Research on the Applicability of Polymer Injection Solution with Surfactant Compound for Lower Miocene, Bach Ho Field

Le Quang DUYEN[1)], Dinh Duc HUY[2)]*

[1)] Hanoi University of Mining and Geology, 18 Vien street, Bac Tu Liem, Hanoi, Vietnam; ORCID https://orcid.org/0000-0001-6953-4762
[2)] Vietnam Petroleum Institute, 167 Trung Kinh Street, Cau Giay, Hanoi, Vietnam
* Corresponding author: lequangduyen@humg.edu.vn

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Abstract

Similar to polymers, currently on the market there are many surfactants with reasonable prices and high activity. However, the simultaneous combination of surfactants and polymers in the same mixture has not been thoroughly studied. In this paper, the authors study the applicability of injecting a mixture of surfactants and polymers for Miocene objects in the lower Bach Ho field. The obtained results show that the technique of integrating the surfactant and polymer solution raise swept and sweep effectiveness, consequently increasing the oil recovery coefficient. Based on the simulation model, the recovery factor increased by 10% and the amount of oil increased by 36.6%. Additionally, findings indicated that the efficiency of increasing oil recovery coefficient from chemical injection via the combination of surfactants and polymers at well No. 1215 is much higher than that at well No. 1204. The research results can be used as a reference for studies with the same purpose conducted in areas with similar characteristics to Bach Ho field.

Keywords: *Enhanced Oil Recovery, injection of polymer solution, surfactants*

1. Introduction

Polymer injection is actually mixing a small amount of polymer into the injection water to increase the viscosity of water, reducing the mobility of the oil-pushing-phase in the reservoir. The polymer mixture, in addition to the ability to operate in high temperature and high pressure environment, also needs to be able to withstand water with great salinity and less adsorption on the rock surface. Currently, there are a number of polymers on the market that meet those extreme requirements and are easily available for purchase in industrial applications. Injection surfactant is essentially mixing a quantity of surfactant into water and injected into the reservoir, when contact with oil and water is made, the surfactant will reduce the interfacial tension between the two immiscible phases, so the trapped oil molecules can easily flow and escape from the holes or throat of pores to the extraction well.

According to recent estimations of Vietnam Government as well as Vietnam Petroleum Institute – VPI, productivity in crude oil and natural gas production of major fields in Vietnam will be less than 2 million tons per year by 2030. Additionlly, oil reserves of recently discovered reservoirs are moderate; most of these reservoirs are small and classified as marginal oil fields. Recently, many studies have been focussing on increasing the oil recovery factor of existing fields. In reality, oil production from Miocene layers accounts for 40% of the total yield of Bach Ho field, however, decline in oil production rate is considerably high with the decline rate of 12% per year. Thus, conducting research on the application of tertiary recovery solutions for the Miocene layer is imperative. Recently, several research works have been carried out to achieve this purpose [1, 2], in which the use of polymer chemicals and sufactants was found to be increase the propulsion coefficient and separate oil sweep, other studies have tried to combine these two kind of chemical elements for similar purpose [3]. In addition, [4] perform a review to study on polymeric surfactants for enhanced oil recovery. A summary of recent research in the literature that provides light on the characteristics, workings, and uses of polymeric surfactants in relation to enhanced hydrocarbon recovery is given in this review. Besides, [5] investigation on the effectiveness of surfactant/polymer flooding at Kumkol Oil Field to improve oil recovery through experimentation. The results indicate that while the polymer injection increases the sweeping front's efficiency, the polymer injection and polymer-surfactant-mixture slug can successfully replace the leftover oil. In order to improve oil recovery, [6] conducted a study on surfactant-polymer flooding and oil field surfactant. Using surfactant and surfactant-polymer slug, a series of flooding tests have been carried out in the present study to examine the increased oil recovery following water flooding. Similarly, [7] presented a new simulator for mixed surfactant/polymer flooding in the enhanced oil recovery processes. Findings showed that the interfacial, rheological, and adsorption rates of the polymer and surfactant are all influenced by each other. According to [8], one attempt to enhance oil recovery in oil reservoirs following the primary and secondary recovery phases is to use the enhanced oil recovery (EOR) approach. EOR screening based on reservoir rock and fluid 'N' parameters shows that alkali surfactant polymer (ASP) injection is the best approach. The laboratory test findings to improve the oil recovery in reservoir 'N' using ASP injection are presented in this study. According to [9], in order to reduce interfacial tension and promote oil recovery at the pore level during a soil decontamination or enhanced oil recovery procedure, a

Tab. 1. Physical properties of rock samples in Mioxen layer

Tab 1. Właściwości fizyczne próbek skał w warstwie Mioxen

Description	Unit	Value
Open porosity	%	16,92
Density of stone frame	g/cm³	2,66
Air permeability	mD	162
Residual water saturation	%	50,7
Compressibilty	10^{-4} MPa	2,11

Tab. 2. Average values of main parameters of Lower Miocene oil

Tab. 2. Średnie wartości głównych parametrów ropy Dolnego Miocenu

Description	Unit	Northern Dome	Central Dome	South Dome
Saturation pressure	MPa	20.42	14.06	8.94
Gas content	m³/t	141.4	95.14	42.7
Volume coefficient		1.399	1.3	1.149
Viscosity under seam condition	cP	1.074	1.76	4.879
Density in seam condition	kg/m³	710.2	741.9	814.8
Separation oil density	kg/m³	865.3	865.2	884.1

surfactant solution must first be injected. This is followed by the injection of a polymer solution to prevent the formation of preferential pathways and to conduct a uniform sweep of the reservoir. Thus, they conducted research on Polymer Surfactant Interactions in oil enhanced recovery processes. The results indicated that utilizing interacting polymer and surfactant systems can sometimes even be beneficial for oil recovery. In another study, the relationship between surfactant and polymer in aqueous solutions for chemically improved oil recovery was analyzed [10]. They confirmed that in EOR, polymer-surfactant partners are screened primarily by their interaction with the polymer. Additionally, research into polymeric surfactants for improved oil recovery, impact of surfactants in surfactant-polymer flooding on crude oil emulsion stability was presented in [11]. The findings showed that the two types of surfactants—petroleum sulfonate and anionic-nonionic composite surfactant—can both raise the surface potential of the oil droplets scattered in the O/W emulsion and reduce the interfacial tension between the oil phase and the aqueous phase, which can improve the stability of the W/O and O/W crude oil emulsions.

In addition to studying relationship between the polymer and surfactants, [12] found the best surfactant for EOR polymer injectivity. Good injectivities are guaranteed by this surfactant under a variety of circumstances. It offers value to polymer flooding projects as the surfactant that is more advantageous commercially. Moreover, [13] performed a study on surfactant-enhanced stimulation technology for polymer-injection wells. Lab test shows that the best results are obtained by using a flooding method that involves injecting an oxidant slug, a surfactant slug, and finally polymer flooding (the permeability to polymer fluid is improved by around 120%).

In Bach Ho field, there are some studies conducted in Lower Miocene reservoir. While [14] implemented seismic attribute analysis in Lower Miocene reservoir, [15] applied surfactant solution for lower oligocene formation, White Tiger field. Additionally, Giang et al. (2021) assesses the variables affecting the flooding process and suggests using a surfactant-polymer chemical flooding solution for the Lower Miocene formation of Bach Ho field South Block. Besides, an effective experimental use of the complex combination surfactant polymer VPI SP to improve oil recovery factor in the Bach Ho field during the Lower Miocene was presented in [16].

Nevertheless, suggested technique is still relatively novel to oil and gas industry, which brings about difficulties in chosing applicable methods to reach the optimun oil recovery factor, especially when using both polymer chemical and sufactants. This current paper presents studies on the suitability of surfactant-compound-infused polymer injection solution for lower Miocene Bach Ho field. The results of study can be used as as reference for research in areas with similar characteristics to Bach Ho field.

2. Properties of reservoir rock and lower Miocene fluid of Bach Ho mine

2.1 The petrographic-sedimentary characteristics of the rocks containing the Lower Miocene

In oder to examine the geotechnical characteristic of samples in Bach Ho field, 601.9m whole core was taken with 92.4% recovery of total lenght from 23 wells. All of these samples were located in the lower Miocene layer of Bach Ho field. Based on these core samples, the lithology and reservoir characteristic were studied. The laboratory analysis showed that the reservoir consistsing of sandstone, siltstone, sandy gravel with loose to medium dense.

Six sedimentary samples of Miocene layer taken from the lower wells namely BH-1203 were analyzed using X-ray method to determine 5 primary chemical components. The kaolinite content in clay minerals of lower Miocene layer ranges from 3.8% to 31.8%, average value of 17.33%; Chlorite content is from 3.8–12.4%, average of 7.53%. The ilite content is from 4.1–16.4%, the average is 10.58%; content of momtmorilonite 41–84.1%, the average of 60.93%; content of other minerals is 0.5–8%, average 3.82%. The laboratory analysis results that the primary element of clay samples located in the BH-1203 is momtmorilonite element (accounting for ~61%), followed by kaolinite (~17.1%), and the remaining minerals accounting for 21, 9%.

2.2 Physical characteristics of rocks containing the Lower Miocene

Lower Miocene reservoirs developed in the entire field, primarily in the north and central areas. The thickness of this reservoir varies between 11.6 and 576.6 m, with a northern average of 30.4 m. The lower Miocene has good quality (permeability = 0.1 - 2000 mD, porosity varying from 15.3÷22.9%) [17]. The author took samples of the lower Miocene layer in

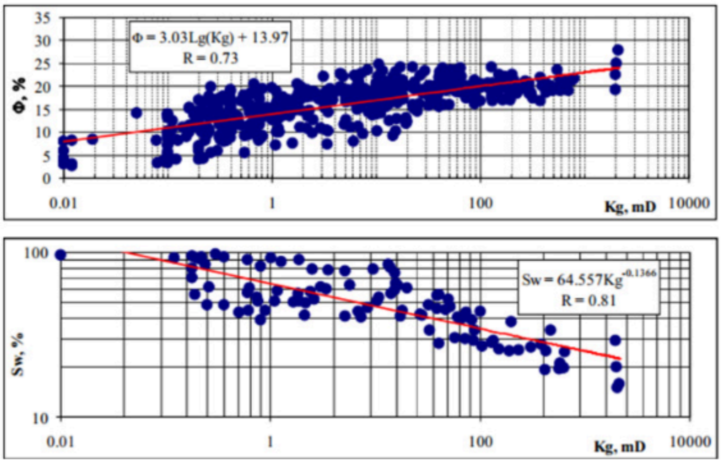

Fig. 1. The petrographic–physics relationships of rocks containing Lower Miocene, Northern dome of Bach Ho field
Rys. 1. Zależności petrograficzno-fizyczne skał zawierających Dolny Miocen, północną kopułę pola Bach Ho

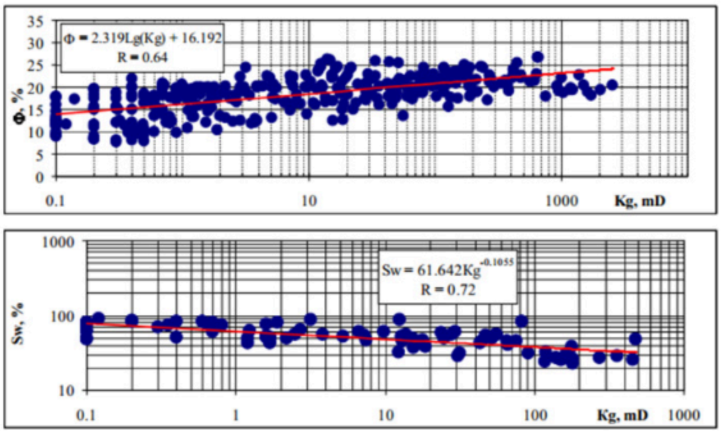

Fig. 2. The petrological relationships of the rocks containing the Lower Miocene, the central arch of the Bach Ho field
Rys. 2. Powiązania petrologiczne skał zawierających Dolny Miocen, centralny łuk pola Bach Ho

the Northern dome and the Central arch of the Bach Ho field to perform experiments to determine physical characteristics. Sampling complies with the procedures and regulations of the Ministry of Natural Resources and Environment. The physical properties of the sediment samples were analyzed based on experimental results of all samples taken from the lower Miocene stratum. The study analyzed sample characteristics including open porosity, density of stone frame, air permeability, residual water saturation, and compressibility. From the analysis results, the average value of the rock properties of the Miocene reservoir was determined (Table 1). In addition, the petrographic-physical relationship of the Lower Miocene reservoir rocks, the Northern dome and the Central arch of Bach Ho field were also determined through the above experiments. The petrographic-physical correlations of the Miocene are shown in Figure 1 and Figure 2.

2.3 Oil properties in reservoir condition

The accurately identification of the oil properties at the reservoir conditions have always been concerned with many experts in the field of oil industry. The correct recognition of these features results in the advancement of reservoir layers and enhances their performance. Reservoir-fluid characteristics are important in the designing and optimizing injection/production plans and surface facilities for effective reservoir management [18]. Therefore, in this study, 12 bottom hole oil samples were used to analyze the oil properties of Miocene reservoir seam including parameters: saturation pressure, gas content, volume coefficient, viscosity under seam condition, density in seam condition, and separation oil density. Analysis results show that the North crest has the highest saturation pressure (20.42 MPa) and the lowest viscosity (1.074 cP), meanwhile the South crest has the lowest saturation pressure (8.94 MPa) and highest viscosity (4.879 cP). The primary parameters of low Miocene reservoir seam oil for all three crests are shown in Table 2.

2.4 Characteristics of water beds in the Lower Miocene

Water in Miocene reservoir is characterized by weak acidic and weak alkali; medium and low mineralization, varying from 3,245–10,911 g/l in the North crest to 13,002–17,721 g/l in the Central crest, and reaching 27,524–30,408 g/l in the South crest (Table 3). From North to South of Bach Ho field, the mineralization of seam water gradually increases, and also the characteristic of water changes from sodium-bicarbonate to calcium chloride.

According to finding from previous publications [19], the water in Miocene layer is characterized by low content of sulphate and magnesium, varying between 25–413 mg/l and 1–88 mg/l, respectively. It is also found that the bicarbonate

Tab. 3. Water parameters of Miocene reservoir at Bach Ho field in reservoir condition

Tab 3. Parametry wody zbiornika mioceńskiego w polu Bach Ho w stanie zbiornikowym

Description	Central Dome		Northern Dome	
	Floor 23	Floor 24	Floor 23	Floor 24
Water gas ratio,m³t.c/ton	3.153	3.245	3.376	3.446
Volume coefficient, unit part	1.0442	1.0454	1.0453	1.046
Viscosity, cP	0.255	0.255	0.265	0.265

Tab. 4 Laboratory results of matrix experiment for evaluation Polymer-Surfactant solution

Tab 4. Wyniki laboratoryjne doświadczenia matrycowego do oceny roztworu polimer-surfaktant

Test	Surfactant	Polymer	Lab procedure and results
Tolerance with sea water and formation water (salinity 25-35 g/liter)	√	\	Unprecipitate, stable properties and steady concentration
Stable at high tempeature (90-110ºC)	√	\	Unprecipitate, stable properties and steady concentration
Reduce interfacial tension (IFT)	√		Interfacial tension of oil-water-chemical system less than 0.01 dynes/cm (IFT < 0.1 dynes/cm)
Stable viscosity		√	Viscosity > 10 cP
Improve recovery factor	√	√	Incremental of oil produced at outlet

content decreases from North to South direction, however, the calcium content gradually increased from several tens of mg/l up to thousands mg/l, and reaching 2,515 mg/l in the south (BH-7).

The bromine and iodine content are found relatively high, meanwhile the ammonia, phenol and naphthenic acid content is low value. One key noted that calcium and magnesium effect to the ability of chemical.

During the producing time, many different measures have been carried out such as seawater injection to maintain reservoir pressureand near-bottomhole treatment. This leads to the physical and chemical properties as well as the composition of ion-water is significantly altered. Besides, on the way reaching oil well, the injected water has interacted with the rock, seam-water and ion exchange taking place. As a result of this process, the calcium content of the water increases, and the content of magnesium, sulphate, bicarbonate and sodium decreases. It is implied that after the appearance of injected water at the extraction wells, the Miocene associated water changed properties, and becomes calcium chloride (XK) water.

3. Advanced mechanism for oil recovery when injecting surfactant and polymer combination

The adsorption of molecules of "Miocene" compound from the inside of the solution to the interface taking place with any concentration of "Surfactant" compound. As the concentration of Surfactant compound goes up, the concentration of surfactant at the interface also increases. When the concentration of Surfactant compound reaches a certain value, the aggregation of Surfactant compound is occurred inside of the solution, this process leads to dramatic change in the physical properties of the solution and the concentration of the solution is called the critical Micelle concentration (CMC). This group of elements is called as Micelle. This solution has a lower surface tension in comparison to that of oil phase, so it increases the mobility of oil trapped in the reservoir. Due to this effect, trapped oil could expel from pore throat and continue flowing into the well bore. Besides, the existence of Polymer chemical could control the mobility of Micelle solution and effectively impel the Micelle solution. As the Polymer solution is constantly injected, the viscosity of Polymer solution increase and able to prevent the dispersion of water penetrating the oil zone. This technique provides a high efficiency of oil recovery due to the simultaneous improvement of the sweeping and repel oil. The simulation results of Liaohe oil seam by Wu Wenxiang., etc (2014) [20] indicated the efficiency as injecting a combination of 0.3% of Surfactant and 1500 mg/l polymer with a molecular weight (MW) of 19 MDa could achieve a value of 30%.

4. Research on mixed injection in the laboratory to predict the results applied to the Ha Miocene, Bach Ho mine

4.1 Research on oil propulsion on reservoir physical model.

Firstly, dodecyl benzene sulfonate was neutralized by caustic soda to obtain sodium 2-dodecylbenzene sulfonate (SDBS). High concentration surfactant solution preparation was conducted. In order to prepare the main surfactant solution, a cup with magnetic stirrer bar was put on a magnetic stirrer. Water was poured into the cup and the stirrer was turned on. After that, AOS, sodium 2-dodecylbenzene sulfonate and isopropanol were added one by one and mixed about 2 hours until clear and homogeneous yellow solution appeared. Subsequently thiourea was added and stirred well until homogeneous and clear solution.

Aiming at evaluating the efficiency of improving oil recovery by using polymer injection solution with Surfactant solution, a simulation model for the Miocene object was built and simulated with a series of sensitivity assessments (Table 4). The primary basis of modelling work is based on performance of adjusted technology using for Bach Ho field along with the updates on the current state of exploitation to the end of 2018. Besides, the results from laboratory test of a combination of polymer and surfactant solution were also utilized as input parameters for the evaluation of oil sweep efficiency in the oil field.

Core flood are conducted on 02 set to evaluate the ability of solution chemical are shown in Figure 3 and Figure 4. Before core flooding test, all physical properties of the chemical are satisfied. The first core set is conducted with 02 stage chemical injection separately. The result showed that using compound solution polymer surfactant is more beneficial recovery than individual. The second core set was injected with complex solution SP after water flooded with no oil appeared at outlet.

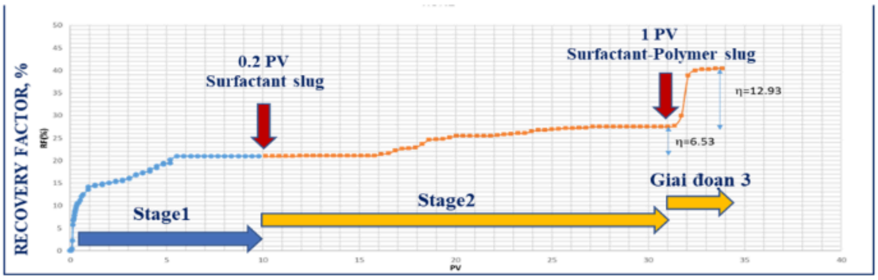

Fig. 3. Core flooding results of the first set core plug

Rys. 3. Wyniki pierwszego zalania rdzenia

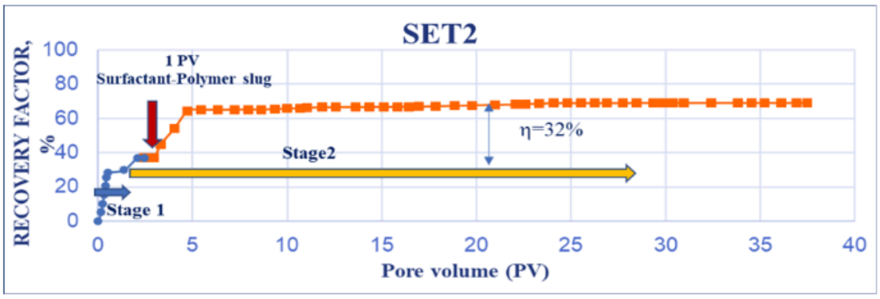

Fig. 4. Core flooding results of the second core plug set

Rys. 4. Wyniki drugiego zalania rdzenia

Set1: Process of 3-stage injection into core samples:

- Stage 1: Inject 10 PV of injection water through the core sample;
- Stage 2: Inject 0.2 PV Surfactant (concentration 20000ppm) through the sample.
- Stage 3: Inject 1 PV solution SP to increase oil recovery (20000ppm surfactant + 5000ppm polymer). Continue inject water to increase oil recovery.

Set2: Process of 2-stage injection into core samples

- Stage 1: Inject 3.5 PV of injection water through the core;
- Stage 2: Inject 1 PV solution SP to increase oil recovery (20000ppm surfactant + 5000ppm polymer). Continue inject water to increase oil recovery.

The results of increased oil recovery on fluid samples and core samples of lower Miocene when injecting show that the injection method of polymer + SURFACTANT mixture can be applied to the research object.

4.2. Research on oil propulsion on reservoir simulation model

Based on the analysis of geological characteristics, the properties of rock-fluid interactions, and the current state of exploitation. The South dome, specifically the BK-14/16 region, was selected as the primary input for the model due to its unique geological features and current exploitation status. This decision was made after a thorough examination of the geological characteristics of the area, including the composition and structure of the rocks, and the properties of the fluids they contain.

The simulation model constructed for this study is quite comprehensive, consisting of more than 400,000 active cells. This high number of active cells allows for a detailed and accurate representation of the geological structure of the South dome are shown in Figures 5. The model also includes a total of 27 flowing wells, providing a realistic depiction of the oil extraction process. Of these wells, 23 are production wells, which are primarily responsible for extracting oil, while the remaining four are injection wells, used for injecting substances to aid in oil recovery.

The simulation model provides an updated production history of the Miocene object until the end of March 2020. This update is crucial as it allows for the tracking of changes in production over time, providing valuable insights into the efficiency and effectiveness of the oil extraction process. Remarkably, the model shows a high degree of accuracy, with a total match of over 90% of wells. This high match percentage indicates that the model accurately represents the real-world conditions of the wells, further validating its reliability and effectiveness.

This data was used to design parameters for a test reagent system, which are set out in Table 5. These parameters were carefully designed based on the test program data to ensure the effectiveness of the reagent system. The reagent system plays a crucial role in the oil extraction process, and the careful design of its parameters is essential for optimizing oil recovery. Therefore, Table 5 is an important component of the study, providing detailed information on the designed parameters of the test reagent system.

Given the logistical imperatives and the infrastructural constraints specific to the pilot area, it becomes evident that judiciously administering a minute quantity of chemical agents during brief and targeted injection intervals into the injector wells is a prudent course of action. The empirical evidence corroborating this approach is succinctly summarized in Table 6, which meticulously outlines the observed enhancements in oil production for the two wells, namely 1203 and 1203B. To facilitate comprehensive pumping tests, we deliberately opted for a subset of wells strategically situated within

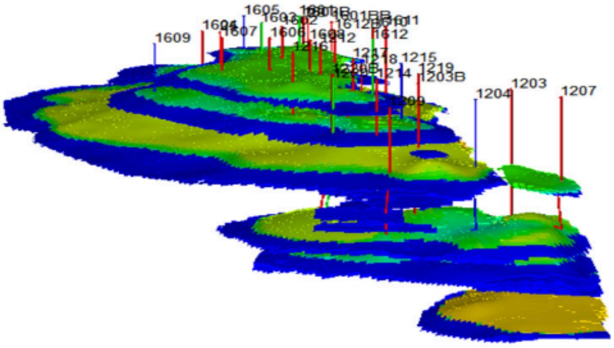

Fig. 5. Simulation model of Lower Miocen, Southern dome, field Bach Ho

Rys. 5. Model symulacyjny Dolny Miocen, kopuła południowa, pole Bach Ho

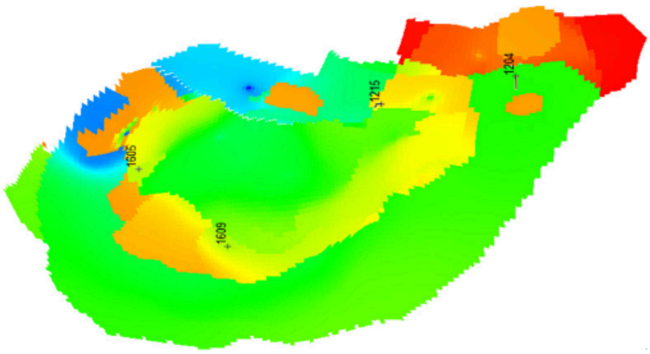

Fig. 6. Location of injection wells on the simulation model of Lower Miocen, Southern dome, Bach Ho field

Rys 6. Lokalizacja odwiertów zatłaczających na modelu symulacyjnym złoża Dolny Miocen, kopuła południowa w polu Bacha Ho

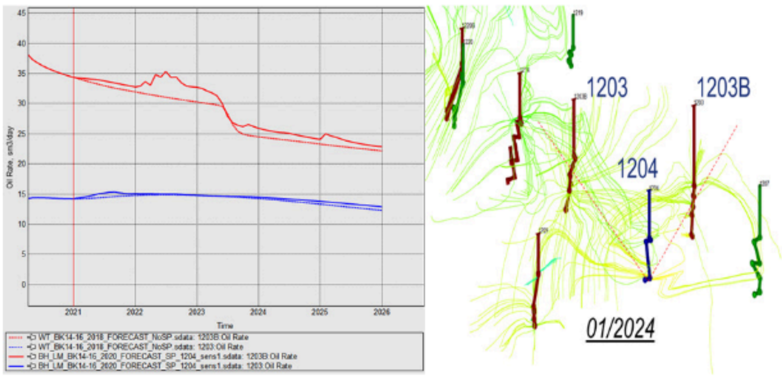

Fig. 7. Increased efficiency of oil recovery from the pump well 2014 to 2024

Rys. 7. Zwiększona efektywność wydobycia ropy z odwiertu pompowego w latach 2014–2024

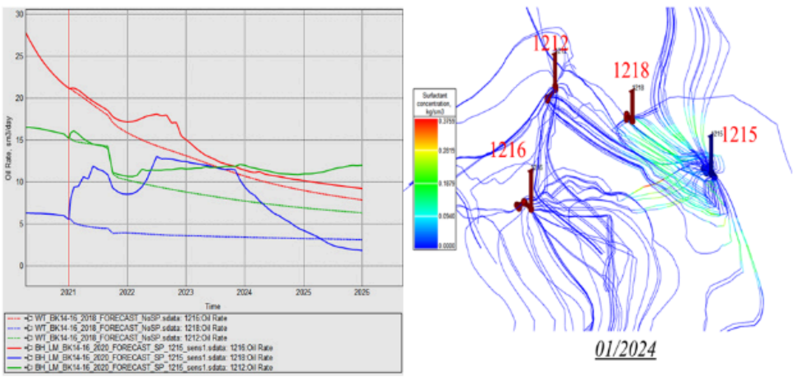

Fig. 7. Increased efficiency of oil recovery from the pump well 2014 to 2024

Rys. 7. Zwiększona efektywność wydobycia ropy z odwiertu pompowego w latach 2014–2024

Tab. 5. Parameters for the experimental chemical system

Tab. 5. Parametry doświadczalnego systemu chemicznego

Viscosity of complex solution SP		Adsorption of chemical		IFT	
concentration of polymer, kg/sm^3	Viscosity of solution, cP	Concentration of polymer, kg/sm^3	Adsorp chemical, kg/kg	Concentration, kg/sm^3	IFT, mN/m
0	1	0	0	0	26.3
2	5.3	0.0003	0	0.01	0.1
3	7.2	2.5	0.00012	0.1	0.05
4	12.5	9.5	0.00025	1	0.01

Tab. 6. Increase production oil of 2 well 1203 1203B

Tab 6. Zwiększenie wydobycia ropy z 2 odwiertów 1203 i 1203B

	Natural flowing (well: 1203 1203B)				Inject SP complex to 1215 well, Observe area (wells: 1212 1216 1218)			
	Applied SP	Water injection	Incremental in comparison with natural flow		Applied SP	Water injection	Incremental comparison with natural flow	
	th.tons	th.tons	th.tons	th.tons	th.tons	th.tons	th.tons	%
1st year	14.4	14.0	0.3	2.4	12.7	10.8	1.9	17.7
2nd year	28.7	27.6	1.1	4.1	24.5	18.9	5.6	29.5
3th year	41.6	40.0	1.5	3.8	35.2	25.9	9.3	35.8
4th year	**53.1**	**51.2**	**1.9**	**3.8**	**43.7**	**32.0**	**11.7**	**36.6**

the southern perimeter of the Bach Ho field. These selected wells were subsequently subjected to rigorous pumping simulations, the results of which are meticulously documented in Figure 6, providing valuable insights into the hydrodynamic behavior and reservoir response within this geologically significant context.

In the course of conducting rigorous simulation tests on a carefully selected subset of wells, the empirical evidence presented in Figures 7, 8, and 9 unequivocally substantiates the efficacy of implementing targeted strategies aimed at augmenting oil recovery over the ten-year period spanning from 2015 to 2024. These illustrative figures serve as compelling visual proof, demonstrating that the adoption of such measures represents a judicious and well-founded approach to enhancing the overall oil extraction performance within the geologically significant lower Miocene Bach Ho field. The implications of these findings are far-reaching, as they underscore the strategic importance of optimizing oil production in this specific geological context, thereby contributing to the sustainable management of hydrocarbon resources in the region.

5. Conclusion

The research presented in this paper has demonstrated the significant potential of a combined surfactant and polymer solution in enhancing oil recovery. The study focused on the Miocene objects in the lower Bach Ho field, an area that has not been extensively explored in previous studies. Our findings reveal that the integration of surfactants and polymers in a single solution can effectively increase both the sweep and swept efficiencies, leading to a substantial improvement in the oil recovery coefficient. The simulation model used in our study further substantiates this, showing a 10% increase in the recovery factor and a 36.6% increase in the amount of oil recovered. A noteworthy observation from our research is the differential impact of the chemical injection at different wells. Specifically, well No. 1215 exhibited a significantly higher efficiency in increasing the oil recovery coefficient compared to well No. 1204. This suggests that the effectiveness of the combined surfactant and polymer solution may vary depending on the specific characteristics of the well. this study provides compelling evidence for the practical applicability of a combined surfactant and polymer solution in enhancing oil recovery. These findings could serve as a valuable reference for future studies aiming to optimize oil recovery in areas with similar characteristics to the Bach Ho field. However, further research is needed to fully understand the factors influencing the effectiveness of this approach at different wells.

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Badania nad przydatnością roztworu wtryskiwania polimeru ze związkiem powierzchniowo czynnym dla Dolnego Miocenu, pole Bach Ho

Podobnie jak w przypadku polimerów, na rynku dostępnych jest wiele środków powierzchniowo czynnych o rozsądnych cenach i wysokiej aktywności. Niemniej jednak, jednoczesne połączenie surfaktantów i polimerów w tej samej mieszaninie nie zostało dokładnie zbadane. W niniejszej pracy autorzy badają możliwość wstrzykiwania mieszaniny surfaktantów i polimerów w celu zwiększenia wydajności wydobycia ropy na obiektach miocenu w dolnym polu Bach Ho. Uzyskane wyniki wskazują, że technika integrowania roztworu surfaktantu i polimeru zwiększa efektywność przepłukiwania i oczyszczania, co w konsekwencji prowadzi do wzrostu współczynnika odzysku ropy. Na podstawie modelu symulacyjnego wskaźnik odzysku wzrósł o 10%, a ilość wydobywanej ropy zwiększyła się o 36,6%. Ponadto wyniki badań wskazują, że efektywność zwiększania współczynnika odzysku ropy poprzez wstrzykiwanie chemiczne za pomocą połączenia surfaktantów i polimerów w odwiertach nr 1215 jest znacznie wyższa niż w odwiertach nr 1204. Wyniki tych badań mogą stanowić punkt odniesienia dla prac o podobnym celu prowadzonych w obszarach o podobnych cechach geologicznych jak pole Bach Ho.

Słowa kluczowe: *zwiększony odzysk ropy, wtrysk roztworu polimeru, środki powierzchniowo czynne*