PELLET INJECTORS DEVELOPED AT PELIN FOR JET, TAE AND HL-2A

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Three novel pellet injectors have been developed for JET (EU), Tri Alpha Energy (USA) and HL-2A (China) for last four years. Designs, characteristics and distinguishing features of each injector are presented in detail.

Steady-state plasma fuelling of ITER by hydrogen isotopes pellets will be based on screw extruders, which demonstrated good performances during pellet injections up to 10Hz on LHD [1] and TORE-SUPRA [2]. In order to increase the pellet injection frequency up to 60Hz for ELM mitigation experiments, a similar extruder, with a larger extrusion rate capacity and a new nozzle having three extrusion channels, has been developed for JET. It was found, however, that the extrusion stability is often deteriorated during simultaneous ice extrusion through two channels. Reasons of unstable extrusion have been established and a new extrusion nozzle has been designed to overcome the extrusion problems. The results of the screw extruder tests with this new nozzle, before installation on the JET pellet injector, are presented and discussed.

An injector capable to inject one deuterium pellet with a diameter of 1 mm and a length variable from 5 to 15 mm at velocity near 50 m/s, followed by eleven independent pellets of 0.9 mm diameter and variable length from 1 to 3 mm with arbitrary time delay from 0 to 100ms at velocities 100-200 m/s has been developed for the Tri Alpha Energy Inc. As for the other multi-barrel injectors, the pellets are produced by means of gas condensation inside pellet generator cells cooled with one common cryorefrigerator. In contrast to other injectors using an additional punch mechanism ahead of a gas valve to reduce the pellet velocity, a novel gas valve with in-built punch mechanism has been designed for the TAE injector. This new technique of pellet injection has been applied to reach pellet velocities down to 40 m/s which was not achievable before with punch mechanism alone [3].

A novel piston type extruder has been designed for a pellet injector developed for the HL-2A tokamak. In contrast to the previous piston extruders, the new one has two chambers of different diameters equipped with a piston of variable cross-section. In the beginning deuterium ice is extruded at low velocity of about 1 mm/s from the first chamber having diameter 5 mm into the second one of rectangular cross-section 1.5x1.8 mm². At the end of extrusion the piston velocity is increased up to 100 mm/s and the extruded ice rod is pushed out from the second chamber at high velocity. It allows injecting pellets at frequency up to 30Hz, which was not achievable before with piston type extruder.

- [1] H. Yamada et al., Plasma Science and Technology, 6, 2004, 2275.
- [1] A. Geraud et al., Fusion Engineering and Design, 69, 2003, 5.
- [1] S. Combs et al., Fusion Technology, 34, 1998, 419.