§27. Installation of ASDEX Type Gauge and Measurements of Neutral Pressure in LHD

Kobayashi, M., Masuzaki, S., Funaba, H., Yamada, H., LHD Experimental Group

Neutral pressure measurements in the magnetically confined fusion devices is important for several reasons: The divertor pumping efficiency, in principle, linearly scales with the neutral pressure in the divertor plenum, where shape of baffle and the divertor plates have to be optimized to maximize neutral pressure there. The charge exchange (CX) process of the neutrals with the plasma produces energetic neutrals which easily escape from the confinement volume and hit the first wall or divertor plates, giving rise to enhanced physical sputtering due to the high energy. The momentum loss of the plasma by CX results in the breakdown of pressure conservation along SOL flux tubes, which tends to decouple up and down stream plasma, affecting the divertor regime, e.g. absence of the high recycling regime.

The ASDEX type gauge[1)] is designed to measure neutral pressure in strong magnetic field, where the standard ionization gauges are not feasible because of the trapping of charged particle by magnetic field due to Larmor motion. The gauge consists of filament, control grid, acceleration grid and ion collector. These electrodes are arranged along an axis, such that the Larmor motion has no effect on the collection of ion current by placing the axis parallel to magnetic field. Fig.1 shows the schematic of the gauge and the electric potential profile between the electrodes. The electrons emitted from the filament which is heated by electric current of about 16A are accelerated by the potential gradient between the acceleration grid and the filament. The ions produced by the ionization of neutral gas are collected with the ion collector. The electron flux from the filament to the acceleration grid is chopped by sweeping the control grid potential with high frequency, during which the offset due to the background plasma (if any) is measured. The offset is subtracted from the ion collector current in order to obtain net ion current from neutrals only.

The ion collector current normalized with the emission current measured at the acceleration grid can be used as a measure of number of neutral particles at the gauge, i.e. neutral pressure. The calibration has been done with the magnetic field activated by the helical coils at about 3 Tesla. During the calibration, the vacuum vessel is isolated from the pumping system in order to ensure the pressure equilibrium in the entire chamber. The cold cathode gauge (PFEIFFER Compact FullRange™ Gauge, PKR 251) which is installed at the outboard port far from the helical coils, is used as a reference pressure. The hydrogen gas is introduced into the vacuum vessel to increase the pressure stepwise. Fig.2 shows the time traces of the reference neutral pressure, emission current, ion collector current for three gauges installed at different locations. The emission current is controlled to stay constant by the system, although at the higher pressure range some of them shows small drop. This is considered due to cooling of filament by the neutral gas. Fig. 3 shows the relation between the output of ASDEX gauge and the reference pressure obtained for two cases of ion current output sensitivities. Roughly linear dependence is obtained and the gauge is calibrated over three orders of magnitude, 10^{-4} to 10^{-1} Pa. The calibrated gauges provide neutral pressure profiles during discharges, where it is found that the pressure at the inboard side is larger than outboard side by a factor of 3 to 10, depending on magnetic configuration of LHD.

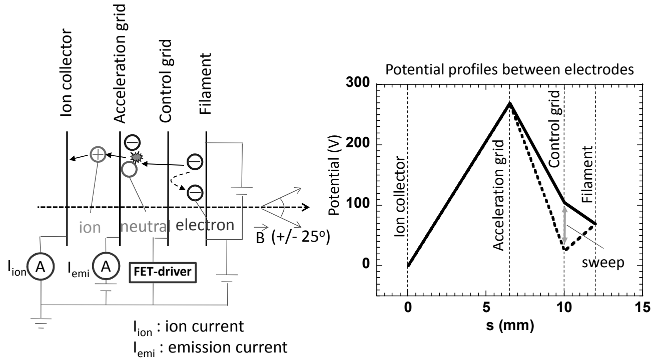

Fig.1 Schematics of electrode arrangement of ASDEX type gauge (left) and the potential profiles.

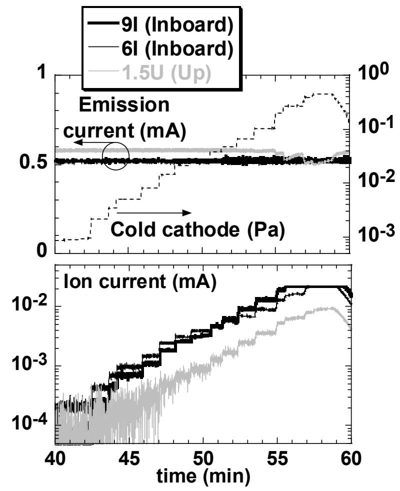

Fig.2 Time traces of emission current, reference pressure by cold cathode gauge (upper figure), ion current (lower figure) for three ASDEX gauges installed at different location (two at inboard side with different toroidal angle, one at upper port).

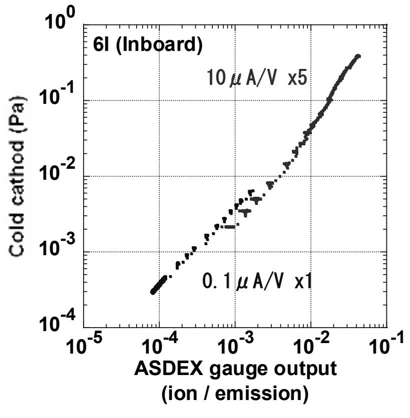

Fig.3 Relation between reference pressure (cold cathode gauge) and output of ASDEX gauge (ion current normalized with emission current), obtained for two different sensitivity set up of ion current.

1) Haas, G., et al. : Journal of Nuclear Materials **121** (1984) 151.