Seminar

Institute for Plasma Research

Title : Study of Beam Collector for a High Power and High Efficiency Gyrotron for Fusion Application

Speaker: Dr. Uttam Goswamy
Central Electronics Engineering Research Institute (CEERI), Pilani

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Time : 03.30 PM

Venue : Committee Room 3, (New Building), IPR

Abstract :

Gyrotron is a vacuum based microwave/millimeter wave source plays vital role in electron cyclotron heating and current drive (ECH&CD). This device was invented in Russia (than USSR) and since then extensively has been used in various tokamak systems around the globe. In Indian context, gyrotron has been commissioned in ADITYA and SST-I tokamak systems at Institute of Plasma Research (IPR) for the indigenous plasma fusion research. Considering the potential future of plasma fusion in the generation of clean and sustainable energy, a program for the indigenous development of 42 GHz, 200 kW (CW) gyrotron was started in 2006 at CSIR-CEERI, Pilani with participation of four other laboratories including IPR, Gandhinagar. I worked in the design & development of this first Indian gyrotron, initially as a project fellow and later on as a research scholar. Apart from the 42 GHz/200 kW gyrotron, I was involved in the design and development of other high frequency, high power gyrotrons, mainly, 120 GHz/1 MW and 170 GHz/1 MW. In the gyrotron research activity at CEERI, Pilani, I was mainly responsible for the design and development of beam collector for various gyrotrons.

The beam collector is a major component in high power gyrotrons used in the collection of the spent electron beam. The main design goals for a beam collector are: (1) maximum spread of the electron beam on the inner surface of collector to minimize the ohmic wall loading, (2) To minimize the secondary electron emission, (3) to convert the electron kinetic energy into electrical energy with highest efficiency. An indigenous design methodology was developed through the combination of commercially available as well as indigenously developed computer codes. The electrical design was performed by the beam optics simulation code EGUN supported by the in-house developed beam-wave interaction codes. More than 65 % of beam energy (e.g. ~ 400 kW 42 GHz gyrotorn) dissipated at the collector wall, which shows the critical need of thermo-mechanical analysis. For this aspect, multi-physics simulator ANSYS was used and the effect of thermal stress/expansion of beam collector further examined through the beam optics simulations. In the running condition of the device, the generated heat at the collector wall must be extracted out efficiently. The fluid analysis was carried out and successfully implemented in the development of cooling arrangement. The developed cooling duct was tested as per the design values. The developed design methodology for 42 GHz/200 kW gyrotron was implemented further in 120 GHz/1 MW and 170 GHz/1 MW gyrotron also. The depressed collector is a preferred choice for the higher power gyrotrons and electrically designed targeting the maximum recovery in beam energy.

I have also been worked in the dielectric heating industry at Mumbai. I studied the design aspects majorly on different types of applicators considering the issues of better uniformity, minimization of multi-pactor effect, microwave leakage suppression, etc. I have been conducted various experiments on different specimen product samples such as medicinal powders, food items, polymers, paper product, etc.