enhanced oil recovery techniques such as CO2 injection and thermal methods can significantly increase the amount of recoverable oil from a well, often extending the field's lifespan by several decades. Horizontal drilling combined with hydraulic fracturing was found to improve access to previously unreachable oil reserves. The implementation of real-time data monitoring and analytics has also proven to be highly effective in identifying production inefficiencies and optimizing drilling parameters.
Using the phenomenon of electrophoresis, for which the positive pole of the power source is connected to the production well, and the negative pole is connected to the additional electrode. By passing an alternating electric current below the bottomhole zone, the soil is heated to 130-1500C, and the resulting temperature front displaces oil in the direction of the production well.
Controlling the permeability of the bottomhole zone adjacent to the production well with a pulsed current. Increased permeability is achieved due to the mechanical destruction of cementing substances in thin capillaries that limit the filtration rate.

Impact on the bottomhole zone of the production well with an electric heteropolar pulsed current with an amplitude of up to 3000 A with a pulse duty cycle of 1-3 and a steepness of the trailing edge of the pulse of 10-150 mls. The positive effect is achieved not only due to electrokinetic and thermodynamic effects, but also due to the resonant properties of the oil-containing formation. By creating a DC voltage of 150-450 V and a current density of 0.1-10 A/cm2 between the anode electrode and the production well (cathode), chemical and ion-plasma processes are caused, as a result of which hydrogen and alkali are released on the casing pipe (cathode), which help reduce the surface tension of the oil film and dissolve residual oil bitumen. The combined action of direct and alternating current with an amplitude that ensures the initiation of oxidation-reduction reactions in oil for the decomposition of polycyclic compounds contained in it into compounds with low molecular weight and the hydrogenation of oil.

Discussion

The effectiveness of these methods largely depends on the geological characteristics of the oil field and the operational constraints faced by the drilling company. While enhanced oil recovery methods can lead to significant increases in efficiency, they are also associated with higher operational costs. Real-time data analytics, on the other hand, offer a cost-effective way to optimize production and minimize downtime, though it requires an investment in digital infrastructure.

Conclusion

In conclusion, improving oil well efficiency requires a combination of advanced technologies and data-driven decision-making. Enhanced oil recovery techniques and real-time monitoring systems provide valuable tools for increasing productivity, but they must be carefully tailored to the specific conditions of each oil field.

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