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Thermal Analysis of Large-scale Cryopump Used in Large Vacuum Leak Detecting System

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A large-scale cryopump (DN1250) used in large vacuum leak detecting system was designed and its performance experimentally investigated by Beijing Institute of Spacecraft Environment Engineering. In the cryopump, the first stage array (radiation shield and baffle) and the second stage cryopanel were cooled by four closed cycle helium refrigerators (two dual stage refrigerators and two single stage refrigerators). The second stage cryopanel were divided into two parts and directly attached to the second stage of two dual stage refrigerators respectively, and were not covered with activated charcoal to avoid pump the helium gas which was the tracer gas in helium mass-spectrum leak detection system. The radiation shield and baffle were also divided into two parts, and each part was cooled by the first stage of one dual stage refrigerators and one single stage refrigerators. The thermal analysis method based on numerical techniques was introduced in this study, the heat transfer in the first stage array and the second stage cryopanel was carefully analyzed to determine important considerations in the thermal design of the cryopump. A performance test system according to the test standards for cryopump was built to test main performance of the cryopump.
The experimental results showed that the structure of first stage array which was optimized by the method could meet the requirement of the second stage cryopanel well. The temperature of the cryopanel was down to 12K within 360min, and the result of experiment was accordant with theoretical analysis conclusion. The test also showed that the pumping speed for N2 of the pump was up to 57,000L/s, the cool down time was about 360min, and the crossover was over than 1,000mbar•L.

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