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Isolation of Water Inflow to Production Wells

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The analysis of dehydration of water-in-oil emulsion from dispersed content is carried out. It is shown that the dispersed system has the connection with drops water-in-oil emulsion and its influence on viscosity and on stability these systems.

The process of formation and transformation of oil-water emulsions in situ and using them to isolate the water inflow to the production wells. The existence of a bond between droplets and a dispersion medium and its effect on the stability and viscosity of an oil dispersed system is shown. One of the effective methods for maintaining reservoir pressure is the flooding of seams, which can ensure high rates of development and achievement of maximum oil recovery.

The process of oil extraction from oil-bearing strata is accompanied by continuous mixing of oil with water and formation of water-oil emulsions (VNE). This process occurs when lifting watered oil from the bottom of the wells to its mouth and further in the fishing lines. The mixing of oil with water and the formation of NOE often occurs already in reservoir conditions in the process of oil displacement by water. In the near-wellbore zone of the well (CCD), the movement of the emulsion occurs under pressure-reducing conditions. A decrease in the pressure in the liquid occurs also when it rises to the wellhead.. The change in the thermobaric conditions is facilitated by the partial separation of the gas components of the oil, the formation of microdispersions from high-molecular compounds. The latter can be sorbed on the surface of water droplets in the emulsion, deposited on the walls of the collectors in the CCD, on the walls of pipes transporting oil. On the surface of water droplets, natural stabilizers of emulsions, available in oil, are also sorbed. As a result of these sorption and hydrodynamic processes, the dispersed composition changes in the direction of decreasing the size of the water droplets and increases the stability of the emulsion /1-4 /.

The water content in oil can reach significant values. The process of watering the wells worsens the state of development of the field. Restriction of water inflow is a problem not only of technological nature, but also directly related to oil recovery of reservoirs.

There are various methods of isolating the water inflow to producing wells: polymer and silicate-gel technology, foam technology, sedimentation, isolation using reverse-type water-oil emulsions (1-4). The aim of the research is to conduct a series of laboratory filtration experiments and determine the effectiveness of using nanoclay to improve the mechanical properties of gels and VNE used in insulation work. To prepare grouting mortars, liquid glass and hydrochloric acid were used. An aqueous solution of

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hydrochloric acid and liquid glass has the property of forming a gel for a period of time, which depends on the concentration of these components.

We conducted experiments using the following composition: liquid glass 3%, hydrochloric acid 0.66%, laponite 1%. The result of the experiment is shown in Figure 1.

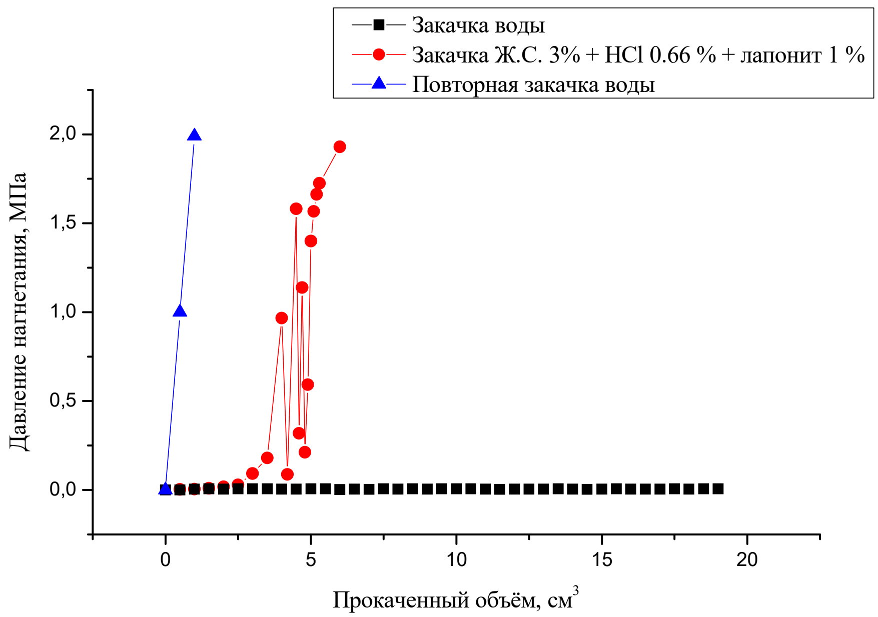

Figure.1. Change in discharge pressure before injection of a solution of liquid glass (3%) + HCl (0.66%) + laponite 1% and with repeated water pumping.

It can be seen from the above figure that when the concentration of laponite was reduced, it was possible to pump a larger volume of a grouting mortar. Re-injection of water led to a sharp increase in injection pressure up to 2 MPa. Such discharge pressure values were not achieved in the two previous experiments. In addition, it can be seen from the figure that a decrease in the concentration of laponite from 6 to 1% allowed pumping the volume of a grouting mortar in the bulk layer equal to 60% of the pore volume.

It should also be noted that when the water was re-injected, there was no displacement of the gel phase from the model. This indicates that the mechanical properties of the gel have been improved by adding laponite to it. The increase in the mechanical properties of the gel led to a decrease in the permeability of the model in this case approximately 400 times. Thus, the results of the experiments showed that using liquid glass, hydrochloric acid and laponite, it is possible to select an optimal solution formulation that will reduce the permeability of the porous medium by 400 or more, which allows us to cover the majority of the bottomhole zone of the well (Fig.1).

In field conditions, VNE is prepared on the surface to create a water-insulating barrier and it is injected into the treated formation through the production well. Under certain conditions, the water-oil emulsion for this purpose can be prepared directly in the productive layer using electric and acoustic methods. The method of electric effect is based on the phenomena of the change in permeability of the filtrate (water and oil) and the change in the filtration properties of the medium when electric current is passed through it in special modes. When the electric current passes through the reservoir, the following physical phenomena occur:

- heating and cooling the fluid in the narrow places of the pore channels of the rock, which leads to cyclic, sharp pressure drops and will facilitate the separation of resin-asphaltene deposits from the walls of pore channels into the oil and water phase;

- thermoplastic stresses arising as a result of various thermal and electrical parameters of the rock and fluid, which will also contribute to the separation of resin-asphaltene deposits;

- Processes of heating the medium while passing a current through the rock will be accompanied by the release of gas from the oil and the evaporation of water, which result in an increase in pressure and the formation of shock waves.

These phenomena occur more intensively in capillaries filled with water, in "more oil capillaries" these processes occur to a lesser degree.

The formation of resin-asphaltene deposits on the walls of the pore channels occurs when oil is filtered through them. This is accompanied by a decrease in their permeability, which manifests itself more in less permeable reservoirs. From more permeable reservoirs, oil separates faster and through these channels the intensive flow of water to production wells begins.

When heated or otherwise exposed, resin-asphaltene deposits are separated from the walls of the collectors, dispersed and form water-oil emulsions with high aggregative and sedimentation resistance. The emulsions formed have a viscosity much greater than oil and water. Their filterability through the pore channels is very small, so the flow of such VNE is directed to higher permeable pores and they are clogged. This leads to a redistribution and equalization of the oil injection profile, oil recovery increases.

The treatment was carried out by the method of electric impact on 34 wells of the Uzen deposit. The following results were obtained:

Success in reducing water cut 85%, increasing oil production by 94%, watercut decreased by an average of 9%, oil production increased by 3.2 tons per day.

The change in the stability of VNE in reservoir conditions can occur with other physical impacts on the productive formation of the bottomhole well zone. This is an acoustic action in which a high-intensity sound wave cleans the collector walls in the CCD from the AFS and other deposits / 3 /.

The method of acoustic impact is based on the phenomena of the change in the permeability of the filtrate (water and oil) and the change in the filtration properties of the medium. The oil reservoir is represented by both solid and liquid phases, in it there is a complex combination of interaction between longitudinal and transverse fields. Under the influence of a longitudinal wave, the filling fluid tends to move toward the pressure drop, flowing into adjacent pores, while at the same time as the shear stresses of the solid skeleton of the collector impart a torque to the fluid. Thus, the fluid movement occurs as a vortex flow, which performs intensive reciprocating movements. These processes determine the nature of fluid motion in the pores of the formation. Acoustic waves are reflected from the walls of the collectors, which leads to the imposition of the incident and reflected waves, the formation of standing waves. The amplitude of the pressure fluctuation within the limits of the wavelength in these sections increases approximately by a factor of two. Such zones are formed at the walls of the collectors.

With acoustic impact on the reservoir, the following physical phenomena occur:

- the vortex reciprocating motion of the filtrate in the narrow places of the pore channels of the rock, which leads to cyclic, sharp pressure drops and will promote the mixing of water and oil with the formation of a water-oil emulsion (VNE);
- These same processes will lead to the separation of resin-asphaltene deposits from the walls of pore canals and their transfer to the oil and water phase, which increase the stability of the formed VNE.

The treatment was carried out by the method of acoustic influence on 3 wells. The following results were obtained:

Success in reducing water cut 100%, increasing oil production by 100%, watercut decreased by an average of 11%, oil production increased by 2.2 tons per day.

We have developed another version of the restriction of water inflow to producing wells.

To improve the technological characteristics of liquid hydrocarbons, other variants of wave and electromagnetic effects can also be used (3,4).

7 Literature

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