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Design and Thermal Fluid Structure Interaction Analysis of Liquid Nitrogen Cryostat of Cryogenic Molecular Sieve Bed Adsorber for Hydrogen Isotopes Removal System

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Efficient design of Tritium Extraction System (TES) for the fuel cycle of any fusion reactor is very important to maintain the tritium breeding ratio and hence sustain the fusion reaction. Hydrogen Isotopes Removal System (HIRS) for Indian Tritium Breeder Blanket removes Q2 (Q = H, D or T) and impurities using Cryogenic Molecular Sieve Bed (CMSB) adsorber at 77K. The CMSB is maintained at liquid nitrogen temperature using a double walled cryostat made up of SS 304L.

This paper describes the design and thermal Fluid Structure Interaction (FSI) analysis of cryostat assembly for CMSB of HIRS. The coupled analysis performed in this work involves solving for the fluid domain and transferring the results to ANSYS Thermal-Static Structural set up to determine the stresses and displacement due to combined effects in the system. The mechanical design of the cryostat components is analytically performed using ASME codes. The velocity, pressure drop and time taken to cool the CMSB are determined by solving the fluid and energy equations in ANSYS Fluent Analysis System. The solutions are imported into ANSYS Thermal-Static Structural analysis system and the thermal-structural stresses and deformations are determined considering the temperature, pressure and acceleration loads. The space between inner and outer vessel is maintained at vacuum, which might lead to buckling. So, the critical buckling load multiplier factor is determined. The modal analysis is also performed to determine the fundamental frequency of vibration of the structure. These results would be used in fabricating the complete cryostat system for CMSB of HIRS.

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