Paper ID: 27757
oral

66th International Astronautical Congress 2015

MICROGRAVITY SCIENCES AND PROCESSES SYMPOSIUM (A2)
Fluid and Materials Sciences (2)

Author: Dr. RONG MA
China Academy of Space Technology (CAST), China, rong.jessica@hotmail.com

Dr. Wei Yao
China Academy of Space Technology (CAST), China, yaowei@cast.cn
Dr. Xiaochen Lu
China, lyuxiaochen@163.com
Dr. chao wang
China, wangchao534@163.com
Dr. Na Yao
Qian Xuesen Laboratory of Space Technology, China, nyao@cantab.net

DIRECT NUMERICAL SIMULATION OF BUBBLE DYNAMIC BEHAVIOR IN ELECTRIC FIELDS UNDER MICROGRAVITY CONDITIONS

Abstract

With the rapid development of human space exploration and space science, multiphase transportation technologies in space have drawn an extensive attention in recent years. Meanwhile, a series of new scientific and technical challenges to the multiphase transport technology brought by the microgravity environment during flight, which have become a hot research spot in the current space science and technology. Nowadays, applying an electric field to a dielectric fluid mixing with bubbles to have an electrohydrodynamic (EHD) effect is an attractive and active technique for enhancing gas-liquid two-phase separation and heat transfer under microgravity environments, which has been demonstrated to have a great promise in aerospace industry. In this article, the EHD effect on bubble dynamic behavior under microgravity conditions are studied by developing a numerical model of applying an electric field on a single bubble in a dielectric fluid based on the commercial software FLUENT. In the process of direct numerical simulation, the volume of fluid (VOF) method is employed to track the interface between the gas-liquid two phases. The user-defined (UDF) code for solving the electric field and the corresponding electric body force is written and added to the momentum equations in a commercial software FLUENT. Governing equations for the flow field and the electric field under microgravity conditions are coupled numerically, which are solved using a non-orthogonal body-fitted mesh system with VOF method tracking the interface on an axial symmetric Cartesian coordinate system. By solving the coupling problems of fluid flow and electric field under microgravity conditions, the effect of an applied electric field on flows for an air bubble surrounded by a dielectric fluid are studied and simulated numerically. The results of direct numerical simulation would compared with those of available experiments to show a good agreement. The mechanism of EHD enhancement of gas-liquid two-phase separation and EHD induced phenomena including bubble dynamic behaviors and complicated interface dynamics under microgravity conditions are analyzed in detail.