RECENT ADVANCES IN FUELING MAGNETICALLY CONFINED PLASMAS WITH PELLETS *

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Pellet injection has been used for many years in a number of magnetic confinement fusion experiments to provide plasma fueling and density profile control. A pellet fueling system for a reactor size device will need to supply hydrogenic fuel deep in the plasma to replace the deuterium-tritium ions consumed and to provide a density gradient for plasma particle (especially helium ash) flow to the edge. Development of injection systems that can provide deep fueling with sufficient throughput to provide these features remains a high priority in the fusion technology program.

Several tokamak devices including DIII-D, ASDEX-Upgrade, and JET, have recently employed pellet injection from the high magnetic field side (inner wall). Injection from the high field side (HFS) yields improved fuel penetration and fueling efficiency over the usual simpler method of low field side injection from the outside midplane. An overview of the resulting improvement in fueling efficiency and fuel deposition will be presented. The improvement is believed to be due to a ∇B drift and curvature induced drift of the pellet ablatant in the major radius direction. Curved guide tubes must be employed to inject from the inner wall in all current devices requiring slow to moderate pellet speeds in order to obtain intact pellets. Alternative injection schemes that take advantage of the HFS injection while allowing for high-speed pellet injection are possible using a vertical injection geometry.

The technology to produce cryogenic pellets of hydrogenic isotopes has matured to the level of reliable pellet injection devices that produce and accelerate intact pellets at high repetition rates. New technology enhancements to pneumatic guns have been developed for the production of slower speed pellets that can survive the curved guide tubes required for HFS injection. Centrifugal accelerators have also been operated at the low velocities required for HFS fueling. The understanding of pellet mechanical properties gained from impact studies has allowed for curved guide tube designs that allow pellets to survive intact at moderate speeds.

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