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THERMOHYDRAULIC ANALYSIS OF HYDROFORMED THERMAL SHROUDS

Content :

Thermal shrouds find enormous application in space programme wherein they are used to carry out thermal cycling test of satellite. The shrouds simulate the affect of move in and out of sunlight and hence effect of drastic temperature change on the components of the satellite. They are know with different names such hydroformed, bubble or dimple panels. Institute for plasma research, Gandhinagar for its project of developing large pumping speed cryoadsorption cryopump for Fusion reactor grade machines developed the hydroformed cryopanels as a spin-off technology. The technology is with the country now with an Indian patent.

The hydroformed cryopanels are used in the developed technology of large pumping speed cryoadsorption cryopump. The core of pump is activated carbon adhered to hydroformed cryopanel cooled to liquid helium temperatures ~ 4K. To protect the cryopanel from radiation heat loads it is placed in a cage and is surrounded by thermal shrouds or radiation shield at 80 K. The pump provides pumping speed of 2.5 to 5 L/sec cm2 with pumping speed of 1.5 x105 L/s for Hydrogen for 3 square meter of surface area coated with activated carbon.

The work presented in this paper describes the CFD analysis of the cryopanel at 4K and radiation shield surrounding the panel and a front shield at the opening of the pump and is at 80K. Cryopanel with a line stitched pattern is at 4.5 K (~ 1000 cm in length 20 cm in width) carries liquid helium at 4 bar. Heat flux of 25 W/m2 impinges on the surface of cryopanel. Analyses were carried out for variable mass flow rate of (i.e. 20 g/sec to 70 g/sec). To study the cryogen flow(80 k helium gas) through diamond pattern stitched hydroformed radiation shields (cylindrical radiation shield surrounding the cryopanels and the shield with the same pattern of stitching at the opening of the pump and called front shield) were also analyzed for the flow pattern and temperature distribution. Both Radiation shield and front shield carry helium gas at 15 bar pressure and at 80K temperature. Heat flux falling on front shield is 365 W/m2 and on radiation shield is 340 W/m2. Analyses was made for variable mass flow rate (i.e. 20 g/sec to 50 g/sec) to obtain optimum value of pressure drop with thermal distribution on hydroformed shield plates.

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