

DEMULSIFICATION OF WATER-IN-OIL EMULSIONS DUE TO COMBINED WAVE ACTION USING NANOSIZED ADDITIVES

ABSTRACT

The relevance of the work

The development of oil fields, as a rule, is faced with the problems of flooding and the use of a large amount of reagents to enhance oil recovery, which often leads to the formation of stable water-in-oil emulsions. In the petroleum industry, demulsifiers are commonly used to prevent the formation of stable emulsions. However, the use of a large number of various expensive reagents leads to an increase in the cost of production and difficulties in oil refining. To select an effective method for the demulsification of water-in-oil emulsions, it is necessary to have information about their properties and factors of their stability. Currently, not only the search and development of new highly effective demulsifiers, but also the creation of alternative methods for breaking emulsions, including those based on the use of physical fields, remains relevant. The literature describes individual examples of the destruction of intermediate emulsion layers using wave action (magnetic, electromagnetic, ultrasonic) together with the addition of demulsifiers and preheating. However, the published results are contradictory, and the conditions specified in them cannot be used a priori without preliminary testing of each object.

Thus, the relevance of this work, aimed at finding new methods for the destruction of stable water-in-oil emulsions, is determined by the lack of available effective methods for their destruction, especially emulsions containing a “gel” formed during oil production and treatment.

The purpose of the work is development of methods for effective destruction of stable water-in-oil emulsions of various compositions through the use of wave action (magnetic and ultrasonic) and with the use of nanosized additives.

The main tasks:

- To determine the rheological characteristics of water-in-oil emulsions to predict their behavior in the process of demulsification.

- To study the influence of the parameters of the wave action (intensity, exposure time, temperature) on the efficiency of the demulsification process.

- To determine the composition of nanosized additives for the destruction of oilfield water-in-oil emulsions.

- To study the effect of nanosized additives and wave action on the efficiency of the demulsification process.

Scientific novelty

1. Experimental data on evaluating the effectiveness of the use of wave effects (magnetic field and ultrasound) and various additives (organic liquids with and without nanoparticles) have been systematized, as well as their combinations for the destruction of stable oilfield water-in-oil emulsions, differing in component composition, water content, presence of mechanical impurities, iron sulfide and "gel", in order to separate them into aqueous and oil phases.

2. For the first time, the possibility of destruction of field gel-containing water-in-oil emulsions due to wave action is shown.

3. It has been proposed to use a nanoparticles AlN suspension in acetone or a nanoparticles Al₂O₃ suspension in acetonitrile together with ultrasonic treatment for effective separation of gel-containing water-in-oil emulsions.

4. The regularities of the influence of the parameters of wave action (magnetic and ultrasonic) and the regularities of the influence of organic liquids and nanoparticles on the completeness of the separation of the aqueous and oil phases have been established. It is shown that during magnetic processing of field water-in-oil emulsions of the inverse type in a dynamic mode, the separation efficiency reaches 99.4%.

5. The composition of the intermediate layer formed between the oil and aqueous phases after the destruction of gel-containing water-in-oil emulsions has been revealed.

6. It is shown that the proportion and concentration of the "gel" affect the rheological properties of water-in-oil emulsions. Emulsions containing "gel" in their composition behave like Bingham liquids. Emulsions that do not contain "gel" with a fraction of an aqueous dispersed phase of ≤ 15.0 wt% behave like Newtonian liquids, emulsions with a fraction of an aqueous dispersed phase of ≥ 37.5 wt% behave like non-Newtonian pseudoplastic liquids.

Practical significance

1. Methods have been developed for the destruction of stable water-in-oil emulsions of various compositions through the use of wave action (magnetic and ultrasonic) and additives of nanoparticles. The composition of nanosized additives has been proposed and the parameters of the wave action have been selected for the effective demulsification of water-in-oil emulsions.

2. The foundations have been proposed for creating a universal technology for the demulsification of stable water-in-oil emulsions for use at the stage of oil preparation, the introduction of which into the technological process does not require the reconstruction of existing technological schemes.

3. The design of the installation of wave action for the implementation of the proposed methods of destruction of emulsions, consisting of three interchangeable blocks and allowing, depending on the characteristics of the emulsions, to choose the necessary combination of these blocks, has been

developed. The created pilot installation of wave action has been successfully tested at Petroleum Studies and Research Centre LLC.

The main provisions for the defense:

- Results of rheological studies of oilfield water-in-oil emulsions.
- Regularities of the influence of the parameters of wave action on the separation efficiency of oilfield water-in-oil emulsions.
- Regularities of the influence of various nanosized additives together with ultrasonic treatment on the separation efficiency of gel-containing emulsions.
- Method of demulsification of oilfield water-in-oil emulsions using magnetic influence.
- Method of demulsification of gel-containing water-in-oil emulsions using ultrasonic treatment together with nanosized additives.