View metadata, citation and similar papers at core.ac.uk
brought to you by CORE
provided by National Institute for Fusion Science (NIFS-Repository)

§66. Simultaneous Measurements of Molecule Pressure and Atomic Flux in QUEST Divertor for Understanding of Neutral-plasma Interaction

Kuzmin, A. (Kyusyu Univ.), Zushi, H. (Kyusyu Univ.), Kobayashi, M.

The neutral particle transport in the divertor region is one important issue for divertor optimization in future reactors due to the effects not only on feul/helium ash pumping efficiency but also on the plasma properties through atomic/molecular processes. Especially in the detached plasma, a momentum loss of the plasma flow through charge exchange or a molecular activated recombination (MAR) process play an important role. In the most of the cases of neutral pressure measurements, the pressure gauge is calibrated in the vacuum circumstance without plasma where the molecules are dominant component. However, during the divertor operation with plasma, there exists a certain fraction of atoms among the molecules, where the fraction is determined by the plasma parameters, divertor geometry, and the condition of the material surface, etc. Therefore, it is important to measure accurately the proportion of the atoms and molecules in the divertor region. In this contribution, we report the first attempt of the simultaneous measurements of atomic and molecular pressure in QUEST tokamak using the permeation probes.

Figure 1 shows the schematic of the QUEST tokamak with the location of the divertor plates (top and bottom) as well as the plasma driven permeation probes (PDP) that measure the atomic flux. The PDP's are installed at the top and bottom of the torus (PDP4, 5) and at the outboard side (PDP6), respectively. Probe membrane is a cylinder 30 mm in diameter made of PdCu foil 20 μm thick supported by stainless steel mesh. Surface area of the membrane is ~ 500 mm^2, 49 % of it is covered by the supporting SS mesh. PDP are placed in a SS box with rectangular orifice with 20×100 mm^2. PDP are facing plasma directly and are exposed to the fluxes of sputtered wall material, no baffle was used to shield them. The total pressure is measured by the ASDEX type gauge, which are installed at the outboard side (not shown in the figure). The partial pressure is measured by quadruple mass analyzer (QMA), located far from the magnetic field of the torus.

The atomic fluence to the first wall is given by integrating the flux obtained with the PDP with respect to time, $Q_{perm} = \int \Gamma_{perm}\, dt$, which was compared with the time integrated H_α signal, $Q_\alpha = \int I_{H\alpha}\, dt$, where $I_{H\alpha}$ is H_α intensity obtained with the spectroscopy. The measurements have been conducted for about 50 shots and the data of 10^{18} ~ 10^{19} Hm^{-2} for Q_{perm} have been obtained. It is confirmed that there is a good correlation between Q_{perm} and Q_α. Figure 2 shows temporal evolutions of various parameters. It has been found that the behavior of atomic flux changes depending on the locations in the torus [1]. The results demonstrate the possibility of atomic flux distribution measurements and thus of detailed analysis of particle balance in the plasma-wall system, which is now under investigation.

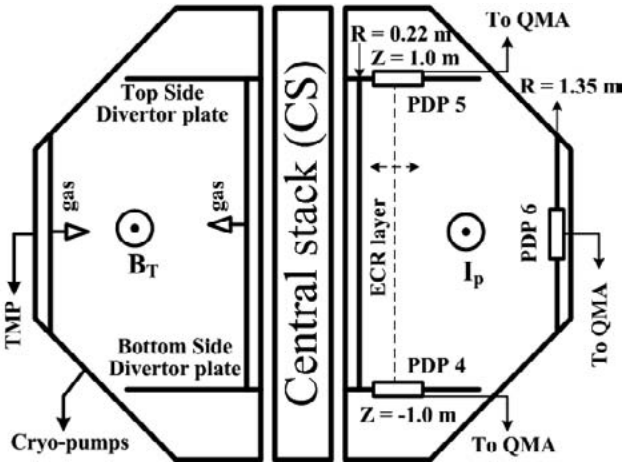

Fig. 1. The schematic of the QUEST tokamak with the location of the divertor plates (top and bottom) as well as the plasma driven permeation probes (PDP), direction of toroidal field, plasma current, pumping location, etc.

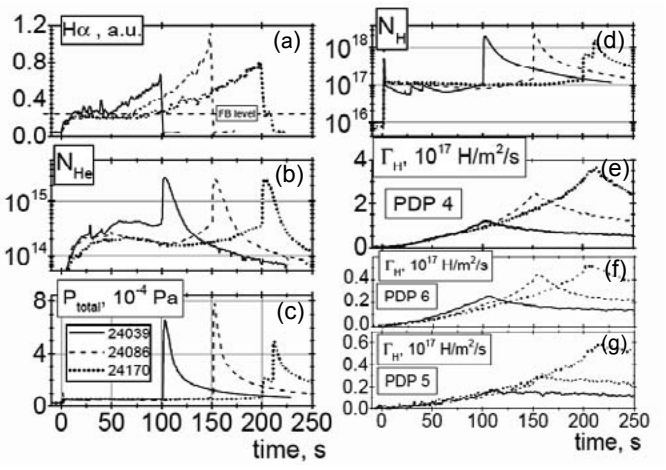

Fig. 2. Temporal evolutions of various parameters in the long pulse discharges. (a) Ha intensity obtained by spectroscopic measurements, (b) number of He particles, (c) total pressure obtained with the ASDEX gauge, (d) number of hydrogen particles, (e), (f), (g) the atomic fluxes obtained with the PDP probes at bottom divertor, outboard side and top divertor, respectively.

1) Kuzmin A., Zushi, H. et al.: *"Atomic Hydrogen Flux Measurement using Permeation Probes in Steady State QUEST Spherical Tokamak Plasma"*, 10th International Conference on Tritium Science and Technology "TRITIUM 2013", October, 21-25, 2013, Nice Acropolis, France.