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COMPUTER SIMULATIONS OF POROUS MEDIA PERMEABILITY AND FLUID DISPLACEMENT INSTABILITY

Abstract

Microgravity investigations serve as a tool, which could help to study flows in porous media being much better understood in microgravity studies eliminating the masking effects of gravity. The background for the performed research is the following. Dimensions analysis of the governing system of equations shows that surface tension relevant effects turn to be essential in the momentum equations for small Bond numbers. Thus, to measure the capillary forces accurately one needs to reduce the Bond number as much as possible. It could be done by various means: decreasing the density difference, increasing the surface tension, decreasing the pore size(r) and decreasing the gravity acceleration (g). The first three groups of parameters are those characterising the media under investigation. Thus, these parameters could not be varied arbitrary. The last of the parameters – g – characterises the environment for the experiment. It could be varied without affecting the media properties. Microgravity environment provides a unique possibility to reduce the parameter practically as low as necessary to get the needed accuracy of measurements. Besides, using the microgravity environment one can essentially increase the characteristic pore size to study the microscopical capillary processes, maintaining the small value of the capillary microgravity parameter . The problem is relevant to a hydrocarbon recovery, which is performed by the flow of gas under a pressure differential displacing the high viscosity fluid. Entrapment of high viscosity fluid by the low viscosity fluid flow lowers down the quality of a hydrocarbon recovery leaving the most of viscous fluid entrapped thus decreasing the production rate. The developed models and obtained results are applicable to description of liquid non-aqueous phase contaminants underground migration, their entrapment in the zones of inhomogenity, and forecasting the results of remediatory activities in the vicinities of waste storages and contaminated sites. The paper is aimed at mathematical modeling of flows in porous medium. The results are compared with model experiments performed under microgravity conditions. Numerical investigations of the instability in displacement of viscous fluid by a less viscous one in a two-dimensional and three-dimensional geometry were carried out. The effect of the three-dimensional phenomena on development of instability was investigated. The authors wish to acknowledge the support by Russian Foundation for Basic Research (Grant initiative 12-08-000198).