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THE APPLICATION OF CONDENSATE IN THE SYNTHESIS OF NANO-STRUCTURED POLYMER-BASED COMPOSITES FOR ENHANCED OIL RECOVERY

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A B S T R A C T

The article considers the influence of a number of external and internal factors, mainly temperature disturbances affecting the change in flow resistance at certain stages of development of oil fields operated for many years. It was found that with a decrease in temperature, the viscosity of oil increases as a result of the formation of asphaltene, resin-paraffin compounds. These associations deposit into the pores, causing a decrease in permeability, a decrease in the inner diameter of the lifting pipes, and an increase in hydraulic resistance. Although the resin was absorbed by the reagent after the nanostructured coordination polymer technique, an increase in oil viscosity was observed. To eliminate the problem, part of the waste of the alkaline diesel fraction included in the composite pumped into the well was replaced by condensate. At the same time, high efficiency was achieved.

K E Y W O R D S

Crude oil;
Viscosity;
Paraffin;
Resin;
Condensate;
Associate;
Nanostructural reagent.

Introduction

For many years in oil fields exploited at some stages of development, a number of external and internal factors, mainly temperature disturbances (temperature drop), have a very serious impact on the change of filtration resistance. With the temperature decrease, by the gradual formation of some of the oil components, especially asphaltene, resin and paraffin associations, viscosity increases. Due to the precipitation of some of these associations into the wellbore zone, there is a decrease in permeability and in the inner diameter of the tubing, which causes disruption of normal operation of wells, reduction of production, and significantly increases the technological, geological and safety risks. Existing methods and technological processes used to solve the problem include the injection of fluids of various purposes and compositions into the wellbore zone. However, in some cases, when the physical and chemical properties of these fluids do not match the characteristics of well-formation systems, the technological operations performed are inefficient. To prevent this, special regulatory reagents are usually added to the system. The effectiveness of the process often depends not only on the physical and chemical properties of these reagents, but also on their quantity. According to majority of researchers, the most effective solution to these problems may be the transition to nanotechnology.

In recent years the technology developed on the basis of synthesized nanostructured coordination polymers being one of such technologies leads to the decomposition of asphalt-resin-paraffin associations in the oil, cleaning of permeability zone and tubing from the associations, improvement of rheological properties of oil and thus, acceleration of oil flow to the wellbore zone. Numerous laboratory studies with the participation of these reagents have confirmed their effectiveness in oil extraction and transportation [1-7]. However, the results of recent unpublished laboratory studies show that oil samples both from local and foreign fields do not adequately respond to the effects of reagents, i.e. the addition of reagents to all tested oils reduces, the viscosity of the oil and resin in the volume of oil. In these oils, on the contrary, with the addition of the reagent an increase in viscosity has been observed, although there is a decrease in the volume of resin.

Materials and methods

The purpose of the problem is to identify the causes of this uncertainty and show the ways to eliminate them. It should be noted that in order to study the effect of the reagent during the application of this technology, changes in the viscosity of the oil under study are determined as an express method.

As it is known, paraffin is one of the factors affecting the viscosity of oils. This factor is more pronounced at low temperatures. Since we see the cause of the uncertainty happening in the oil samples in the taken paraffin factor, it is intended to test the possibility of using condensate as an additive to the reagent.

Laboratory tests have been carried out on oil samples taken from several wells operating in the field of «Absheronneft» OGPS of the Republic of Azerbaijan and «Analgin» field of the Republic of Tatarstan. The results of the research showed that when these samples are treated with a nanostructured coordination polymer-based composite,

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their viscosity increases despite a significant decrease in the resin. Subsequent researches were continued on an oil sample taken from well №1097 in the Pirallahi field of the Absheronneft OGPS of the Republic of Azerbaijan. This well was put into operation on 20.01.2014. The depth of the well is 810 m, the interval of the filter is 770-807 m, the daily production is 2.5 t/day oil, 1.1 t/day water. The oil sample taken from this well was treated with a 1.0% composite of nanostructured coordination polymer in alkaline diesel fraction waste (ADFW). Physicochemical characteristics of the oil sample were determined after the composite effect. It should be noted that the study was carried out at 50 °C because the oil sample did not flow through the viscometer at room temperature.

Density and kinematic viscosity of oil samples was determined using Anton Paar SVM 1001. Dynamic viscosity of oil was measured using Anton Paar MCR 302. Mechanical impurities were determined according to standard ASTM D473. The resin content was determined according to ASTM D381 standard. Water content was determined using ASTM D4006-16E1 standard.

Results and discussion

The change in viscosity and physicochemical characteristics of the oil sample depending on the volume of the reagent are given in tables 1 and 2, respectively.

As it can be seen from the tables, the viscosity increases rapidly (table 1) despite a sharp decrease in the percentage of resin in the oil sample by 85% (table 2). As it has been mentioned earlier, the viscosity had to fall sharply as the resin decreased. But this does not happen. This can be explained by the fact that the oil associations lead to an increase in the viscosity of the oil, after the resin is absorbed by the reagent, the process of associating asphaltene with paraffin takes place and it does not allow the oil viscosity to decrease (fig. 1).

To prevent this process, it is necessary to add a composite, which can also be condensate.

Taking this into account, the effect of condensate on the specified oil sample has also been studied. Thus, the dynamics of viscosity change has been observed by directly affecting the new sample taken from that oil with condensate, and its physical and chemical characteristics have been determined after the addition of condensate. The dependence of the dynamics of the change of oil sample viscosity on the condensate volume and its physical and chemical characteristics are given in tables 3 and 4, respectively. These studies have been performed at 50 °C as described above.

As it can be seen from tables 3 and 4, when the oil sample is exposed only with condensate, its viscosity decreases, among other parameters, the resin decreases by 6%, and mechanical impurities increase by 2.6 times (10%). As it can be seen from table 4 (before addition), this oil has a high-resin (40%) and paraffin, and as it has been mentioned earlier, the formation temperature is very low (20-25 °C). In this case, the resin and paraffin will rapidly precipitate in the permeability zone, gradually restricting the flow of oil from the formation to the bottom zone, creating conditions for well irrigation, and as a result, oil production will fall sharply. According to the information, such wells are often flushed.

As it can be seen from tables 2 and 4, the coordination polymer-based composite oil sample developed in ADFW reduces resin and the free condensate by dissolving the paraffin causes viscosity decrease. It can be concluded that the use of equal amounts of ADFW and condensate in the preparation of the composite to affect the wellbore zone in order to increase oil production can give the expected result.

Considering this, the oil sample has been treated with a composite consisting of a mixture of nanostructured polymer: ADFW: condensate. The results of the study are presented in table 5.

As it can be seen from the table, the characteristics of the oil vary significantly depending on the ADFW: condensate ratio in the composite. Thus, if the specific gravity of the oil was normally 915 kg/m^3 at 50 °C, in ADFW: condensate ratio in the composite - 20:20, 40:40, 40:50 (ml) this figure would be 912, 910, 907 kg/m^3, respectively.

The kinematic and dynamic viscosities of oil depending on these ratios, 17.06 (19.29); 7.3 (8.02); 5.9 (6.5) cSt, rapidly

Table 1
Dynamics of change of oil sample viscosity depending on the composite volume

S/N	Volume of the additive, ml	Kinematic viscosity, cSt	Dynamic viscosity, cP
1	0	14.8	16.26
2	20	24.8	27.25
3	40	28.4	31.21
4	60	33.7	37.03
5	80	58.7	64.50

Table 2
Physicochemical characteristics of the oil sample after the last addition of the composite (80 ml)

S/N	Indicators	Before addition	After addition
1	Pure oil in the sample, %	87	70
2	Specific gravity of oil kg/m^3, (20 °C)	910	910
3	Kinematic viscosity, cSt	14.8	58.7
4	Dynamic viscosity, cP	16.26	64.50
5	Mechanical mixtures, %	10.00	25.0
6	Resin, %	40.0	6.0
7	Water separated from oil, %	3.0	5.0

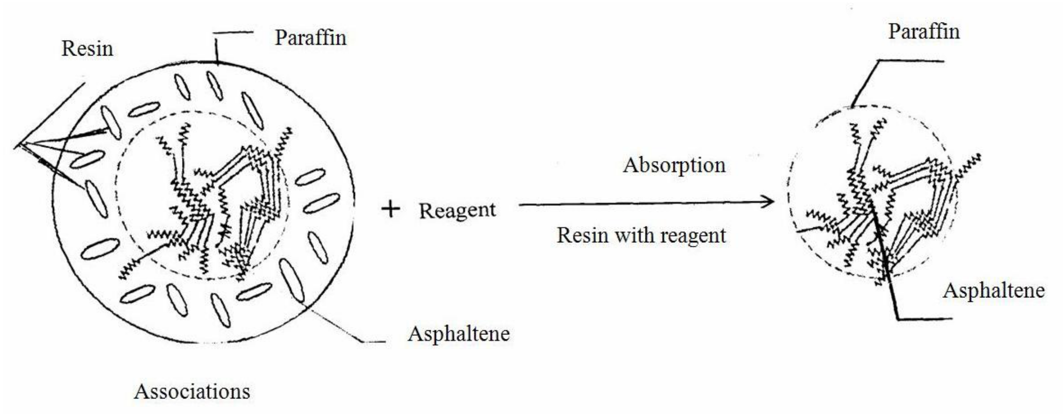

Fig. 1. Scheme of transformation of associations under the influence of the reagent

Table 3
Dynamics of change of oil sample viscosity depending on the condensate volume

S/N	Volume of the additive, ml.	Kinematic viscosity, cSt	Dynamic viscosity, cP
1	0	14.8	16.26
2	20	7.2	7.91
3	40	6.3	6.92
4	60	4.6	5.05
5	80	3.3	3.62

Table 4
Physicochemical characteristics of the oil sample after the last addition of condensate

S/N	Indicators	Before addition	After addition
1	Pure oil in the sample, %	87	72.67
2	Specific gravity of oil kg/m^3, (20 °C)	910	910
3	Kinematic viscosity, cSt	14.8	3.3
4	Dynamic viscosity, cP	14.49	3.62
5	Mechanical mixtures, %	10.00	26.67
6	Resin, %	40.0	34.0
7	Water separated from oil, %	3.0	3.0

decrease, and this is one of the important parameters for increasing the efficiency of well production. If we look at the dynamics of the change in the amount of resin in these ratios, we see that in the first ratio of 20:20, this amount fell from 40% to 23%, and in subsequent ratios to 0%. This indicates that the resin was completely absorbed by the reagent and as a result the viscosity of the oil dropped sharply to 5.9 cSt. Other characteristics of the oil also improved significantly depending on this ratio, for example, mechanical impurities decreased from 26.7% to 0.6%, and the amount of water separated from the oil was 3.6%. The amount of pure oil in the sample increased from 73.3% to 95.8%.

For clarity, the dynamics of the change of oil viscosity and resin depending on the ADFW: condensate ratio in the

Table 5
Dynamics of change of oil parameters depending on ADFW: condensate ratio in 1% nanostructured coordination polymer-based composite (50 °C).

S/N	Indicators	ADFW: condensate ratio in 1% composite			
		0:0	20:20	40:40	40:50
1	Specific gravity of oil kg/m^3, (20 °C)	915	912	910	907
2	Kinematic viscosity, cSt	23.0	17.06	7.3	5.9
3	Dynamic viscosity, cP	25.13	19.29	8.02	6.5
4	Mechanical mixtures, %	26.7	13.3	3.33	0.6
5	Resin, %	40.0	23.0	0	0
6	Water separated from oil, %	0	3.0	3.6	3.6
7	Pure oil in the sample, %	73.3	83.7	93.07	95.8

composite is given below (fig. 2).

As it can be seen from the graph, the increase in viscosity and the change in resin on the ADFW: condensate in the composite in equal (20:20; 40:40) and 40:50 ratios are almost parallel, i.e. the viscosity decreases with the resin reduce. When using only ADFW in the preparation of the composite, this process was accompanied by a sharp increase in viscosity, as it has been noted earlier (table 1).

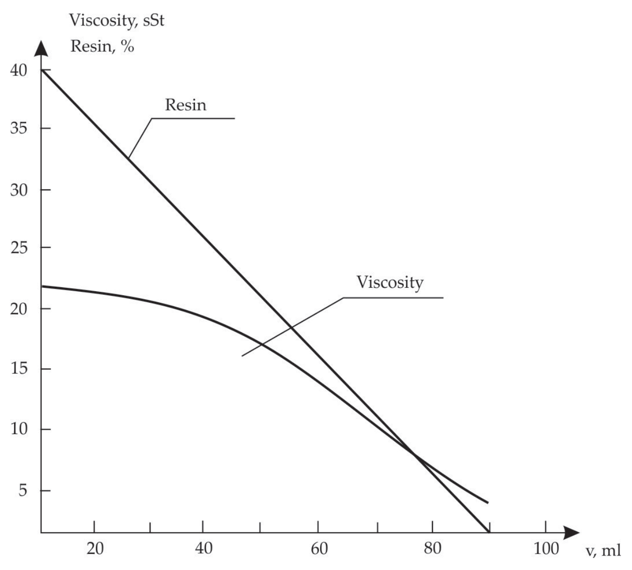

Fig. 2. Dynamics of change of oil viscosity and resin depending on ADFW: condensate ratio in the composite

Conclusion

Thus, researches show that the use of condensate in the preparation of nanostructured coordination polymer-based composites injected into the wellbore zone is very important, for increasing oil production in the extraction of such oils, as oils treated with this type of composite retain their properties for a long time.

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Применение конденсата для синтеза наноструктурированных композитов на основе полимеров для повышения нефтеотдачи пластов

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Реферат

В статье рассмотрено влияние ряда внешних и внутренних факторов, в основном температурных возмущений, влияющих на изменение сопротивления течению на определенных стадиях разработки нефтяных месторождений, эксплуатируемых в течение многих лет. Установлено, что с понижением температуры вязкость нефти увеличивается в результате образования асфальтеновых, смоло-парафиновых соединений. Эти ассоциации осаждаются в поры, вызывая снижение проницаемости, уменьшение внутреннего диаметра подъемных трубопроводов и увеличение гидравлического сопротивления. Несмотря на то, что смола поглощалась реагентом после применения технологии на основе наноструктурированного координационного полимера, наблюдалось увеличение вязкости нефти. Для устранения проблемы часть отходов щелочной дизельной фракции, входящих в состав закачиваемого в скважину композита, была заменена конденсатом. При этом было достигнута высокий эффективность.

Ключевые слова: нефть; вязкость; парафин; смола; конденсат; ассоциат; наноструктурный реагент.

Neftvermə əmsalının artırılması üçün kondensatın nano-strukturlu polimer əsasli kompozitlərin sintezində tətbiqi

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Xülasə

Məqalədə uzun illər istismar edilən neft yataqlarında işlənmənin müəyyən mərhələlərində süzülmə müqavimətinin dəyişməsinə bir sıra xarici və daxili amillərin, əsasən temperatur rejiminin pozulmasının təsirinə baxılmışdır. Müyyən edilmişdir ki, temperaturun aşağı düşməsilə neftin tərkibindəki asfalten, qatran və parafin assosiatlarının əmələ gəlməsi nəticəsində özlülük artır. Bu assosiatlar məsamələrə çökərək keçiriciliyin aşağı düşməsinə, qaldırıcı boru xətlərinin daxili diametrinin kiçilməsinə və hidravlik müqavimətin yüksəlməsinə səbəb olur. Nanoquruluşlu koordinasion polimerlər əsaslı texnologiyanın tətbiqindən sonra qatranın reagent tərəfindən udulmasına baxmayaraq, neftin özlülüyünün artması müşahidə edilmişdi. Problemi aradan qaldırmaq məqsədilə quyudibi sahəyə vurulacaq kompozitin tərkibinə daxil olan qələviləşdirilmiş dizel fraksiyası tullantısının bir hissəsi kondensatla əvəzlənmiş və yüksək effekt əldə olunmuşdur.

Açar sözlər: neft; özlülük; parafin; qatran; kondensat; assosiat; nanoquruluşlu reagent.