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Pellet fuelling prospects and injector system for Aditya-U tokomak

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High density plasma operation with centrally peaked profile is one of the key aspects in achieving break-even condition in magnetically confined fusion devices. In this prospect an efficient fuelling method capable of supplying particles into the core of the plasma is desired. Till date, cryogenically solidified pellets of hydrogen isotopes have been proved as an efficient method of replenishing the spent fuel in fusion devices. Apart from fuelling, pellet injection is also useful for plasma confinement improvement, ELM (edge localized mode) pacing, plasma disruption mitigation (which can damage the tokomak first wall) using shattered pellets are other important application. The use of pellet injection technique is actively considered for ITER plasma and for future DEMO relevant studies.
Institute for Plasma Research (IPR), India has initiated development of Pellet Injection System. A study related to pellet injection in ADITYA-U is planned and desired pellet parameter is estimated by applying standard theoretical models such as neutral gas shielding models (NGS). While designing the pellet injection system, the targeted plasma electron temperature considered is few hundreds eV to 2 KeV. For ADITYA the pellet size and speed are decided to be ~1.5 mm and < 800 m/s, respectively. Considering estimated design parameters a single barrel hydrogen pellet injection system is developed for pellet injection related studies. The injector is based on pipe gun concept, where, a pellet formed in situ in the gun barrel is accelerated to high speed using high pressure light propellant gas. This system uses a cryogen free, closed loop compact cryocooler, which provides operational reliability to the pellet freezing process. Pellet formation study is successfully demonstrated using the designed injector. In test bench setup pellet size of < 1.8 mm and velocity of < 900 m/s has been demonstrated. A programmable logic controller based control system is integrated to the tokomak to operate the injector remotely during plasma operation. The pellet parameters are characterized using standard diagnostic such as fast imaging camera and light gate system. This injector will be employed for experiment in Aditya-U tokomak. The design of the pellet injector and its future prospect for application in Aditya-U tokomak will be presented.

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