§53. Study on Plasma-Wall Interaction and Global Particle Balance in QUEST

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The achievement of the stable steady state operation (SSO) is one of the most important issues for the future fusion reactor. The issue contains not only subjects related to the core plasma such as confinement, heating and current drive but also those related to the plasma-wall interaction (PWI) such as hydrogen recycling. An objective of this research is to study hydrogen recycling and particle control for better understanding of PWI phenomena.

In this time, particle balance analysis has been carried out in long duration discharges of QUEST. Figure 1 show a gas supply system with which a precise amount of hydrogen gas fueling can be evaluated from a volume of the buffer tank including pipes and change in the pressure (ΔP) inside the buffer tank. The pressure inside the buffer tank decreases according to the amount of gas supply to the plasma with a piezoelectric valve. ΔP is difference between pressures just before the discharge and during or after the discharge.

The wall pumping rate Γ_{wall} is written by

$$\Gamma_{wall} = \Gamma_{fuel} - \Gamma_{pump} ,$$

where Γ_{fuel} is a fueling rate and Γ_{pump} is a pumping rate. Figure 2 shows time evolutions of the number of hydrogen gas fueling, the amount of pumped hydrogen gas and the difference between them which means time integral of the fueling rate in one experimental day. This time evolution includes six long duration discharges with the discharge duration of 500 s. The number of the fueled H_2 gas increased significantly but that of the pumped H_2 gas did not increase so much, meaning that the wall retained hydrogen atoms. The retained hydrogen atoms (i.e. wall inventory) increased shot by shot and finally it reached 3 x 10^{19} H/m^2. The number of the retained hydrogen decreased during the interval time of the discharges as shown in Fig. 2, indicating that the wall released the retained hydrogen. Figure 3 shows time evolution of the temperatures of the plasma facing components in the same day as that shown in Fig. 2. The temperatures increased due to the heat load from the plasma. It is found that the release of hydrogen gas from the wall was enhanced much due to large increase in the temperatures of the plasma facing components.

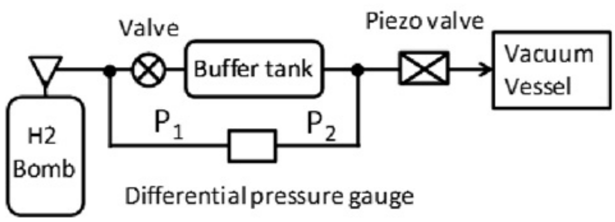

Fig. 1 Schematic view of the hydrogen gas supply system.

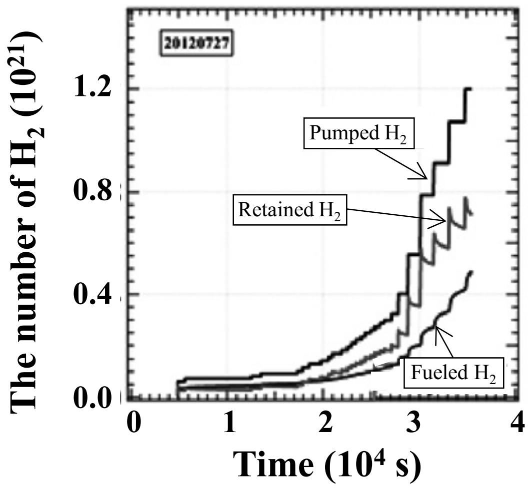

Fig. 2 Time evolution of the number of hydrogen gas fueling, the amount of pumped hydrogen gas and the retained hydrogen gas in one experimental day.

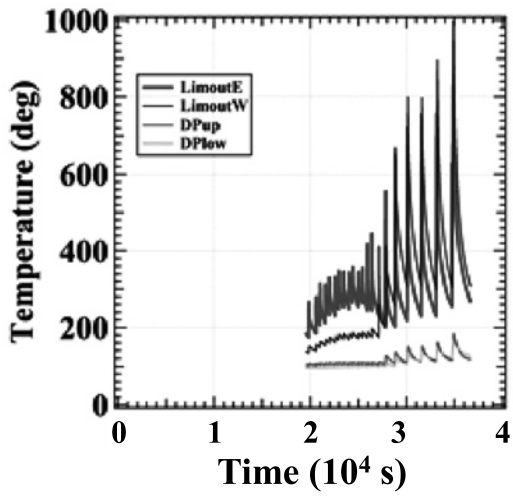

Fig. 3 Time evolution of the temperature of the plasma facing components in the same day as that shown in Fig. 2.