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Contents

Influence of transverse magnetic field on the process of sand settlement in water

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Keywords: transverse magnetic field, magnetic field strength, solid particles, sand, test tube.

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1. Introduction

During the oil production process, a constant transverse field is use to increase oil productivity. This field also affects the movement of the mixture of gas - water - oil - solid particles in the production wellbore. In this case, complex processes of interaction of each fragment with others occur, one of which is the precipitation of solid particles from the mixture. Rock fragments that make up the reservoirs of the oil reservoir represent the main part of the solid particles: sand, clay, mica, etc.
Modeling the process of flow movement in a production wellbore and studying, the influence of the sand fraction on this process is very difficult. The complexity increases due to the creation of a stable emulsion, through which it is difficult to observe the process of emulsion separation and sedimentation of solid particles.
Therefore, decided to follow world practice, in which the behavior of a complex system considered as a set of simple ones. Examine them separately and establish the areas of magnetic fields that lead to a positive result in each case. By comparing the intervals of successful magnetic field strengths of each fraction, the most acceptable one for the system selected.
Numerous studies show that the magnetic field has a significant effect on clay particles; however, plugs in the wellbore contain a large percentage of sand fractions. Therefore, it decided to study the influence of a magnetic field on the process of sand deposition, since clay particles relatively well carried away by an upward flow of liquid.
In our studies, transverse constant magnetic fields were use. It is known, that an alternating magnetic field with an oscillation frequency of 50 Hz does not produce a noticeable effect, while a constant magnetic field increases oil recovery from a porous medium. Therefore, in all subsequent studies a constant magnetic field was use.

2. Methodological part

In this work, we study the effect of a transverse magnetic field in the strength range H = 0 – 176 000 A/m on the process of sedimentation of sand particles in water.
For this purpose, an experimental setup was created, consisting of an electromagnet, in the core of which a 78 mm long slot was cut. Since the results of studies of the transverse and longitudinal magnetic fields were supposed to be compared in the future, the magnetic field intensity gradient in both cases should have been the same. This was achieved by placing the test tube with the sample in the same gap of the electromagnet. In the case of a transverse magnetic field, the magnet poles were located in the horizontal plane; with a longitudinal field – in the vertical plane. Using a power source, a direct current of various voltages supplied to the electromagnet and the magnetic field

strength determined using a Teslameter at three points A;B;C. İn the figures, the magnetic field strength corresponds to the value in the middle of the gap - along the axis of the test tube (point C in Fig. 1).
The experiments were carried out as follows. A test tube 77.5 mm high was filled with 50% sand and 50% water; the test tube was tightly sealed to prevent water evaporation and the concentration of the water and sand fractions remained constant. In this case, the size of sand particles was in the range of 10 – 20 microns.
Before the experiment, the test tube was shaken so that the separated sand formed a uniform mixture of sand in water. The test tube was left in a vertical position and the appearance of the interface between the water and the sand fraction was observed. Sand settlement was observed by tracing the interface. The settling rate of sand particles was calculated by dividing the distance traveled at the interface level by the settling time, which was determined using a stopwatch.

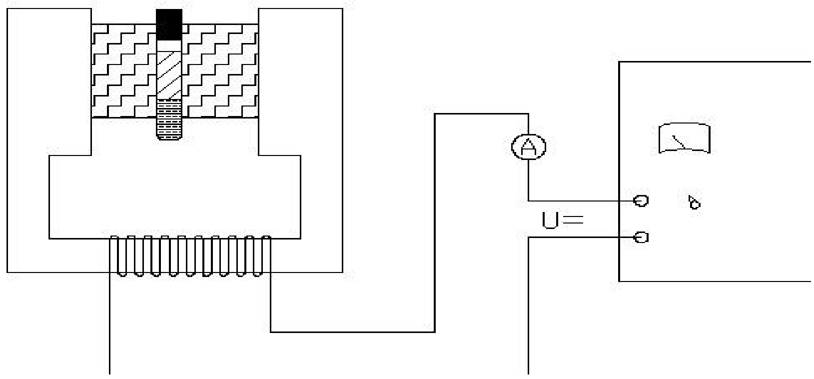

Figure 1. Scheme of the experimental setup.

To determine the influence of a magnetic field on the subsidence process, a comparison base is needed, which is the subsidence rate of sand particles in the absence of a magnetic field. The settling rate of sand particles in the absence of a magnetic field was determined by placing a test tube in a mesh metal screen. This is done in order to eliminate the influence of the Earth's magnetic field on the subsidence rate. The resulting curve is a reference, it is shown in Fig. 2.

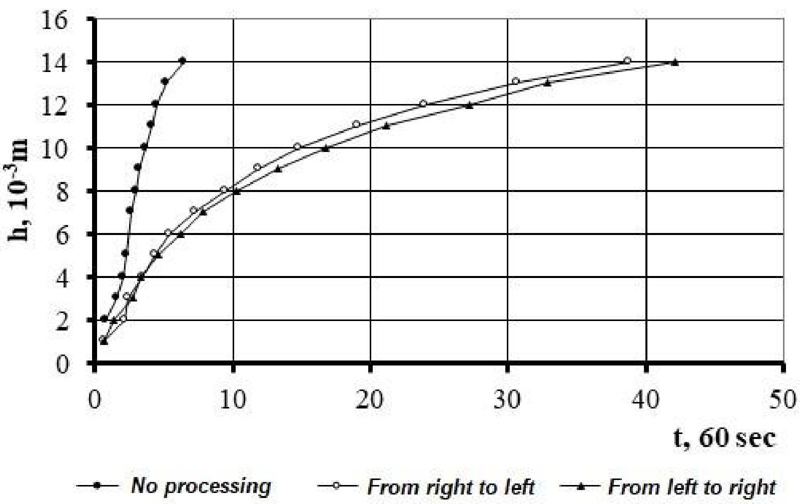

Figure 2. Dynamics of sand subsidence.

Fig. 2 also shows the sand subsidence curves in the presence of a magnetic field with a strength of 152 00 A/m. It follows from the figure that in this case the process of settling sand particles can be divided into two stages:

- main – in which the sand is separated from the water and settles to the bottom of the test tube (section I);
- final – in which further repacking of layered sand particles occurs (section II).

From Fig. 2 it follows that in the absence of a magnetic field, the final stage (sand repacking) takes approximately the same time as the particle settling stage. In both periods, the rate of change in the interface of the “water-porous medium” system is approximately the same.

Subsequently, the magnetic field strength was increased, the experiment was carried out again, and the settling rate of the particles was measured. The magnetic field strength varied from 0 to 176 000 A/m. In order to eliminate the influence of residual magnetization on the process of sedimentation of sand particles, the magnetic field strength was changed in an increasing manner. Based on the data obtained, the average speed for various stages of sedimentation of sand particles was calculated. The obtained values of average velocities of descent without an external field were compared with the average values of velocities of subsidence, and a conclusion was drawn about the influence of the created magnetic field.

A similar procedure was carried out for different magnetic field strengths. The settling rate of sand particles was studied in two directions of the magnetic field:

1. The magnetic field lines are directed perpendicular to the direction of particle settling, the N pole was on the left, and the S pole was on the right.
2. The magnetic lines of force are directed in the opposite direction, that is, the N pole was on the right, and the S pole was on the left.

The results of the average sedimentation rate of sand particles are shown in Fig. 3,4.

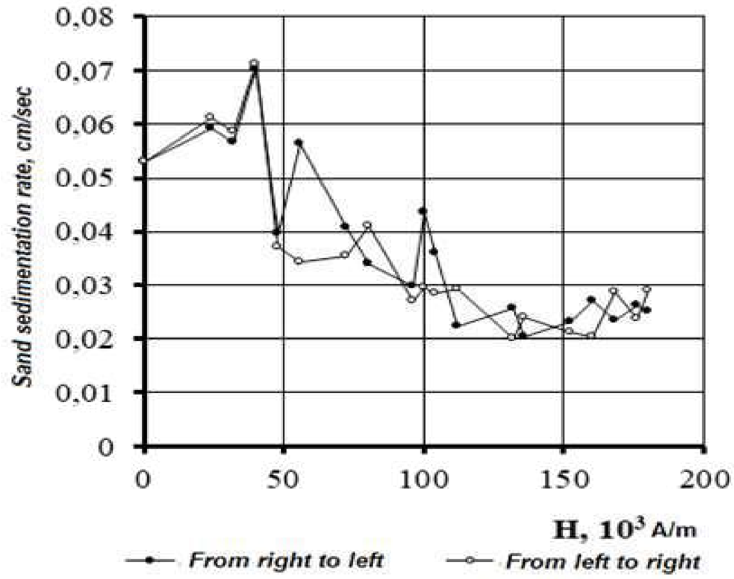

Figure 3. Dependence of the rate of sedimentation of sand in water on the strength of the transverse magnetic field.

3. Results and discussion

In the region (I) of sand particle separation, the following is observed. When the direction of the magnetic field, when the N pole was on the left and S on the right, is perpendicular to the settling of sand in the range of magnetic field strength 24 000 – 40 000 A/m, an increase in the settling rate of sand particles is observed by 15% at the end of the interval compared to the settling rate of sand in absence of a magnetic field, which was 0.053 cm/s Further, the settling rate of sand particles uniformly decreases, however, there is a surge in speed at a magnetic field strength of 56 000 A/m, which increases the settling rate. Another surge in the increase in the sedimentation rate of sand particles is observed in the range of 100 000 – 104 000 A/m, with a general tendency for the sedimentation rate to decrease. This increase in rate reaches approximately twice the average rate of decrease in subsidence.

At a magnetic field strength of 114 000 A/m, the subsidence rate is reduced by 2 times compared to the subsidence process in the absence of a magnetic field. A further increase in the magnetic field strength does not lead to a significant change in the sedimentation rate of sand particles up to 176 000 A/m. In this case, the curve of the dependence of the settling rate on the magnetic field strength throughout its entire length has periodic bursts in the settling rate of particles with a small amplitude. The minimum value of sand subsidence speed is 0.022 cm/s at a magnetic field strength of 112 000 A/m.

In the case when the direction of the magnetic field is opposite to that discussed above, that is, the N pole was on the right, and the S pole was on the left. The settling speed of particles in the magnetic field strength range of 24 000 - 4 0000 A/m, an increase in the settling speed is observed by an average of 15% at the end of the interval.

Further, the settling rate of sand particles drops sharply and, at a magnetic field strength H = 46 000 A/m, decreases by 30% compared to the settling process in the absence of a magnetic field, which is 0.053 cm/s. A further increase in the magnetic field strength to 132 000 A/m leads to a gradual decrease in the rate of deposition of sand particles. In this case, the curve of the dependence of the settling rate of sand particles on the magnetic field strength throughout its entire length is smooth. In the range of 132 000 – 160 000 A/m, the settling speed of particles is two times less than the settling speed in the absence of a field.

In the range of 160 000 – 176 000 A/m, there is a slight increase in the particle sedimentation rate by an average of 10% compared to the minimum sedimentation rate. The minimum value of the sand subsidence speed is 0.02 cm/s at a magnetic field strength of 132 000 A/m.

In region II of repacking of sand particles, the following is observed.

In the direction of the magnetic field, when N – was on the left, and S – on the right, perpendicular to the repacking of the sand. In the magnetic field strength range of 24000–40000 A/m, a slight decrease in the particle settling rate is observed. Further, the rate of sedimentation of sand particles drops sharply and, at a magnetic field strength of 56000 A/m, decreases by 4 times compared to the repacking process in the absence of a magnetic field.

A further increase in the magnetic field strength does not lead to a significant change in the rate of repacking of sand particles up to 176 000 A/m. In this case, the curve of the dependence of the subsidence rate on the magnetic field strength throughout its entire length has a wave character. The maximum deviation from the average subsidence rate, in some cases, is up to 0.05 cm/s. The minimum value of sand subsidence speed is 0.01 cm/s at a magnetic field strength of 132 000 A/m.

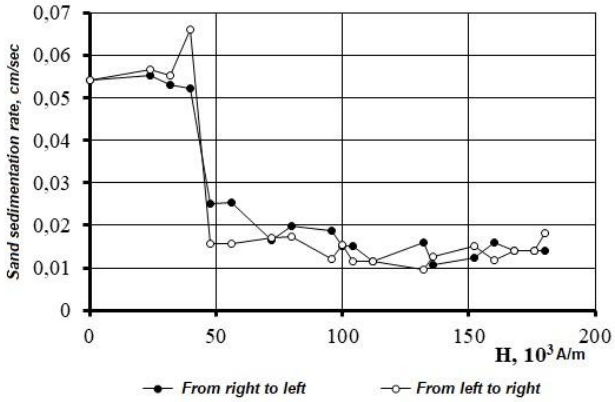

Figure 4. Dependence of the speed of redistribution of sand particles in water on the strength of the transverse magnetic field.

In the case when the direction of the magnetic field is opposite to that considered above, the repacking of sand particles in the magnetic field strength range of 24 000 – 40 000 A/m is observed to increase the settling speed of sand particles by 25% at the end of the interval. At a magnetic field strength of 48 000 A/m, the sedimentation rate decreases by approximately 4 times compared to the settling process in the absence of a magnetic field. A further increase in the magnetic field strength does not lead to a significant change in the sedimentation rate of sand particles up to 176 000 A/m. In this case, the curve of the dependence of the subsidence rate on the magnetic field strength throughout its entire length is smooth. The minimum value of the sand subsidence speed is 0.011 cm/s at a magnetic field strength of 136000 A/m.

`4. Conclusion

Summarizing the above, we can conclude that by changing the magnitude and direction of a constant transverse magnetic field, it is possible to regulate the process of sedimentation of sand particles: enhancing or slowing down this process when necessary in various oil production processes.

For example, an increase in the settling rate of particles is necessary during the primary processing of oil: in a separator, the rapid separation of the emulsion from sand leads to an increase in the productivity of treatment facilities.

Reducing the settling rate of particles is necessary when flushing wells or in the process of preventing the formation of plugs during the operation of sand-producing wells

If it is necessary that sand particles are suspended and better removed from the wellbore, then when using a transverse constant magnetic field, it is most preferable to place the N-pole of the magnet on the left and the S-pole on the right in the direction of flow. In this case, it is advisable to maintain the measured magnetic field in the measurement range of 132 000 – 176 000 A/m.

Conflict of interest

The authors declare that they have no conflict of interest in relation to this research.

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Assessment of technological measures effectiveness based on the interpretation of pressure build-up curves using identification equations

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Abstract.
Identification of hydrodynamic studies of wells is important in the control and management of various technological processes of oil production. One of the most used research methods in oilfield practice is taken by taking pressure recovery curves in production wells. Determination of the filtration characteristics of the formation by pressure buildup makes it possible to reasonably select wells under the influence, the method of the impact on the bottomhole zone itself, the necessary optimal operations, as well as to assess the degree of effectiveness of the geological and technological measures being carried out.
Keywords: pressure build-up, production, identification equations, productivity index, unbiased criterion

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1. Introduction

Hydrodynamic methods for assessing the effectiveness of impact on the bottom-hole zone of wells are based on model ideas about the nature of filtration flows and the geological structure of the formation.

Such, for example, are a priori ideas and assumptions about radial filtration, uniformity of the formation in thickness, invariability of the formation pressure at a certain specified distance from the well, etc. In a number of cases, mathematical research approaches and schemes are not adequate to the actual processes occurring during hydrodynamic testing of wells.