Investigation of the stability of the oxidation front, depending on the pressure drop during filtration with the release of the gas phase

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Currently there are large hard-to-recover hydrocarbon reserves, the extraction of which requires the development of original production methods. One of the methods to increase oil recovery is the use of acid treatment of the reservoir. The method consists in pumping into the formation of acids capable of dissolving part of the skeleton and creating highly permeable channels. However, at present, the process of filtration with a change in the phase composition of the filtered components due to chemical transformations is little studied.

It was previously found that the filtration isothermal process with the release of the gas phase may be unstable [1,2]. The authors indicate that the oxidizer is filtered by waves called "secondary oxidation waves". However, in the course of these works, no studies were performed describing the parameters on which the frequency and amplitude of the secondary oxidation waves depend or not.

The purpose of this work is a laboratory study of the dependence of the frequency and amplitude of secondary oxidation waves on the pressure drop causing filtration, divided by the length of the porous medium in which filtration was observed.

For the experimental work, a flat cell with dimensions of 350x200x45 mm, formed by two transparent polycarbonate plates with an internal space of dimensions 350x160x15 mm, was used. In the upper part of the cell, there are exits of tubes connected to a peristaltic pump, and a system for maintaining constant pressure from thin tubes. Along the cell there are 15 pressure sensors with a pitch of 20 mm.

At the beginning of the experiment, the cell was filled with glass bead mixed with a reducing agent (baking soda), after which the mixture was saturated with mineral oil. Next, an oxidizing agent (citric acid solution) was pumped through the delivery tube. As a result of filtration of the oxidizer through the model of a porous medium, secondary oxidation waves were observed, arising with some constant period. In experiments on pressure sensors, periodic pressure oscillations were observed.

As a result of experimental work, it was found that the period of pressure fluctuation in the secondary oxidation waves does not depend, and the amplitude weakly depends on the pressure drop divided by the length of the cell.

[1] Konyukhov A.V., Zavialov I.N. Numerical investigation of oscillatory multiphase flow in porous medium with chemically active skeleton //Journal of Physics: Conference Series. – IOP Publishing, 2016. – Т. 774. – №. 1. – С. 012059.

[2] Konyukhov A.V., Zavialov I.N. Influence of time-delayed reaction on stability and transition to self-oscillating mode of multiphase flow in porous medium // Turbulent Mixing and Beyond Sixth International Conference Tenth Anniversary Program, The Abdus Salam International Centre for Theoretical Physics, Italy, 2017, P. 22.