Possible Reason of the Dependence of an Apparent Permeability on the Pressure Gradient at low Flow Rates in Laboratory Study

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Currently, a number of studies showing that the injection of fluid into the formation can cause induced seismicity. Usually, it is associated with a change in the stress-strain state of the reservoir during the pore pressure front propagation. Modeling this process requires knowledge of the features of the filtration properties of reservoir rocks. Many researchers note the fact that the measured permeability of rock samples decreases at low pressure gradients. Among other things, this may be due to the formation of boundary adhesion layers with altered properties at the interfaces between the liquid and solid phases. The characteristic thickness of such layer can be fractions of a micron, and the effect becomes significant when filtering the fluid in rocks with a comparable characteristic pore size. The purpose of this work was to study the filtration properties of rock samples with low permeability at low flow rates. Laboratory modeling of such processes is associated with significant technical difficulties, primarily with the accuracy limit of measuring instruments when approaching zero speed values. The technique used by us to conduct the experiment and data processing allows us to study the dependence of the apparent permeability on the pore pressure gradient in the range of 0.01 MPa/m, which is comparable to the characteristic pressure gradients during the development of oil fields. In the course of the study, we carried out laboratory experiments on limestone core samples, during which the dependencies of their apparent permeability on the pore pressure gradient were obtained. We observed a significant decrease in their permeability at low flow rates. In the course of analyzing the experimental results, we proposed that a decrease in apparent permeability may occur due to the effect of even a small amount of residual gas in the pore space of the samples. This has been confirmed by additional experiments. The possibility of clogging of core sample pore space must be considered when conducting laboratory studies of the core apparent permeability.