§42. Vacuum Pumping System of the LHD

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The Fundamental design of the vacuum pumping system for the LHD has been reported elsewhere [1].Here the constructed vacuum pumping system as the second version of the design is described. The pumping system of the LHD consists of two pumping systems for the plasma vacuum and the cryostat . Fig.1 shows the overall constitution of the pumping system. Each pumping system is connected with a long duct to each vacuum chamber of the LHD. The duct for plasma vacuum vessel is 9.6m in length and 1200 mm in diameter, to which following pumps are connected: two cryo-pumps (PCP1, PCP2) with pumping speeds of 70000L/s for H_2O, two turbomolecular pumps (PTH1, PTH2) with pumping speed of 5500L/s for N_2, and two compound turbomolecular pumps (PTH1, PTH2) with pumping speeds of 1800L/s . The duct for the cryostat is 8.7m in length and 800mm in diameter, to which the following pumps are connected: two cryogenic pumps (DCR1, DCR2) with pumping speed of 25000L/s for H_2O and two compound turbomolecular pumps (DTG1, DTG2) with pumping speeds of 5500L/s for N_2.

Because each vacuum chamber has a large volume, i.e., the plasma vacuum vessel is 210m^3 and the cryostat is 580m^3, mechanical pumps to be used for the roughing of the two chambers from atmospheric pressure have to have large pumping speeds. The nominal pumping speeds of prepared mechanical pumps of APR1 and APR2 are 900m^3/h Pumping speeds of the other rotary pumps of DRP1, DRP2, PRP1, PRP2, DRP3, and PRP4 are 85m^3/h. For the efficient gas pumping in the medium flow region, mechanical booster pumps of DMB and PMB are also used and the pumping speeds are 1630m^3/h.

Pressures of the manifolds are measured with ionization gauges(i), penning gauges(Pe), and pirani gauges(P). Two mass spectrometers are also available to monitor water leak and helium gas leak. All these devices are set as far as possible from the LHD to avoid high magnetic field problem . As the same reason, all valves are controlled by high pressure air.

During pumping of the LHD by the pumping system, the pressures, the operating states of the pumps, and the states of opening and closing of valves are monitored by the sequencer and the operators at the control building.

Baking heater is set on the duct which is connected to the plasma vacuum vessel to degas absorbed water on the duct surface and to achieved an uhv pressure less than $5x10^{-8}$ Torr in the plasma vacuum vessel. On the other hand, it is not essential to pump out or degas water because the cryostat after cooling down itself is like as a cryo-pump and has moderate ability to absorb residual water in the cryostat.

Dry air and nitrogen gas are prepare as a filling gas on the breaking of vacuum in the two chambers. The duct for plasma vacuum vessel has a manhole flange, from which personnel can enter to perform any necessary task in the chamber. For the security in such case, dry air is served.

Reference

[1]Fujiwara et al.J.Fusion Energy, No.1-2,64 (1996)

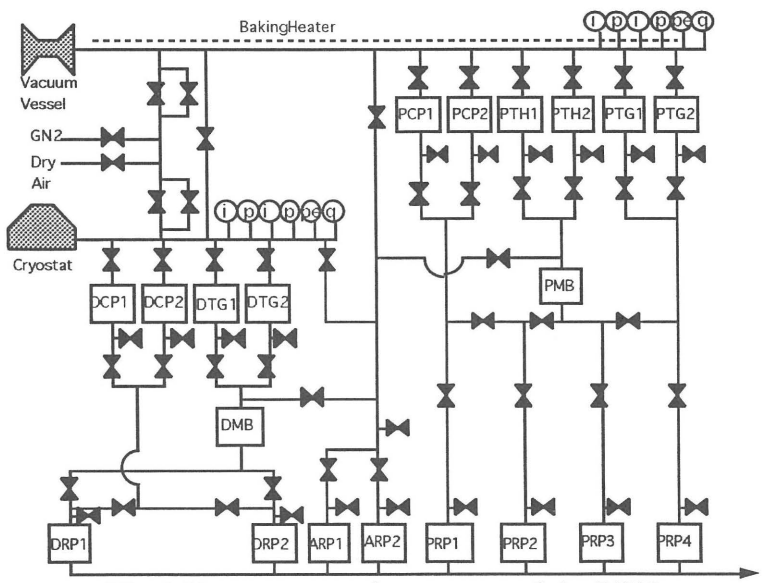

Fig.1 Vacuum pumping system of the LHD