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PREPARATION OF HEAVY OILS FOR TRANSPORTATION USING MULTIFUNCTIONAL COMPOSITE REAGENTS

Specialty: 3354.01 - Construction and operation of oil and gas pipelines, bases and storage facilities

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ABSTRACT

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The dissertation work has been carried out at the "Transportation and storage of oil, gas" department of Azerbaijan State Oil and Industry University, PLE.

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GENERAL DESCRIPTION OF THE WORK

Relevance of the thesis and degree of development: At present, the share of heavy oil production in countries with developed oil industry is constantly increasing, and these types of oils are characterized by the formation of stable water-oil emulsion. Factors determining aggregative and kinetically stable water-oil emulsion in heavy oils are usually asphaltenic, resinous, paraffin components, mineral salts contained in formation water, different percentage of mechanical mixtures, as well as chemical reagents of different composition used to intensify production and increase the oil yield factor.

Increase in the production of heavy oils forming stable water-oil emulsion system requires improvement of traditional technologies preparing this type of oil for transportation and refining. The presence of water in oil increases energy and production costs necessary for its transportation due to the complication of rheological properties and increase in the volume of fluid. At the same time it should be noted that formation water in oil settles in the lower part of treatment facilities and pipelines, causing the formation and intensification of internal surface corrosion. Also the presence of mineral salts in the form of crystals and solutions in formation water, mechanical mixtures leads, first of all, to wear of technological equipment of oil refineries and further to erosion-corrosion process.This, undoubtedly, leads to reduction of service life of equipment and facilities, deterioration of quality of produced oil products, violation of technological modes. It is for this reason that modern problems of oil refining require deep demulsification of oil being delivered to refineries.

Therefore, protection of the internal surface of the equipment from corrosion, significant reduction of transportation costs, improvement of traditional technologies of heavy oil preparation in accordance with the requirements of oil refineries are among the important tasks arising from the requirements of time. For this reason the search and development of multifunctional compositions with high surface activity for intensification of dehydration processes and desalination of heavy oils with the property of forming stable water-oil emulsion and improvement of technologies are considered to be very actual problems.

Object and subject of the research. Taking into account the above mentioned, the research object of the thesis was determined to study oil samples taken from Muradkhanli, Umbaki, Bulla-Deniz, Neft Dashlari, Surakhani and Balakhani fields of SOCAR company, as well as the study of individual reagents and new compositions based on them.

Aims and objectives of the research. The aim of the thesis work was to develop multifunctional compositions with high surface activity and study their properties in laboratory conditions.

To achieve the chosen goal the following tasks were set and solve:

1. Preparation of new compositions from reagents of the same and different purposes in laboratory conditions;
2. The research of the effect of new compositions of series A on the disintegration of stable water-in-oil emulsions of Muradkhanli, Umbaki, Bulla-deniz, Balakhani, Neft Dashlari and Surakhani oils at different temperatures;
3. The research of the effect of new compositions of series KAB on the decomposition of stable water-oil emulsions of Muradkhanli and Umbaki oils;
4. The research of the effect of new A series compositions on freezing point and dynamic viscosity of Muradkhanli and Umbaki oils;
5. The research of the effect of new A series composition on the electrochemical corrosion rate in hydrogen sulfide formation waters;
6. Development of the basic technological diagram and working process of the improved dosing device for preparation of heavy oils for transportation in mining conditions.

Methods of research. Various experimental research methods were used to solve the problems posed in this thesis work.

The main provisions to be defended:

1. New compositions prepared from reagents of the same and different purposes in laboratory conditions;

2. Experimental results related to the study of the effect of new compositions of series A on the disintegration of stable water-in-oil emulsions of Muradkhanli, Umbaki, Bulla-deniz, Balakhani, Neft Dashlari and Surakhani oils at different temperatures;

3. Experimental results related to the study of the effect of new compositions of KAB series on the disintegration of continuous water-in-oil emulsions of Muradkhanli and Umbaki oils;

4. Experimental results related to the study of the effect of new A series compositions on the freezing point and dynamic viscosity of Muradkhanli and Umbaki oils;

5. Experimental results related to the study of the effect of new A series compositions on the rate of electrochemical corrosion in hydrogen sulfide formation waters;

6. Principal technological diagram and improved dosing device for preparation of heavy oils for transportation in mining conditions.

Scientific novelty of the research: A series compositions were prepared from reagents of different purposes in laboratory conditions, and their multifunctional properties were confirmed by experimental results.

On the basis of analyzing the results of numerous laboratory experiments it was established that composition A-3 has high efficiency in demulsification of heavy oils with stable water- oil emulsion and is proposed for wide application in mining conditions.

It is established that A-series compositions have an effective impact on demulsification, freezing point and dynamic viscosity of heavy oils, as well as the rate of corrosion caused by formation water.

The basic technological diagram and working process of the improved doser for heavy oil preparation for transportation have been developed.

Theoretical and practical significance of the research. The scientific level of the new results obtained in the research process allows them to be included in relevant reference books, data banks and international scientific information systems.

The practical significance of the work is that the new multifunctional compositions prepared in laboratory conditions based on local raw materials can be applied to solve deemulsification and corrosion problems with high efficiency in the heavy oil preparation system.

Authorization and publication. Scientific results of the dissertation work were reported and discussed at the following scientific meetings and conferences: at the meetings of Azerbaijan State Oil and Industry University; Scientific-practical conference dedicated to the 100th anniversary of Azerbaijan State Oil and Industry University (Baku, 2020); VI International Conference of Young Researchers dedicated to the 99th anniversary of national leader Heydar Aliyev (Baku, 2022); XLVII International Scientific and Practical Teleconference "Achievements at the national level" (Baku, 2022).

Research publication rate. 13 scientific papers have been published on the subject of the dissertation work. Of them 9 are articles and 4 are theses of reports. Three articles were published by one author, and four were published in periodical scientific publications included in international summarization and indexing systems.

Name of the institution where the dissertation work was done. Azerbaijan State Oil and Industry University, "Transportation and Storage of Oil, Gas" Department.

Structure and volume of the dissertation work. The dissertation consists of an introduction, three chapters, conclusions and proposals, a list of 217 cited references.The thesis consists of 194 pages, 190433 signs, 13 pictures, 69 tables and 42 graphs, and concludes with abbreviations.

Personal contribution of the author. The main leading role belongs to the author in the analysis of literary sources, problem statement, formulation of new ideas, planning and carrying out experimental work, explanation and generalization of the principal results obtained by various research methods.

CONTENT OF THE WORK

The introductory part explains the general description of the thesis, justifies the relevance of the subject, the data about work objective, the main questions of the research, scientific innovations, defended provisions, theoretical and practical significance of the results, the approval, publication, structure and volume of the work is explained. The dissertation consists of three chapters.

The first chapter is dedicated to the discussion of literature review concerning stable oil-water emulsions. This chapter presents theoretical and experimental materials on the factors determining the formation and stability of water-in-oil emulsions, mechanisms of their decomposition, factors determining the surface-active properties of demulsifiers, methods of releasing stable water-oil emulsions and factors determining corrosion in water-oil emulsions are analyzed and solved. It is shown that there are a number of theories explaining the formation of kinetic and aggregative stability in water-oil emulsions from a unified point of view. In these theories there is a common approach, which is based on the necessity of participation of a third component capable of providing aggregative and kinetic stability of emulsion formed from two liquids insoluble in each other. In the process of well operation, due to rapid mixing of oil with formation water, water-in-oil emulsions consisting of oil, water and stabilizers are formed, which have high viscosity, aggregative and kinetic resistance. It is the formation of stable water-oil emulsions that occurs after mixing of oil containing stabilizing components with formation water. Water-oil emulsion is stabilized due to the formation of a physical barrier between dispersed water droplets from adsorption coatings. Various high-molecular oil components and other inactive substances called natural stabilizers participate in the formation of the barrier. The main components of the boundary layer are asphaltenes, resins, paraffin single crystals, ions, salts, sand, clay, silt. According to R.A.Rebinder and his colleagues, the factor providing stability of oil emulsions is the formation of structural and mechanical barrier around water globules as a result of adsorption on the interfacial surface of natural emulsifiers contained in oil.

The technology of oil preparation for transportation in mining conditions includes the use of demulsifying reagents that promote the separation of oil-water emulsions into oil and water. Back in 1936, R.A.Rebinder came to the conclusion that in order for the process of coalescence of water-oil emulsion to occur, it is necessary to destroy the structural and mechanical barrier on the surface of droplets due to the impact of dispersed medium. In order to create a barrier that prevents the reduction of the thickness of the coating during the approach of the droplets and, as a result, prevents their coalescence process, it is required to introduce into the system substances with more surface activity than the natural emulsifiers contained in the medium, or rather, demulsifiers. There are various theories explaining the mechanism of action of demulsifiers. Currently, the most important of these theories is put forward by R.A.Rebinder and his followers. According to this theory, when demulsifiers are introduced into an oil emulsion, the solid gel-like layer formed by natural emulsifiers is first peptized, and then they are removed from the oil-water interface. Demulsifiers adsorb on colloidal or coarse particles of natural emulsifiers of oil-water emulsions and alter their wetting properties. Demulsifiers are surfactants that have a destructive effect on oil emulsions that meet industrially defined requirements. It is found that most demulsifiers do not show sufficient efficiency and their use requires the consumption of additional reagent, which is not considered economically feasible according to the regulations. From the studies of recent years it became known that the efficiency obtained from the use of a particular type of demulsifier is mainly determined by the water content of the emulsion. Emulsion stability depends, among other things, on the quality of the oil. In general, depending on the qualitative composition of oil, the amount of hydrocarbons and water, reagent consumption varies. For this reason it is necessary to develop new technologies of reagent application.

In addition to the diversity of its physical and chemical properties, the raw materials delivered at oil production facilities are characterized by changes in composition over time. Application of a new technology of dispersing continuous water-oil emulsion requires the development of scientific bases explaining the structure of the interfacial layer in the water and oil phases.

Thus, on the basis of the conducted literature analysis, as well as corrosion of the inner surface of heavy oil tanks under the action of aggressive medium, we can say that this problem is an urgent problem arising from the requirements of time. Therefore, we believe that the solution of the mentioned problem is possible by preparing multifunctional compositions with high surface activity and studying their efficiency in laboratory conditions and realizing their application in mining conditions.

The second chapter of the thesis is dedicated to the research of the effect of individual demulsifiers, new A and KAB series compositions made of different and identical reagents on demulsification of stable oil-water emulsions. Also, in this chapter, the results obtained from the effect of A-series compositions on the corrosion rate in hydrogen sulphide formation water, the freezing temperature of Umbaki and Muradkhanli oil samples, and the dynamic viscosity were reflected, and at the same time, a mathematical model based on the results obtained from the effect of A-3 composition on the deemulsification process of Muradkhanli and Umbaki oil samples was reflected is also given.

Table 1 presents physical and chemical characteristics of heavy oil samples from Umbaki and Muradkhanli fields used to study the effect of demulsifiers and their new compositions on demulsification of stable water-oil emulsions. During the research, firstly, the time dependence of the deemulsification of both oil samples at temperatures of 40, 50, 60 and 70°C without adding reagents was studied, and then, the effect of individual demulsifiers such as ND-12, Dissolvan-4411, Alkan-415, Difron-9426 on the deemulsification of stable water-oil emulsions at the mentioned temperatures for two hours was studied. As a result of laboratory tests, the dynamics of water separation and the degree of residual dilution of the oil phase were evaluated.

Table 1

Physical and chemical characteristics of crude oil

№	Indicators	Muradkhanli	Umbaki
1	Density 20°C, kg/m^3	947.3	962.5
2	Viscosity 20^{o}C, mP·s,	2157	2246
3	Amount of water, mass, %	41	31
4	Amount of chlorine salts, mg/l	534.3	152.1
5	Amount of mechanical mixtures, mass, %	5.86	1.9
6	Amount of resins, mass, %	18.1	9.7
7	Amount of asphaltenes , mass, %	4.5	5.0
8	Amount of paraffins, mass, %	5.8	6.2
9	Freezing point, ^{o}C	+19.5	+16

At present, the increase in the share of heavy oil production characterized by the formation of stable water-oil emulsion systems requires the preparation of hydrocarbon raw material for further processing by improving traditional technologies. During dehydration and desalination of heavy oils there are usually complications associated with the presence of various impurities that need to be removed by the most effective methods. An important aspect of obtaining oils of this type is the development of reagents with high surface activity. The main requirements to such reagents are efficiency at low temperatures and dynamics of deep dehydration of continuous oil-water emulsions. On the other hand, it should be noted that corrosion inevitably bypasses transportation treatment devices, the inner surface of which is regularly in contact with emulsified oil, and sometimes this process is faster depending on the aggressiveness of the environment. Therefore, in countries where the oil industry is developed, along with the process of demulsification, at the same time one of the important issues is the protection of the inner surface of vehicles from corrosion. In this regard, obtaining multifunctional compositions with both demulsifying and anti-corrosion properties is one of the important issues. On the basis of the abovementioned in the course of research work a large number of compositions of reagents of different purposes were prepared and their properties were studied.

Table 2 lists the conventional name, component composition and component ratios of the five new multi-functional compositions with the best effectiveness after numerous tests.

Table 2

Conventional name of the compositions and component composition

№	Name	Component composition	Content ratio
1	**A-1**	Dissolvan-4411+Alkane-415+ND-12+ Gossypol resin	**1:1:1:1**
2	**A-2**	ND-12+ Gossypol resin	**3:1**
3	**A-3**	ND-12+ Gossypol resin + isoproponol	**4:1.5:0.5**
4	**A-4**	Difron-9426+ Gossypol resin	**4:1**
5	**A-5**	Difron-9426+ Gossypol resin+isoproponol	**5:1.5:0.5**

The effect of A series new compositions on demulsification of oil samples produced in Muradkhanli oil field at temperatures of 40, 50, 60°C, as well as at temperatures of 40, 50, 60 and 70°C was studied in laboratory conditions. Table 3 shows experimental and calculated results of the effect of composition A-3 on demulsification of Muradkhanli oil sample at temperatures of 50 and 60°C.

Table 3

Demulsification of Muradkhanli oil sample with presence of A-3 composition

Initial dilution rate, %	temperature, °C	Consumption g/t	Amount of released water (% by volume)				Amount of residual water, %	Content of ballast water, %
			30 min	60 min	90 min	120 min		
41	50	300	59.7	78.9	91.2	95.4	**4.6**	**3.0**
		400	67.2	87.4	93.5	97.8	**2.2**	**1.5**
		500	78.1	90.7	95.2	99.1	**0.9**	**0.6**
		600	81.3	93.6	97.4	99.82	**0.18**	**0.12**
	60	300	63.4	82.6	93.1	96.0	**4.0**	**2.7**
		400	70.4	88.7	95.3	98.0	**2.0**	**1.4**
		500	81.6	92.4	97.1	99.4	**0.6**	**0.4**
		600	85.7	94.8	98.3	99.86	**0.16**	**0.1**

As it is seen from table 3 the amount of ballast water in the Muradkhanli oil sample with an initial dilution rate of 41% at increasing the concentration of composition A-3 in the range of 300-600g/t at temperatures of 50 and 60°C varies between 3.0-0.12% and 2.7%-0.1%. respectively.

Table.4 shows experimental and calculated results of the effect of A-3 composition on demulsification of Umbaki oil sample at temperatures of 50, 60 and 70°C.

Table 4

Demulsification of Umbaki oil sample in the presence of composition A-3

Initial dilution rate, %	**Temperature, ° C**	**Consumption, g/t**	**Amount of released water (% by volume)**				**Amount of residual water,%**	**Content of ballast water,%**
			30 min	**60 min**	**90 min**	**120 min**		
31	50	300	57.4	61.9	67.2	72.6	27.4	**10.96**
		400	65.3	70.4	76.7	81.5	18.5	**7.67**
		500	68.6	70.7	75.3	84.2	15.8	**6.63**
		600	71.3	79.8	87.6	89.94	10.06	**4.33**
	60	300	58.4	66.7	73.2	81.4	18.6	**7.71**
		400	64.5	73.7	80.1	83.6	16.4	**6.86**
		500	70.8	76.4	82.3	89.5	10.5	**4.50**
		600	79.6	88.2	91.4	94.86	5.14	**2.26**
	70	300	65.4	86.7	94.2	97.5	2.5	**1.11**
		400	72.4	89.5	95.9	98.4	1.6	**0.71**
		500	83.2	93.1	97.8	99.5	0.5	**0.22**
		600	87.2	96.3	99.6	99.72	0.28	**0.13**

As can be seen from table 4 when increasing the concentration of composition A-3 in the range of 300-600g/t at temperatures of 50, 60 and 70°C the amount of ballast water in the Umbaki sample oil with initial dilution rate of 31% varies in the range of 10.96-4.33%, 7.71-2.26% and 1.11-0.13%. respectively.

Table 5 shows a comparative analysis of the amount of ballast water during deemulsification at optimal density for Muradkhanli and

Umbak oil samples with the presence of A series compositions at different temperatures.

Table 5

Comparative analysis of the results of deemulsification at the optimum concentration of the compositions

№	Composition	Optimum concentration, g/t	Temperature, °C	Initial dilution rate, %	Amount of ballast water, %
for Muradkhanli oil sample					
1	A1	600	50	41	0.27
			60		0.24
2	A-2	600	50		0.20
			60		0.18
3	A-3	600	50		0.12
			60		0.10
4	A-4	750	50		0.30
			60		0.25
5	A-5	700	50		0.17
			60		0.15
for the Umbaki oil sample					
6	A1	600	50	31	4.47
			60		2.64
			70		1.13
7	A-2	600	50		5.21
			60		2.58
			70		0.76
8	A-3	600	50		4.33
			60		2.26
			70		0.13
9	A-4	750	50		4.70
			60		2.45
			70		0.62
10	A-5	700	50		4.37
			60		2.48
			70		0.25

As can be seen from table 5, in the deemulsification process conducted with both oil samples, the highest result was obtained in composition A-3.

Table 6 shows the comparative analysis of efficiency rates in demulsification of Muradkhanli oil sample at temperatures of 50 and 60°C of A series compositions at optimum concentration.

Table 6

Comparative analysis of the efficiency of compositions in demulsification at optimum concentration

№	Composition	Optimum concentration, g/t	Temperature, °C	Efficiency rate,%
1	**A-1**	600	**50**	**99.3**
			60	**99.4**
2	**A-2**	600	**50**	**99.5**
			60	**99.6**
3	**A-3**	600	**50**	**99.7**
			60	**99.8**
4	**A-4**	750	**50**	**99.3**
			60	**99.4**
5	**A-5**	700	**50**	**99.4**
			60	**99.6**

As can be seen from table 6 in the process of deemulsification of the Muradkhanli oil sample with a dilution rate of 41% at temperatures of 50 and 60°C, the efficiency of A-1 composition is 99.3% and 99.4%, respectively. and the efficiency of A-2 composition is 99.5% and 99.6%, composition A-3 has an efficiency of 99.7% and 99.8%, composition A-4 has an efficiency of 99.3% and 99.4%. and composition A-5 has an efficiency of 99.4% and 99.6%. Table 7 shows the comparative analysis of efficiency rates in the deemulsification of the Umbaki oil sample at temperatures of 50, 60 and 70°C.

Table 7

Comparative analysis of the efficiency of compositions in demulsification at optimum concentration

№	Composition	Optimum concentration, g/t	Temperature, °C	Efficiency rate,%
1	A-1	600	50	85.6
			60	91.4
			70	96.3
2	A-2	600	50	83.2
			60	91.6
			70	97.5
3	A-3	600	50	86.0
			60	92.7
			70	99.6
4	A-4	750	50	84.8
			60	92.0
			70	98.0
5	A-5	700	50	85.9
			60	92.0
			70	99.2

As can be seen from table 7 in the process of demulsification of the Umbaki oil sample with a dilution rate of 31% at temperatures of 50, 60 and 70°C, the efficiency of composition A-1 is 85.6%, 91.4% and 96.3 % respectively. and the efficiency of composition A-2 is 83.2%, 91.6% and 97.5%, composition A-3 has an efficiency of 86.0%, 92.7% and 99.6%, composition A-4 has an efficiency of 84.8%, 92.0% and 98.0% and composition A-5 has an efficiency of 85.4%, 92.0% and 99.2%.

Thus the comparative analysis of the efficiency of A series compositions in the process of demulsification of Muradkhanli and Umbaki oil samples with stable water-oil emulsion and dilution rate of 41% and 31% at different temperatures shows that A-3 composition got the highest value. It is for this reason that A-3 composition is proposed to be widely used in demulsification of heavy oils in mining applications.

The effect of A series compositions on the amount of chloride salts and mechanical mixtures in Muradkhanli and Umbaki oil samples was also studied during the thesis work and the best result was obtained in A-3 composition. In order to properly conduct a comparative analysis of the results of laboratory experiments obtained in the preparation of heavy oil for transportation on the subject of the thesis and assess the degree of the effect of reagents on the formed water-oil emulsions depending on the components. at the same time as the research object heavy oil samples extracted from Bulla-deniz, Balakhani, Neft Dashlari and Surakhani fields of ”SOCAR” were used. It should be noted that the share of wells producing heavy oil from the wells in exploitation in the Bulla-deniz, Balakhani, Neft Dashlari and Surakhani fields is very small. Heavy oil samples from these wells were used for the demulsification process. Physical and chemical parameters given for oil samples in table 8 suggest that all four oil samples belong to the type of heavy oils.

First, the effect of demulsifiers ND-12, Dissolvan-4411, Alkane-415, Difron-9426 as individual reagents on demulsification process of oil samples of Bulla-deniz, Balakhani, Neft Dashlari and Surakhani was studied in laboratory conditions. The effect of the reagents on demulsification of the mentioned emulsion oils in laboratory conditions was also carried out at temperatures of 40, 50, 60°C by “Bottle test” method. The demulsifying effect of different concentrations of the mentioned individual demulsifiers was studied.

The effect of A series new compositions prepared in laboratory conditions on stable water-oil emulsion in the mentioned oils was also studied. The best effect of A series compositions on demulsification of oil samples of Bulla-deniz, Balakhani, Neft Dashlari and Surakhani at temperatures of 40, 50 and 60°C was observed in the amount of 600 g/t of compositions A-1, A-2, A-3 and 750 g/t of composition A-4 and composition amount of 700 g/t of A-5.

Table 8
Physical and chemical parameters of oil samples

№	Indicators	Bulla-deniz (heavy)	Balakhani (heavy)	Neft Dashlari (heavy)	Surakhani (heavy)
1	Density 20 °C, kg/m^3	973.8	923.0	904.7	912.8
2	Viscosity 20 °C, mP·s.	2445	2126	1968	2021
3	Amount of water, mass %	31	29	24	27
4	Amount of chlorine salts, mg/l	493.8	378.7	329.3	394.9
5	Amount of mechanical mixtures, mass %	4.53	3.98	3.26	3.85
6	Amount of resins, mass %	9.3	8.4	13.7	14.9
7	Amount of asphaltenes, mass %	0.18	0.14	3.9	2.75
8	Amount of paraffins, mass %	12.9	0.43	2.6	2.1
9	Freezing point, °C	+18.0	-1.5	-7.5	-2.0

The amount of residual water was 0.05, 0.05, 0.03 and 0.04%, respectively, during the effect of the composition A-3, which showed the highest result at the temperature of 60°C, on the oil samples mentioned in the optimal consumption rate.

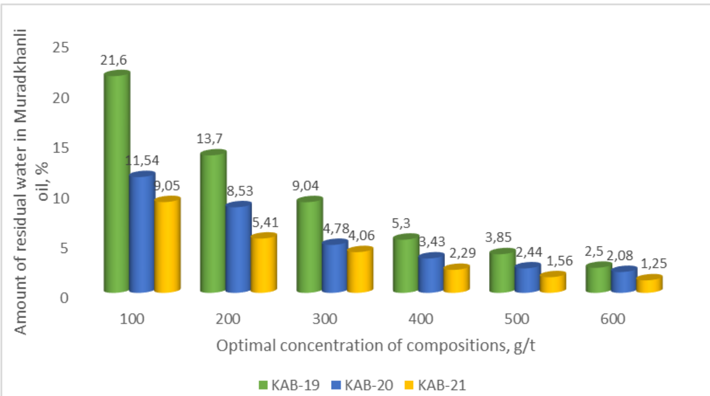
In order to find out how the effect of compositions on stable water-oil emulsions formed by heavy oils changes depending on the components of the dissertation work. new compositions were prepared from different proportions of reagents with the same purpose and their efficiency in demulsification of stable water-oil emulsions was studied. To achieve the set goal. from Muradkhanli oil samples with 52% dilution rate and Umbaki oil samples with 48% dilution rate. Dissolvan-4411, ND-12, Alkan-415, Difron-9426 demulsifiers as individual reagents and table 9 new KAB series compositions were used.

Table 9

Conventional name of compositions and component composition

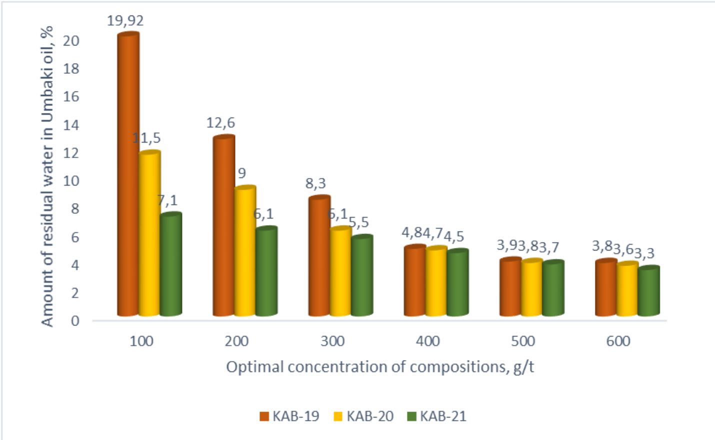
№	Conventional name of compositions	Component composition	Content ratio
1	**KAB-19**	Dissolvan-4411 + ND-12	**1:1**
2	**KAB-20**	Dissolvan-4411 + Alkane-415	**1:1**
3	**KAB-21**	Dissolvan-4411 + Difron-9426	**1:1**

The dependence of the percentage of residual water in Muradkhanli and Umbaki oil on the concentration of the composition of KAB-19, KAB-20 and KAB-21 compositions at 60°C is shown in graphs 1 and 2.



Graph 1. Dependence of percentage amount of residual water on composition concentration (in Muradkhanly oil)

Analysis of demulsification efficiency of compositions in continuous water-oil emulsions of Muradkhanli field shows that the maximum demulsification efficiency of existing water-oil emulsions was obtained for composition KAB-21.



Graph 2. Dependence of percentage amount of residual water on composition concentration (in Umbaki oil)

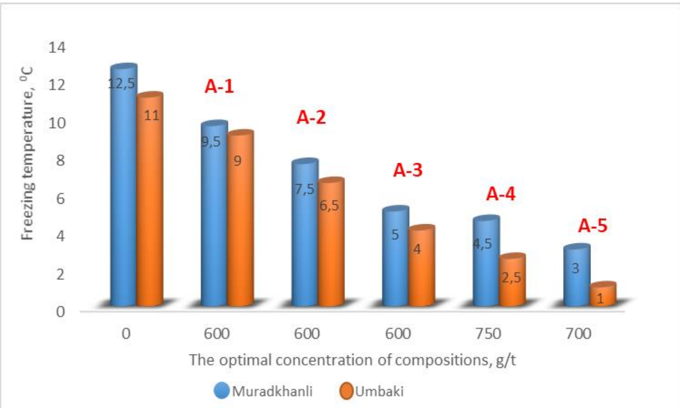
Graph 2 shows that as in the case of Muradkhanli oil samples the composition of KAB-21 shows the greatest effect on stable water -oil emulsion in Umbaki oil.

Thus. for the first time KAB series new composition. the components of which consist of demulsifiers of different grades. have been developed and their effect on disintegration of stable water-oil emulsions of Muradkhanli and Umbaki oil fields has been studied. According to the results of laboratory tests it was found that the components included in the KAB series new composition show good deposition dynamics in comparison with the basic reagents due to synergetic effect and provide a high degree of stable water-oil emulsions decomposition at a temperature of 60°C. The maximum amount of water released during dehydration of Muradkhanli and Umbaki oil fields was observed when using KAB-21 composition.

The lower efficiency of components KAB-19, KAB-20, KAB-21 in the process of demulsification in comparison with the compositions of A series can be justified by higher surface activity of new components obtained by mixing reagents of different purposes. Thus, compositions KAB-19, KAB-20, KAB-21 consist only of a mixture of demulsifiers. However A-series compositions include components combining other properties in addition to demulsifier.

The effect of A series composition on the freezing point of Muradkhanli and Umbaki commercial oil samples was studied in laboratory conditions according to the method RD 39-3-812-82. Laboratory tests were carried out on oil samples without composition and with added composition. During the experiment. 200, 400, 600g/t concentrations of A-1, A-2, A-3 compositions. 350, 550, 750g/t of A-4 composition and 300, 500, 700g/t of A-5 composition were used for Muradkhanli and Umbaki oil samples.

Graph 3 shows the effect of the compositions on the freezing point of the oil samples at the optimum concentration. As can be seen from the graph. the optimum amount of compositions added to Muradkhanli and Umbaki commercial oil samples causes a decrease in the freezing point of the oil. Based on the obtained results. the effect of the optimum amount of each composition on the freezing point of oils can be characterized as follows.



Graph 3. Dependence of freezing point of Muradkhanli and Umbaki commercial oils on composition density

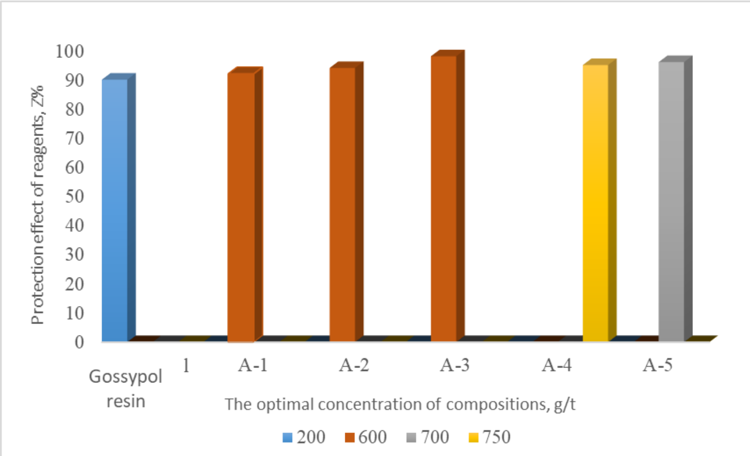
Due to the effect of composition A-1. the freezing point of Muradkhanli and Umbaki oil samples decreases from +12.5°C and +11°C to +9.5°C and +9°C, due to the effect of composition A-2 it decreases to +7.5°C and +6.5°C, due to the effect of composition A-

3 it decreases to +5°C and +4°C, due to the effect of A-4 it decreases to +4.5°C and +2.5°C and due to the effect of of composition A-5 it decreases to +3°C and +1°C respectively.

In the course of the thesis work. the effect of new A-series composition on the dynamic viscosity of Muradkhanli and Umbaki oil samples was studied in laboratory conditions. The results of numerous experiments showed that A-5 composition has the greatest effect on the viscosity of Muradkhanli and Umbaki oil samples. Thus. by adding optimum concentration of A-5 composition in the studied velocity gradient. the dynamic viscosity of Muradkhanli commercial oil and oil samples with dilution rate of 5, 10, 20, 30, 41% decrease by 65.2, 70.0, 75.7, 83.2, 87.4 and 90.4 % respectively. This shows a further decrease in dynamic viscosity by 19.8%, 18.2%, 14.7%, 10.5%, 7.6% and 5.8% compared to the uncompounded oil samples. Also, in case of adding optimum consumption rates of composition A-5 of Umbaki oil samples with the dilution rate of 0.0%, 5%, 10%, 15%, 20%, 31% the dynamic viscosity decreases in the range of 76-9, 121-25, 170-27, 242-30 and 558-32 mPa·s. respectively.

Presence in formation water of mineral salts. carbon dioxide. hydrogen sulfide and sulfate-reducing bacteria. creating water-oil emulsion. causes electrochemical corrosion in the inner surface of transportation treatment devices. In this regard. corrosion protection effect of Gossypol resin and A-series composition as an corrosion reagent included in the compositions was also studied in laboratory conditions. Hydrogen sulfide formation water was used as an aggressive corrosive medium. The corrosion rate was determined by gravimetric method in both reagentless and reagent media. the corrosion protection effect of Gossypol resin and A-series compositions was calculated.

The dependence of the optimum concentration of Gossypol resin and A-series composition on the protection effect is shown in graph.4.



Graph 4. Protection effect of reagents in optimum layers

As can be seen from graph 4 at optimum concentration the corrosion protection effect of Gossypol resin is 90%. the corrosion protection effect of composition A-1 is 92%, the corrosion protection effect of composition is A-2 94%, the corrosion protection effect of composition A-3 is 98%, the corrosion protection effect of composition A-4 is 96% and the corrosion protection effect of composition A-5 is 96%.

Thus. the comparative analysis of the above results suggests that the wide application of composition A-3 which exhibits high demulsifying and anticorrosive effect in the preparation of heavy oils with stable water-oil emulsion for transportation. in mining conditions is more effective from the economic and environmental point of view. Because A-3 multifunctional composition not only destroys the emulsion. but also causes an increase in the time between operation and maintenance of transportation preparation devices.

The third chapter is dedicated to the development of the basic technological diagram and working process of the improved dosing device in the preparation of heavy oil for transportation. Also in this chapter the multifunctionality and efficiency of compositions. the results of genetic analysis of Muradkhanli oil at the optimum concentration of composition A-3, as well as the importance of the choice of separators used in the preparation of oils for transportation in accordance with RD 39-0004-90 are substantiated.

On the basis of our scientific analysis we analyzed the rheo-physical-chemical properties of Muradkhanli field oil and found that the amount of water in crude oil is 41% (by weight). It was found that the most effective result on water separation is obtained after the addition of composition A-3. Our laboratory studies showed that the reason for this is due to high molecular weight compounds contained in Muradkhanli oil. It should be noted that A-3 is also effective against corrosion.

It is recommended to use separator RD which is a three-phase oil-gas-water separator characterized by special technological parameters. which can be used in the process of preparation of heavy oils for transportation. It is noted that the separation unit carries out this type of use in the preparation of heavy oils for transportation in accordance with safety requirements. The distinguishing features of such a separation apparatus from other separation apparatus are that its use is more economically and environmentally efficient. Such distinctive features include connection of the gas outlet with a drop eliminator in the separator, installation of additional equipment for effective emulsion separation. minimization of process safety and increase of oil consumption. By reconstructing the technological processes used in the oil fields of Azerbaijan. the application of such separators will become more expedient.

It is known that the main condition for supply of reagents used in preparation of oil for transportation is their dosing according to modern technology. Dosing of the reagent is carried out depending on distances of location of receiving and delivery stations of the oil pipeline used in preparation for transportation. At the same time the reagent norms provided by the technological diagram should be fulfilled according to the regulations in accordance with the requirements of qualitative properties of used oil. When preparing oils for transportation different types of dosers are used which differ from each other by the principle of operation and geometric dimensions.

The most effective metering device used to feed chemical reagent into the system when preparing oil for transportation are pressure regulators of existing conditions. The use of our proposed type of fuel dispenser for preparation of heavy oils for transportation is considered to be more efficient in terms of safety of environmental impact and economic efficiency. It is economically and environmentally more convenient to feed chemical reagents into the system with such metering units when preparing heavy oil for transportation. It is considered more feasible to inject new composition into the system of heavy oil preparation for transportation with the proposed dispenser.

The technology of heavy oil preparation for transportation is rather complicated. The predominance of heavy hydrocarbon groups in its composition a large number of high molecular weight compounds. at the same time ionic composition of formation water and abnormal properties due to mechanical mixtures remaining in the volume of these oils, require improvement of existing technologies and the selection of a more effective method. At present, the topic of selecting the optimal option of technology of heavy oil preparation for transportation in our country remains relevant. In order to avoid abnormal properties caused by heavy oils in a number of mines, they have to be heated to 75-80 and even 85°C in the process of preparation for transportation. Exactly from this point of view, in accordance with the purpose of the thesis, an effective principal technological diagram of heavy oil preparation for transportation with improvement of the existing technology and introduction of new multifunctional compositions is proposed (Fig.).

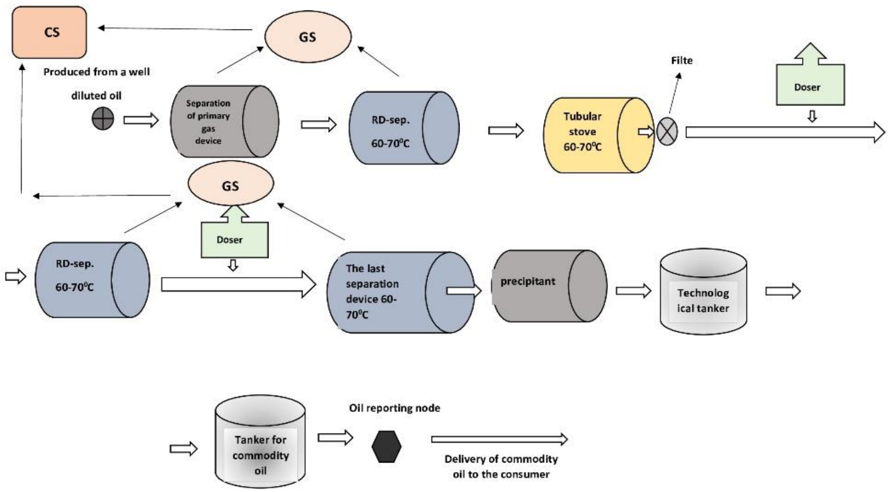


Figure. Principal technological scheme of heavy oil preparation for transportation

According to the technological diagram. the highly diluted oil extracted from the well first enters the primary gas separation unit (separator) for its purification from additional gas mixtures. At this time additional gas mixtures are separated from the oil. which do not belong to the group of hydrocarbon gases and have a negative impact on the rheology and corrosion of oil. Further. the well production separated from free gases is directed to the three-phase separator proposed in the thesis. Taking into account oil characteristics and emulsion stability. it is recommended to set the temperature in the separator at 60°C for Muradkhanli field oils and 70°C for emulsified heavy oils of Umbaki field. As a result of the temperature. a certain amount of water. mechanical mixtures and gases are separated from the emulsion oils in the three-phase separator. The gases separated from the RD separator and the primary gas separation unit are sent to the gas pipeline together due to their close composition. According to the scheme. in the next step the oil enters the oil-emulsion U-shaped tube furnace. where it is reheated to temperatures of 60-70°C respectively. When leaving the tubular furnace. the heated emulsion oil passes through two parallel filters (one working. the other backup). The purpose of the filter placement in the technological scheme is partial purification of asphaltenes. which are mainly solid particles. from mechanical mixtures released from the hydrocarbon part of the emulsion as a result of heating. The composition is sprayed into the emulsified oil stream, which passes through the filter and is cleaned of solid components, through a specially designed dosing device. The amount of composition injected into the system by the metering unit is half of the optimum flow rate. Emulsified oil after mixing with the reagent enters the EP separator at the next stage. Emulsified oil mixed with the reagent is reheated in the RD separator demulsified due to temperature (60-70°C) and passes the stages of separation into mechanical mixture + water oil and gas in the three-phase separator. After leaving the separator RD demulsified oil is again mixed with the rest of the optimal rate of the composition in the process pipeline by means of a doser and enters the last separation unit. In the last separation unit. the oil mixed at the maximum flow rate is demulsified by temperature (60-70°C). Since the gases separated from the last separation unit and the RD separator which is the previous stage. are similar in composition. they are sent to the gas pipeline together. After completion of the gradual demulsification process due to the effect of temperature and reagent. the oil from the last separation unit goes to the precipitator. from there to the process tank and finally to the tank for commercial oil. In the technological diagram. the separated gases are delivered to the compressor station for appropriate treatment and compression for transportation to consumers.

In the proposed basic technological diagram for demulsification of heavy oils remains a minimum amount of water. At the same time according to the technological diagram purification of mechanical mixtures from oil by means of filters has a very positive effect on its rheology. which increases the efficiency of the process when mixing the reagent with oils in two stages. At the same time. another reason that increases the action of the reagent is that the reagent undergoes a heating stage in both units before and after mixing with oil. Considering that when the oil cools. the action of the reagent will decrease and the demulsification process may be weakened. such cases are prevented by carrying out the demulsification process immediately after heating in the RD separator in the process flow diagram.

CONCLUSION AND PROPOSALS

1. In the course of research of properties of A and KAB series compositions made from individual reagents of different and the same purposes in laboratory conditions for preparation of heavy oils for transportation. it was found that A series composition have higher efficiency due to the inclusion of multifunctional properties.

2. As a result of laboratory studies, as a new multifunctional composition A-1, A-2, A-3 600g/t, A-4 750g/t and A-5 at the optimal consumption rate of 700g/t, the residual water during the effect of heavy oils on stable water-oil emulsion it was determined that composition A-3 had the lowest demulsification effect.

3. The effect of KAB series composition on demulsification of Muradkhanli and Umbaki oil samples obtained better results compared to their constituents at optimum concentration of 600g/t. It was determined that the efficiency of KAB-21 composition is higher than other compositions of KAB series.

4. Compositions A-3 and A-5 were found to have the greatest efficiency during the effect of A-series composition on the corrosion rate in hydrogen sulfide formation water. freezing point and dynamic viscosity of Muradkhanli. Umbaki commercial oils.

5. As a result of the conducted researches the basic technological scheme and the improved dosing device for preparation of heavy oils for transportation in mining conditions were developed and proposed for use in mining conditions.

6. Based on the results of numerous laboratory studies. a wide use of cost-effective A-3 composition as a multifunctional agent against complications arising during the preparation of heavy oil for transportation in mining conditions was proposed.

The main content of the thesis has been published in the following scientific papers:

1. Gurbanov H.R., Gasimzada A.V. Study of the efficiency of composite demulsifiers for the destruction of stable oil-water emulsions // Transportation and storage of oil products and hydrocarbon raw materials, 2020. №2. P. 41-47.

2. Gasimzada A.V. Destruction of stable water-oil emulsions// Scientific Conference of young scientists and doctoral students dedicated to the 100th anniversary of Azerbaijan State Oil and Industry University, 2020. December 25. P. 898-902.

3. Gasimzada A.V. Study of the effect of demulsifiers on the group composition of transported azerbaijani crude oils // Proceedings on Engineering Sciences. 2021. Vol 3. №4. P. 491-496.

4. Nurullayev V.H., Gurbanov H.R., Gasimzadeh A.V. Reopysical-chemical properties and behavior of a phase from containing wax, asphaltene, rezin of crude oil // International Journal of Engineering Research and Technology, 2021.Vol.8. №10. P.45-53

5. Gasimzada A.V. Study of the effect of new reagent compositions on different oil emulsions of Azerbaijan // News of Azerbaijan Higher Technical Schools, 2021. Vol.10. №6. P. 4-14.

6. Nurullayev V.H., Gurbanov H.R., Gasimzada A.V. Necessity of control of organic chlorine compounds during oil transportation // Oil Industry, 2021. №11. P.49-54.

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8. Gasimzada A.V. Study of the corrosion protection effectiveness of the composition based on Nd-12 and gossypol // VI international scientific conference of young researchers dedicated to the 99th anniversary of the birth of National Leader Heydar Aliyev. BEU, 2022. April 29. P. 908-910.

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[2]. [3]. [5]. [8]. [9].[10]. – performed independently.

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