

Seminar

Institute for Plasma Research

Title : Design and Development of Prototype Cryocoolers for Cryopump

Speaker: Dr. Rohan Dutta

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Date : 25th October 2021 (Monday)

Time : 03.30 PM

Venue : Online - Join the talk:

https://meet.ipr.res.in/RohanDutta-PDF-Extension_Seminar

Abstract :

Cryopumps find applications to pump-out large amount of water vapour and nitrogen during baking of vacuum vessel of fusion machines. Exhaust and Fuelling Technology Development division at Institute for Plasma Research has developed such kind of cryopumps with liquid nitrogen bath to evacuate water vapour, nitrogen, etc. However, handling two-phase may create hindrance in operation as well may put difficulties in controls of such pumps. Therefore, attempt is made to develop cryogen free, indigenous cryocoolers for supplying the desired cooling duty there. At first, two different configurations, namely Stirling cycle based and pulse tube based cryocoolers, were selected for prototyping. In order to design Stirling cycle based cryocooler, a design methodology was formulated. A python based open-source and standalone software, StirlingCalc V0.1.1, with appropriate Graphical User Interface was developed to perform the design calculations and parametric studies. For a typical 3 W at 80 K Stirling cryocooler, the design of compressor, displacer and the regenerator using StirlingCalc was validated using design data available in literature. Further, StirlingCalc was used to design a 100 W at 77 K gamma-type Stirling cycle based cryocooler. The performance of this cryocooler was verified using Computational Fluid Dynamics study in the commercial software, Ansys FLUENT™. On the other hand, a prototype of a single stage, low-frequency (2 Hz), doubleinlet, orifice pulse-tube for 140 K at no-load condition is designed and fabricated for demonstration of its operability and effectiveness as well as for validation of the adopted design methodology. This pulse-tube was tested at low pressure (3 bar to 9 bar) with a three-way solenoid valve providing square-wave of pressure variation and steel wool as regenerator material, and achieved a temperature of 256 K. Reasons behind not achieving designed temperature were also identified and will be addressed in future.
