SPACE SYSTEMS SYMPOSIUM (D1)
Poster Session (P)

Author: Dr. Yu Zhang
Shanghai Institute of Satellite Engineering, China, zhang225yu@163.com

Dr. Jiang Wang
Shanghai Institute of Satellite Engineering, China, fcwjseu@gmail.com
Prof. Wen Wang
Shanghai Jiaotong University, China, wenwang@sjtu.edu.cn
Mr. Gaoxiong Zhang
Shanghai Institute of Satellite Engineering, China, zgx248@163.com

THEORETICAL AND EXPERIMENTAL RESEARCH OF A GRAVITY-INSENSITIVE HEAT PUMP FOR SPACE APPLICATION

Abstract

The space application of heat pumps becomes essential because of the high heat rejection demand during the space explorations for Moon, Mars and other planets in the future. Heat pumps utilize the latent heat of refrigerants during heat transfer, so that it provides much higher power density than other heat rejection methods. However, the dependence on gravity of heat pumps on the ground restrains its application in the microgravity environment of space. In this paper, a gravity-insensitive heat pump for space use is proposed. A reformed compressor is equipped in the system, which employs centrifugal force and surface tension to drive its lubrication circulation. Meanwhile, a radiator plays the part of the condenser in the heat pump. A theoretical analysis is performed to predict the performance of both heat pumps on Earth and in the space firstly. The results demonstrate that the designed heat pump exhibits a great potential in heat rejection in the space. Then, both common and antigravity experiments have been performed to test the performance of a prototype based on the design. The prototype achieves a heat dissipating capacity of 150W under all experimental conditions. In addition, the COP of the heat pump is greater than 3 in both common and antigravity experiments. However, the power consumption of the compressor increases by a certain degree during the antigravity experiments. As a result, the COP of the heat pump in antigravity experiments is lower than that in common experiments. Through theoretical and experimental analysis, the gravity-insensitive design of heat pumps for space application has been proven rational and efficient.