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Manufacturing and performance characterization of radiation shield baffle structure of a large area cryocooler based Cryosorption pump for INTF

Content :

To characterize Diagnostic Neutral Beam (DNB) for ITER, a test facility (INTF) is being developed at ITER-India laboratory, in Institute for Plasma Research, Gandhinagar. Operation of the beam source (BS) in INTF is based on the production of a H⁻ ion beam of energy 100 keV. - To meet the requirement of high vacuum in INTF, twelve sets of Cryocooler cooled cryo-sorption based Cryopumps are planned of size 3.0m × 0.6m × 0.3m (L×W×D) to be installed in the INTF vacuum vessel.

Each cryopump consists Liquid Nitrogen (LN₂) cooled 210 black TiO₂,Al₂O₃ ceramic coated V-shaped chevron baffles arranged in staggered way precisely as radiation shield around cryocooler cooled activated charcoal coated cryopanel, with temperature around 15 – 20K. Each LN₂ baffle is connected to four LN₂ distribution pipes at four corners of it, maintaining precious gap to ensure sufficient gas molecule transmission through it with negligible photon transmission to cryopanel.

The manufacturing of Cryopumps employs two important processes which are Black coating of chevron baffles and joining process of total 210 × 4 joints with the LN₂ pipes. In the past, Cryopumps for SST-1 have been manufactured by utilizing (1) plasma spray technique for black coating (2) TIG brazing for joining Pipe to baffles joints. In the present case, while coating is applied using the same spray technique, the joining technology selected is vacuum brazing. The advantage of vacuum brazing is it makes it possible to join large number of baffles at one go, compared to TIG brazing technique which joins the baffles one of one.

Emissivity of the black coating was found to be better than 0.9 exceeding the technical specification of 0.8. Adhesion of black coating with the substrate is found to be adequate. Vacuum brazing of coupons have been qualified for the requirements of the joints. Presently, the manufacturing of Cryopumps have progressed to the extent that all the black coated baffles have been made and all the preparation is made for carrying out vacuum brazing. Before carrying out the actual brazing a characterization experiment is conducted on a prototype with few baffles brazed on pipes to qualify the brazing with respect to the quality of thermal conduction.

In this paper, baffle manufacturing experience and the experimental results of characterizing the baffle performance are presented in terms of coating quality, joining quality, mechanical stability and thermal distribution over the baffle structure.

Primary authors : Mr. MILIND PATEL, Milind (ITER-India, IPR)

Co-authors : Mr. ARUN KUMAR CHAKRABORTY, Arun Kumar (ITER-India, IPR) ; Mr. MAINAK BANDYOPADHYAY, Mainak (ITER-India, IPR) ; Mr. CHANDRAMOULI ROTTI, Chandramouli (ITER-India, IPR)

Presenter : Mr. MILIND PATEL, Milind (ITER-India, IPR)

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