§12. Study of the Effect of Improved Divertor Cryosorption Pump on Divertor Recycling

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For active plasma density control in LHD, the closed helical divertor equipped with a cryosorption pump has been installed in four sections of the inner torus side. In the 18th experimental campaign, the activated carbon bonded on the cryo panels has been improved in the 8I closed divertor. About eight times larger pumping speed (7-9 m^3/s) was obtained, compared with existing cryosorption pumps in other three sections.

The pumping effect on the neutral pressure in the divertor and the divertor plasmas was investigated in the 18th experimental campaign. The constant plasma density was controlled by gas puffing (1×10^{19} - 7×10^{19} m^{-3}). In the low density case, three tangential NBIs were injected. In the high density case, two perpendicular NBIs in addition to tangential NBIs were utilized. Figure 1 shows the time dependence of the temperature of the cryo panels. In the existing cryo panels, the oscillation of the temperature was quite large possibly due to the thermal instability of the cooling system. In the improved cryosorption pumps, the temperature variation of cryo panels becomes small. In addition to the change of the activated carbon, the path of the cooling pipe is optimized. That might be a reason why the stable cooling is attained.

Figure 2 shows the neutral pressure in the case that the cryosorption pump is activated. If the divertor flux is high, it can be seen that the neutral pressure in the divertor is lower. However, no clear difference in the low divertor flux is observed. It is expected that the effect of divertor pumping can be obtained in the high divertor flux condition such as high density experiments.

After the experiments, the cryosorption pump is regenerated to evaluate the total absorbed amount. 170 Pam^3 of hydrogen is absorbed in the cryo panels. During the discharges, the panels absorb the hydrogen of 112 Pam^3. In the inter discharges, the panels absorbs the hydrogen of 58 Pam^3. Therefore, 60-70% of total absorbed hydrogen is absorbed during the discharge.

The temperature dependence of the pumping speed is investigated. The result is shown in Fig. 3. When the temperature of the panels attains to be around 60 K, the panels begin to absorb the hydrogen. The pumping speed is increasing with the decrease of the panel temperature. If the temperature is below 20 K, the pumping speed is almost fixed.

To date, only one cryosorption pump has been improved. No clear effect of the divertor pumping on the edge plasma is observed. In the next experimental campaign, three cryosorption pumps have a plan to be improved. The continuous investigation is needed to understand the pumping effect on the plasma.

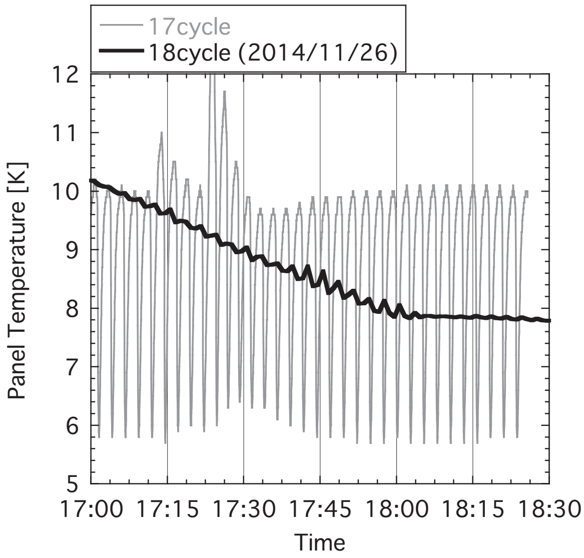

Fig. 1. Panel temperature of 8I cryo-pump.

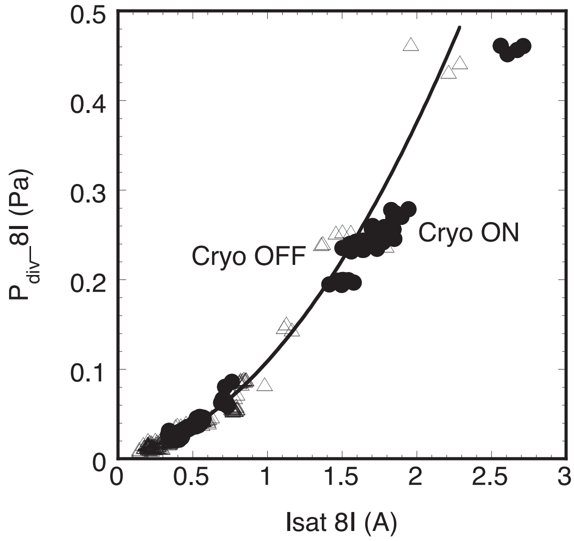

Fig. 2. Neutral pressure in the 8I closed divertor as a function of divertor flux.

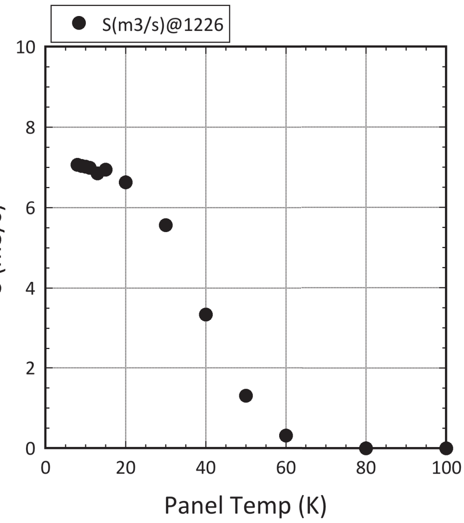

Fig. 3. Pumping speed on panel temperature.