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Developments and experiments of D_2 pellet injector on EAST

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Pellet injector using hydrogen isotopies is widely used in tokamaks for advanced core fueling to get high density plasma, ELM trigger to reduce the transient heat flux to plasma facing walls, and also for disruption killer in some case. On EAST, two D_2 pellet injectors in steady state mode based on screw extruder have been developed recently. Here, we give a review of the design of D_2 pellet injectors and its applications, i.e. on the fueling, edge-localized mode (ELM) trigger, pellet induced MHD and L-H transition. Also lessons during construction and experiments will be given.

One 10Hz injector, which is aimed for the core plasma fueling and installed on EAST in 2012, can fire large pellet (2mm in diameter and 2mm in length) in steady state mode with reliability greater than 95% with a velocity between 150 to 300 m/s [1]. This injector could inject pellet from either high-field side (HFS) or low-field side (LHS). It is observed that the fueling efficiency of the injector is higher than other methods, i.e. gas puffing, supersonic molecular beam injection. It has also found that the pellet is so big that only the pellet injected from LHS with a low speed could trigger a bigger ELM, which is followed by a number of smaller ELMs at about 300Hz [2]. Using this injector, pellet-induced snake oscillation was observed by soft x-ray (SXR) diagnostic in EAST for the first time [3]. It is clear that the snake resided in a broad region between the magnetic axis and the q =1 surface derived from equilibrium reconstruction. And the snake oscillation was greatly affected by the sawtooth collapse. Moreover, the pellet injection could trigger L-H transition in EAST with radio frequency heating with two modes of single-stage and two-stage transition [4]. The pellet induced H-modes in EAST reduced the power threshold of L-H transition by ~10%. And the density gradient induced by the pellet at the plasma and the increase of edge radial electric field can be an important factor affecting the transition. In single-stage L-H transition, the pellet-induced edge density gradient play key role. But in the two-stage L-H transition, both density and temperature play roles on the delay of the transition.

And the same time, another 50Hz injector for small size pellets, designed mainly for ELM control and is ready for physical experiment, is achieved by two separated modules that can be operated independently from 1 to 25 Hz [5,6]. The nominal injection velocity is 250 m/s with a scatter of 50m/s at a repetition rate of 50Hz. Dedicated vacuum and robust control system were developed to ensure to increase hydrogen/deuterium ice quality and eliminate the influence of propellant gas on plasma operation, respectively. Laboratory test demonstrated that the system can reliably inject pellets at a repetitive frequency of 50 Hz with a reliability over 93%. It is planned to be operated soon in the coming campaign in 2018.

References

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