

Technique and Technology of Cryogenic Sorption Vacuum Pumps

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Abstract

The modern stage of vacuum technique development is characterized by important peculiarities of increased demand towards obtaining and keeping the vacuum. To create the high and super high oil-free pumping devices with prolonged working recourse and low consumption of cooling agents, it is necessary to solve the thermo-physical problems, conduct researches of construction materials, renovate the manufacturing technology of the surfaces of the cryoconstruction ones, choose the methods of minimizing the heat leakages, and work out the construction of pumping devices. These problems brought the necessity of elaboration of principally new equipment and methods of obtaining and keeping the vacuum. Cryogenic pumps are one of the most perspective and efficient pumping devices.

A new type of high-performance Cryosorption Pump (CSP) with liquid nitrogen as a cooling agent has been elaborated within the Project G-027, funded by the International Scientific and Technical Center (ISTC) in 1997-1999 (collaborator Stan D. Augustinowicz, Dynacs Eng. & Kennedy Space Center NASA, Florida, USA). The pump is intended for obtaining and keeping the high vacuum in chamber, preliminarily pumped up to 10 Pa. The pumping speed according to N₂ is equal to 1 m³/s, range of working pressure - $10 \div 10^{-5}$ Pa, consumption of LN₂ -12 L/24 hours. Enhancement of pump's working efficiency is achieved by usage of technical tricks with further optimization of the construction. The last is realized on the basis of theoretical analysis of the processes taking places in Cryosorption Pump, including the process of tracing the trajectories of molecule movement in the pump's channels using the Monte Carlo method.

Since 2001 a technology of producing the Cryosorption Pump was worked out within the Project G-401 (International Scientific and Technical Center, collaborator - S.D. Augustynowicz), a development type of Cryosorption Pump was produced; a vacuum test desk (VTD) for determination of cryo-vacuum characteristics of Cryosorption Pump was worked out and created. An experimental investigation of pumping process was realized on the test desk, the basic regularities of the process were studied. As a result of the experiments the following parameters of the Cryosorption Pump were defined: limiting pressure, pumping speed in working range of the pressure, adsorption capacity, consumption of liquid nitrogen, and the temperature field of cryopanel and pumping component surfaces.

The satisfactory coincidence of calculated values of the pump's basic characteristics with the experimental results indicates the correctness of the used approaches of theoretical model and realized measurement.