Paper ID: 44015
oral

IAF MICROGRAVITY SCIENCES AND PROCESSES SYMPOSIUM (A2)
Fluid and Materials Sciences (2)

Author: Dr. Satoshi Matsumoto
Japan Aerospace Exploration Agency (JAXA), Japan, matsumoto.satoshi@jaxa.jp

BOILING TWO-PHASE FLOW EXPERIMENT IN MICROGRAVITY ONBOARD INTERNATIONAL SPACE STATION

Abstract

In the future enlarged space platforms and vehicles, the consumption of electric power will increase and the thermal management will become much more important to cool the electric devices to proper temperature. It is inevitable to adopt high performance and more efficient method to remove thermal energy, for which new devices using boiling and two-phase flow is more promising than the conventional methods using single-phase liquid. However, there is no systematic or no coherent data needed for the design of space thermal management systems. Especially, effect of gravity on the heat transfer coefficient and the critical heat flux for a flow boiling is still open problem. A series of systematic experiments was performed using a boiling and two-phase flow loop under the microgravity condition provided by the International Space Station. Based on the understanding of gas-liquid interfacial behavior and highly reliable data on heat transfer characteristics from this experiment, we clarify the details of elementary processes concerning boiling two-phase flow under the microgravity condition. This experiment also demonstrates a boiling cooling system in space. Through this experiment, we acquired data useful for designing a high-performance and compact thermal control system, aiming to develop it into an innovative space platform. The apparatuses used in the experiment are the two-phase mechanical pumped fluid loop was employed. It is composed of gear pump, flow meter, pre-heater, heated test sections, adiabatic observation sections, condenser and accumulator. These components are connected by pipes with inner diameter of 4 mm. The deaerated n-perfluorohexane is employed as a test fluid. Temperature and pressure are measured by thermocouples and pressure sensor at the required part. A high-speed camera is to measure void fraction, thickness of annular liquid film and two-phase flow structure. One of heated test section is transparent glass tube to directly observe boiling behaviors using CCD cameras. The microgravity experiment was performed from July 2017 to March 2018. The experimental facility worked well and a lot of data were able to accumulate. Under the certain regime of experimental condition, it was completely different from the behavior of boiling bubbles on the ground. As a result, heat transfer also showed unique characteristics.