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Thermal Analysis and Computational Fluid Dynamics Simulation of Large-Scale Cryopump

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Abstract : 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. The cryopump was cooled by four closed cycle helium refrigerators (two dual stage refrigerators and two single stage refrigerators). Detailed numerical analysis of the heat transfer in the first stage array and the second stage array were performed by using computational fluid dynamic method (CFD). Several design parameters were considered to find the effect on the temperature distribution and the cooldown time. The variation of thermal conductivity and heat capacity with temperature was taken into account. 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 RNEUROP standards 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 cryopump well. The temperature of the cryopanel was down to 10K within 300 min, and the result of the experiment was accordant with theoretical analysis' conclusion. The test also showed that the pumping speed for N2 of the pump was up to 57,000 L/s, and the crossover was over than 300,000 Pa•L.

Keywords : cryopump, temperature distribution, thermal analysis, CFD Simulation
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