§11. Construction of Tracer-Encapsulated Solid Pellet Injection System for LHD

Tamura, N. (Grad. Univ. Advanced. Studies), Khlopenkov, K.V., Sudo, S.

The tracer-encapsulated solid pellet (TESPEL) injection system has been installed for LHD in the 3rd campaign of LHD experiment. Fig. 1 shows the schematic drawing of the TESPEL injection system. The TESPEL consists of polystyrene (-$CH(C_6H_5)CH_2$-) as outer shell and tracer particles as an inner core. In the preliminary experiment of the 3rd campaign, the typical outer and inner diameter of the polystyrene shell are 450 - 650 μm and 100 μm, respectively. As the tracer particle, LiH or Si is used. The fabrication method of TESPEL is described in detail in [1].

The TESPEL injection system consists of a TESPEL injector part and a differential pumping system with three expansion chambers isolated by fast gate-valves. The main parts of the TESPEL injector are a magazine with a rotating disk, gun barrel and observation chamber. The rotating disk has 60 holes with inner diameter of 0.99 mm. In one series of experiments, 59 pellets can be loaded in the disk. The AC servomotor, which can be controlled remotely, is connected to the disk, and rotates the disk. For positioning the next TESPEL on the injection axis the disk can be rotated, which is controlled through a PC in the LHD control room. That action will be finished within 40 sec, after the PC sends a command. The method for accelerating the TESPEL takes the pneumatic method. A helium gas is used as the propellant gas and the typical pressure is about 25 atm with duration of 3 msec, and the typical TESPEL velocity with this pressure is about 200 - 350 m/sec. In the next campaign, that pressure will be adjustable remotely, since the pellet velocity depends strongly on the propellant gas pressure. The TESPEL injector is connected to the 1st expansion chamber through gun barrel with 1.0 mm as the inner diameter. The 1st expansion chamber is connected to a buffer tank (volume: 100 l) in order to consume the pressure jump due to the propellant gas, and is evacuated by the common exhaust. And the 2nd and 3rd expansion chambers are evacuated by the turbo molecular pump (TMP) and common exhaust. These TMPs have been installed at about 6 m away from the connecting port with LHD, for avoiding an effect of the high magnetic field. The ultimate pressure at the 3rd expansion chamber is 2.6 x 10^{-6} Pa.

The light emission from the TESPEL, injected to the LHD plasma, is collected by the optical system using a half mirror, and it is divided to one CCD camera and two photo multiplier tubes (PMT). The CCD camera and the PMT are equipped with an optical filter (either Hα or Li I (or Li II)). The image of this CCD camera is a temporal integrated image and provides the information about the scattering angle from the TESPEL injection axis. And the PMT signal, which is spatial integrated signal by the lens, is obtained with high time resolution (up to 1 μsec). The additional two compact CCD cameras have been installed at location with looking aslope at the TESPEL injection axis. From the light intensity profile in the CCD images of these two CCD cameras, the deposited location in the LHD plasma is obtained. The tracer particles, deposited locally, diffuse in the plasma as ions. This diffusion, especially in the radial direction, is measured by observing the Li^{2+} lights (λ : 449.9 nm) arising from the process of charge exchange of Li^{3+} ions with neutral hydrogen atoms, originated from the NBI. In order to obtain the pure emission from charge exchange process in the core region, the Li^{2+} lights are observed at the location with NBI path and at that without NBI path, and the difference of these signal is used as a pure emission from the core region. In the 3rd campaign, five sight lines are equipped at each location. The photo multipliers are used as a detector with high time resolution (up to 10 μsec).

Reference:
[1] K. Khlopenkov, S. Sudo, Rev. Sci. Inst., 1998, **69**, pp.319--323

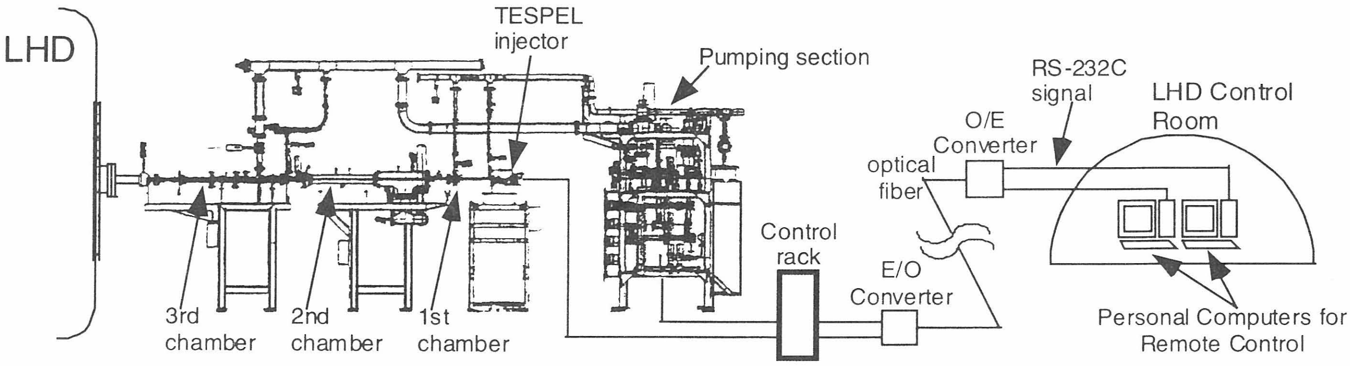

Fig. 1 The schematic drawing of the TESPEL injection system