§17. Vacuum Tests of LHD

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Vacuum Tests of LHD were successfully finished before the purification of helium gas in the helium cooling pipes for the cooldown of LHD.

Vacuum tests of the cryostat began on Tuesday, 20 January, although the plasma vacuum vessel was left open. Figure 1 shows the time dependence of the cryostat pressure. During these tests on 20 January, the cryostat pressure decreased rapidly as time passed. However, the slope of the pressure vs time became gentle at about 1,000 Pa because of outgassing, and was almost flat at about 200 Pa. At this moment we filled the cryostat with dry nitrogen gas and then left it alone for 12 hours. We pumped the nitrogen gas out of the cryostat the next day, and the cryostat pressure reached about 20 Pa when the slope of the pressure vs time became almost flat, as shown in Fig. 1. This pressure was lower than that obtained the day before by one order of magnitude. In this way we could achieve a cryostat pressure of about 0.02 Pa within 4 days, which is low enough for the cooldown of LHD. The main species of the desorbed gas was found to be water, as expected. Helium leak detection revealed a few small leaks in the helium cooling pipes that are located inside the cryostat and used for the cooldown. These were stopped up, and no leak remains in the cryostat in the range 10^{-8} Pa·m^3/sec.

The plasma vacuum vessel was ready for pumping on Wednesday, 28 January, and the vacuum tests of the plasma vacuum vessel began on Friday, 30. Figure 2 shows the inside of the completed plasma vacuum vessel. There are two grooves, each 1-m wide, for one pair of helical coils; hence, the plasma vacuum vessel is helically twisted and rather complex, as shown in Fig. 2. The person in the vessel is about 1.67 m tall, and one of the outer horizontal ports can be seen near him. Water cooling pipes can be also seen, located on the plasma vacuum vessel surface that faces the plasma. Heat flux from the core plasma reaches the divertor plates and the first wall of the plasma vacuum vessel, so they must be cooled by a water cooling system. The first wall will be installed in the near future. Successful heat removal from the plasma vacuum vessel and the divertor plates is one of the important conditions for stable operation of a superconducting coil system and production of high-quality plasmas. The pressure of the plasma vacuum vessel reached 3×10^{-5} Pa within a day from the pressure of the atmosphere, and no leak was found in the plasma vacuum vessel itself and water cooling pipes in the range 10^{-9} Pa·m^3/sec. Baking of the plasma vacuum vessel up to 95 ℃ was performed before the conditioning of the plasma vacuum vessel. In the middle of March the pressure in the plasma vacuum vessel was about 9×10^{-7} Pa.

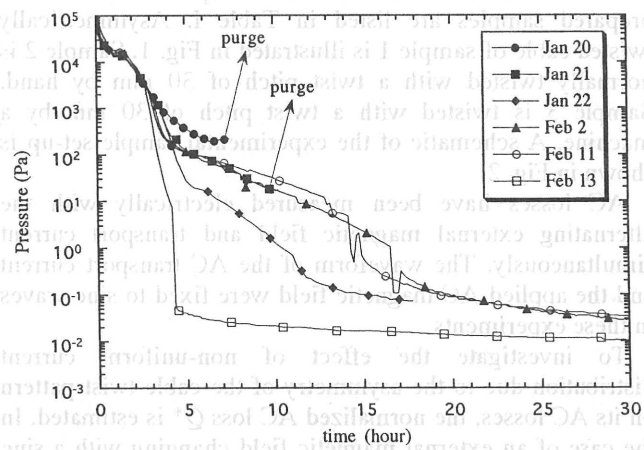

Fig. 1. Cryostat pressures as a function of time.

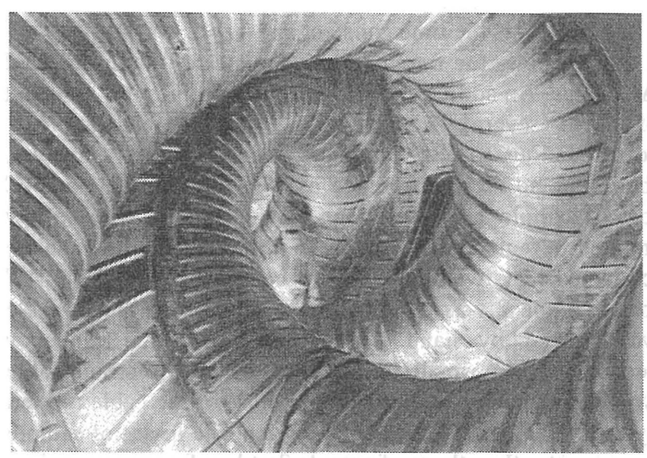

Fig. 2. The inside of the plasma vacuum vessel of LHD.