§48. Wall Conditioning at the Start up Phase of LHD

Sagara, A., Iima, M., Inoue, N., Masuzaki, S., Noda, N., Yamada, H.

The first cycle of the LHD plasma operation is scheduled to set off from the end of March, 1998 as shown in Fig.1. At this first stage the magnetic flux density at the plasma axis B_0 is 1.5T, and the plasma heating with 84GHz ECH of the total input power 1MW is arranged, which is operated using the second harmonics with the cut-off plasma density of $4.4 \times 10^{19} m^{-3}$.

According to the estimate of radiation loss using the 1-D time-dependent transport code under the first operation condition [1], it is required for the oxygen concentration in the hydrogen plasma to be less than 1.8%, that is, the Z_{eff} lower than 2 in order to obtain the line averaged plasma density $\langle n_e \rangle$ of about $2 \times 10^{19} m^{-3}$ with the plasma temperature $T_e(0)$ higher than 1.5keV.

On the other hand, according to the results observed in the wall conditioning procedure performed in the start up phase of CHS [2], ECR discharge cleaning using hydrogen was effective to reduce down partial pressures of H_2O, CO and CH_4, resulting in suppression of uncontrollable density rise under ECH discharges by mainly reducing down oxygen impurities. As for the problem of density rise up to the cut-off density after a long ECR-DC with H_2, the glow-DC with He was effective to reduce down hydrogen recycling.

Reduction of oxygen impurities is therefore the main purpose of the wall conditioning at the start up phase of LHD. Suppression of hydrogen recycling is also necessary after conditioning with H_2. Standing on this guide line, the main scenario of wall conditioning in LHD has been decided including arrangement of hardware required.

The 300kW hot water utility is arranged for baking the vacuum vessel which is made of 316 stainless steel with the total surface area of $777.5 m^2$ and the total mass of 77.7ton including ports and bellows. However, this baking procedure is not sufficient, because the temperature is limited at the max. 100°C and there is not enough time for baking.

The main wall conditioning method is the 20kW ECR(2.45GHz)-DC with H_2. After this procedure, the main discharge is set off with ECH, which is also considered as an effective conditioning of the wall surfaces.

Titanium-gettering is arranged as the main backup method, which covers the 30% area of V/V and suppresses both of oxygen impurities and hydrogen recycling. Actual design and operation of Ti-getters are under investigation, because it is estimated to take about a half hour in LHD to make a Ti coated film of 3 monolayer required to bury oxygen contaminants on wall surfaces [3].

Glow discharge with He is also arranged as a complementary backup method to reduce hydrogen recycling after ECR-DC with H_2. Design and operation of discharge electrodes are also under investigation. Based on intensive R&D results, boronization using glow discharge is scheduled to be put into operation from the 2'nd cycle in 1998.

References

[1] H. Yamada, 13th annual meeting of J. Plasma and Fusion Research (1996) 22aD2, p187.
[2] N. Noda, Annual Review of IPP Nagoya University (April, 1988 - May, 1989) p9.
[3] A. Sagara, J. Nucl. Mater., 93&94(1980) 847.

Wall Conditioning to Start up LHD Plasmas