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ИССЛЕДОВАНИЕ ФИЗИКО-ХИМИЧЕСКОГО ВОЗДЕЙСТВИЯ НА РЕОЛОГИЧЕСКИЕ ПОКАЗАТЕЛИ ВЫСОКОПАРАФИНИСТОЙ НЕФТИ

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Представленная статья посвящена раздельному и совместному влиянию магнитного поля и новой композиции, приготовленной в соотношении Дифрон-4201 + БАФ = 1:1, на реологические свойства высокопарафинистой эмульсионной нефти. При проведении лабораторных исследований использовали концентрации композиции 200, 300, 400, 500, 600 и 700 г/л. Влияние магнитного поля изучали в течение 5, 10, 15, 25 и 30 мин. Образец нефти, использованный в ходе экспериментов, исследовали при температурах 0,5, 10, 15, 20, 25 °С. В качестве высокопарафинистой нефти использована проба, взятая из скважины №208 месторождения 28 мая SOCAR. Изучено раздельное и совместное влияние магнитного поля и состава на температуру замерзания, эффективную вязкость и количество асфальтено-смоло-парафиновых отложений высокопарафиновой нефти. Определено, что комбинированное воздействие магнитного поля с композицией более эффективно.Таким образом, в то время как магнитное поле и состав снижают температуру замерзания нефти с +17 °С до +4 °С и +2 °С соответственно, при совместном воздействии температура замерзания нефти падает до -2 °С. Эффективная вязкость масла при воздействии магнитного поля составляет 0,66 Па·с, при воздействии состава – 0,44 Па·с, при совместном воздействии – 0,003 Па·с. Изучено влияние магнитного поля, состава и комбинированного воздействия магнитного поля с композиции на количество парафиновых отложений и определено их влияние методом «Колдфингертест». Определено, что влияние магнитного поля на парафиновые отложения, накопившиеся на поверхности теста Колдфингер, составляет 52%, влияние композиции – 74%, комбинированной формы – 90%.

Ключевые слова: магнитное поле, состав, тест Колдфингера, высокопарафинистая нефть, эффективная вязкость, температура замерзания

RESEARCH OF PHYSICO-CHEMICAL IMPACT ON THE RHEOLOGICAL PARAMETERS OF HIGH-PARAFFIN OIL

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The presented article is dedicated to the separate and joint effect of magnetic field and the new composition prepared in the ratio of Difron-4201 + BAF = 1:1 on the rheological properties of highly paraffinic, emulsion oil. The sample taken from well number 208 of field May 28 of SOCAR has been used as high paraffin oil. Separate and joint impact of the magnetic field and composition on the freezing temperature, effective viscosity and amount of asphaltene-resin-paraffin deposits of high-paraffin oil has been studied. It was determined that the combined effect of the

magnetic field with the composition is more effective. Thus, while the magnetic field and composition reduce the freezing temperature of oil from +17 °C to + 4˚C and + 2 °C, respectively, the freezing temperature of oil drops to -2 °C during the joint impact. The effective viscosity of oil under the impact of the magnetic field is 0.66 Pa·s, under the impact of the composition it is 0.44 Pa·s, and during the joint impact it is 0.003 Pa·s. The impact of the magnetic field, composition and the combined impact of magnetic field with composition on the amount of paraffin deposits has been studied and their effect has been determined by "Coldfingertest" method. It has been determined that the effect of the magnetic field on paraffin deposits accumulated on the surface of the Coldfingertest is 52%, the effect of the composition is 74%, and the effect of the combined form is 90%.

Key words: magnetic field, composition, Coldfingertest, high paraffin oil, effective viscosity, freezing temperature

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INTRODUCTION

Currently, the produced oils are very diverse according to their physico-chemical properties, such as, viscosity, amount of asphaltenes, resin and paraffins. Oils having such properties are rheologically different and have high freezing temperature [1-4].

The main objective in oil extraction and oil refining processes is to develop technological processes that will reduce energy loss and prevent additional losses of hydrocarbon raw materials. Oils with anomalous physico-chemical properties are the solution to these problems [5, 6].

In this regard, studying the scientific basis of improving physico-chemical and rheological properties of anomalous oils with high paraffin and high freezing temperature is of great importance. All this creates conditions for the economically efficient pipeline transportation of oil and its scientific and technological efficient transportation through pipelines. These researches enable the safe transportation of oil through pipelines [7-10].

Based on the above-mentioned researches, the impact of high paraffin oils on oil, improving their rheological properties, and carrying out the transportation process through new technology have not lost their relevance even today. Facilitating the transportation of high viscosity oils, reducing viscosity and increasing the transmission capacity of oil pipelines is one of the important issues that are constantly in the focus of attention [11-15].

Recently, in order to improve the transport properties of high-paraffin oils, polymeric substances-additives are widely used, which prevent the formation of a paraffin space crystal lattice in the oil and, as a result, lower the freezing temperature. Currently, not any methodology is available for selecting optimal additives for any non-Newtonian oil. Since some of the additives lower the freezing temperature, some lower the static viscosity, and some lower the dynamic viscosity, it is impossible to determine which of them is better. The selection of the additive and its concentration is determined experimentally [16-18].

Also recently, the application of the magnetic field jointly with other methods of impact has given effective results. The application of the magnetic field partially compensates for the role of chemical reagents, which are expensive and rarely found. Thus, it is possible to obtain the effect of a solid solution by magnetizing solutions of low-concentrated, expensive reagents. It should be noted that there are various scientific-research and mining-testing works on increasing the effect of various chemical reagents as a result of the impact of the magnetic field [19-23].

For this purpose, a new composition was prepared, which reduces the consumption of expensive inhibitors used against paraffin deposition, and provides long-term protection of equipment and the downhole environment from asphaltene-resin-paraffin (ARP) deposition. In the article, the results of the research about separate and joint impact of the new composition and magnetic field on high paraffin oil are investigated.

Research objective is to study separate and joint impact of the new composition and magnetic field on high paraffin oil sample.

METHODOLOGY EXPERIMENT

Physico-chemical parameters of the oil sample taken from well number 208 of May 28 field for research are presented in Table 1.

Table 1

Physico-chemical properties of high-paraffin oil
***Таблица 1.* Физико-химические свойства высокопарафиновой нефти**

№	Composition	Well number 208, amount, %	Definition
1	Paraffin	15.1	SS 11851-85
2	Asphaltene	6.3	SS 11851-85
3	Resin	11.9	SS 11851-85
4	Freezing temperature,°C	+17	SS 20287-91
5	Amount of water	52	-

As it is seen from the table, the oil sample taken for research belongs to the group of high-paraffin oils and is characterized by a high amount of paraffin hydrocarbons.

In laboratory conditions, the freezing temperature of oil was carried out according to the method of RD 39-3-812-82 [24]. Determining the amount of paraffin in the oil was then carried out by the method of Engler-Glade and adsorption in a Soxhlet apparatus with freezing at -20 °C. At the same time, the amount of silica-gel resin and asphaltenes was determined [25].

«Coldfingertest» method being used in the evaluation of the effectiveness of depressor additives and determination of the optimal consumption rate was used in the formation process of ARPD in high paraffin oil without reagents and with the presence of reagents [25]. This method is based on the deposition of asphaltene-resin-paraffin deposits from oil moving on a cold metal surface. In the experiments, the mass of oil deposits accumulated on the surface of «Coldfingertest» at temperatures of 0, 5, 10, 15, 20, 25 was determined by having been weighed on an analytical scale. The mass share of asphaltene component in the oil deposit was determined through the separation of asphaltenes by Golden's «cold» method, and resin substances were determined by the chromatographic (calon-adsorption) method. The new composition was prepared from the 1:1 ratio of Difron-4201 and BAF-1 reagents, and during the research, its optimal consumption rate was 700g/t. Viscometric researches were carried out in the "Reotest-2" rotary viscometer. Depressor additive of «Difron-4201» is produced by organization «EKOC» of the Russian Federation. «BAF-1» reagent is produced on the basis of local raw materials of Azerbaijan.

RESULTS AND DISCUSSION

The effectiveness of the composition prepared in laboratory conditions was studied on the emulsion oil sample taken from well number 208 of the field May 28.

Separate and joint impact of the magnetic field and new composition on asphaltene-resin-paraffin deposits in high-paraffin oil was determined by using «Coldfingertest» method. The results obtained from the experiment are given in Tables 1-3.

As it is seen from the tables, if the amount of ARPD from the studied oil sample at temperatures of 0, 5, 10, 15, 20, 25 °C was 16.60, 14.30, 10.20, 7.40, 2.10 and 1.30 g, respectively, the amount of paraffin deposits accumulated on the surface of the «Coldfingertest» after the impact of the magnetic field was 13.28, 10.72, 6.43, 4.29, 1.10, 0.62 g, due to the impact of the composition it was 10.79, 8.29, 4.69, 2.59, 0.63, 0.34 g, respectively, and after the joint effect, it was respectively, 8.96 , 6.86, 3.26, 1.92, 0.38, 0.13 g. As it is seen from the results, since the temperature and composition concentration increase, the amount of oil deposits accumulated on the surface decreases. In all three experiments, the highest effect was recorded at 25 °C and was 52% for the magnetic field, 74% for the composition, and 90% for the joint effect. Therefore, the joint combination of the magnetic field and composition has a higher effect against paraffin deposition.

Table 2

Impact of magnetic field on paraffin deposition
***Таблица 2*. Влияние магнитного поля на отложение парафина**

Temperature, °C	The amount of paraffin in the oil, g	The amount of paraffin after the impact of the magnetic field (30 min), g	The effect of the magnetic field, %
0	16.60	13.28	20
5	14.30	10.72	25
10	10.20	6.43	37
15	7.40	4.29	42
20	2.10	1.10	48
25	1.30	0.62	52

Table 3

Impact of the composition on paraffin deposition
***Таблица 3.* Влияние композиции на отложение парафина**

Temperature, °C	The amount of paraffin in the oil, g	The amount of paraffin after the impact of the composition, g	The effect of the composition, %
0	16.60	10.79	35
5	14.30	8.29	42
10	10.20	4.69	54
15	7.40	2.59	65
20	2.10	0.63	70
25	1.30	0.34	74

Table 4

Joint impact of the composition and magnetic field on paraffin deposition

Таблица 4. **Совместное воздействие состава и магнитного поля на отложение парафина**

Temperature, °C	The amount of paraffin in the oil, g	The amount of paraffin after the impact of the composition and magnetic field, g	The effect of the composition and magnetic field, %
0	16.60	8.96	46
5	14.30	6.86	52
10	10.20	3.26	68
15	7.40	1.92	74
20	2.10	0.38	82
25	1.30	0.13	90

Separate and joint impact of the magnetic field and new composition on the freezing temperature of high-paraffin oil was studied in laboratory conditions. This time, concentrations of 200, 300, 400, 500, 600 and 700 g/l of the composition were used. The effect of the magnetic field was studied for 5, 10, 15, 20, 25, 30 min. In the joint impact, the effect of the magnetic field in each concentration of the composition was for 30 min. The results obtained during the experiment are reflected in figures 1 and 2.

As it is seen from Fig. 1 (curve 2), the freezing temperature of high-paraffin oil decreases consistently as the concentration of the composition increases. Thus, the amount of 200 g/l increases the freezing temperature of oil from +17 °C to +12 °C, at 300 g/l to +9 °C, at 500 g/l to +4 °C, at 600 g/l to +3 °C, at 700 g/l to +2 °C. Thus, it was determined that the optimal concentration of the new composition is 700 g/l. The freezing temperature of the studied oil sample lowers from +17 °C to 14, 11, 7, 5 and 4 °C, respectively during the impact of the magnetic field for 5, 10, 15, 20, 25 and 30 min (curve 1). During the joint impact of the composition and magnetic field, the freezing temperature of high paraffin oil decreases from +17 °C to 10, 7, 2, -2 and -5 °C, respectively at concentrations of 200, 300, 400, 500, 600 and 700 g/l of the composition. The conducted experiment once again suggests that the joint impact is more effective.

Separate and joint impact of the magnetic field (within 30 min) and newly prepared composition on the effective viscosity of high-paraffin oil were studied in laboratory conditions, and the obtained results are given in table 5.

As it is seen from table 5, the increase in temperature in the range of 5-25 °C without external impact reduces the viscosity of oil from 15.8 to 1.78 Pa·s. Under the impact of the magnetic field for 30 min, the viscosity decreases from 8.01 to 0.66 Pa·s in the specified temperature range. The viscosity decreases from 5.38 to 0.474 Pa·s at the specified temperatures in the range of 300-700 g/l of the composition. The viscosity decreases from 0.2 to 0.003 Pa·s due to both the impact of the magnetic field (30 min) and joint impact of the composition (in the range of 300-700g/l concentration). Thus, from the analysis of the results of the experiment, it is known that the magnetic field reduces the viscosity by 88.7%, the composition by 91.7%, and the joint impact by 98.5%. The results obtained once again show that the joint impact is more effective for the studied high paraffin oil.

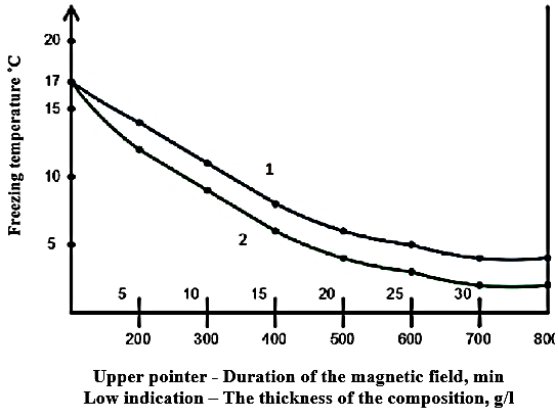

Fig. 1. The impact of the magnetic field and composition on the freezing temperature of high paraffin oil: 1-magnetic field, 2-composition

Рис. 1. Влияние магнитного поля и состава на температуру замерзания высокопарафиновой нефти: 1-магнитное поле, 2-состав

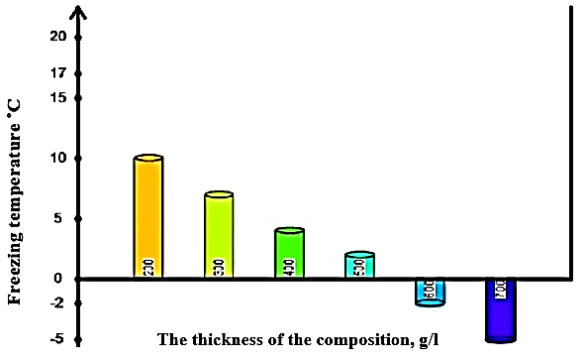

Fig. 2. Joint impact of the magnetic field (30 min) and composition on the freezing temperature of high paraffin oil

Рис. 2. Совместное воздействие магнитного поля (30 мин) и состава на температуру замерзания высокопарафиновой нефти

Thus, the results of the experiments carried out in laboratory conditions can be used to improve the transportation of high-paraffin oils at low temperatures in the oil industry with a 1:1 ratio of Difron-4201 and BAF-1 reagents with a magnetic field.

Table 5

Impact of the magnetic field and composition on the effective viscosity of high paraffin oil at different temperatures

Таблица 5. **Влияние магнитного поля и состава на эффективную вязкость высокопарафиновой нефти при различных температурах**

Concentration/Time	Oil temperature, °C	Effective viscosity, Pa·s
0.00	5	15.8
0.00	10	9.73
0.00	15	6.06
0.00	20	2.37
0.00	25	1.78
Impact of the magnetic field		
30 min	5	8.01
30 min	10	5.1
30 min	15	3.5
30 min	20	1.03
30 min	25	0.66
Impact of the composition		
300 q/l	5	5.38
400 q/l	10	3.38
500 q/l	15	2.02
600 q/l	20	0.98
700 q/l	25	0.44
Joint impact of the magnetic field and composition		
300 q/l30 min	5	0.2
400 q/l /30 min	10	0,01
500 q/l 30 min	15	0.003
600 q/l/ 30 min	20	0.008
700 q/l/ 30 min	25	0.003

CONCLUSION

The effect of the magnetic field, new composition and the joint effect of the magnetic field and composition on the rheological parameters of high paraffin oil sample were studied in laboratory conditions and their optimal consumption rate was determined.

It was determined that the freezing temperature of high-paraffin oil decreases from +17 °C to +4 °C due to the impact of the constant magnetic field for 30 min, due to the impact of 700 g/l of the composition it decreases to +2 °C, and due to the joint impact of both it decreases to 2 °C.

It was shown that the highest impact was observed in the combined method during the physicochemical effect against paraffin deposition in oil by the «Coldfingertest» method. This time, the protective effect of the combined method was 90%.

As a result of the experimental study, it was determined that the minimum value of the viscosity was within the range of 0.003 Pa·s due to the effect of the physico-chemical method during the separate and joint impact of the constant magnetic field and composition on the effective viscosity of oil.

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The authors declare the absence a conflict of interest warranting disclosure in this article.

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