Reagent of Complex Action for Oil Transportation

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Abstract: - Traditional methods of pipeline cleaning: scraping and heating of problem areas are quite time-consuming and costly. Cost optimization in this area should be associated with the introduction of new high-tech technologies, as well as the use of effective domestic analogues of materials and components. Recently, the use of chemical reagents has become a method of influencing the rheological properties of the oil stream. It was found that solutions of the additive in toluene have optimal low temperature properties, which is obviously determined by its pour point (-95°C). The study of rheological properties was carried out at a low shear rate of 3.75 s-1, which corresponds to the starting loads on pumps of the oil pumping station, as well as in the range of shear rates at temperatures typical for gathering, infield and main oil transportation processes. Innovative methods for dealing with complications in oil transportation. Proposed by a number of developers, they are based on electromagnetic and ultrasonic treatment of the oil flow by stationary devices. Studies of dynamic viscosity during cooling in the temperature range from 70°C to minus 10°C made it possible to determine the depression of the saturation temperature of oil with paraffins in the presence of the developed reagent, which was 6°C, which reduces the cost of heating the oil-gathering header and infield pipeline when transporting oil in winter. At a low speed in the studied temperature range, the viscosity decreases by an average of 35%, which significantly reduces the starting loads on the pumps. This reagent may vary depending on the application conditions and reach 50% by weight. while maintaining the possibility of up to -30°C without preheating. The results show that the developed reagent effectively inhibits the formation of ASF in oils at economically reasonable concentrations of 100...200 g/m3 and is not inferior in efficiency to modern domestic and foreign analogues. On average, the intensity of the cleaning of pipes from the formed deposits will be reduced by 2.5 times.

Key-Words: - oil transportation, pipeline cleaning, *operation, viscosity, reagent, properties, additives*

Received: January 15, 2023. Revised: November 18, 2023. Accepted: December 18, 2023. Published: January 16, 2024.

1 Introduction

The increase in the operating costs of in-field and trunk oil pipelines is associated with an increase in the cost of transport equipment components and components used in the processes of oil transportation. At the same time, the opportunities for increasing the cost of transportation of hydrocarbons are limited. Therefore, cost optimization in this area should be associated with the introduction of new high-tech technologies, as well as the use of effective domestic analogues of materials and components. Reducing the deposition of asphalt-resin-paraffin deposits and pressure losses is one of the most costly measures carried out to maintain the required operational characteristics of in-field and trunk oil pipelines. Traditional methods of pipeline cleaning: scraping and heating of problem areas are quite time-consuming and costly. In addition, scrapers often get stuck, which violates the technological mode of operation and requires additional measures to remove them.

Innovative methods of combating complications in oil transportation. Offered by a number of developers, they are based on electromagnetic and ultrasonic processing of the oil stream by stationary devices. As a result, as stated in [1, 2], the viscosity of oil decreases, but in practice the effect of such an impact is short-lived.

The optimal method of influencing the rheological properties of an oil flow has recently become the use of chemical reagents: ASPO inhibitors, viscosity regulators, anti-turbulent and depressant additives. ASPO inhibitors and pour point depressants act on asphaltenes (solid petroleum hydrocarbons) by adhesion and co-crystallization, prevent their aggregation into large associates, and thereby reduce the pour point of oils and the rate of

precipitation of ASPO. Viscosity regulators act in a similar way; they form asphaltene colloids as a result of adsorption on aggregates, due to which the energy of their interaction is significantly reduced. In fact, these substances compensate for the lack of resins in oils [3]. Anti-turbulent additives act differently: by migrating high-molecular-weight linear polymers to the pipeline walls, they create a liquid layer near them with an ordered laminar flow regime, which prevents turbulent friction near the walls and creates the effect of a hydraulically smooth pipeline [4].

This article describes the development process, laboratory tests and prospects for the use in pipeline transport of the AHA-10 complex action reagent, which combines the effect of an ASPO inhibitor and an oil viscosity regulator, made on the basis of raw materials produced in Azerbaijan.

2. Objects and methods of research

It is known that large molecules containing ester groups have the ability to regulate the viscosity of oil, since they are capable of forming an external lipid layer on paraffin-asphaltene associates in the same way as resins [5]. Therefore, one of the components of the reagent being developed was the synthetic carboxylic acid ester, the synthesis of which is carried out by the reaction of etherification of tetraatomic alcohol, which takes place at atmospheric pressure in one stage, at a temperature of 144°C for 6...8h.

Another group of active components of the reagent under development were imides of synthetic fatty acids used as anti-wear additives to oils [7]. They are also components that modify the structure of solid petroleum hydrocarbons at the molecular level, thereby preventing the formation of ASPO [8]. Their synthesis was carried out in a similar way, but in two stages: at temperatures of 144 and 230°C for 6 and 4 hours, respectively.

The conditions for obtaining the initial components are available for petrochemical enterprises and allow the entire production process to be carried out within one specialized technological installation. Both synthesized products are surfactants by their chemical structure.

The reagent also contains a solvent that allows the reagent to be dosed in the liquid phase at low temperatures and is capable of synergistically increasing the effectiveness of its active components. The solvent was selected based on its effect on the rheological properties of the oil of the Russian field, as well as on the pour point of the active components in this solvent. According to [6], aromatic hydrocarbons with various methylamine substituents (benzene, toluene and para-, meta- and ortho-xylene) have the best ability to disperse (destroy) asphaltene associates, therefore, the solvent selection was carried out on the basis of these substances by determining the pour point of synthesized surfactants in their solutions according to GOST 20287-74.

It was found that additive solutions in toluene have optimal low-temperature properties, which is obviously determined by its solidification temperature (-95°C). The physico-chemical properties of the components and the reagent are shown in Table 1.

Table 1. Physico-chemical properties of components and reagent

Substance	Average molar mass, g/mol	Acid number, m KOH/g	Density at 20 °C kg/m3	T, °C
SZHK Complex Ether	1173	13,9	925	-26
Image of the SZHK	952	11	914	-28
ANA-10	210	-	419	Less than -30

The optimal method of influencing the rheological properties of the oil stream has recently become the use of chemical reagents: ASF inhibitors, viscosity regulators, anti-turbulent and depressor additives. ASF inhibitors and depressor additives act on asphaltenes of solid petroleum hydrocarbons by adhesion and co-crystallization, prevent their

aggregation into large associates and thereby reduce the pour point of oils and the intensity of ASF precipitation. Viscosity regulators act in a similar way, form asphaltene colloids as a result of adsorption on aggregates, due to which the energy of their interaction is significantly reduced. In fact, these substances make up for the lack of resins in oils [3]. Anti-turbulent additives act differently: by migrating linear polymers of high molecular weight to the walls of the pipeline, a liquid layer with an ordered laminar flow regime is created in their vicinity, which prevents turbulent friction at the walls and creates the effect of a hydraulically smooth pipeline [4, 10, 11].

This article describes the development process, laboratory tests and prospects for the use in pipeline transport of the complex action reagent ANA-10, which combines the effect of an ASF inhibitor and an oil viscosity regulator made on the basis of raw materials produced in Azerbaijan.

To optimize the component composition in the composition, the method of inductive dielectric studies was used, based on measuring the tangent of the dielectric loss angle of the substance under study in a polar solvent. The ability of the reagent to reduce the forces of intermolecular interactions, which are the main component of the viscous friction forces, was determined by the magnitude of the extremum of this indicator at a frequency of 50 kHz (lg v = 1.7) [9].

The effect of the obtained reagent on the rheological properties of the watered oil was studied by comparing the viscosity of the Muradkhanli oil and water emulsion of the Az field. Oil bush 3, sle. 381c with a density of 76% by volume, 2.06% by weight and a density of 985 kg/m3 in the presence of the developed reagent in various concentrations and without it.

Rheological properties were studied at a single shear rate of 3.75 s-1, on a Brookfield DV-II + Pro rotary viscometer with an operating range of 0.3...1031 sPa and a CRYO VT-1 cryostat connected to a measuring cell that provides viscosity measurement during cooling. Rheological properties in a wide temperature range (from 70 to -10°C), characteristic of oil transport processes, were studied on a vibrating viscometer SV-10, the shear rate in this temperature range varied from 590 to 10 s-1.

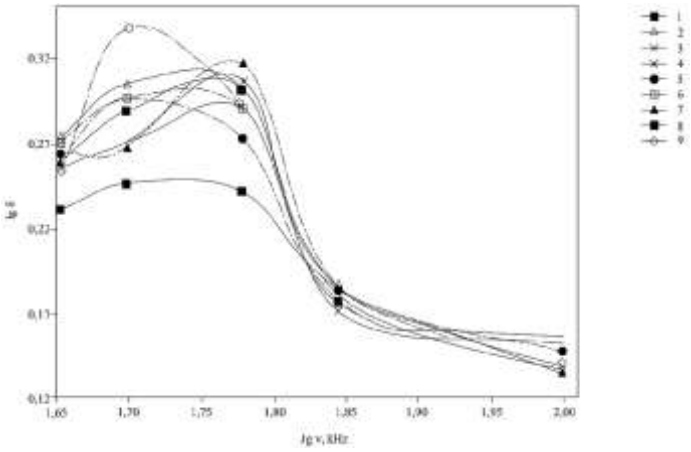

Fig.1. Dependence of the tangent of the dielectric loss angle in solutions of imide/ester surfactants in isopropanol on the frequency of the electromagnetic field, respectively, % vol.

1-10/90; 2-20/80; 3-30/70; 4-40/100; 5-50/50; 6-60/40; 7-70/30; 8-80/20; 9-90/10

The ability of the developed reagents to inhibit the deposition of ASPO oil was studied by the cold finger test method [10 with 151].

To test the ANA-10 reagent, oil from the NGDU Pirallakhy field was used - a combined sample with sle. 1214 plat. 5, 1342 plar. 8, 1453 plat. 9 having similar physico-chemical properties (Table 2). The inhibitor was injected into oil at a temperature of 45°C.

3. The results obtained

The reagent AHA-10 is a 12.5% by weight solution in toluene of a composition of synthesized surfactants. This concentration may vary depending on the application conditions and reach 50% by weight. while maintaining the possibility of up to -30°C without preheating.

Table 2.
Physic-chemical characteristics of borehole oil used for

Objects	Water content % by volume	Content, % by weight			ρ_4^{20} g/cm^3	Viscosity, MPa*s	
		Asphal-tenes	Resins	Paraffins Tpl., °C		20 °C	50 °C
Platform 5, well 1214	3	4,46	7,64	2,15(58)	0,889	62,50	13,7
Platform 8, well 1342	4	3,24	12,00	2,74 (55)	0,877	38,00	6,4
Platform 9, well 1453	4	3,41	10,9	2,65(53)	0,881	41,0	7,6

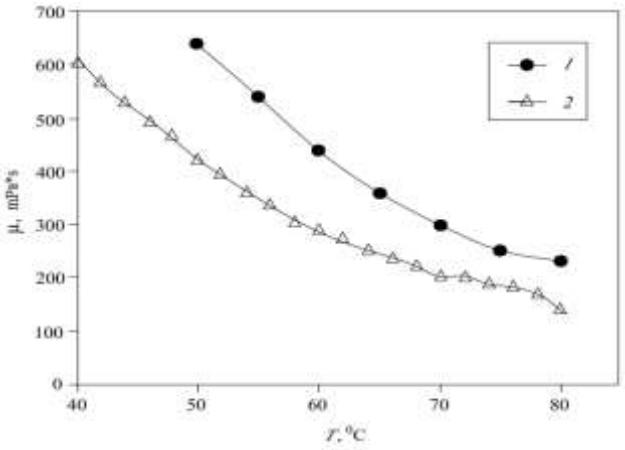

Fig. 2. The dependence of the dynamic viscosity at a shear rate of 3.75 s-1 on the temperature for the Muradkhanli oil emulsion of the field 1-oil emulsion; 2-SAN-10 oil emulsion at a concentration of 200g/l

The rheological properties were studied at a low shear rate of 3.75 s-1, which corresponds to the starting loads on the pumps of the NPS (Fig.2), as well as in the range of shear rates at temperatures characteristic of the collection processes, in-field and trunk oil transport (Fig.3).

The diagram shows that at low speed in the studied temperature range, the viscosity decreases by an average of 35%, which significantly reduces the starting loads on the pumps. Studies of dynamic viscosity during cooling in the temperature range from 70°C to minus 10°C (Fig.3) allowed us to determine the depression of the oil saturation temperature with paraffins in the presence of the developed reagent, which was 6°C, which reduces the cost of warming up the oil collector and the in-field pipeline during oil transportation in winter. At the same time, the average decrease in the viscosity of the test sample in the range from the oil saturation temperature with paraffin in the presence of a reagent (7.5°C) to 20°C, typical for conditions of in-field oil transport, is 55%.

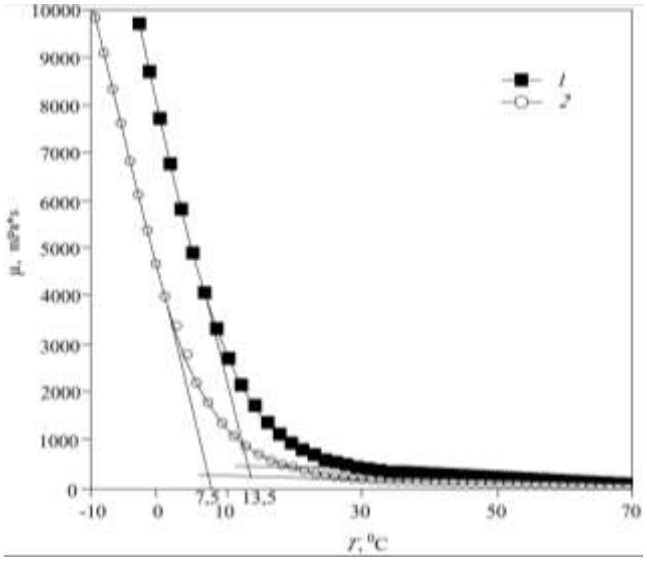

Fig. 3. Dependence of dynamic viscosity on temperature for Muradkhanli oil emulsion of the field
1-oil emulsion, 2- oil emulsion with ANA-10 at a concentration of 100 g/l

The study of the ability of the ANA-10 reagent to inhibit the deposition of ASF oil was carried out by the "cold rod" method [10] and compared with the results of similar studies of ASF inhibitors from other manufacturers (Table 3).

Table 3.

Results of determining the degree of inhibition of deposits of the Muradkhanli oil field by the ANA-10 reagent in comparison with analogues

Reagents		The content of inhibitors in oil mg/l		
		80	100	200
SHPX-2005	Degree of inhibition ASPO, % mas.	2,1	27,1	61,9
SHPX - 7920		43,0	55,9	65,2
EC 5888A		45,4	57,3	63,7
Flexoil CW 288		37,3	50,6	52,1
ANA-10		51,6	54,1	60,7

According to the results (Table.3) it can be seen that the developed reagent effectively inhibits the formation of ASF in oils at economically justified concentrations of 100...200 g/m^3 and is not inferior in efficiency to modern domestic and foreign analogues. Evaluation of the possibility and effectiveness of the developed reagent in in - field and trunk oil pipelines was carried out by calculating the pressure losses in the pipeline for friction according to the method. It was determined that the use of the developed reagent on a separate section or on the entire length of the pipeline in the absence of additional supply branches will reduce the pressure loss at the pump by 7%. In addition, the intensity of the cleaning of pipes from the formed deposits will be reduced by an average of 2.5 times.

4. Conclusion

The decrease in the dynamic viscosity of oil using the developed reagent in the temperature range characteristic of oil transportation processes at a shear rate corresponding to starting loads was 55%.

The effectiveness of the ANA-10 reagent as an inhibitor of ASF formation in comparison with industrially produced analogues has been experimentally proven.

The technical and economic feasibility of using the developed reagent of complex action when collecting borehole fluid and transporting oil by pipeline transport is justified by a reduction in operating costs when using it by 10... 15%, taking into account the commercial cost of chemicalization of the transportation process of 20 rub/m^3.

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Contribution of Individual Authors to the Creation of a Scientific Article (Ghostwriting Policy)

Abdulaga Gurbanov carried out the simulation and the optimization.
Ijabika Sardarova and Almaz Mehdiyeva answered for the statistics.

Sources of Funding for Research Presented in a Scientific Article or Scientific Article Itself
No funding was received for conducting this study.

Conflict of Interest
The authors have no conflicts of interest to declare that are relevant to the content of this article.