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Thermal Control Scheme Study of Scientific Experiment Rack of New Manned Space Station

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Abstract

The thermal control system of the scientific experiment rack of the new manned spaces station is composed of the liquid cooling system and the air cooling system, which can be divided into three patterns, the liquid cold plate cooling, the air circuit cooling and the combination of cold plate and the air circuit cooling. According to the different cooling capabilities of the liquid cooling and the air cooling system, each scientific experiment rack is properly installed with one of the alternatives based on its own cooling requirements. Meanwhile this article compares the thermal performance parameter of the thermal control system of the China new manned space station with that the international space station to provide certain references to the research and development of the thermal control system of China space station.

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Keywords: new manned space station; science experiment rack; thermal control system

1. Introduction

Space technology plays a very important role in the field of the modern scientific research and the engineering application. In the past few decades, the space technology has led a speedy development in our country. Except for being able to accomplish the work that the unmanned spacecraft engages, the manned spacecraft could more exert the subjective initiative of human beings with the participation of the astronauts. In September 2011, China has

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launched the Tiangong I module, whose primary mission is to carry out the space experiment in order to establish a long-running unmanned reliable independently-operated space experiment platform. In the later period, the Tiangong II module will be launched to accumulate experience for the establishment of the manned space station. The new manned space station of China can load multiple types of payloads integrated in the scientific experiment rack where scientific and technological experiments of multiple areas could be carried out, such as space life science, space material science, fluid science, basic physics, technology test, etc [1,2].

In order to guarantee the normal operation of the scientific experiment, the thermal control system of the scientific experiment rack, takes on important functions of controlling the temperature change and distribution of the payloads and maintaining the normal operation of various electronic components, which is one of the indispensable parts of the new manned space station. According to different temperature requirements, thermal control interface and work mode of various scientific experiment racks, the thermal control scheme can be divided into three types, that is, the liquid-cooling thermal control system and the air-cooling thermal control system and the combination of cold plate and the air circuit cooling system in order to meet the temperature requirements of different scientific experiment racks. This article introduces these three types thermal control systems and makes a comparison with the thermal control system of the scientific experiment rack of the international space station.

2. The heat transfer theory of the scientific experiment rack and the cabin body

Each part-cabin is equipped with the applied secondary fluid circuit to collect the heat produced by the applied load in the scientific experiment rack. Meanwhile the liquid-to-liquid heat exchanger uniformly delivers the heat to the medium temperature loop, and the experiment rack and the applied secondary fluid circuit are connected by the quick disconnecter. The design principle of the applied secondary fluid circuit is as shown in Fig. 1.

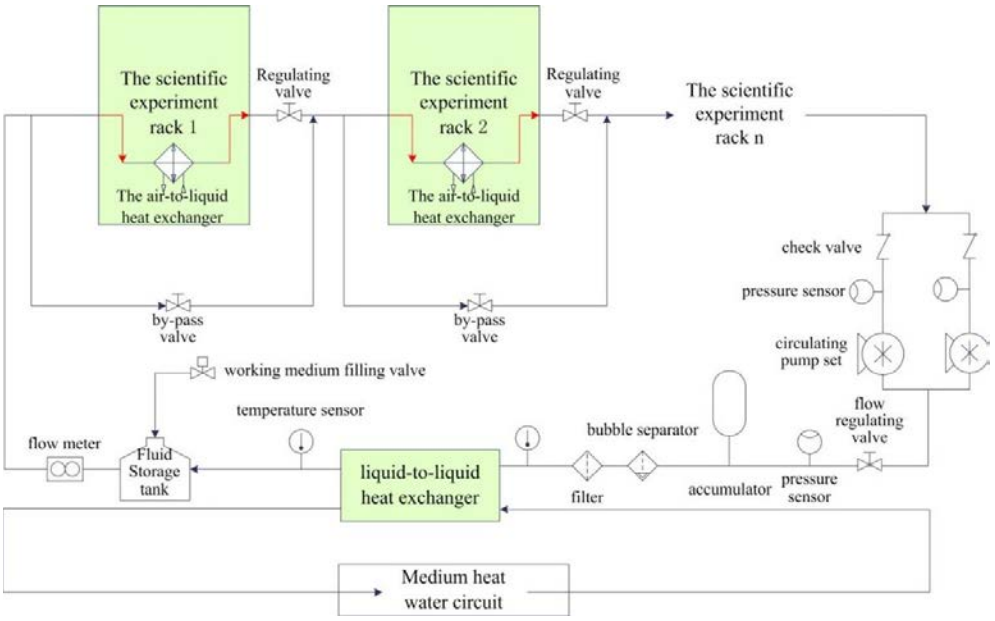

Fig. 1. Principle diagram of the applied secondary fluid circuit

The designed capability of the liquid-to-liquid heat exchanger of medium heat loop of the space station is 5000W. The working medium flow of the cold side is 500l/h and that of the heat side is 600l/h. The working medium of both sides is ethylene glycol aqueous solution.