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Large Pumping Speed Pump: To pump Space Simulators & Fusion Reactors

Content :

Space research, Fusion reactors and many other technological areas require large pumping speed to pump large volumes or to handle voluminous exhaust gases. Space simulation chambers like Chamber A at Johnson Space Center in Houston (used in testing of James Webb Space Telescope, the “pathfinder”) with a volume of 11330 cubic meter require about 22680 kilograms of air to be pumped off. [Ref <http://www.nasa.gov/>]. ITER an experimental fusion reactor requires 400×10^3 L/sec pumping speed to pump about 800 cubic meter of volume [Ref <http://www.iter.org/>]. Other space applications for its various space simulation facilities like Magneto-plasma-dynamic (MPD) thrusters, Electrode less thrusters and low flow propulsion test bed, Pulsed Plasma Thrusters, large scale space simulation test facilities for testing the satellite payloads and components etc, require pumping speed in the range of $> 60,000$ L/s. In an attempt to target the development of large scale pumping speed for exhaust gases like hydrogen and Helium gases from Fusion reactor, a cryoadsorption cryopump is developed in India at Institute for Plasma Research. The pump uses activated carbon sorbents coated on indigenously built hydro-formed cryopanel.

Hydroformed cryopanel which are used as thermal shrouds inside vacuum chamber of space simulator are now fabricated, tested for their leak tightness and uniform temperature distribution in India (Earlier the shrouds/thermal shields/bubble panels were imported from foreign countries). The shrouds carrying cryogen simulate the space environment when satellite enters its orbit and faces thermal environment difference and the thermal impact caused as orbital spacecraft move in and out of sunlight.

Institute for plasma research in its project of developing cryoadsorption cryopump developed these panels of different shapes and sizes. Industry transfer of the technology has been done and now India is self sufficient with providing the panels/thermal shrouds/bubble panels/dimple plates to the Space research programme and various other applications requiring the same.

The developed cryoadsorption cryopump at Institute for Plasma Research can provide pumping speed of 2 to 5 L/s-cm² with cryopanel surface area of 3.2 m² coated with activated carbon. It was tested to give pumping speed of 70,000 L/s for Helium and 1,50,000 L/s for Hydrogen in the pressure range of 10^{-4} to 10^{-5} mbar. This paper describes the journey towards development of cryoadsorption cryopump and pumping characteristics of the developed pump. The technology is now available with India

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