IAF MICROGRAVITY SCIENCES AND PROCESSES SYMPOSIUM (A2)
Microgravity Sciences on board of Space stations (6)

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FLOW AND HEAT TRANSFER RESEARCH IN SPACE AND TWO-PHASE SYSTEM EXPERIMENT PLATFORM ON ABOARD CHINA SPACE STATION

Abstract

The two-phase fluids system in space becomes more interesting and important research subjects of fluid physics in microgravity environment, due to its relative engineering applications in space explorations such as the management systems of fluids and heats in space, and no very well understanding of the fundamental phenomena of two-phase system in space, such as interfacial flow with phase change and heat transfer behaviors in microgravity condition. For further knowledge of the two-phase fluids flow and heat transfer in space environment, since 2011 the "Flow and Heat Transfer Research in Two- Phase System Applied in Space" have been planned as one of main space research projects of microgravity sciences in the frame of China's Manned Space Engineering Program. A "Two-phase System Research Experiment Rack (TPSR) " developed as the multi-function space experimental platform were launched in 2022 and runs more than one year on aboard of China Space Station (CSS). The present paper presents the functions, performance and support capabilities of the scientific experiment system of TPSR. It consists of six main modules: (1) optical observation platform; (2) gas management module; (3) low-flow liquid supply module; (4) high-flow liquid supply module; (5) experiment MCU, and (6) experiment project module. The system can meet the space experiment needs on phase-changed fluid interfacial flow phenomena; heat and mass transfer process with phase change; two-phase flow and dynamic behaviors of systems and fluid managements on orbit in space. The replaceable experimental project module adopt a standard plug-in unit (SPU) (size: 545 mm 444.6 mm 257.6 mm) is placed in the center of the optical observation

platform with the supply of gas and liquid resources of TPSR. The four first batch of space experiments of two-phase systems such as the Drop Evaporation, Condensation, Boiling Heat Transfer and Two-Phase Heat Transfer Loop experiments have been arranged to conduct in orbit on TPSR within the first two years of the experimental rack operation, in which the Droplet Evaporation experiments have been completed successfully in 2023. A series experiments of liquid drops evaporation with different experimental parameters, such as substrates material, coating surface of the substrate, heating temperature, gas flow, volume of the drop, heating environment around gas-liquid interface, etc. have been performed to investigate the interfacial flow behaviors and the heat mass transfer mechanisms. Preliminary experimental results of ground-based and in space are presented in this work. Acknowledgement: This work are financially supported by China Manned Space Program and CSS Experiment Projects (TGMTYY14019) , the CMSA-ESA International Cooperation of Space Experiment Project and Bureau of International Cooperation of the Chinese Academy of Sciences.