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EXPERIMENTAL INVESTIGATION OF DROP EVAPORATION IN TWO-PHASE SYSTEM RACK ABOARD CHINA SPACE STATION

Abstract

By using the Two-Phase System Research Rack(TPSR), which is the main space experimental platform of fluid physic research on board the China Space Station, a series of space experiments can be carried out to study the interfacial flow behaviors and the complex process of heat and mass transfer with an evaporating phase-changed interface. The first experimental project in Two Phase System Rack (TPSR) on Chinese Space Station (CSS) were carried out in 2023 for more than 400 different experimental cases. The drop evaporation experimental module integrated in a SPU (Standard Payload Unit) is installed in TPSR. A series of space experiments studying on convective flow and heat-mass transfer law of gas-liquid interface with evaporation are planning to perform in the long time microgravity environment. In the experiments, both liquid drop evaporation and liquid layer 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, have been observed experimentally to investigate the interfacial flow behaviors and the heat mass transfer mechanisms in microgravity environment.

By means of the key public optics observation module, public thermal cycling and control system of the TPSR, initial experimental condition was constructed, experimental progress were controlled and the flow fields in the liquid, surface temperature fields, evolution of the feature of the gas-liquid interface, etc. are obtained to analyze the gas-liquid interfacial phenomena with heat and mass exchange, non-equilibrium effects and instabilities of evaporation interface, interaction mechanism between surface evaporation and convection driven by surface tension, the effect of evaporation on liquid-solid interface interaction and the effects of gravity and evaporation environmental conditions on the interfacial evaporation and convection. The analysis of space experimental results and the comparison with the observation results of evaporation process on ground 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.