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SURFACE TENSION-DRIVEN FLOWS IN EVAPORATIVE TWO-PHASE SYSTEMS IN MICROGRAVITY CONDITIONS

Abstract

This article deals with numerical and experimental research activities in preparation of the experiment "SELf rewetting fluids for thermal ENErgy management" (SELENE). This research program foresees the development of a dedicated hardware (Thermal Platform) for microgravity experiments in the Fluid Science Laboratory (FSL) on board the International Space Station (ISS). The primary objective of the research is to investigate multiphase flows in special heat transfer fluids, called self-rewetting fluids, including binary mixtures with unusual surface tension behaviour. In particular, for such binary or multi-component mixtures, the reverse Marangoni effect at liquid-vapour interfaces is responsible for relatively strong surface tension-driven flows towards the hot region of the interface. One of the most interesting applications of this effect, as proposed by the investigators, is spontaneous liquid inflow towards hot spot or dry patch on the heater surface of heat pipe or similar evaporation-based heat transfer devices. As shown in previous papers (Ref. 1-6), self-rewetting mixtures prevent the liquid film dry-out and increase the heat transfer performances of the system. SELENE will give the possibility to investigate the fundamental physics and the evaporative heat and mass transfer from the free surface of these fluids in a transparent model configuration, taking advantage from flow visualization and optical diagnostic techniques available in the Fluid Science Laboratory in the ISS. This paper discusses the different aspects of the experiment in microgravity conditions, were surface tension-driven phenomena dominate fluid behavior. In preparation of the space experiment a number of activities have been carried out, including: 1) breadboards development and support to the definition of the scientific requirements for the ISS experiment; 2) modeling of the capillary/surface tension driven flows in mini-channels; 3) numerical modeling of the breadboard apparatus; 4) thermo-physical properties measurements; 5) flow visualization of the Marangoni flow and test on the heat transfer performances of different self-rewetting-fluids.

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