MICROGRAVITY SCIENCES AND PROCESSES SYMPOSIUM (A2)
Science Results from Ground Based Research (4)

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VIBRATION-INDUCED PARTICLE MOTION UNDER MICROGRAVITY

Abstract

The microgravity environment enables purely diffusive mass transport by suppressing convection effects and can be used to produce high quality materials such as semi-conductor and protein crystals. Such materials have several superior properties that can improve the quality of human life. One example is the production of advanced drugs by synthesis of protein crystals with improved structure. However, g-jitter induced convective flows can cause certain effects that would reduce the quality of the produced crystals. In this work, experiments have been conducted under normal gravity to investigate the effects of g-jitter on the motion of small particles. Stainless steel particles of different sizes were suspended by a thin wire in a rectangular fluid cell. The fluid cell was filled with silicone oil with viscosity of either 350 or 1,000 cSt. The cell was subjected to horizontal sinusoidal vibrations with different frequencies and amplitudes. A 3D numerical simulation code, PARTFLOW3D [1], was also used to predict the effects of vibrations on a wire-free particle under microgravity. The simulation results were also analyzed to investigate the effects of physical parameters on the attraction or repulsion force on the particle. The parameters investigated were: fluid cell amplitude, fluid and particle densities, angular frequency of the cell vibration, initial distance between the particle centroid and the closest cell wall, particle radius, and dynamic viscosity. In previous studies [2], relatively low viscosity fluids such as water have been determined to produce a force on the particle, normal to the direction of the vibration, which attracts the particle to the nearest fluid cell wall. The experiments with high viscosity fluids in this work however, have revealed an interesting change in the force from attraction to repulsion. Furthermore, the repulsion force was observed to increase with an increase in the fluid viscosity and the amplitude and frequency of the fluid cell vibrations. Based on the simulations a non-dimensional relation was developed to relate the physical parameters to the repulsion or attraction force affecting the particle. This relation shows that the repulsion or attraction force is increased by the increase in the cell vibration amplitude and frequency, and also the force direction would change from attraction to repulsion above a threshold viscosity. References [1] Hu, H.H., Patankar, N.A. Zhu, M.Y. (2001), J. Comput. Phys. 169(2), 427–462. [2] Hassan, S., Lyubimova, T.P., Lyubimov, D.V. Kawaji, M. (2006a), International Journal of Multiphase Flow 32(9), 1037 - 1054.