Physico-chemical analysis of oil emulsions

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Abstract. The article is devoted to the study of the separation of water-oil emulsions. Most of the existing fields are at the final stage of development, which is characterized by an increase in the water cut of the extracted oil fraction. In the presence of highly stable "old" trap oils, separation methods with demulsifiers are used to increase the efficiency and reliability of their dehydration processes. Demulsifiers of a nonionic nature are currently most widely used. The work assessed the effectiveness of three demulsifiers that comply with state sanitary and epidemiological rules and regulations: Emalsatron R2601-A, Khimtekhno-527, SNPKH-4114. The demulsifiers studied have successfully passed tests and can be recommended for industrial use, as they have a number of advantages.

1 Introduction

Oil is nowadays one of the key pillars of the country's energy industry. Therefore, the problems that arise in the process of oil production do not lose their importance from year to year.

One of the most pressing problems in the collection, transportation and preparation of oil is the destruction of oil-water emulsions. This problem requires different approaches depending on the stage of field development.

Experience in the development of oil fields indicates that in the process of opening and exploitation of productive formations there is a gradual deterioration in the filtration properties of the formation in the near-well zone. Most often this occurs due to the negative influence of water, which forms a stable emulsion with oil. This is the main reason for large oil losses and the rise in cost of its transportation and preparation for processing.

Most of the existing fields are at the final stage of development. The production of production wells in such fields is characterized by a decrease in oil production, an increase in the water cut of the produced oil fraction, as well as an increase in the number of stabilizers and emulsifiers in its composition [1].

In connection with the above, it is relevant to determine the most effective methods for separating oil-water emulsions.

A review of scientific and technical literature on available separation methods and technical solutions showed that foreign and domestic practice has accumulated some experience in the destruction of oil waste.

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2 Materials and methods

The main methods published in the literature over the past two decades include the following:

- physical, subdivided into gravitational settling, separation using centrifugal forces, extraction (use of solvents);
- chemical, which involves the use of chemical reagents.

These methods are used in various specific conditions depending on the properties of water-oil emulsions. In the presence of "stale" oil, in order to increase the efficiency and reliability of their dehydration processes, more complex combined methods using demulsifiers should be used [2].

3 Results and discussion

The role of a demulsifier is reduced to converting an oil emulsion from a finely dispersed state with high aggregative stability into a coarsely dispersed stratified system with low kinetic stability.

The most widely used at present are nonionic demulsifiers, which are surfactants whose molecules do not dissociate in solution and remain electrically neutral. They are obtained by adding ethylene oxide CH2OCH2 to organic substances with a mobile hydrogen atom: acids, alcohols, phenols, etc. [3,4].

The best demulsifier for a particular oil emulsion is the one that quickly provides the maximum depth of oil dehydration and desalting [5-7].

As a result of the test, the effectiveness of three nonionic demulsifiers that comply with sanitary and epidemiological rules and regulations was determined:

- Emalsatron R2601-A is a combination of nonionic surfactants in a solvent – a mixture of methanol and toluene intended for use as an auxiliary reagent (demulsifier) in the oil industry.
- SNPKH-4114 is a composition of nonionic surfactants in a mixture of aromatic and alcohol solvents. They are used in the process of dehydration and desalting of oil in collection systems and oil treatment plants in a wide temperature range; for deep desalting of oil at oil refineries; for dehydration of fuel oil, processing and disposal of industrial waste; for the destruction of intermediate layers stabilized by mechanical impurities (including iron sulfide) associated with paraffin.
- Khimtekhno-527 is a solution of a nonionic surfactant mixed with an aromatic solvent and methanol in various ratios designed to destroy highly resistant oil-water emulsions complicated by the presence of paraffin. It has high dynamics of water separation and depth of oil dehydration at temperatures of 30-50°C. It can be used in low temperature conditions (5-10°C).

For testing, samples of crude oil (emulsion taken from wells) were taken with the following indicators: the amount of resinous components - 3.83%, the amount of paraffins - 0.9%, sulfur content - 0.127%, viscosity at 20 0 C and 50 0 C is 31 and 11.5 mPa s, respectively, water cut is 50% wt., the content of mechanical impurities is 180-300 mg/dm3.

The number of samples and other physicochemical indicators are presented in Table 1.

Table 1. Physico-chemical properties of samples.

Sample number	Pad number	Well number	Density at 20°C, kg/m^3	Content of chloride salts, mg/dm^3
1	10	1	824.4	901.18
2	10	2	826.4	1084.57
3	10	3	966.2	1206.75

4	10	5	843.3	2276.15
5	4	2	868.2	3743.73
6	10	1	825.4	910.56
7	10	2	969.2	1085.69
8	10	3	873.2	1209.03
9	10	5	821.4	2345.69
10	10	10	812.4	840.40
11	10	10	809.8	850.36
12	10	10	814.8	8392.22
13	4	3	924.2	1709.51
14	4	3	925.2	1695.63
15	4	3	943.2	1706.87
16	4	3	944.2	1708.91

The separation method using laboratory centrifuges based on separation using centrifugal forces with subsequent calculation of the volume fraction of water was chosen for the study.

The samples were centrifuged for 5 minutes at a rotation speed of 3000 rpm; the emulsion samples were settled after treatment with demulsifiers at a temperature of 25 0 C.

The results of separated water when using demulsifiers are presented in Table 2.

Table 2. Volume of separated water, % vol.

Sample number	SNPKH-4114	Emalsatron R2601-A	Khimtekhno-527
1	2	3	2
2	2	4	2
3	43	47	39
4	5	11	5
5	9	18	8
6	2	3	2
7	21	35	25
8	20	45	10
9	7	15	2
10	8	9	1.2
11	1	1	1
12	1	2	1
13	45	62	7
14	52	63	35
15	42	55	29
16	39	62	35

Based on the results given in the table, it is concluded that a larger amount of water was released using the Emalsatron R2601-A demulsifier.

From an economic point of view, Emalsatron R2601-A is the most expensive reagent; therefore, various combinations of the analyzed demulsifiers were tested in a 1:1 ratio. The results are presented in Table 3.

Table 3. Volume of released water with combinations of demulsifiers, % vol.

Demulsifier	Volume of separated water, %			
Sample number	1	5	7	12
Without reagent	1	2	17	0.4
SNPKH-4114 + Emalsotron R2601-A	2	13	37	1

SNPKH-4114 + Khimtekhno-527	1	5	27	1
Emalsotron R2601-A+ Khimtekhno-527	2.4	14	38	1

The results given in Table 3 show that in all four cases a greater amount of water was separated by the combination of Emalsotron R2601-A and Khimtekhno-527; the combination of SNPKh-4114 with Emalsotron R2601-A performed slightly worse.

4 Conclusion

The demulsifiers studied have successfully passed tests and can be recommended for industrial use. They have a number of advantages:

- high dynamics of water separation;
- deep oil dehydration;
- clear phase boundary;
- preventing the formation of intermediate layers;
- purity of produced water.

To date, the problems associated with the separation of water-oil emulsions have not been fully resolved and require additional research and development that will allow them to be separated with high quality indicators of water and oil.

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