Seepage flows through porous media under extreme conditions

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This work considers the modeling of the process of liquid flow through a porous medium under microgravity conditions, as well as in the presence of chemical reactions or combustion. The behavior of liquids in microgravity is significantly different from the behavior in terrestrial conditions. Many processes on space stations are associated with fluid flow: heat pipes, life support systems, fuel supply systems. For predictive modeling of orbital hydromechanics processes, it is necessary to develop appropriate mathematical models based on experimental data. Studies of the flow of liquids due to capillary forces are very relevant for space technologies. This investigation discusses experiments on imbibition of a porous medium during parabolic flights. The results of processing experiments when the flow occurred in a porous medium formed by glass balls are presented. A study of fluid flow in a Hele-Shaw cell is proposed for modeling microgravity conditions. A series of experiments devoted to the study of unstable multiphase flow in a Hele-Shaw cell with inserts located inside the cell is described. A stable flow in a Hele-Shaw cell is also considered, the problem of mathematical modeling of such flows are discussed. Capillary instability is described and the mechanisms of its occurrence are investigated. The poster presents the results of numerical modeling of a three-phase unstable flow in a Hele-Shaw cell. The development of the mathematical models and numerical simulations were performed using the facilities of National Research Centre "Kurchatov Institute" Federal Science Centre "Scientific Research Institute for System Analysis of the Russian Academy of Sciences" on the topic No. FNEF-2024-0002