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Microgravity Experiments from Sub-orbital to Orbital Platforms (3)

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GROUND-BASED EXPERIMENTS IN PREPARATION OF HEAT PIPE EXPERIMENTS ONBOARD MIOSAT MICROSATELLITE

Abstract

This article summarizes ground-based research activities in preparation of a microgravity experiment to be carried out onboard MIOSAT microsatellite developed by the Italian Space Agency. The microsatellite will host a dedicated payload to investigate behaviour of heat pipes with self-rewetting fluids in microgravity environment. The primary objective of the heat pipe experiments is to investigate possible improvements of heat transfer performances related to the reverse Marangoni effect, typical of self-rewetting liquid mixtures, for which surface tension increases with temperature. The experiments will be carried out on heat pipes filled with self-rewetting fluids, brines and nanofluids. The power will be provided at the evaporator section with cartridge heaters and heat will be dissipated at the condenser section by passive radiative cooling in the space environment, using thin alluminium panels and/or flexible radiators based on polymers sheets. A number of temperature sensors will be distributed along each heat pipe to characterize the thermal performances. In preparation of the flight experiment a number of research activities have been performed. They include: 1) thermophysical properties measurements and capillarity effects in laser-engraved micro-channels; 2) interferometric analysis of thermal and concentration for a typical experimental configuration characterized by a thin liquid layer in a transparent quartz cuvette, with an imposed horizontal thermal gradient; 3) thermal performances test on heat pipes in horizontal configuration, with almost negligible influence of gravity force, for selection of candidate working fluids for the flight experiment. Fundamental studies have been carried out on a nearly 2D flow field using a two wavelength Mach-Zehnder interferometer. From interferometry the thermal and concentrations fields are quantified and compared to numerical simulations. For the first time the relative importance of thermal and concentration effects has been evaluated, to quantify the different driving forces in pure liquids and self-rewetting solutions based on high number carbon alcohols. An experimental study of capillary rising in laser-engraved microchannels (with triangular and trapezoidal cross sections) has been carried out using several liquids, including single component fluids (e.g. ethanol) and self-rewetting fluids. In the latter case, very high capillary rising was observed, which is attributed to the evaporation of more volatile component and consequent surface tension unbalance. Numerical simulations are also in progress to explain and correlate the experimental results.