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INVESTIGATION OF THE FLUIDS BEHAVIOR UNDER MICROGRAVITY CONDITIONS: CONDUCTING EXPERIMENTS, MATHEMATICAL MODELING AND NUMERICAL SIMULATIONS.

Abstract

The study of the features of processes associated with multiphase fluid flows in microgravity conditions is of great importance both for the development of space technologies and for some terrestrial applications. It is well known that the behavior of a fluid under conditions of reduced gravity differs significantly from behavior under terrestrial conditions. Under conditions of reduced gravity, capillary effects become the main driving force in the flow of liquids. For example, on board the space station, the supply of liquid from a reservoir (for example, fuel) is possible only due to capillary forces. Also, capillary effects play an important role in the movement of fluids in heat pipes of spacecraft thermal control systems. Many biological processes occurring in living organisms are associated with the process of fluid flow in porous media and thin capillaries. The conditions of reduced gravity have a tremendous effect on the functioning of all body systems, the well-being of astronauts, and on regeneration in case of injury or burn. Therefore, a fundamental study of the mechanical aspects of fluid flow under microgravity conditions will be of great importance for space biomedicine. Also, the results of studying seepage processes in microgravity can be useful in the development of a plant growing system for bioregenerative life support systems in space for long-term manned flights. It should be noted that the results of studying seepage processes under microgravity conditions can also find applications for Earth technologies and processes, for example, for oil production. Capillary effects strongly influence the seepage processes under terrestrial conditions, but the study of capillary effects under standard gravity is difficult: it is problematic to visualize the liquid flow in small pores, and capillary imbibition is impossible in large pores due to the prevailing gravity. Therefore, it is so important to conduct experiments on the flow of liquid due to capillary effects in microgravity. This paper describes experiments on capillary impregnation at a station in Earth orbit, as well as during parabolic flights: 1) experiments on repeated impregnation of an artificial porous medium (glass balls of various diameters) during parabolic flights of the Airbus A300-ZeroG aircraft organized by the European Space Agency, 2) experiments on capillary impregnation of natural porous medium (80The authors wish to acknowledge the support by Russian Science Foundation (Grant initiative 21-71-10023).