Effect of a direct current on the fluid filtration rate in rock samples

Maibuk Z.Y., Kireenkova S.M., Ponomarev A.V., Sobolev G.A.

Schmidt Institute of Physics of the Earth of the Russian Acsdemy of Sciences, Moscow, Russia

e-mail: avp46@mail.ru

Influence of direct electric field on the filtration of aqueous solutions of NaCl, KCl, citric acid and suspensions with nanoparticles of aluminum oxide (Al2O3) in sandstone has been studied experimentally. The studies were performed on cylindrical samples of quartz-feldspar sandstone (diameter 30 mm, length 60 mm), porosity 13–15%, and grain size 0.5–1.5 mm. The main rock-forming mineral is quartz, cemented by clay and ferruginous minerals. High porosity allowed passing solutions under atmospheric pressure. Samples of sandstones in a heat shrinkable tube were fixed vertically on the bracket. At the ends of the sample, platinum electrodes were installed, the design of which provided wettability for more than 90% of the end faces of the sample. Most of the experiments were performed with a sequential stepwise increase in the applied voltages from a DC source in the range of $12 \div 100$ V.

Previously, each sample was saturated with a solution of a given composition, and the saturation state was maintained throughout the experiment. Next, the time was measured for which a solution volume of 0.23 ml (5 drops) was percolating through the sample at a given voltage. Then the voltage decreased to zero, and the cycle was repeated at a higher voltage. Each experiment consisted of 6 cycles.

We used different fluid compositions (suspensions) with different concentrations of its constituent components from 0.0025% to 0.02%. The main types of fluid were distilled and natural (tap water), to which citric acid (LK), nano-sized Al2O3 particles ranging in size from 20 to 80 nm, KCl and NaCl were added.

It was established that the filtration rate of solutions with additives of NaCl, KCl, Al2O3 and citric acid with a concentration of 0.01