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THE RESEARCH ON INFLUENCE OF GOSSYPOL-BASED COMPOSITION ON PARAFFIN SEDIMENT

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The effects of the composition of herbal origin, prepared at the ratio of gossypol resin:MARZA-1=3:1 (MARZA-1 is a reagent of surfactant organic origin with a halogen atom and three triple bonds in the molecule), on the paraffin sediment in high-paraffin oil and the kinetics of sediment formation was investigated under laboratory condition. An oil sample produced from Narimanov deposit was used for the experiment. It was found that the most of asphaltene-resin-paraffin sediment (ARPS) emerged at the temperature of 20^0C and formed 28.7%. However, at the same temperature, the amount of sediment in the oil with the addition of 700 g/t composition was reduces by 4 times and the protective effect of the reagent was 76%. As the oil temperature rises, the protective activity of the composition decreased. Thus, it was 57%, 39%, and 6.5% at 30^0C, 40^0C, and 50^0C, respectively. The rate of paraffin sediment formation was reduced by 1.75 times, 2.3 times and 3.5 times when the temperature was increased from 20^0C to 30^0C, 40^0C, and 50^0C, respectively. The highest rate of sediment formation in all temperature intervals under study is mainly observed during the first five minutes of the process. As the duration of the process increases, the rate decreases by 3–4 times depending on the temperature. The composition significantly reduces the rate of sediment formation by retaining the paraffin hydrocarbon crystals dependent on the oil volume. As compared with the reagent-free oil, the rate is reduced by an average of 2.3 times in the temperature interval of 20–30^0C. However, the rate of sediment formation in reagent-free and reagent-added oil is reduced by 1.5 times at 40–50^0C. The group composition of asphaltene-resin-paraffin sediments varies depending on the accumulation of oil sediments. The amount of paraffin hydrocarbons increases sharply in the sediment obtained from the original oil during the first 5–15 minutes, and practically does not vary during subsequent periods. On the other hand, paraffin hydrocarbons/asphaltene-resin ratio in the original oil increases from 1.2 to 2.2 over time, indicating that the sediment contains paraffin and paraffin hydrocarbons play a crucial role in the sediment formation process. However, after the application of the reagent, the amount of paraffin hydrocarbons in the ARPS decreases by 8–13%, depending on the time, as compared with the original oil.

Keywords: gossypol resin, composition, high-paraffin oil, asphaltene-resin-paraffin sediment, cold finger test, reagent.

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Introduction

Currently, the increase in the share of high-paraffin oil dispersion systems in the total volume of hydrocarbon raw materials in the developed oil-producing countries of the world is constantly observed, which leads to a number of complex and important problems to be solved. Thus, the process of paraffin sediment in the storage and transportation systems of this type of oil occurs regularly, which results in the emergence of viscous-plastic, viscous-elastic, thixotropic, etc., which are characteristic of non-Newtonian fluids that manifest themselves at relatively low temperatures. In well-storage and transportation systems of such oils, intensive paraffinization occurs on the inner surface of the equipment, which leads to a shrinkage of the cross-sectional area of the pipelines, resulting in a decrease in well productivity and, in some cases, complete suspension of transportation. This, in turn, does not allow realizing the efficient exploitation of wells, oil storage, its preparation for transportation and pipeline transportation. Thus, the exploitation process becomes much more complicated, maintenance interval is shortened, and labor, material expenditures and the cost of oil increase [1–3]. As in any industry, the main goal in the oil industry is to prevent energy losses and additional losses of hydrocarbons raw materials. The solution to these problems lies in the development of modern technologies and their application to the oil industry. The development of new technology requires the study of the scientific basis of the complexities and problems that arise, taking into account the physicochemical and rheological properties of high paraffin oils. In this regard, despite numerous studies, the above-mentioned problems have not yet been resolved and remain relevant [4–7]. Currently, the most cost-effective of the many methods of combating paraffin sediments in high-paraffin oil dispersion systems is in the use in terms of chemical reagents that reduce the viscosity and hydraulic pressure in small doses. These types of reagents enables to improve the flow of oil at temperatures below freezing point, reduce hydraulic losses and the amount of paraffin sediment on the inner surface of pipelines and equipment, as well as improve their exploitation conditions. On the other hand, the main advantages of chemical reagents are simplicity of application technology, good compatibility with other additives used in the production, transportation and storage systems of high-viscosity oils and high economic efficiency obtained from their use [8–11]. The function of reagents is to hydrophilize paraffin crystals with their polar group being crystallized with paraffin hydrocarbons at the moment of emergence of a new phase when the temperature drops, as well as reduce the adhesion of the solid phase on the metal surface and keep the solid phase in the case of fine dispersion. Generally, determining the action mechanism of reagents used against asphaltene-resin-paraffin sediment is a very complex task and mainly includes the followings.

1. Research of paraffin crystals formation mechanism in a multicomponent dispersion medium;

2. Research of thermodynamics and kinetics of paraffin hydrocarbons crystallization;

3. Research of changes in dielectric and other electrical properties;

4. Research of the intermolecular interaction of the reagent with n-alkanes and other components of the oil.

This work was aimed at researching the effect of gossypol-based composition on the kinetics of sediment formation in high-paraffin oil and the composition of oil sediments in the laboratory conditions.

Experimental

Physical and chemical properties of the oil sample produced from Narimanov deposit taken for the experiment are shown in Table 1.

Table 1

Physical and chemical properties of oil

Parameters	Quantity	Determination method
Mass fraction of sulfur, %	0.19	SS 1437-75
Concentration, ρ_4^{20} kg/m^3	894.3	SS 3900-85
The amount of paraffin, %	8.7	SS 11851-85
The amount of resin, %	3.1	SS 11851-85
The amount of asphaltene, %	4.1	SS 11851-85

As is seen from Table 1, the oil sample taken for research belongs to high-paraffin oil group and is characterized by a high amount of paraffin hydrocarbons. MARZA-1 is a reagent of surfactant organic origin with a halogen atom and three triple bonds in the molecule.

The process of formation of ARPS in reagent-free or reagent-containing high paraffin oil was investigated. For this purpose, the «Cold finger test» method was used to estimate the effectiveness of reagents and determine the optimal consumption rate [12–14]. The experiment was carried out at a temperature of -10^0C in the «Cold finger test» and the mass of oil sediments accumulated on the surface of the pipe every 5, 10, 15, 30, 50 minutes was determined through analytical weighing. The mass fraction of the asphaltene component in the oil sediment was determined by Golden's «cold» method and separation of asphaltenes and resin substances were determined by chromatographic (column-adsorption) method. Molecular-mass distribution (MMD) of n-alkanes in asphaltene-resin-paraffin sediments was determined by high-temperature gas-liquid chromatography. 3:1 ratio of Gossypol resin and MARZA-1 mixture, which are separated waste during the production of cottonseed oil, was used as a reagent. The optimal consumption rate of Gossypol-based composition was 700 g/t.

Results and discussion

The results regarding the sediment formation at different temperatures and different time intervals for reagent-free and composite (700 g/t) oil on the «Cold finger test» are given in Table 2. As is seen, the amount of paraffin sediments varies inverse proportionally to temperature and direct proportionally to time. Most paraffin sediments emerge at a temperature of 20^{0}C and form 28.7%. However, at the same temperature, the amount of sediment in the composite oil is reduced by 4 times and the protective effect of the reagent is 76%. As the oil temperature rises, the protective activity of the composition decreases to 57% at 30^{0}C, 39% at 40^{0}C and 6.5% at 50^{0}C.

Table 2

Amount of sediment gathered from high paraffin oil on the surface of the «Cold finger test» at different temperatures*

Time, min	Amount of sediment, wt.%							
	20^{0}C		30^{0}C		40^{0}C		50^{0}C	
	1	2	1	2	1	2	1	2
5	17.6	5.3	13.0	5.9	12.3	7.5	6.1	5.3
10	20.2	6.3	13.6	6.5	13.2	8.0	6.2	5.8
15	24.3	7.1	15.7	7.3	14.1	8.5	6.0	5.8
30	26.8	7.3	17.7	8.3	15.0	8.9	7.6	6.3
50	28.7	7.3	19.8	8.5	15.5	9.5	7.8	7.3

* Note: 1 – reagent-free high paraffin oil; 2 – high paraffin oil with added composition.

Based on the results of the experiments, the rate of sediment formation at different temperatures was calculated for both oil samples (Tables 3 and 4).

As is seen from these tables, the rate of paraffin sediments formation depends significantly on the temperature of oil. Thus, an increase in temperature from 20^{0}C to 30^{0}C, 40^{0}C and 50^{0}C reduces the rate of paraffin sediments formation by 1.75, 2.3 3.5 times, respectively. The highest rate of sediment formation in all temperature intervals investigated is mainly observed during the first five minutes of the process. As the process duration increases, the rate decreases by 3–4 times depending on the temperature.

Table 3

Sediment formation rate in composite oil

T_{Oil}, ^{0}C	Sediment formation rate Δm/Δt, g/min					
	time, min					
	5	10	20	30	40	50
20	3.15	1.85	1.26	1.1	1.0	0.7
30	2.3	1.25	0.8	0.7	0.5	0.4
40	1.75	1.2	0.75	0.6	0.55	0.3
50	0.75	0.42	0.36	0.3	0.28	0.2

Table 4

Sediment formation rate in composite oil

T_{Oil}, ^{0}C	Sediment formation rate Δm/Δt, g/min					
	time, min					
	5	10	20	30	40	50
20	1.4	0.8	0.6	0.5	0.4	0.3
30	0.8	0.6	0.4	0.3	0.2	0.17
40	0.7	0.5	0.3	0.2	0.18	0.14
50	0.5	0.3	0.2	0.18	0.14	0.12

Due to the effect of the composition, the rate of sediment formation in high-paraffin oil decreases (Table 4). As compared with the reagent-free oil, the rate decreases by an average of 2.3 in the temperature interval of 20–30^{0}C. However, at temperatures of 40–50^{0}C, the sedimentation rate in reagent-free and reagent-added oil is reduced by 1.5 times, which depends on the temperature factor.

Table 5

Group composition of sediments formed at the temperature of 30^{0}C

Sediment sample	Time, min	Quantity of components*, %				
		WFH	PH	Resin	Asphaltene	PH/ARC
Oil		81.1	8.7	3.1	4.1	1.2
Original oil	5	62.27	38.8	13.3	14.3	1.6
Oil+comp.		64.45	34.1	12.1	13.6	1.5
Original oil	10	64.43	50.3	10.7	15.6	2.3
Oil+comp.		64.46	43.8	13.5	12.7	1.7
Original oil	15	69.06	50.9	11.5	9.8	2.4
Oil+comp.		64.66	43.8	15.8	7.6	1.9
Original oil	30	71.26	50.2	12.1	6.9	2.6
Oil+comp.		64.96	46.2	19.1	6.0	1.8
Original oil	50	66.96	54.2	16.3	8.2	2.2
Oil+comp.		70.26	47.3	12.1	9.7	2.2

* Note: WFH – wide fraction of hydrocarbons; PH – paraffin hydrocarbons; ARC – asphaltene-resin components.

It should be noted that in addition to the kinetics of sediment formation, it is necessary to know information about the group composition of oil sediments in order to select a more cost-effective method in combatting asphaltene-resin-paraffin sediments (Table 5).

Depending on the accumulation of oil sediments, the group composition of asphaltene-resin-paraffin sediments varies. The analysis of the experiment results showed that the amount of paraffin hydrocarbons in the sediment obtained in the original oil during the first 5–15 minutes increases sharply and practically does not vary in the subsequent periods (Table 5). Such dependence is consistent with the results in the rate of sediment formation. On the other hand, over time, PH/AR ratio in the composition of ARPS in the original oil increases from 1.2 to 2.2. This indicates that the sediment contains paraffin and paraffin hydrocarbons play a crucial role in the sediment formation process. However, after the application of the composition, the amount of paraffin hydrocarbons in the ARPS decreases by 8–13% depending on the time as compared to the original oil.

Original and oil sediments with added composition also differ from each other in terms of molecular-mass distribution of n-alkanes (Table 6).

MMD of paraffin hydrocarbons practically does

Table 6

Molecular-mass distribution of paraffin hydrocarbons in oil sediments

The number of carbon atoms	Time, min	Mass fraction of carbon, %	
		Original oil	Reagent-added oil
C_{12}	5	0.16	1.7
	10	0.3	0.4
	15	0.3	0.2
	30	0.7	0.7
	50	0.4	–
C_{13}	5	1.7	5.0
	10	3.1	3.8
	15	2.8	3.2
	30	3.8	4.8
	50	3.8	0.1
C_{14}	5	4.9	6.7
	10	6.2	7.2
	15	5.9	7.4
	30	6.0	7.7
	50	7.4	1.5
C_{15}	5	9.5	9.6
	10	8.1	8.8
	15	8.3	10.4
	30	7.7	9.6
	50	9.3	1.5
C_{16}	5	10.8	7.9
	10	7.9	8.4
	15	7.8	9.6
	30	7.3	8.7
	50	8.5	9.9
C_{17}	5	10.8	7.6
	10	7.9	8.2
	15	7.8	9.3
	30	7.7	8.7
	50	8.6	11.2
C_{18}	5	8.2	6.9
	10	7.2	7.2
	15	7.3	8.1
	30	7.6	8.3
	50	8.0	10.8

Table 6

The number of carbon atoms	Time, min	Mass fraction of carbon, %	
		Original oil	Reagent-added oil
C_{19}	5	7.4	6.5
	10	6.5	6.6
	15	6.8	6.9
	30	6.6	7.1
	50	6.9	9.5
C_{20}	5	7.4	6.1
	10	6.3	6.1
	15	7.0	6.7
	30	7.2	7.0
	50	6.9	9.6
C_{21}	5	7.4	6.1
	10	6.6	6.0
	15	6.5	5.9
	30	6.5	6.2
	50	6.4	8.9
C_{22}	5	5.9	5.4
	10	5.6	5.4
	15	6.0	5.2
	30	6.0	5.5
	50	5.6	7.6
C_{23}	5	5.4	5.5
	10	5.9	5.6
	15	6.0	4.9
	30	6.0	5.4
	50	5.6	7.4
C_{24}	5	4.7	4.8
	10	5.0	4.5
	15	4.9	3.8
	30	5.0	4.2
	50	4.4	5.6
C_{25}	5	3.3	4.3
	10	4.7	4.8
	15	4.9	3.3
	30	4.6	3.8
	50	4.2	4.8
C_{26}	5	3.3	3.3
	10	3.6	3.4
	15	3.8	2.9
	30	3.7	3.0
	50	3.3	3.4
C_{27}	5	2.3	3.2
	10	3.5	3.3
	15	3.6	2.8
	30	3.4	2.6
	50	3.0	2.5
C_{28}	5	1.9	2.8
	10	3.0	2.4
	15	2.7	2.0
	30	2.4	1.7
	50	2.2	1.5

Table 6

The number of carbon atoms	Time, min	Mass fraction of carbon, %	
		Original oil	Reagent-added oil
C_{29}	5	1.5	2.4
	10	2.5	2.3
	15	2.5	2.0
	30	2.1	1.3
	50	1.7	1.1
C_{30}	5	1.2	1.8
	10	2.1	1.9
	15	2.2	1.6
	30	1.7	1.0
	50	1.5	1.1
C_{31}	5	0.9	1.4
	10	1.4	1.3
	15	1.5	1.1
	30	1.3	0.7
	50	0.9	0.7
C_{32}	5	0.7	0.9
	10	1.1	1.0
	15	1.3	1.1
	30	1.2	0.4
	50	0.8	0.6
C_{33}	5	0.8	0.6
	10	0.8	0.7
	15	0.7	0.6
	30	0.7	0.4
	50	0.4	0.6

not vary in sediment samples accumulated in composite oil for 30 minutes. However, an increase in the percentage of low molecular n-alkanes was observed 60 minutes after the start of the test. Based on the change in the composition of paraffin hydrocarbons depending on the time, it can be said that the amount of oil sediments is firstly formed by solid n-alkanes, and in the last stage at the expense of low-molecular n-alkanes.

The obtained result is consistent with the results of the group composition of oil sediments. Thus, in the sediment formed at the beginning of the test, the amount of asphaltene components containing solid paraffin hydrocarbons in ARPS increases. However, a decrease in the amount of solid hydrocarbons results in a decrease in the percentage of asphaltenes in the sediment (30–60 minutes intervals). The MMD percentage of n-alkanes in

Table 7

Dependence of PH composition in oil sediment on the duration of sediment formation

Sediment samples	Time, min	Mass fraction, %		
		$\Sigma C_{12}–C_{16}$	$\Sigma C_{17}–C_{33}$	$\Sigma C_{12}–C_{16}/\Sigma C_{17}–C_{33}$
Original oil	5	27.06	73.1	0.37
Oil+composition	5	30.9	64.9	0.48
Original oil	10	25.6	73.9	0.35
Oil+composition	10	28.6	70.7	0.40
Original oil	15	25.1	75.5	0.33
Oil+composition	15	30.8	68.2	0.45
Original oil	30	25.5	72.7	0.35
Oil+composition	30	31.5	67.3	0.47
Original oil	50	29.4	70.4	0.42
Oil+composition	50	13	79.5	0.16

the sediment formed from the composite oil in 5–50 minutes has a different character. In the first five minutes, the mass fraction of those with the least number of carbon atoms, and then the most, increases as compared with the original oil. During 5–30 minutes of the experiment, in comparison with reagent-free oil, the addition of composition leads to an increase in the concentration of low-molecular hydrocarbons and a decrease in the concentration of solid n-alkanes (Table 7).

The composition retains a significant proportion of paraffin hydrocarbons in the oil volume during the mentioned period. Therefore, their amount in composite oil is less than in reagent-free oil [15]. The amount of solid hydrocarbons in the sediment formed from the composite oil in 60 minutes is much higher than that in the sediment accumulated in 5–30 minutes. Such difference in the composition of the sediments is probably due to the reduced capacity of the composition to store solid hydrocarbons in the oil volume, so that the solid PH passes into the sediment together.

Conclusions

1. The amount of paraffin sediments accumulated on the «Cold finger test» at different temperatures (20, 30, 40, and 50^{0}C) and at different times (5, 10, 15, 30, 50^{0}C) for reagent-free and composition-added oils (700 g/t) was calculated. It was found that the amount of paraffin sediments varies inversely proportionally to temperature and directly proportionally to time. Most paraffin sediments emerge at a temperature of 20^{0}C and form 28.7%. However, at the same temperature, the amount of sediment in the composition-added oil reduces by 4 times, and the protective effect of the composition is 76%. As the oil temperature rises, the protective activity of the composition decreases to 57%, 39% and 6.5% at 30^{0}C, 40^{0}C and 50^{0}C, respectively.

2. For the first time, the kinetics of sediment formation at different temperatures in reagent-free and reagent-added high-paraffin oil samples was investigated. It was found that the rate of oil sediment formation depends significantly on the temperature; and as the temperature of the oil increases, the rate of sediment formation decreases.

3. Analysis of the results obtained from the dependence of sediment formation rate on the time showed that the highest rate is registered during the first minutes in all temperature intervals. Thus, in the first 5–10 minutes the amount of PH increases sharply in the sediment composition in composite oil, and then the concentration of PH practically does not vary. It was found that at first the amount of oil sediment forms due to solid n-alkanes, and finally to low-molecular n-alkanes.

4. It was found that the rate of sediment formation in oil decreases under the influence of gossypol-based composition. The reason for the decrease in the rate is that the composition retains solid PH crystals in the oil volume, which in turn results in a change in the group composition of the sediment.

5. The rate of sediment formation is reduced by an average of twice at 20–30^{0}C as compared with original oil. However, at temperatures of 40–50^{0}C, the rate of sediment formation in reagent-free and reagent-added oil is reduced by 1.5 times, which depends on the temperature factor.

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ДОСЛІДЖЕННЯ ВПЛИВУ КОМПОЗИЦІЇ НА ОСНОВІ ГОСИПОЛУ НА ПАРАФІНОВІ ВІДКЛАДЕННЯ

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В лабораторних умовах досліджено вплив композиції рослинного походження, приготовленої у співвідношенні госиполова смоли:МАРЗА-1=3:1 (МАРЗА-1 – поверхнево-активна речовина органічного походження з атомом галогену і трьома потрійними зв'язками в молекулі), на парафінові відкладення у високопарафіновій нафті та кінетику утворення осаду. Для експериментальних досліджень використовували зразок нафти, видобутої з Наріманівського родовища. Встановлено, що більша частина асфальтен-смоло-парафінового осаду (АСПО) виникла при температурі 20^{0}С і становила 28,7%. Однак при тій же температурі кількість осаду в нафті з додаванням 700 г/т складу зменшувалася в 4 рази і захисний ефект реагенту становив 76%. З підвищенням температури масла захисна активність композиції знижувалася. Таким чином, вона становила 57%, 39% і 6,5% при 30^{0}С, 40^{0}С і 50^{0}С, відповідно. Швидкість утворення парафінового осаду знижувалася в 1,75 рази, у 2,3 рази та в 3,5 рази при підвищенні температури з 20^{0}С до 30^{0}С, 40^{0}С і 50^{0}С відповідно. Найбільша швидкість утворення осаду в усіх досліджуваних інтервалах температури спостерігається переважно протягом перших п'яти хвилин процесу. Зі збільшенням тривалості процесу швидкість зменшується в 3–4 рази залежно від температури. Композиція значно зменшує швидкість утворення осаду за рахунок збереження кристалів вуглеводнів парафіну в залежності від об'єму нафти. У порівнянні з безреагентним маслом швидкість зменшується в середньому в 2,3 рази в інтервалі температур 20–30^{0}С. Проте швидкість утворення осаду в безреагентній і доданій олії зменшується в 1,5 рази при 40–50^{0}С. Груповий склад асфальтен-смоло-парафінових відкладень змінюється в залежності від скупчення нафтових відкладень. Кількість парафінових вуглеводнів різко зростає в осаді, отриманому з вихідної нафти протягом перших 5–15 хв, і практично не змінюється в наступні періоди. З іншого боку, співвідношення парафінових вуглеводнів/асфальтен-смола у вихідній нафті з часом збільшується з 1,2 до 2,2, що вказує на те, що осад містить парафін, а парафінові вуглеводні відіграють вирішальну роль у процесі утворення осаду. Однак після застосування реагенту кількість парафінових вуглеводнів у АСПО зменшується на 8–13% порівняно з вихідною нафтою і залежно від часу.

Ключові слова: госиполова смола, склад, високопарафінове масло, асфальтен-смоло-парафінові відкладення, тест «холодного пальцю», реагент.

THE RESEARCH ON INFLUENCE OF GOSSYPOL-BASED COMPOSITION ON PARAFFIN SEDIMENT

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The effects of the composition of herbal origin, prepared at the ratio of gossypol resin:MARZA-1=3:1 (MARZA-1 is a reagent of surfactant organic origin with a halogen atom and three triple bonds in the molecule), on the paraffin sediment in high-paraffin oil and the kinetics of sediment formation was investigated under laboratory condition. An oil sample produced from Narimanov deposit was used for the experiment. It was found that the most of asphaltene-resin-paraffin sediment (ARPS) emerged at the temperature of 20^{0}C and formed 28.7%. However, at the same temperature, the amount of sediment in the oil with the addition of 700 g/t composition was reduces by 4 times and the protective effect of the reagent was 76%. As the oil temperature rises, the protective activity of the composition decreased. Thus, it was 57%, 39%, and 6.5% at 30^{0}C, 40^{0}C, and 50^{0}C, respectively. The rate of paraffin sediment formation was reduced by 1.75 times, 2.3 times and 3.5 times when the temperature was increased from 20^{0}C to 30^{0}C, 40^{0}C, and 50^{0}C, respectively. The highest rate of sediment formation in all temperature intervals under study is mainly observed during the first five minutes of the process. As the duration of the process increases, the rate decreases by 3–4 times depending on the temperature. The composition significantly reduces the rate of sediment formation by retaining the paraffin hydrocarbon crystals dependent on the oil volume. As compared with the reagent-free oil, the rate is reduced by an average of 2.3 times in the temperature interval of 20–30^{0}C. However, the rate of sediment formation in reagent-free and reagent-added oil is reduced by 1.5 times at 40–50^{0}C. The group composition of asphaltene-resin-paraffin sediments varies depending on the accumulation of oil sediments. The amount of paraffin hydrocarbons increases sharply in the sediment obtained from the original oil during the first 5–15 minutes, and practically does not vary during subsequent periods. On the other hand, paraffin hydrocarbons/asphaltene-resin ratio in the original oil increases from 1.2 to 2.2 over time, indicating that the sediment contains paraffin and paraffin hydrocarbons play a crucial role in the sediment formation process. However, after the application of the reagent, the amount of paraffin hydrocarbons in the ARPS decreases by 8–13%, depending on the time, as compared with the original oil.

Keywords: gossypol resin; composition; high-paraffin oil; asphaltene-resin-paraffin sediment; cold finger test; reagent.

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