Seminar

Institute for Plasma Research

Title : Heat Transfer Analysis of PINI Ion Source Back Plate Using ANSYS

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Date : 16th December 2021 (Thursday)

Time : 10.30 AM

Venue : Online - Join the talk:
https://meet.ipr.res.in/PDFextensiontalk_Dr.TejendraPatel

Abstract :

Injection of energetic neutral beam (H^o/D^o) into tokamak plasma is successful method for plasma heating and current drive. The system which produced energetic neutral beam is called Neutral Beam Injection (NBI) system. Steady-state Superconducting Tokamak (SST-1) has a provision of Positive hydrogen ion-based Neutral Beam Injection (NBI) system to inject 0.5 MW neutral hydrogen power at 30 keV. The important component of NBI system is PINI (Positive Ion Neutral Injector) ion source which consists of plasma box, back plate, ion extractor system and neutraliser. The functions of the back plate are to provide the vacuum integrity to the plasma box, to accommodate magnet filament holders and to remove the heat load. In order to satisfy all these functions, back plate consists of (i) Oxygen Free Electronic (OFE) copper cooling plate of size 588 mm (L) × 318 mm (B) × 4 mm (T) machined of 35 inner and 8 outer cooling grooves each of size 4+0.1 mm (W) ×1.8+0.2 mm (H) (ii) SS304L magnet positioning plate of size 667 mm (L) × 397 mm (B) × 27 mm (T) (iii) SS304L Magnet cover plate of size 590 mm (L) × 293 mm (B) ×2 mm (T). The copper cooling plate is vacuum brazed with magnet positioning plate using BINI-7 brazing material. Thermal analysis of beck plate is very important with the focus of thermos-structural stability. This talk will focus on the 2D steady-state thermal analysis of back plate using the Finite Element (FE) numerical model with the help of ANSYS computer program considering cross-section of 31 mm (W) × 17 mm (H) for back plate. The model includes OFE copper cooling plate with five cooling channel each of size 4 mm (W) ×1.8 mm (H), one magnet positioning plate with groove of 10 mm (W) ×9 mm (H) and magnet cover plate of 2 mm thickness. The heat flux boundary condition has been given to the outer top surface of the OFE copper cooling plate. The peak heat flux of 8 MW/m^2 is given to the top surface near the magnet position whereas average heat flux of 2 MW/m^2 is given to the remaining top surface area of the OFE copper cooling plate. The convection heat transfer coefficient of 52 $kW/(m^2\ K)$ is used as a boundary condition at the internal surface of a cooling channel near the magnet position while 44 $kW/(m^2\ K)$ at the internal surface of remaining cooling channels. The other surfaces of the model has been consider as adiabatic surface. The results of analysis shows the temperature distribution of OFE copper cooling plate and the maximum surface temperature is ~ 155 0C at the middle surface of OFE copper cooling plate near the magnet position. The maximum temperature around the magnet is observed to be 82°C. This talk will also include some preliminary results of thermal analysis for the actual size of PINI ion source Back Plate.