Vol. 25, No. 1
2025

PROSPECTING AND DEVELOPMENT
OF OIL AND GAS FIELDS

https://pdogf.com.ua/en

Received: 08.01.2025. Revised: 06.05.2025. Accepted: 02.06.2025

UDC 622.267

DOI: 10.63341/pdogf/1.2025.10

Use of the electrohydraulic effect as a means of intensifying the technological processes of oil collection and preparation

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Abstract. Unlike many other industries, where the electrohydraulic effect is widely used, its potential is practically not used in oil production. However, this phenomenon allows for the efficient conversion of electrical energy into mechanical energy and can contribute to the intensification of oil production processes. The aim of the study was to analyse the use of the electrohydraulic effect in industry, develop an electrical circuit for its implementation in the laboratory, and assess the possibilities of using this circuit to intensify oil production and treatment processes. For this purpose, the available literature on the electrohydraulic effect in other industries was analysed. A schematic diagram of a laboratory setup has been developed that will allow studying the effect directly on oil samples and oil emulsions. The created electrical circuit consists of elements that allow processing various liquid media, including formation water, oil emulsions and oil itself. The key advantages of using this circuit are high efficiency, powerful intensity of action, environmental friendliness, and the ability to adjust the intensity of the process. Widespread practical application of study results will help improve the efficiency and environmental safety of processes in the oil industry; thus, revealing the potential of this effect will be a significant step forward in the technologies of collecting, preparation and intensification of production of high-viscosity oils. This will reduce the cost of oil production, improve the quality of commercial oil, reduce oil losses with stable oil emulsions, and increase production. The results of this study will form the practical basis for the development of optimal technologies for the treatment of various types of heavy oils using the electrohydraulic effect

Keywords: technology; high-viscosity oil; electrical circuit; viscosity; oil emulsion

Introduction

The analysis of the state and problems of the technology of collection and preparation of oils and oil emulsions with abnormally viscous, non-specific properties shows that these technological processes require comprehensive research and intensification. These problems are mainly related to abnormal, non-standard, different physico-chemical properties of well products, such as density, viscosity, pourpoint, the presence of resins and asphaltenes, the content of paraffins and accompanying formation waters, etc. At the same time, the environmental component of production is also important, as the state of technology for the collection and processing of such abnormally viscous oils and oil emulsions can have a significant impact on the technogenic load in oil production areas. Solving these problems requires the use of similar non-standard solutions for intensifying production processes. One of the

Suggested Citation: Shumilin, T., & Kondrat, O. (2025). Use of the electrohydraulic effect as a means of intensifying the technological processes of oil collection and preparation. *Prospecting and Development of Oil and Gas Fields*, 25(1), 10-18. doi: 10.63341/pdogf/1.2025.10.

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ways of significant intensification of technological processes of collection and treatment of mainly high-viscosity oil emulsions can be the technology of action using the electrohydraulic effect (EHE).

The EHE is used in various technological processes. For example, Q. Yu *et al*. (2022) investigated the effect of pulsed electrohydraulic shock used in the stimulation of hydrocarbon production on the parameters of a production well. The authors emphasised the main advantages of this method of action compared to others: significant energy capacity, the ability to remotely control the intensity and frequency of the action, environmental friendliness, etc. S. Chushchak *et al*. (2023) theoretically substantiated the use of electrohydraulic action to increase the efficiency of disintegration of tungsten pseudoalloys into microcomponents. In the work by A.G. Naryzhnyj (2019), the technology of using the EHE for deformation of a metallic cylindrical shell has been described. Researchers V. Matviychuk *et al*. (2020) described the application of the EHE in the agro-industry, where the classical scheme of the developed effect is used; equipment parameters and scope of application are given. In their research, V. Popescu *et al*. (2019) also justified the development of an electrohydraulic scheme for processing agricultural products. V. Baranov *et al*. (2022) suggested using the electrohydraulic method for promising methods of obtaining organic fertilisers. In the work by V. Bereka & I. Kondratenko (2021), the use of the EHE for water purification and disinfection has been justified, and in the article by A. Turdiboyev *et al*. (2023), the EHE has been used to disinfect the water environment and feed plants. N. Markaev *et al.* (2023) also substantiated the use of EHE for intensification of plant growth. The paper by J.V. Sabrejos *et al*. (2020) showed the design parameters of the hydraulic installation and simulated the factors influencing the process of electrohydraulic water treatment.

Basically, all the mentioned works relate to the use of EHE in various industries. In the oil industry, this effect was hardly used, and research on the intensification of the processes of preparation of abnormally viscous oils and oil emulsions, as well as associated formation waters using the EHE, is devoted to a small number of works, which indicates insufficient study of the effective action of this effect and the conditions of its application. The above-mentioned well-known and quoted works, such as Q. Yu *et al.* (2022), did not provide reasonable electrical schemes for the realisation of this effect. Experimentally, V. Bychkov & A. Ivanov (2019) established that it is possible to deliberately distribute the energy properties of discharges in series-connected three-electrode systems. This finding expands the technological possibilities for processing materials in discharge chambers with complex geometry. There are practically no laboratory facilities, the different modes of operation of the facilities are not studied, and there are no characteristics of the necessary equipment, etc. This work requires extensive consideration, justification and research. The purpose of this study was to justify the use of EHE in the production and preparation of high-viscosity oil. This required an analysis and comparison of the way this effect is used in other industries, as well as the creation of a basic electrical scheme for implementing this effect in laboratory conditions.

Materials and Methods

A comprehensive analysis and integral summary of a significant mass of scientific and technical literature was carried out; a large number of literary sources, including monographs, articles in leading scientific publications, materials from conferences devoted to the use of EHE in various industries were analysed. Most of these sources refer to the initial period of the discovery of this effect by L. Yutkin in the period from 1950 to 1989. This analysis made it possible to identify modern trends and gaps in research and to formulate concrete tasks for the application of this effect in the oil industry. More than 238 patents were searched, leading technical solutions, structural features, parameters, trends in the development of technologies using EHE were analysed in detail, which allowed to theoretically substantiate the optimal parameters for specific conditions of its application (Google patents, n.d.). The main patent base for the analysis were the developments and official patents developed by L. Yutkin as the founder of this field of research.

An analysis of existing problems in the extraction of abnormally viscous oils and oil emulsions was carried out. Based on the theoretical analysis of the physico-chemical properties of oils, oil emulsions and accompanying waters with different physico-chemical characteristics, the analysis of regulatory and technical documentation, a wide array of patent information, the use of the EHE in the collection and preparation of oil is substantiated. An analysis of the sources of existing methods of extracting high-viscosity oils and technologies of wave action on them was also carried out. In the course of this research, a thorough comparative analysis of existing technologies and various methods and approaches to the creation and practical application of the EHE in scientific research and industry was carried out. The methodological basis of the study was a detailed study and critical analysis of the results of previous studies of this issue already available in the scientific literature. Scientific methods were comprehensively applied in the research, a comprehensive analysis of literature, patents and technical solutions was carried out in order to deeply study the possibilities and positive aspects of using the EHE.

An in-depth analysis of the physical processes that can occur during the application of EHE allowed the development and theoretical substantiation of the optimal parameters and regimes of the electrical circuit for specific conditions and applications. The main principles of the development of this electrical scheme were that the scheme should fully ensure the given functionality and work reliably and stably in the entire possible range of operating modes and operating conditions, taking into account limit and transient processes. It must be as simple as possible, logically and rationally constructed, and use the optimum element base from the point of view of the price/quality ratio in order to reliably achieve all the necessary technical parameters, characteristics and requirements. In addition, the developed scheme shall include reliable and comprehensive means of protection against the possible harmful effects of interference, current and voltage overloads, short circuits and other emergency and undesirable situations that may lead to damage or failure.

Results

The production of classic abnormally viscous oils and oil emulsions is insignificant in Ukraine. Such oils are produced in the Kokhanivske, Bugrivativske, Orkhovytske and Yablunivske fields. The almost insignificant production of such oils from these deposits is due to industrial and production difficulties, increased costs, problems with oil collecting and preparing, etc. Taking into account the properties of oils under standard conditions, according to international practice, hard-to-recover oils and oil emulsions also include oils with a high pour point due to high paraffin content; therefore, the share of such oils is much higher. As an example, such oils can be mentioned as oils from the Verkhnemaslovetske field with a pour point of +16 °C, Novoskhidnetske (+14 °C), Zavodivske (+20 °C), Oryv-Ulychnianske (+20 °C) and others. To minimise these costs and increase production at such fields, it is necessary to introduce new methods and technologies to intensify all technological processes from the well to the finished product. One of these new, innovative methods can be the method of acting on oil and oil emulsions using the EHE.

EHE is based on a hitherto unknown phenomenon, which consists in a sharp increase in the hydraulic and hydrodynamic effect, as well as the amplitude of the shock wave, when a pulsed electrical discharge is created in a liquid. In order to obtain the maximum effect, it is necessary to reduce the duration of the pulse to a minimum in order to ensure the possible leading edge of the pulse and its shape close to the aperiodic one. EHE was discovered in 1953 by L. Yutkin (1955). In spite of numerous discussions about this phenomenon, the effect is widely used in many industries to develop advanced technologies. L. Yutkin made a significant contribution to the research and implementation of EHE and was awarded around 200 patents (Electrohydraulic effect..., n.d.). The researcher's work helped to realise the potential of this discovery in practice. As of 2024, the figure of L. Yutkin and his achievements are undeservedly forgotten. Effective implementation of EHE in industry requires thorough laboratory research and feasibility studies. It is important to record all the results of such work for further analysis and improvement of technologies based on this effect. As L. Yutkin (1986) stated, the essence of this method is that when a specially formed pulsed electric discharge (spark, brush and other forms) is carried out inside a volume of liquid located in an open or closed vessel, ultra-high hydraulic pressures arise around the zone of its action, capable of performing useful mechanical work and accompanied by a complex of physical and chemical phenomena.

The mechanical effect of the fluid on the objects located near the discharge channel according to the basic scheme shown in Figure 1 is extremely small for fluids with ionic conductivity (formation water) and comparatively larger for fluids with dielectric properties (oil). The mechanical effect is due to the pressure inside the vapour-gas bubble in the discharge zone. According to V. Matviychuk *et al.* (2020), these values are insignificant and do not have a significant effect on the fluid.

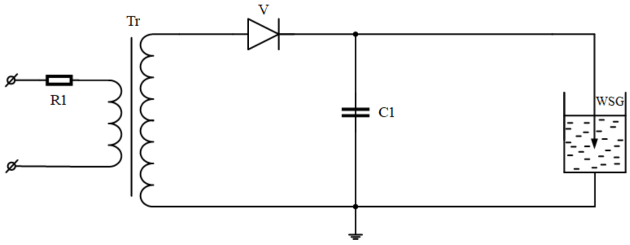

Figure 1. The basic electrical scheme of electric discharge technology

Note: R1 – charging resistance; Tr – transformer; C1 – capacitor, working capacity; V – rectifier; WSG – working and spark gap in the liquid

Source: created by the authors based on L. Yutkin (1955)

According to the scheme shown in Figure 1, L. Yutkin (1986) proposed schemes (Fig. 2; Fig. 3) that made it possible to significantly increase the intensity of the mechanical action of the discharge on the liquid and which differ in that they contain an air spark gap that forms the discharge.

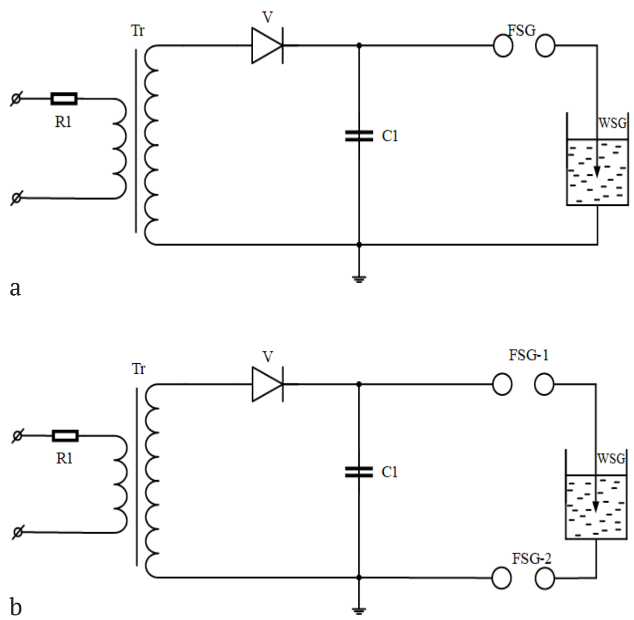

Figure 2. Schematic diagram of the EHE

Note: a – schematic diagram of the EHE with one forming spark gap (FSG); b – schematic diagram of the EHE with two FSGs

Source: created by the authors based on L. Yutkin (1986)

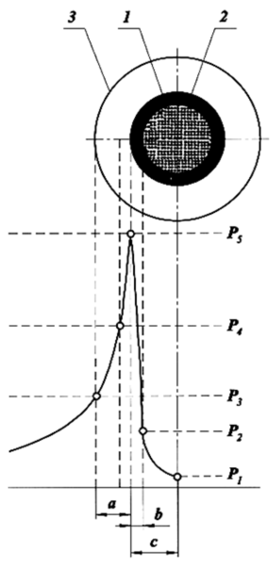

Figure 3. Schematic diagram of the discharge channel structure and pressure distribution

Note: 1 – the central part of the discharge channel; 2 – "skin" shell of the channel; 3 – vapor-gas shell; *a* – thickness of the vapour-gas shell, $a \approx 0.001...0.1$ mm; *b* – thickness of the "skin" shell, $b \approx 10^{-5}...10^{-3}$ mm; *c* – radius of the discharge channel, $c \approx 0.5...$ 5 mm; $P_1...P_5$ – pressures in the corresponding zones, $P_1 = 0...2 \times 10^6$ Pa, $P_2 \leqslant 2 \times 10^8$ Pa, $P_3 \leqslant 5 \times 10^9$ Pa, $P_4 \leqslant 2 \times 10^{10}$ Pa, $P_5 \leqslant 10 \times 10^{10}$ Pa

Source: created by the authors based on L. Yutkin (1986)

L. Yutkin (1986) defined three main operating modes of operation of the plant: hard – V > 50 kV; C < 0.1 μF; medium – 20 kV < V < 50 kV; 0.1 μF < C < 1.0 μF; soft – V < 20 kV, C > 1.0 μF. According to L. Yutkin (1986), FSGs provide an opportunity: to accumulate the necessary amount of energy with a pulse supply for the main gap of the discharge; to significantly reduce the pulse time and regulate its frequency and intensity; to create a steep pulse front preventing the transition to an arc discharge; to obtain the required current and voltage at a given main gap; to create the required shape and character of the pulse. The implementation of the EHE is characterised by the mode of energy release at the active resistance of the circuit close to the critical one, according to the formula:

$$1/C < R^2/4 \times L, \qquad (1)$$

where *C* is a capacitor capacity; *R* is an active resistance of the circuit; *L* is an inductive resistance of the circuit. The main idea is that due to the special parameters of the electric pulse in the fluid, there is a sharp increase in hydraulic and impact effects, which was previously an unknown phenomenon. According to the formula, the key factors influencing the occurrence of EHE are the amplitude, the slope of the front, the shape and the duration of the electric current pulse.

The duration of the current pulse, measured in microseconds, allows the instantaneous power of the pulse to reach hundreds of thousands of kilowatts. The steepness of the pulse front determines how quickly the discharge channel expands. At voltages of several tens of kilovolts, the current amplitude of the pulse reaches tens of thousands of amperes, resulting in a sharp increase in fluid pressure. This sudden increase in pressure results from the instantaneous release of a significant amount of energy within a confined volume of liquid. The implementation of EHE is associated with a relatively slow accumulation of energy in the power source and its almost instantaneous release into the liquid medium. The energy is gradually accumulated and then suddenly released, creating an EHE.

The main factors of EHE are ultra-high impulse hydraulic pressures (Fig. 3), which cause shock waves with supersonic speed; significant impulse movements of liquid at a speed of hundreds of metres per second; powerful cavitation processes; infrared and ultrasonic radiation; mechanical resonance phenomena; strong electromagnetic fields; intense light, heat, ultraviolet and X-ray radiation; pulsed gamma and neutron radiation; multiple ionisations of substances. All these factors together create a powerful, complex effect on the liquid and the objects in it. Due to these factors, EHE is able to perform a wide range of physical and chemical actions. For example, shock waves can destroy solid structures, and cavitation processes can disperse solid particles.

The main advantages of using EHE include: high intensity of action; the possibility of simple intensity adjustment; a relatively simple scheme with the use of standard elements; environmental friendliness; and high efficiency. The EHE is of great practical importance and is used in various fields, from mining to medicine. Due to the unique capabilities of this physical phenomenon, EHE allows solving complex technical and technological problems. Research on EHE is still ongoing, as this effect still holds significant potential for the development of science and technology. Powerful shock waves arising during the development and sudden collapse of cavitation cavities can destroy non-metallic materials and cause plastic deformations of metallic objects located near the discharge zone. Intense infra- and high-frequency ultrasonic vibrations accompanying the electro-hydraulic effect during the discharge additionally grind materials already split into pieces, cause resonant destruction of large solid objects into separate small crystalline particles, and intensify the fast-moving chemical processes of synthesis, polymerisation, and breaking of sorption and strong chemical bonds between molecules.

The strong electromagnetic fields generated during electrical discharge also have a significant impact on both the discharge process itself and the ionic processes occurring in the liquid around the discharge channel. Under the influence of these electromagnetic fields, a variety of transient physical and chemical changes can occur in the processed material and the surrounding liquid. The form of electrical discharge, which causes the generation of powerful impulse shock waves and pressures, can be very diverse – from a spark discharge to a discharge in the form of a long brush, as well as in the form of a continuous flow without a clear structure (the so-called impulse electric wind). The use of the method of generating ultra-long spark discharges directly in liquid media is the basis that provides wide technological possibilities of the EHE and its application for processing various materials. However, the EHE and related phenomena can also be obtained as a result of another physical process, the so-called “thermal explosion”, when instead of a spark electric discharge, rapid heating and explosive vaporisation of a thin conductive element connecting electrodes placed in liquid The use of this method makes it possible to expand the fields of application of phenomena related to the EHE to high-temperature liquid and gaseous media, including melts of metals and salts, as well as plasma.

The environmental friendliness of processing materials by means of EHE should be emphasised, as the physical principle of this method does not introduce any harmful impurities or additional sources of pollution into the processed environment. The electro-hydraulic influence is based solely on the use of electrical energy and the properties of the medium itself. EHE can be effectively used in chemical technologies to intensify processes. As a method of mechanical, physical and chemical action on materials, it can be used for polymerisation, depolymerisation, synthesis of chemical compounds, increasing the activity of catalysts and accelerating the speed of reactions in the chemical industry.

Studies of the effects of waves and pulses on oil and gas formations have been carried out in the past but have not been widely used. Recently, attention to such methods has increased in connection with the development of technologies and the search for new effective approaches to the extraction of hard-to-reach hydrocarbon reserves. Abroad, considerable success has been achieved in the production of high-viscosity oil using new specialised equipment such as long-stroke rod pumps, screw pumps and hydraulically driven centrifugal pumps. This allows more efficient production of complex, high-viscosity hydrocarbon reservoirs.

A promising direction is the complex combination of various physicochemical methods for the integrated impact on the productive layer and the maximum increase in the efficiency of extraction of hard-to-reach hydrocarbon reserves. Each of the methods correctly selected for specific geological and technological conditions will achieve a positive result. A group of technologies based on various wave and resonance processes and chemical or thermal effects can be considered promising for the development of hard-to-extract reserves. To study the effect of EHE on oil-water mixtures, a scheme for conducting laboratory studies was developed (Fig. 4).

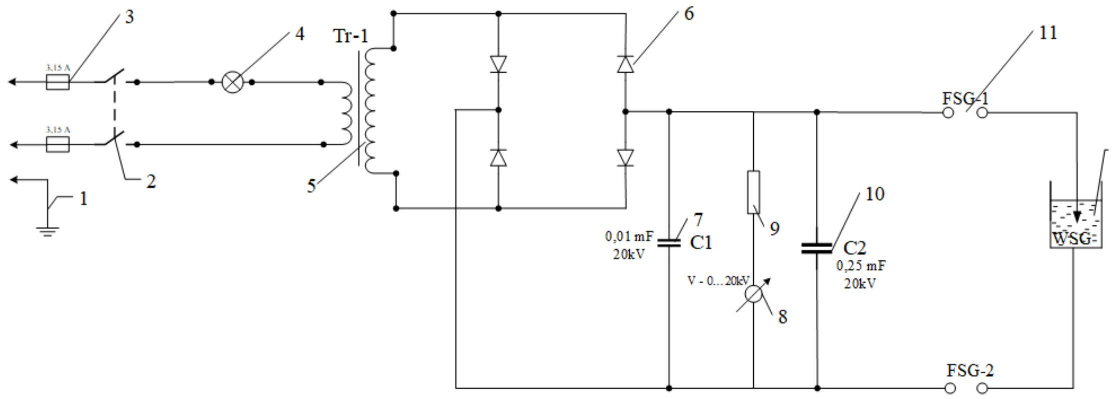

Figure 4. Developed schematic electrical diagram of the EHE study

Note: 1 – grounding; 2 – switch; 3 – fuse; 4 – lamp; 5 – transformer; 6 – diode; 7 – capacitor; 8 – voltage regulator; 9 – resistor; 10 – working capacitor; 11 – air spark gap; 12 – WSG forming spark gap in the working capacity

Source: created by the authors

The main advantages of using this scheme are high efficiency, high intensity of action, environmental friendliness, ability to regulate the intensity of the process, etc. The aim is to reduce the cost of oil production, improve the quality of commercial oil, minimise oil losses by maintaining stable oil emulsions and ultimately increase production rates. As known from L. Yutkin (1955), the efficiency of EHE is significant. It should be noted that, according to the scheme developed, the intensity of the effect can be regulated by changing the charging rate of the capacitors, which makes it possible to process emulsions at three different charging rates. The intensity of the effect can also be adjusted by choosing the distance between the air gaps and the capacitance of the capacitors. The use of this effect will make it possible to reduce or even eliminate the use of chemicals in the destruction of stable emulsions. The developed scheme will allow the medium to be processed at medium speed and can be used in both industrial and laboratory conditions. The high efficiency of EHE and the unique possibilities of electrohydraulic action are the basis for the wide use of EHE in all fields of science and technology.

Discussion

According to the analysis of the existing literature, the use of EHE for the preparation and extraction of heavy oil was practically not carried out. At the same time, EHE is used in other industries due to its versatility. For example, A.G. Naryzhnyj (2019) considered a mathematical model of thermomechanical processes in a technological system of free dispensing of a thin-walled shell under the influence of the EHE. The model included: vapour-plasma channel that expands as a result of the release of a heat pulse, a process fluid that transmits hydraulic action, equipment that directs the movement of the fluid and a technological object in the form of a thin-walled deformable elastic-plastic shell. The model was used to study the processes of EHE action on a thin-walled shell in specific technological schemes, which were used for experimental studies and their comparison.

Since its discovery, the EHE has been mainly used to deform metals. V. Zagoruyko (2019) emphasised that one of the distinctive features of high-energy metal processing methods is the ability to stamp hard-to-deform metals and alloys. In addition, such methods ensure the manufacture of parts with high dimensional and shape accuracy. An important factor is the uniform load distribution over the entire surface of the workpiece during deformation. This ensures that the relative velocities of the workpiece particles are below critical values and eliminates the possibility of metal fracture. V. Sirenko & O. Manchenko (2020) substantiated that the use of electrical energy – a high-potential and environmentally friendly form of energy – contributes to the implementation of technological processes with high intensity and minimal emissions. The direct interaction of electric and magnetic fields and their effect on food raw materials is particularly effective in the processing of agricultural products. The main feature of these processes is the direct conversion of electrical energy into mechanical action. However, the duration of this action cannot be too long due to the significant thermal effects that occur.

N. Markaev *et al*. (2023) investigated the effect of EHE on the aquatic environment and considered possible options for electrical schemes. The article by A. Turdiboyev *et al*. (2023) described the use of the EHE for wastewater decontamination and increasing the nutrient content in water. They emphasised that EHE is characterised by low energy consumption, short processing time, simplicity of equipment, and environmental friendliness. The developed circuit contained a laboratory autotransformer, high-voltage diodes, a high-voltage capacitor bank K75-15, and an FP-emission gap for voltage regulation. J.V. Sabrejos *et al*. (2020) also studied the technology and technical means of electrohydraulic action on water. The authors developed the shape of the electrode tip to increase the electromagnetic field density and reduce power losses. The paper specified the parameters of the electrohydraulic plant, modelled the factors affecting the process of electrohydraulic water treatment, optimised the operating modes of the electrohydraulic plant, and conducted a feasibility study. The work of T. Golubeva *et al*. (2018) presented the experimental laboratory equipment developed by the authors, which enables the use of a pulsed electric discharge using the EHE. This experimental equipment can be used to treat wastewater from thermal power plants, oil refineries, and other polluting industrial enterprises. The work investigated the environmental effects of the developed equipment on the example of water contaminated with phenols and oil products, which is purified by destroying molecular and ionic bonds with free electrons and ions that appear during the discharge.

The effect of EHE use during reservoir treatment can significantly intensify and increase the production of heavy oil. Research by I. Denysiuk *et al*. (2019) showed that the oscillating movement of a viscous fluid in the pore channels of an oil reservoir is accompanied by waves of compression and rarefaction. These waves create a dynamic effect on the pore channels and initiate directionally variable filtration flows. The analysis of velocity profiles along the cross section of the pore channels revealed that during the harmonic action, reverse oscillatory flows occur inside the pores. There is also an increase in fluid velocity near the walls of the pore channels compared to regions near the axis of the channel. According to the results of numerical calculations of the volumes of fluid filtered through the pore channels of the formation during wave treatment and the analysis of literary sources, it is recommended to use the combined effect of several methods, for example, a combination of wave and chemical treatment. The basic idea is that the oscillatory movement of the fluid in the pore channels creates compression/discharge waves that initiate alternating filtration flows, reverse flows, and an uneven velocity profile. To increase production efficiency, it is proposed to combine wave treatment with other methods, such as chemical treatment.

The technology for the intensification of oil production by means of wave technology is described in the work of Y. Yakymechko & S. Oveckiy (2023). This study described the technology and technical means for creating a shock wave impact on the bottomhole zone of a productive formation in the perforation interval. This allows to locally simulate the geodynamic impact on the formation in small volumes. Restoration of the potential productivity of production and injection wells is achieved by destroying colloidal dispersed systems that clog the bottomhole zone of the formation. This occurs as a result of wave impact, which restores the permeability and patency of the pore channels in this zone. Thus, a special technology is used with the use of technical equipment to generate shock waves and transmit them to the bottomhole zone of the well. This simulates the impact of natural geodynamic processes and allows the formation zone near the well to be cleaned of contaminants, restoring its productivity. A similar effect on the formation can be achieved using EHE.

More recent studies on the bottomhole treatment of reservoir zones carried out in Ukrainian fields include V. Zhekul *et al*. (2017). They presented a generalised analytical review of research and development carried out at the Institute of Pulse Processes and Technologies of the National Academy of Sciences of Ukraine from the end of the 1970s, regarding the creation of downhole electric discharge units for the intensification of mineral production. The features and advantages of such installations are: high power, selectivity and cyclicity of repeated impact on the treated object – the bottomhole zone of an oil and gas formation; the ability to regulate the main technological parameters; ease of operation; safety and environmental friendliness with a fairly high impact efficiency and relatively low costs for well treatment. The idea that the use of the EHE is not only efficient but also causes minimal environmental damage is confirmed by A. Satybaldin *et al*. (2021). In this paper, researchers considered the application of the EHE for the processing of oil sediments.

As can be seen from the above discussion, EHE is widely used in many industrial sectors: mechanical engineering – sheet metal stamping, cylindrical billet forming, calibration, pressing, strengthening, and removal of residual stress in structures; metallurgy – intensification of charge preparation processes, ingot crystallisation, flattening, drawing and pressing, destruction of metallurgical equipment lining during repair work, regeneration of lining materials mining and exploration – rock destruction, ore dressing; oil and gas – well drilling, cleaning of drilling equipment; construction – sinking of sheet piles, piles, pipes, soil compaction, development of frozen ground, preparation of mortars, etc. The number of studies investigating the application of this effect in the oil and gas industry is limited, yet highly promising.

Conclusions

Technological processes for the collection and preparation of oils with abnormal properties, such as high-viscosity, presence of resins, asphaltenes, paraffins, etc., require careful study and intensification due to their specific physical and chemical characteristics and the potential environmental impact of their production. The use of EHE can be a promising and effective way to intensify the processes of collection and preparation of high-viscosity oils and oil emulsions. However, despite its significant potential, the use of EHE in the oil industry is currently limited and existing research does not provide sufficient data and technical solutions for its practical implementation and introduction into production processes. The purpose of this study was achieved by summarising and analysing the available data on the use of the EHE in various industries, identifying possible technical solutions, developing a basic electrical circuit for the laboratory implementation of the effect, selecting the main components of the circuit and establishing its modes of operation for the intensification of oil production and preparation processes. In the framework of this research, a comprehensive approach was used, which involved the use of a wide range of both theoretical general scientific methods and empirical methods of scientific research. In particular, a thorough comparative analysis of existing technologies, various methods and approaches to the creation and practical application of the EHE in scientific research and industrial fields was carried out.

The circuit diagram developed within the framework of the study includes modern elements that allow processing various liquid media, such as produced water, oil emulsions, and oil. In the future, the developed scheme will be implemented and integrated into the scheme of laboratory testing of oils and oil emulsions. It is expected that the results of this study will allow to substantiate and develop effective technical means and to conduct laboratory studies on the use of EHE as a promising technology to improve the efficiency of operations with abnormal high-viscosity oils and emulsions, which will contribute to the improvement of their production and treatment processes.

Acknowledgements

None.

Funding

None.

Conflict of Interest

None.

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Використання електрогідравлічного ефекту як способу інтенсифікації технологічних процесів збору та підготовки нафт

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Анотація. На відміну від багатьох інших галузей промисловості, де електрогідравлічний ефект має широке застосування, у нафтовидобутку його потенціал практично не використовується. Проте саме це явище дозволяє ефективно перетворювати електричну енергію в механічну і може сприяти інтенсифікації процесів нафтовидобутку. Метою дослідження було здійснення аналізу використання електрогідравлічного ефекту в промисловості, розробка електричної схеми для його реалізації в лабораторних умовах та оцінка можливостей застосування цієї схеми для інтенсифікації процесів видобутку та підготовки нафти. Для цього було проведено аналіз доступних літературних даних щодо електрогідравлічного ефекту в інших галузях промисловості. Розроблено принципову електричну схему лабораторної установки, яка дозволить досліджувати ефект безпосередньо на зразках нафти та нафтових емульсіях. Створена електрична схема складається з елементів, які дають змогу обробляти різноманітні рідкі середовища, зокрема пластову воду, нафтові емульсії та саму нафту. Ключовими перевагами використання цієї схеми є високий коефіцієнт корисної дії, потужна інтенсивність дії, екологічність, а також можливість регулювати інтенсивність процесу. Широке практичне застосування результатів дослідження сприятиме підвищенню ефективності та екологічної безпеки процесів у нафтовидобувній галузі, таким чином, розкриття потенціалу цього ефекту стане значним кроком вперед у технологіях збору, підготовки та інтенсифікації видобутку високов'язких нафт. Це дасть можливість зменшити собівартість видобутку нафти, покращити якісні показники товарної нафти, зменшити втрати нафти зі стійкими нафтовими емульсіями, збільшити видобуток. Результати цих досліджень стануть практичною основою для розробки оптимальних технологій підготовки різних типів важких нафт із використанням електрогідравлічного ефекту

Ключові слова: технологія; високов'язка нафта; електрична схема; в'язкість; нафтова емульсія