Abstract

The Oregon State University team proposed performing two independent fluid dynamic experiments during micro-gravity the flights:

a) Behavior of convection in solid to liquid phase changes, and
b) Fluid dynamic behavior of the Magnetically Assisted Fluidized Bed.

Both experiments were mounted on the same frame structure.

Any multiphase flow situation in micro-gravity is considerably different from the same flow situation under normal gravity conditions. Melting ice in a cylindrical vessel (pipe) is additionally complicated with a heat transfer problem which is related to the heat conduction/convection through a multiphase layer (vapor + liquid + solid). This 'heat transfer - phase change' situation is of particular interest in the start-up of frozen lines within a space station infrastructure. In the proposed experiment we observed how the phase change front between 'ice- liquid water - water vapor' progresses radially inside a cylindrical vessel initially containing frozen water. These observations were compared to the data obtained with the same equipment under laboratory 1g conditions. Furthermore, we obtained additional data for 2g, Moon and Mars gravity conditions.

Our second experiment, also a multiphase (solid-liquid) fluid flow situation, tested the fluid dynamic behavior of a Magnetically Assisted Fluidized Bed (MAFB). Since normal fluidization operation is impossible without a gravitational force, we designed, manufactured, and tested the Magnetically Assisted Fluidized Bed in which the gravitational force is replaced with a magnetic force. The magnetic force is created through the interaction of a non-uniform magnetic field and magnetized ferromagnetic particles. The ferromagnetic particles suspended in water are sought as carriers or platforms for the immobilization of biomaterials (in a fluidized bed bioreactor), bio-catalyst or inorganic catalyst (in a fluidized bed catalytic reactor). During the flight we tested the fluid dynamic behavior of the fluid-solid mixture in micro-gravity and variable gravity by exposing it to the forces created by non-uniform magnetic field.

The OSU team has considerable experience in designing and operating the MAFB technology in micro-gravity. One very successful feasibility test of the proposed technology was performed during the RGSFOP March 2000 flight. The results of this test opened many questions related to fluid dynamics of the two-phase system in the magnetic field. As the results of the fluidization were communicated to the scientific community, we received many questions and inquiries for experimental data. Our intention was to execute an experimental plan on the newly constructed and improved fluidized bed equipment that reflected the knowledge gained during the previous flight. Based on the available data we were able to develop a hydro-magnetic flow model that we used to design better experiments. Based on the modeling results we learned how to operate the MAFB with different fluidization conditions and used particles substantially different from our original design.

2000 – 2001 Oregon State University Microgravity Flight Team
Magnetically Assisted Fluidized Bed and Microgravity Ice Thaw Experiment

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