UDC 622.276.72

Guseyn R. Gurbanov, Aysel V. Gasimzade, Nigar A. Abdullayeva

APPLICATION OF NEW REAGENTS AGAINST ASPHALTENE-RESIN-PARAFFIN DEPOSITS AND CORROSION

Azerbaijan State Oil and Industry University, Baku, Republic of Azerbaijan

The impact of the depressant additive Difron-4201 and the composition (hereinafter referred to as AI-1) on paraffin deposition, freezing temperature and surface tension in high-paraffin oil at the ratio of S-1 inhibitor:Difron-4201=28:1 was studied under laboratory conditions for the first time. It was found that the composition AI-1 has a higher efficiency compared to the depressant additive Difron-4201. Thus, at the optimal concentration where the highest effect is observed, the effect of the additive and composition is 96.3% and 97.8% on paraffin deposition, 155.6% and 200% on freezing temperature, and 52.3% and 69.1% on surface tension, respectively. In addition, the impact of inhibitor S-1 and composition AI-1 on the corrosion rate in an aggressive medium with hydrogen sulfide, carbon dioxide and their mixture, as well as on the vital activity of sulfate-reducing bacteria from the Postgate's «B» nutrient medium, was studied. The results of experiments showed that the optimal concentration of inhibitor S-1 is 45 g/t, while the optimal concentration of composition AI-1 is 700 g/t. In comparison with reagent S-1 in the Postgate's «B» nutrient medium, the AI-1 composition shows higher activity both in aggressive environments where gases are present separately and together, and also in a fertile environment for the growth of sulfate-reducing bacteria. At the optimal concentrations of inhibitor S-1 and composition AI-1, the corrosion protection effects are 95.8% and 98.7% in a hydrogen sulfide environment, 88.9% and 93.8% in a carbon dioxide environment, and 90.3% and 95.4% in the environment where both gases coexist. At the optimal concentration, the bactericidal effects of inhibitor S-1 and composition AI-1 are 86% and 97%, respectively.

Keywords: composition, depressant additive, inhibitor, corrosion, protection effect, freezing temperature, viscosity, surface tension.

DOI: 10.32434/0321-4095-2025-162-5-117-124

Introduction

Currently, the share of problematic oil systems characterized by a high amount of paraffin hydrocarbons and resin–asphaltene components in the total volume of raw materials produced in our country and abroad is increasing. During the production and transportation of paraffin and high-paraffin oil systems, the formation of asphaltene–resin–paraffin deposits occurs on the inner surface of oilfield facilities, which leads to a decrease in the productivity of wells, shrinkage of the cross-sectional area of oil pipelines, and in some cases to complete suspension of transportation. Oils with a high freezing temperature are non-Newtonian fluids having specific physicochemical and rheological properties. Therefore, transportation in such an environment by pipelines becomes difficult due to the high freezing temperature and viscosity anomaly.

At present, the investigation of economically viable and reliable means and techniques for improving the rheological properties of anomalous non-Newtonian oils during their transportation is one of the most important issues. The decline in oil production volume leads to underutilization of main and mine pipelines, and to a decrease in throughput and flow rate, which in some cases makes traditional transportation techniques economically unaffordable. Therefore, other, cheaper and more efficient transportation techniques should be employed.

Currently, in order to enable the transportation of high-paraffin oils through pipelines, various techniques for increasing their fluidity, in particular, the addition of depressant additives, are employed. The transportation of high-paraffin oils through pipelines with the addition of depressant additives is considered one of the relatively promising transportation methods. The main advantages of depressant additives are the simplicity of their addition to the transferred oil streams, their compatibility with other chemical additives used in the production, transportation, and storage systems of high-freezing-point oils, and the high economic effect achieved through their use. In addition, the use of depressant additives makes it possible to significantly reduce hydraulic losses during the transportation of high-paraffin oils, reduce the amount of paraffin deposition on the walls of pipelines and facilities, and ease the operating conditions of oilfield and oil pipeline facilities [1–9].

On the other hand, ensuring the reliability and durability of oil industry facilities and pipeline systems is considered an important issue during the development of oil fields and subsequent transportation of hydrocarbon raw materials. However, the corrosion activity of the operating environment in this area, in turn, is largely associated with the presence of aggressive gases (H_2S, CO_2, O_2) and sulfate-reducing bacteria. For oil pipelines, the condensate generated during the decrease in oil temperature is particularly hazardous. It constitutes a two-phase corrosion system, in which the corrosion processes occur in the aqueous phase.

The impact of an aggressive corrosion environment is not limited to the degradation of metals. In particular, one of the relatively hazardous manifestations of hydrogen sulfide corrosion is sulfide corrosion fracture under tensile stress. In addition, the detached corrosion products fall onto the pumping equipment, causing blockage and jamming, which leads to a decrease in the productivity of oil formations. Iron sulfides and oxides produced along with well products are considered stabilizers of oil emulsions, which increase the cost of processing oil at facilities. In addition, corrosion of steel facilities of wells, highway, and technological pipelines can seriously damage the environment, as well as reduce their service life and increase their maintenance costs. Damage to facilities leads to salinization of the soil by aggressive formation waters and to pollution of soil and natural water reservoirs with oil and oil products.

In this regard, great attention is currently being paid to the problem of increasing the service life of well technological facilities in oil fields. One efficient method of corrosion protection of mining equipment and pipelines in the oil industry is the use of corrosion inhibitors. The use of inhibitors is a relatively widespread and economically proven method of corrosion protection for mining equipment and pipelines. It is possible to reduce the corrosion rate to an acceptable level without fundamentally changing the existing technological schemes by changing the concentration of the inhibitor or by using various multifunctional corrosion inhibitors [4,10].

The work objective is to investigate the efficiency of reagents of various purposes and a newly developed composition.

Research methodology

The physicochemical properties of the oil sample from the Bulla-deniz field used in the experiment are shown in Table 1.

As is seen from Table 1, the oil sample taken for the research belongs to the group of high-paraffin oils and is characterized by a high amount of paraffin hydrocarbons.

Under laboratory conditions, a new composition was developed with a 28:1 ratio of the depressant additive Difron-4201: to a reagent with the chemical formula $C_{11}H_9Cl_2O$ (designated S-1). The composition was designated AI-1.

The formation of asphaltene–resin–paraffin

Table 1

Physicochemical properties of oil

Parameter	Value	Method of avaluation
density, ρ_4^{20}, kg/m^3	973.8	state standard GOST 3900-85
content of paraffin, %	12.9	state standard GOST 11851-85
content of resin, %	9.3	state standard GOST 11851-85
content of asphaltene, %	0.18	state standard GOST 11851-85
freezing temperature, ^{0}C	+9	state standard GOST 20287-91

deposits in high-paraffin oil in the presence of Difron-4201 and the AI-1 composition was studied. For this purpose, the cold-finger test, a method used to evaluate reagent efficiency and to determine the optimal dosing rate, was employed. The experiment was carried out at +50^{0}C using a cold finger; the mass of oil deposits accumulated on the finger surface over 60 minutes was determined by weighing on an analytical balance. The mass fraction of the asphaltene component in the deposits was determined by separation of asphaltenes using Golden's «cold» method, and resin substances were analyzed by a chromatographic (column-adsorption) method. Under the experimental conditions, the optimal dosage of the AI-1 composition (Difron-4201:$C_{11}H_9Cl_2O$=28:1) was 700 g/t; the dosage of Difron-4201 alone was 900 g/t, and the consumption rate of S-1 (inhibitor) was 45 g/t.

Ct3-grade steel samples were used to investigate corrosion intensity (Table 2).

To determine the corrosion rate of Ct3-grade steel plates (30×20×1 mm) by mass loss, tests were carried out under laboratory conditions for 6 hours at 25^{0}C.

Steel plates of Ct3 grade were polished on a grinding machine. After cleaning the surface with acetone and ethanol, they were weighed on an analytical balance. Upon completion of the laboratory test, the plates were removed from the test environment and cleaned of corrosion products. The plates were rubbed with cotton soaked in a solution of 10% hydrochloric acid and 40% formalin, rinsed with running water, and dried using acetone. To achieve constant mass, the plates were placed in a desiccator for 10–12 hours both before and after the experiment. Finally, the plates were weighed again on an analytical balance.

The corrosion rate was calculated using the following equation:

$$K = \frac{m_1 - m_2}{S \cdot \tau},$$

where m_1 is the pre-test weight of the sample (g); m_2 is the weight of the sample after removal of corrosion products (g); S is the exposed area of the sample (m^2); and τ is the test duration (h).

The retardation factor was calculated as follows:

$$\gamma = \frac{K_0}{K_{inh}},$$

where K_0 is is the corrosion rate without reagent; and K_{inh} is the corrosion rate in the presence of the reagent (g/m^2·h).

The protective effect of the reagents was calculated using the following formula:

$$Z = \frac{K_0 - K}{K_0} \cdot 100\%,$$

where K_0 is the corrosion rate without reagent; and K_{inh} is the corrosion rate in the presence of the reagent (g/m^2·h).

Postgate's «B» nutrient medium was used for the cultivation and growth of sulfate-reducing bacteria (Table 3).

To determine the bactericidal properties of the reagents under laboratory conditions, strains of the sulfate-reducing bacteria *Desulfomicrobium* and *Desulfovibrio desulfuricans* were used. The bacteria employed in the experiment were isolated from the formation water of well No. 1082 at the Bibiheybatneft oil and gas extraction facility of SOCAR.

The growth factor of sulfate-reducing bacterial cells in the presence of the reagent was calculated using the following expression:

$$N,\% = \frac{n_0 - n_{inh}}{n_0} \cdot 100\%,$$

where n_0 is the number of microorganisms in the reagent-free environment; and n_{inh} is the number of microorganisms in the environment with the reagent.

Table 2

Chemical composition of Ct3-grade steel

Element	C	Mn	Si	P	S	Cr	Ni	Cu	Fe
Content, %	0.2	0.5	0.15	0.04	0.05	0.30	0.20	0.20	98.36

Table 3

Composition of the Postgate's «B» nutrient medium

Component	NH_4Cl	K_2HPO_4	$MgSO_4 \cdot 7H_2O$	$CaSO_4$	Ca lactate	Na_2S	Na_2SO_3	$FeSO_4$ (5% solution in 1% HCl)
Content, g/L	1.0	0.5	2.0	1.0	2.6	0.2	2.0	0.5

Results and discussion

The effect of the oil sample used in the study on the accumulation of asphaltene–resin–paraffin deposits on the surface of the cold finger at a temperature of $+5^0$C over 60 minutes, as well as on the freezing point and surface tension of the oil, and the effect of the reagents Difron 4201 and the composition Difron-4201+$C_{11}H_9Cl_2O$ (28:1, AI-1) were investigated. Concentrations of 100, 200, 300, 400, 500, 600, and 700 g/t of both the Difron 4201 depressant additive and the AI-1 composition were tested. The experimental results are presented in Table 3. As can be seen from the table, increasing the concentrations of the Difron 4201 additive and the AI-1 composition led to a decrease in the amount of paraffin deposits, the freezing point, and the surface tension of the oil (Table 4).

Due to the effect of the additive Difron 4201, the mass of paraffin deposits decreases from 32.5 to 1.2 g, while under the influence of composition AI-1, it decreases from 32.5 to 0.7 g. In this case, the reduction in paraffin deposits amounts to 96.3% and 97.8%, respectively.

Under the effect of the additive Difron 4201, the freezing temperature of the oil decreases from $+9^0$C to -5^0C, while under the influence of composition AI-1, it decreases from $+9^0$C to -9^0C. In this case, the reduction percentages are 155.6% and 200%, respectively.

Due to the effect of the additive Difron 4201, the surface tension decreases from 26.2 to 12.5 mN/m, while under the effect of composition AI-1, it decreases from 26.2 to 8.1 mN/m. The reductions in surface tension caused by the reagents are 52.3% and 69.1%, respectively.

The protective effect of the depressant additive Difron 4201 and the AI-1 composition against paraffin deposition as a function of concentration is shown in Fig. 1.

Under laboratory conditions, the inhibitory properties of inhibitor S-1 and the AI-1 composition were investigated in an aggressive corrosive environment containing hydrogen sulfide, carbon dioxide, or a mixture of both gases. Experiments were conducted at room temperature for six hours under dynamic conditions. The experimental results are presented in Tables 5 and 6.

As can be seen from Table 5, increasing the concentration of inhibitor S-1 from 15 g/t to 45 g/t leads to an increase in corrosion protection in all three environments, with the highest effect observed at 45 g/t. Within this concentration range, the protective effect is 82.4–95.8% in a hydrogen sulfide environment, 68.6–88.9% in a carbon dioxide environment, and 57.6–90.3% in the environment containing both gases. The results indicate that inhibitor S-1 is most effective in the hydrogen sulfide environment.

As can be seen from Table 6, the protective

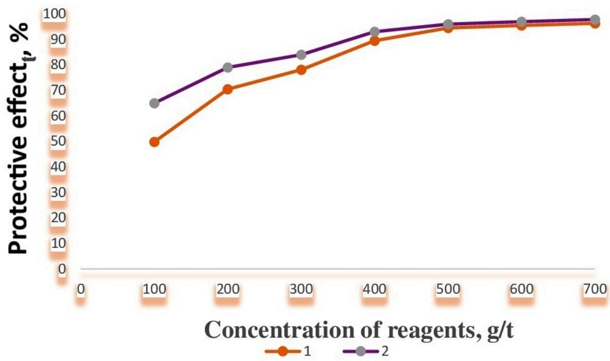

Fig. 1. Protective effect of the reagents on paraffin deposition as a function of concentration:
1 – Difron 4201; 2 – AI-1 composition

Table 4

Effect of the compositions Difron 4201 and «Difron 4201+S-1=28:1» (AI-1) on the amount of deposits accumulated on the surface of the «cold finger» (t=+5^{0}C)

Composition dosage, g/t	Amount of deposits, g		Protective efficiency, %		Freezing point, ^{0}C		Effect on freezing temperature, %		Surface tension, mN/m		Effect on surface tension, %	
	Difron 4201	AI-1	Difron 4201	AI-1	Difron 4201	AI-1	Difron 4201	AI-1	Difron 4201	AI-1	Difron 4201	AI-1
0	32.5	32.5	0.0	0.0	+9.0	+9.0	0.0	0.0	26.2	26.2	0.0	0.0
100	16.3	11.4	49.8	65	+7.2	+5.4	20	40	17.7	11.5	32.4	56.1
200	9.6	6.8	70.5	79	+6.4	+4.3	28.8	52	17.5	11.3	33.2	56.8
300	7.1	5.1	78.1	84	+4.8	+3.2	46.6	64	17.3	11.2	33.9	57.2
400	3.4	2.3	89.5	93	+2.3	+1.5	74.4	83	17.0	11.0	35.1	58.0
500	1.8	1.3	94.5	96	0.0	–3	100	133.3	14.5	9.4	44.6	64.1
600	1.5	1.0	95.4	97	–1.5	–7	112.8	177.7	13.5	8.7	48.5	66.7
700	1.2	0.7	96.3	97,8	–5	–9	155.6	200	12.5	8.1	52.3	69.1

Table 5

Protective effect of inhibitor S-1 in different corrosive environments

C_{inh}	S, m^2	m_1, g	m_2, g	m_1–m_2, g	$K_{without}$ inhibitor, $g/m^2 \cdot s$	K_{with} inhibitor, $g/m^2 \cdot s$	γ	Z,%
H_2S environment								
0	0.0013	8.6697	8.6327	0.037	4.72	–	–	–
15			8.6637	0.006		0.8307	5.68	82.4
25			8.6647	0.005		0.6277	7.52	86.7
35			8.6667	0.003		0.3634	12.99	92.3
45			8.6687	0.001		0.1982	23.81	95.8
CO_2 environment								
0	0.0013	8.6697	8.6357	0.034	4.34	–	–	–
15			8.6597	0.010		1.3627	3.18	68.6
25			8.6607	0.009		1.1110	3.90	74.4
35			8.6637	0.006		0.7074	6.13	83.7
45			8.6657	0.004		0.4817	9.00	88.9
H_2S+CO_2 environment								
0	0.0013	8.6697	8.6387	0.031	4.06	–	–	–
15			8.6567	0.013		1.7214	2.35	57.6
25			8.6607	0.009		1.2789	3.17	68.5
35			8.6657	0.004		0.5765	7.04	85.8
45			8.6667	0.003		0.3938	10.30	90.3

Table 6

Protective effect of the AI-1 composition in different corrosive environments

C_{inh}	S, m^2	m_1, g	m_2, g	m_1–m_2, g	$K_{without}$ inhibitor, $g/m^2 \cdot s$	K_{with} inhibitor, $g/m^2 \cdot s$	γ	Z,%
H_2S environment								
0	0.0013	8.6697	8.6327	0.037	4.72	–	–	–
400			8.6637	0.006		0.7410	6.36	84.3
500			8.6657	0.004		0.5380	8.77	88.6
600			8.6677	0.002		0.2171	21.74	95.4
700			8.6692	0.0005		0.0613	76.99	98.7
CO_2 environment								
0	0.0013	8.6697	8.6357	0.034	4.34	–	–	–
400			8.6607	0.009		1.2369	3.51	71.5
500			8.6627	0.007		0.9851	4.40	77.3
600			8.6647	0.005		0.5902	7.35	86.4
700			8.6677	0.002		0.2690	16.13	93.8
H_2S+CO_2 environment								
0	0.0013	8.6697	8.6387	0.031	4.06	-	-	-
400			8.6577	0.012		1.5346	2.64	62.2
500			8.6617	0.008		1.0637	3.82	73.8
600			8.6667	0.003		0.3410	11.90	91.6
700			8.6687	0.001		0.1867	21.74	95.4

effect increases with increasing concentration of the AI-1 composition, reaching its maximum at 700 g/t. Within the concentration range of 400–700 g/t, the protective effect is 84.3–98.7% in a hydrogen sulfide environment, 71.5–93.8% in a carbon dioxide environment, and 62.2–95.4% in the aggressive environment containing both gases. Similar to inhibitor S-1, the AI-1 composition exhibits the highest protective efficiency in the hydrogen sulfide environment.

Comparison of the results for inhibitor S-1 and the AI-1 composition across all three environments shows that the composition provides a higher protective effect, which can be attributed to the synergistic effect arising from the mixture of reagents with different functions.

The bactericidal effects of inhibitor S-1 and the AI-1 composition were studied in Postgate's «B» nutrient medium. During the experiment, strains of *Desulfomicrobium* and *Desulfovibrio desulfuricans* were used. The tests were conducted over 15 days, and the bactericidal effects of inhibitor S-1 and the AI-1 composition were calculated based on the changes in hydrogen sulfide concentration in the medium (Figs. 2 and 3).

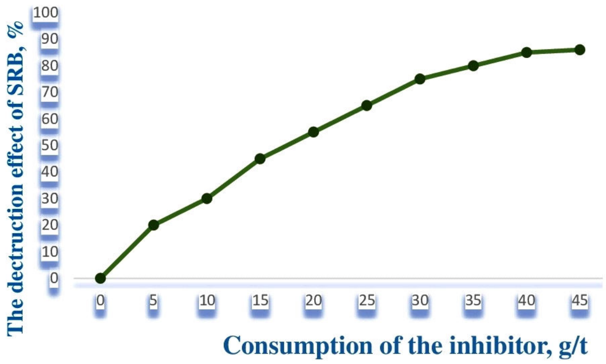

Fig. 2. Effect of inhibitor S-1 on sulfate-reducing bacteria

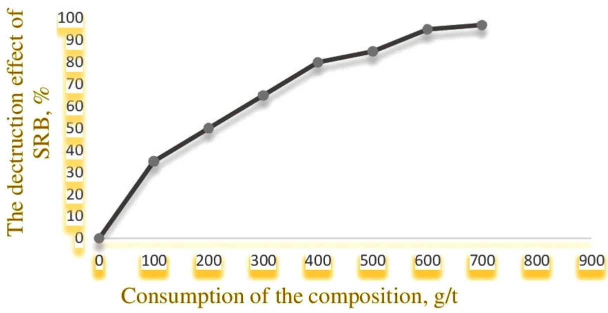

Fig. 3. Effect of the AI-1 composition on sulfate-reducing bacteria

As can be seen from Figs. 2 and 3, the optimal concentration of inhibitor S-1 is 45 g/t, while the optimal concentration of the AI-1 composition is 700 g/t.

A comparative analysis of the experimental results shows that the AI-1 composition is more effective against sulfate-reducing bacteria, while simultaneously using less inhibitor S-1, since 700 g/t of the AI-1 composition contains only 25 g/t of inhibitor S-1.

Thus, the effects of the depressant additive Difron 4201 and the AI-1 composition on paraffin deposition, freezing point, and surface tension in high-paraffin oil were investigated for the first time. It was found that the AI-1 composition exhibits a stronger effect compared to the depressant additive Difron 4201. Additionally, the effects of inhibitor S-1 and the AI-1 composition on the corrosion rate in environments containing hydrogen sulfide, carbon dioxide, and a mixture of both gases, as well as on the viability of sulfate-reducing bacteria in Postgate's «B» medium, were studied. The laboratory experiments showed that the synergistic effect in the AI-1 composition results in a higher overall efficiency compared to inhibitor S-1.

The observed superior performance of the AI-1 composition compared to the individual reagents can be explained by the synergistic interactions between its components. The mixture of the depressant additive Difron 4201 and the $C_{11}H_9Cl_2O$ reagent not only enhances the inhibition of paraffin deposition and reduces the freezing point of high-paraffin oil, but also improves surface activity, leading to lower surface tension. In corrosion tests, the combined effect of inhibitor S-1 and $C_{11}H_9Cl_2O$ in the AI-1 composition likely facilitates the formation of a more uniform and protective adsorption layer on the steel surface, which reduces metal dissolution in aggressive environments. Similarly, the enhanced bactericidal effect against sulfate-reducing bacteria may result from the simultaneous action of both components, disrupting bacterial metabolism more effectively than either reagent alone. These mechanisms collectively account for the higher efficiency of the AI-1 composition across all tested parameters.

Conclusions

1. The effects of the depressant additive Difron 4201 and the composition «Difron 4201+$C_{11}H_9Cl_2O$=28:1» on paraffin deposition, freezing point, and surface tension in high-paraffin oil, on the corrosion rate in hydrogen sulfide, carbon dioxide, and mixed H_2S+CO_2 environments, and on the viability of sulfate-reducing bacteria in Postgate's «B» medium were studied under

laboratory conditions.

2. The experiments revealed that the optimal dosage of the depressant additive Difron 4201 and the AI-1 composition (Difron 4201+$C_{11}H_9Cl_2O$=28:1) is 700 g/t, while the optimal dosage of the $C_{11}H_9Cl_2O$ reagent alone is 45 g/t. The composition exhibits a stronger effect compared to the additive Difron 4201 and the $C_{11}H_9Cl_2O$ reagent, which can be attributed to the synergistic effect arising from the mixture of reagents with different functions.

3. At the optimal dosages, the effects of Difron 4201 and the AI-1 composition on paraffin deposition are 96.3% and 97.8%, respectively; on freezing point, 155.6% and 200%; and on surface tension, 52.3% and 69.1%. Similarly, the protective effects against corrosion at optimal concentrations of $C_{11}H_9Cl_2O$ and the AI-1 composition are 95.8% and 98.7% in a hydrogen sulfide environment, 88.9% and 93.8% in a carbon dioxide environment, and 90.3% and 95.4% in the mixed H_2S+CO_2 environment. The bactericidal effects of inhibitor S-1 and the AI-1 composition at optimal concentrations are 86% and 97%, respectively.

REFERENCES

1. *Bakhtizin R.N., Karimov R.M., Mastobaev B.N.* The effect of high-molecular components on flow properties, depending on the structural-group and fractional oil content // SOCAR Proc. – 2016. – No. 1. – P.42-50.

2. *Studies* on the influence of long chain acrylic esters polymers with polar monomers as crude oil flow improver additives / Kuzmic A.E., Radosevic M., Bogdanic G., Srica V., Vukovic R. // Fuel. – 2008. – Vol.87. – P.2943-2950.

3. *Rheology* of structured oils / Kelbaliev G.I., Rasulov S.R., Rzaev A.G., Mustafaeva G.R. // J. Eng. Phys. Thermophys. – 2017. – Vol.90. – P.996-1002.

4. *Khidr T.T.* Pour point depressant additives for waxy gas oil // Pet. Sci. Technol. – 2010, – Vol.29. – No. 1. – P.19-28.

5. *Semenova I.V., Florianovich G.M., Khoroshilov A.V.* Corrosion and corrosion protection. – M.: Fizmatlit, 2002. – 336 p.

6. *Menshikov I.A., Shein A.B.* Corrosion protection of low-carbon steel in acidic environments with inhibitors of SOLING series // Izv. Vyssh. Uchebn. Zaved. Khim. Khim. Tekhnol. – 2016. – Vol.59. – No. 2. – P.70-73.

7. *Menshikov I.A., Shein A.B.* Protection properties of inhibitors of SOLING series in acidic hydrogen sulfide-containing media // Izv. Vyssh. Uchebn. Zaved. Khim. Khim. Tekhnol. – 2018. – Vol.61. – No. 7. – P.91-98.

8. *Kichenko S.B.* Using MP 01-75 standard to evaluate the corrosion activity of acidic media from the point of view of their possible impact on the decomposition of carbon and low-alloy steels // Pract. Anti-Corros. Prot. – 2011. – Vol.4. – No. 62. – P.48-58.

9. *Gurbanov H.R., Abdullaeva Z.A.* Research of multifunctional combined inhibitor for oil and gas industry // Pract. Anti-Corros. Prot. – 2018. – Vol.2. – No. 88. – P.16-20.

10. *Inhibition* effect of 6-benzylaminopurine on the corrosion of cold rolled steel in H_2SO_4 solution / Li X., Deng S., Fu H., Mu G. // Corros. Sci. – 2009. – Vol.51. – P.620-634.

Received 02.01.2023

ЗАСТОСУВАННЯ НОВИХ РЕАГЕНТІВ ПРОТИ АСФАЛЬТЕНИ-СМОЛИСТО-ПАРАФІНОВИХ ВІДКЛАДЕНЬ ТА КОРОЗІЇ

Г.Р. Гурбанов, А.В. Газімзаде, Н.А. Абдуллаєва

Вперше в лабораторних умовах було досліджено вплив депресантної добавки Difron-4201 та композиції (далі – AI-1) на відкладення парафіну, температуру застигання та поверхневий натяг у високопарафіновій нафті за співвідношення інгібітор S-1:Difron-4201=28:1. Було встановлено, що композиція AI-1 має вищу ефективність порівняно з депресантною добавкою Difron-4201. Таким чином, при оптимальній концентрації, де спостерігається максимальний ефект, вплив добавки та композиції становить відповідно 96,3% і 97,8% на відкладення парафіну, 155,6% і 200% на температуру застигання та 52,3% і 69,1% на поверхневий натяг. Крім того, було досліджено вплив інгібітору S-1 та композиції AI-1 на швидкість корозії в агресивному середовищі з сірководнем, діоксидом вуглецю та їх сумішшю, а також на життєву активність сульфатредукуючих бактерій у поживному середовищі Postgate's «B». Результати експериментів показали, що оптимальна концентрація інгібітору S-1 становить 45 г/т, тоді як оптимальна концентрація композиції AI-1 – 700 г/т. У порівнянні з реагентом S-1 у поживному середовищі Postgate's «B» композиція AI-1 демонструє вищу активність як в агресивних середовищах, де гази присутні окремо та разом, так і у сприятливому середовищі для росту сульфатредукуючих бактерій. При оптимальних концентраціях інгібітору S-1 та композиції AI-1 ефект корозійного захисту становить відповідно 95,8% і 98,7% у середовищі сірководню, 88,9% і 93,8% у середовищі діоксиду вуглецю та 90,3% і 95,4% у середовищі, де обидва гази співіснують. При оптимальній концентрації бактерицидний ефект інгібітору S-1 та композиції AI-1 становить відповідно 86% і 97%.

Ключові слова: композиція; депресантна добавка; інгібітор; корозія; ефект захисту; температура застигання; в'язкість; поверхневий натяг.

APPLICATION OF NEW REAGENTS AGAINST ASPHALTENE-RESIN-PARAFFIN DEPOSITS AND CORROSION

Guseyn R. Gurbanov [*]***, Aysel V. Gasimzade, Nigar A. Abdullayeva***

Azerbaijan State Oil and Industry University, Baku, Republic of Azerbaijan

[*] **e-mail: ebikib@mail.ru**

The impact of the depressant additive Difron-4201 and the composition (hereinafter referred to as AI-1) on paraffin deposition, freezing temperature and surface tension in high-paraffin oil at the ratio of S-1 inhibitor:Difron-4201=28:1 was studied under laboratory conditions for the first time. It was found that the composition AI-1 has a higher efficiency compared to the depressant additive Difron-4201. Thus, at the optimal concentration where the highest effect is observed, the effect of the additive and composition is 96.3% and 97.8% on paraffin deposition, 155.6% and 200% on freezing temperature, and 52.3% and 69.1% on surface tension, respectively. In addition, the impact of inhibitor S-1 and composition AI-1 on the corrosion rate in an aggressive medium with hydrogen sulfide, carbon dioxide and their mixture, as well as on the vital activity of sulfate-reducing bacteria from the Postgate's «B» nutrient medium, was studied. The results of experiments showed that the optimal concentration of inhibitor S-1 is 45 g/t, while the optimal concentration of composition AI-1 is 700 g/t. In comparison with reagent S-1 in the Postgate's «B» nutrient medium, the AI-1 composition shows higher activity both in aggressive environments where gases are present separately and together, and also in a fertile environment for the growth of sulfate-reducing bacteria. At the optimal concentrations of inhibitor S-1 and composition AI-1, the corrosion protection effects are 95.8% and 98.7% in a hydrogen sulfide environment, 88.9% and 93.8% in a carbon dioxide environment, and 90.3% and 95.4% in the environment where both gases coexist. At the optimal concentration, the bactericidal effects of inhibitor S-1 and composition AI-1 are 86% and 97%, respectively.

Keywords: composition; depressant additive; inhibitor; corrosion; protection effect; freezing temperature; viscosity; surface tension.

REFERENCES

1. Bakhtizin RN, Karimov RM, Mastobaev BN. The effect of high-molecular components on flow properties, depending on the structural-group and fractional oil content. *SOCAR Proc.* 2016; (1): 42-50. doi: 10.5510/ogp20160100269.

2. Kuzmic AE, Radosevic M, Bogdanic G, Srica V, Vukovic R. Studies on the influence of long chain acrylic esters polymers with polar monomers as crude oil flow improver additives. *Fuel.* 2008; 87: 2943-2950. doi: 10.1016/j.fuel.2008.04.006.

3. Kelbaliev GI, Rasulov SR, Rzaev AG, Mustafaeva GR. Rheology of structured oils. *J Eng Phys Thermophys.* 2017; 90: 996-1002. doi: 10.1007/s10891-017-1649-z.

4. Khidr TT. Pour point depressant additives for waxy gas oil. *Pet Sci Technol.* 2010; 29(1): 19-28. doi: 10.1080/10916460903330155.

5. Semenova IV, Florianovich GM, Khoroshilov AV. *Corrosion and corrosion protection.* Moscow: Fizmatlit; 2002. 336 p.

6. Menshikov IA, Shein AB. Corrosion protection of low-carbon steel in acidic environments with inhibitors of SOLING series. *Izv Vyssh Uchebn Zaved Khim Khim Tekhnol.* 2016; 59(2): 70-73. doi: 10.6060/tcct.20165902.5265.

7. Menshikov IA, Shein AB. Protection properties of inhibitors of SOLING series in acidic hydrogen sulfide-containing media. *Izv Vyssh Uchebn Zaved Khim Khim Tekhnol.* 2018; 61(7): 91-98. doi: 10.6060/ivkkt.20186107.5703.

8. Kichenko SB. Using MP 01-75 standard to evaluate the corrosion activity of acidic media from the point of view of their possible impact on the decomposition of carbon and low-alloy steels. *Pract Anti-Corros Prot.* 2011; 4(62): 48-58.

9. Gurbanov HR, Abdullaeva ZA. Research of multifunctional combined inhibitor for oil and gas industry. *Pract Anti-Corros Prot.* 2018; 2(88): 16-20.

10. Li X, Deng S, Fu H, Mu G. Inhibition effect of 6-benzylaminopurine on the corrosion of cold rolled steel in H_2SO_4 solution. *Corros Sci.* 2009; 51: 620-634. doi: 10.1016/j.corsci.2008.12.021.