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NUMERICAL AND EXPERIMENTAL RESULTS ON SELF-REWETTING FLUIDS FOR TWO-PHASE HEAT EXCHANGERS IN LOW-G EXPERIMENTS

Abstract

This paper summarizes main results of a long-term research about self-rewetting fluids for two-phase heat exchangers in low-g experiment. Heat exchanger devices like heat pipes are used in thermal management of electronics, engines in automotive and aeronautic industries, and heat recovery systems like thermal solar panels. Several scientific experiments for studying heat transfer phenomena within different types of heat pipes are foreseen to be performed on a multi-experiment research tool called Heat Transfer Host 1, or simply HOST1, installed onboard the International Space Station. Self-rewetting fluids are also foreseen to be tested on board the HOST1. They are binary mixture with an anomalous behavior of the surface tension with temperature. In presence of a thermal gradient the thermocapillary flow as well as the solutal Marangoni effect due to the differential evaporation rate along the liquid vapor interface, moves liquid from the cold to the hotter regions and this is beneficial for two phase systems like heat pipes. Experiments are aimed at comparison of heat transfer performances of conventional single-component liquid and binary self-rewetting mixtures. Furthermore, they will be tested both on a simplified groove heat pipe model and on more advanced heat transfer devices likes pulsating heat pipe where the heat exchange is given by the oscillatory regime of a slug/plug flows. Development of these experiments requires considerable advancement in modeling of two-phase flow as well as on experimental techniques needed to achieve all scientific objectives of the project. In this paper both these aspects will be considered. In particular, numerical modelling of the two-phase flow is carried out by means of a CFD code were evaporation and condensation processes are included considering the kinetic theory. Typical experimental conditions foreseen on board the International Space Station are considered. Experiments are carried out also in laboratory and thermocapillary phenomena observed using different geometry. Some of them were obtained by means of Additive Manufacturing tecnique. Results are discussed.