IAF MICROGRAVITY SCIENCES AND PROCESSES SYMPOSIUM (A2)
Facilities and Operations of Microgravity Experiments (5)

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EXPERIMENTAL INVESTIGATION OF ON-ORBIT FLUID MANAGEMENT BY USING VARYING-GRAVITY EXPERIMENT RACK ON SPACE STATION

Abstract

Fluid management in space under alterable gravity level deals with many key problems of fluid physics in lower and microgravity environment, such as capillary flow, free or interface effects, multi-phase fluid and propellant reorientation dynamics. Recently, with the development of manned spaceflight and the further deep space exploration, the application research of on-orbit fluid management widely spread among space engineering projects, one needs the relative fundamental theoretical and technological acknowledgment to support of the long-term aerospace engineering and human space exploration activities. The present work focus on the experimental investigation of the on-orbit fluid management process in microgravity and variety gravity environments, by using the Varying-Gravity Experiment Rack (VGER) which could provide long-term microgravity and simulating gravity environments with 0.01g2.0g by the centrifuge of 90cm in diameter onboard China Space Station. The on-orbit fluid experimental facility has been developed and lunched on China Space Station in November 2023. As main unite of the space experimental facility, an experimental model tank of radius 35 mm and length 90mm are placed on the multifunctional platform for reciprocating translational and swinging rotational motion. The experimental fluid FC72 was used in this investigation, and the experimental tank is made of plexiglass in order

to optical observation of free surface flows and gas-liquid distributions under the different imposed external movement status of the liquid tank such as the translational vibration, swinging rotational motion and their combination movement, liquid reorientation in the tank. A series experiments of more than four hundred cases in space are planning to conduct to the investigations on the two-phase fluid flows of space propellant storage tanks including the fluid static equilibrium processes and special behaviors of liquid sloshing, oscillation behaviors and recovery period of free liquid surface, in-orbit refueling process of test liquid in the modeling storage tank under microgravity and different varying gravity environments, specially at lower gravity conditions on the Moon and Mars. AcknowledgementThis work are financially supported by China Manned Space Program and CSS Experiment Projects (YYWT0601XEP1901), the CMSA-ESA International Cooperation of Space Experiment Project and Bureau of International Cooperation of the Chinese Academy of Sciences.