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India's Pellet fueling program

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Fusion community worldwide is looking forward to an efficient pellet injection system catering to the requirements of fueling high temperature and high density plasma. Various DEMO reactor design world over portray importance underlying development of this technology. The important characteristics being looked forward are operational flexibility, high reliability and remote operation with minimal maintenance. Fusion grade plasma machines find solution in pellet fueling for ELM pacing by triggering small ELMs at higher frequency, disruption mitigation by injecting impurity pellets to handle the intense heat flux, the forces from halo currents, and the potential first wall damage from energetic runaway electrons.

In India, Institute for Plasma Research (IPR) has initiated its domestic pellet fueling program. As a first step towards it, Single pellet injector system (SPINS-IN) is successfully operating, producing pellets of size 2 mm and shooting them at velocity of 700 m/s. It is a cryogen free system with pellet forming in a sleeve cooled to less than 10 K using GM cryocooler. The system is easy to handle, very flexible.

For a plasma temperature in the range of 1 to 3 KeV and density $< 5 \times 10^{19} \text{ cm}^{-3}$, a study was carried out using NGS model for penetration depth of pellet in plasma. Injector is now installed on SST-1 tokamak for pellet injection related experiments.

Advancing on the roadmap of pellet fueling technology development of an Extruder Type Pellet Injection System (ETPIS) for continuous supply of hydrogen ice has been undertaken. ETPIS is a twin screw based cryogenic extruder. Its arrangement of pre-cooler and liquefier is being studied. The DEMO machines will be requiring pellet fueling in various forms e.g. impurity pellets for radiative diverters, micro pellets for ELM mitigation, massive pellet injection for controlled plasma disruption, etc. This paper describes India's contribution towards exploring the development in the field of pellet fueling technology.

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