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CALCULATION OF PARTICLE MOTION IN MICROGRAVITY CONDITIONS BY METHODS OF COMPUTATIONAL POTENTIAL THEORY

Abstract

Development of space technologies makes to consider a lot of sophisticated processes in continuous media in microgravity conditions, for example, multiphase flows in microgravity. Usually, multiphase flows include extremely complex and difficult for analysis processes of mechanical motions of phases, heat and mass transfer inside every phase and between phases and, possibly, chemical reactions. However, there are specific circumstances, in microgravity conditions, which can simplify correspondent mathematical morels for same cases. The present work is devoted to one model problem of multiphase fluid motion in microgravity. Let us consider some restricted domain, fulfilled by liquid, which contains a finite number of spherical objects of the second phase (solid particles or gas bubbles). Let us assume that there is not any external mechanical action on the considered volume, beside of enough small body forces to provide microgravity conditions. Diffusive and thermal external actions are possible. A fluid in the considered domain can move due to weak free thermal and concentration convection and interaction with disperse phase. Motions of disperse phase objects are stimulated by body forces (sedimentation or flotation) and thermophoretic and diffusiophoretic forces, beside of that, there can be Marangoni's effect if disperse phase objects are gas bubbles. The distributions of temperature and concentrations are described by correspondent transfer equations, but convective terms are relatively small in these equations. It can be shown enough easy, that the flows stimulated by the considered cautions must be Stokes flows. Obtained problem is quasi-linear, what gives an opportunity to search its solution as superposition of weak free convection velocity and velocity disturbances, caused by motion of every particle. Generally speaking, velocity of every particle must be calculated as solution of Cauchy problem for system of ordinary differential equations, describing motion of solid body, but taking into account spherical shapes of particles, last system can be reduced to similar system for material point motions. If the considered fields an enough smooth, the particle velocity can be found from equilibrium condition of forces, acting on the particle, including drug force. In this case analytical solution for Stokes flow about sphere can be used to avoid numerical solution the correspondent Stokes flow problem. Boundary element method is applied for numerical calculations of the mentioned fields. A specific feature of this approach is analytical taking into account of actions of particular particles on whole flow and fields of temperature and concentrations.