Evaluation of the methods of separation into phases of the emulsion of the intermediate layer formed in the process of oil preparation

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Abstract. The paper considers the problem of the accumulation and disposal of oil sludge, which include a stable oil-water emulsion, and the main causes of the formation of oil-water emulsion. It also gives a classification of separation methods. The results of experimental data on the analysis of hot sludge and centrifugation methods using demulsifiers are presented: DIN 12D 2018, DIN 12D 2017, SNPH, KR-11DE.

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

The experience of developing oil fields indicates that in the process of opening and exploitation of productive formations, a gradual deterioration of the filtration properties of the formation in the near-well zone occurs. Most often this is due to the negative influence of water, which forms a stable emulsion with oil. In the presence of solid particles, the stability of emulsions is significantly increased, in addition, their viscosity is increased. The main reason for large oil losses and the cost of its transportation and preparation for refining is the formation of emulsions during production. Therefore, issues of increasing the efficiency of oil production, transport and oil preparation processes are considered important, based on the study of the effects of chemicals used in oil production on them, the improvement of demulsifiers used, the study of methods for optimizing the operation of oil treatment plants and oil-water emulsion processing technologies.

Most existing fields are in the final stages of development. The production of producing wells of such fields is characterized, first of all, by a decrease in oil production, an increase in the water content of the extracted oil fraction, as well as an increase in the number of stabilizers and emulsifiers in its composition [1].

In connection with the foregoing, the selection of the most effective methods for the separation of water-oil emulsions and the experimental analysis of the most commonly used methods (the method of hot sludge and centrifugation) using demulsifiers on a sample of an oil and water mixture are relevant.

There are five main reasons for the formation of an oil-water emulsion:

- mixing of oils of different oil-bearing horizons;
- presence of mechanical impurities in oil emulsions;
the presence in the intermediate layer of refractory paraffin hydrocarbons with a melting point up to plus 85 °C;

application of oilfield chemistry reagents; -long technological chain of the oil path from the well to the settling tanks and the use of intensive hydrodynamic modes of movement of well products [2], [3].

A review of the scientific and technical literature on the available methods and technical solutions for the preparation of trap oils has shown that in foreign and domestic practice, certain experience has been accumulated on the destruction of oil waste.

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

- physical, divided into gravity sedimentation, separation by centrifugal forces, extraction (use of solvents);
- chemical, consisting in the use of chemical reagents.

The methods discussed above are used in various specific conditions, depending on the properties of the trap emulsions. In the presence of highly stable "old" trapping oils, more complex combined methods should be used to increase the efficiency and reliability of their dehydration processes.

In the course of the experimental work done, two laboratory methods for separating the oil emulsion, the most commonly used in laboratory practice, were considered.

- the method of hot sludge, the essence of which is to separate the emulsion by the action of gravitational force, with the addition of a demulsifier and gradual heating in a water bath. The advantages of this method include the accuracy of the analysis, its simplicity and accessibility, the disadvantages of mono include the duration of the analysis, which ranges from 30 to 60 minutes.
- the centrifugation method, the essence of which is to separate the emulsion when the particles are subjected to centrifugal forces, the advantages of the method are obtaining results for a short period of time, tightness and compactness of the equipment, automatic operation, the disadvantages include the high cost of the equipment [5], [6]. In the analysis, four different demulsifiers were used: DIN 12D 2018, DIN 12D 2017, SNPH, KR-11.

When separating the oil-water emulsion by these methods using the listed demulsifiers, the results were analyzed after 30 and 60 minutes.

![Figure 1. Content of separated water after 30 minutes using the hot sludge method.](image-url)
Based on the results obtained, it can be seen (figures 1-2) that when using the hot sludge method, the emulsion was most separated by demulsifiers SNPCH and KR-11DE. The greatest amount of water was released when using demulsifiers DIN 12D17 and KR-11DE, but at the end of 30 minutes, the emulsion was more quickly separated by demulsifiers SNPCH and KR-11DE. Based on the foregoing, we can conclude that of all analyzed demulsifiers, KR-11DE shows the best values.

When the emulsion was separated by centrifugation, the results were recorded after 5 and 10 minutes. Based on the data obtained, the highest effectiveness of the demulsifier KR-11DE was revealed (figures 3-4).

**Figure 2.** Separated water content after 60 minutes using the hot sludge method.

**Figure 3.** Separated water content after 5 minutes using the centrifugation method.
Based on the results obtained, it can be concluded that when using the methods of hot sludge and centrifugation for the separation of water-oil emulsions, KR-11DE can be considered the most effective of the studied demulsifiers. It should also be noted that the separation of the emulsion by the centrifugal force method is faster than the hot sludge method, but the equipment is more expensive and requires high energy costs to maintain the process, which is economically less profitable.

The oil refining company should carry out its production activities taking into account the balance of environmental and economic interests, therefore, the issue of reducing the amount of production waste in the form of oil sludge should be given special attention as part of the implementation of measures to improve indicators in the field of environmental protection [7-8].

To date, the problems associated with the intermediate layers are not fully resolved and require additional research and development of methods that will allow us to fully separate the oil-water emulsion, with high indicators of water and oil quality.

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