Seminar

Institute for Plasma Research

Title : Pumping speed of Hydrogen and Helium gases using activated carbons as sorbent material at liquid helium temperature for cryopump applications

Speaker : Ms. Ranjana Gangradey
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Date : 16th June , 2020 (Tuesday)

Time : 11:00 AM

Venue : Online- Join the talk:

https://meet.ipr.res.in/talk_ranjana

Abstract:

Cryopump is a widely studied subject and with an inherent scope for improvement. The challenge lies in pumping the voluminous amount of exhaust gases of the order of 2000 to 4000 mbar-l/s (especially helium) in a continuous mode. Pumping a colossal mass of gases is a topic of intense demand in the field of vacuum science. The areas demanding massive pumping speed include environmental test facility in space research, fusion plasma devices, accelerators, laser interferometer gravitational-wave observatory like LIGO, etc. The required pumping speed is of the order of 100 to 500 thousand-l/s, and the market of vacuum pumps falls scanty of the kind of the pumps needed to fulfil such requirements. Also, when it comes to the pumping of the large volume of light gases like helium and hydrogen, there is a limitation with commercially available solutions.

The principal objective of the work presented is an experimental investigation of using a specific kind of charcoal with large surface area, an adhesive which adheres charcoal to metal cryopanels and sorbent coated cryopanels sustaining high temperature which helps in removing adsorbed gases from pores of the sorbent making it fresh surface. The study of adsorption isotherm of charcoal was carried out to know its pore surface area, pore-volume, pore size, etc. The sorbent used is coconut shell charcoal, it is microporous with pore size in the range of < 2 nm and pore surface area of 1285 (± 5%) m2/g. The glue/adhesive was characterized for its vacuum compatibility, thermal conductivity, and thermal cycling. To the metal surface, the charcoal coating is done using a glue. The glue is thermally conducting. It is stable during thermal cycling from 4 K to 200□C and is vacuum compatible with a low outgassing rate. Indigenously developed charcoal coated sample panels were tested for thermal cycling from 4 K to 2000 C. Charcoal and glue was then, used to coat cryopanels with surface area of 0.1 m2.

The cryopanels are a special kind of heat exchanger plate formed by joining two plates and then given the shape of a quilt. The panels are then coated with glue followed by coconut shell charcoal. The work discusses the results of pumping speed by mounting the developed cryopanels cooled to liquid Helium temperature to pump gases like Hydrogen and Helium in an experimental set. Pumping speed found for Hydrogen and Helium gases is in the range of 2800 and 2500 l/s, respectively. Molflow code based on the Monte Carlo technique developed by CERN was used to simulate the experimental setup; the results of Molflow simulation are also presented.