Seminar

==========

Institute for Plasma Research

==========

Title: 3D Computational Fluid Dynamics Analysis of PINI Ion Source Back Plate under high heat flux condition

Speaker: Dr. Tejendra Patel
Institute for Plasma Research, Gandhinagar

Date: 21st December 2022 (Wednesday)

Time: 10:30 AM

Venue: Join the online meeting:
https://meet.ipr.res.in/join/6168276489?be_auth=MTc1MzQ4
(Conference ID: 6168276489; Password: 175348)

Abstract

Neutral Beam Injection (NBI) is very efficient technique for heating and current drive of Tokamak fusion plasma. Steady State Superconducting Tokamak- 1 (SST-1) has a provision of Positive ion based NBI (PNBI) system which has capability of delivering 0.5 - 1.7 MW neutral hydrogen beam power at 30 - 55 keV [1]. JET PINI (Positive Ion Neutral Injector) type ion source is used in PNBI systems. The PINI ion source is the heart of PNBI system. It consists of plasma box, back plate, ion extractor system and neutralizer. Back Plate (BP) is an important component of the PINI ion source. It is made up of SS 304L magnet positioning plate, SS 304L magnet cover plate and Oxygen Free Electronic (OFE) copper cooling plate respectively. During beam operation BP receives maximum heat flux of 8 MW/m^2 near the magnetic cusp region and maintaining average heat load of ~ 2 MW/m^2 at other region. To remove such high heat load, dense networks of water cooling channels are provided in the OFE copper cooling plate. The BP also provides vacuum integrity to the plasma box and holds the 48 no. of filaments which are required in plasma production. There are 43 numbers of rectangular cross-section cooling channels each of size 4 mm (W) × 1.8 mm (H) CNC machined on OFE copper plate which is vacuum brazed with the SS 304L magnet positioning plate. For steady state operation under high heat load environment, study of 3D fluid flow and heat transfer analysis is most important from the point of view of thermos-structural stability of BP. In the present stduy, first 2D steady-state thermal analysis of a prototype test sample of BP of size 31 mm (W) × 17 mm (H) with five cooling channels has been done using ANSYS R121 and the result shows that the maximum surface temperature on OFE copper cooling plate is 155 ^{0}C. Then 3D steady-state Computational Fluid Dynamics (CFD) analysis of actual size BP has been carried out with the help of ANSYS computer program. Inlet water of 60 LPM at 34 ^{0}C is supplied to the manifold of BP. The analysis result shows that simulated surface temperature distribution pattern is consistent with the experimental results with electron beam power load of 2.5 MW/m^2 [2]. The maximum surface temperature on the OFE copper cooling plate is 174 ^{0}C and average temperature is 138^{o}C.