Physical constraints on the design of the DEMO pellet fueling system

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Pellets have demonstrated their capacity for depositing matter in the plasma core and are therefore the chosen candidate for DEMO fueling. This deep deposition results from two phenomena: the pellet penetration which – for given plasma profiles – depends on the pellet mass and injection velocity (the ablation phase), then the displacement of the locally deposited material due to its drift down the magnetic field gradient during homogenization. Present day devices and DEMO exhibit different characteristics with respect to these two phenomena. In today's machines, pellet penetration is typically larger than the ∇B-induced displacement, when in DEMO the matter penetration will be dominated by the ∇B-induced displacement. For this reason, the fueling of DEMO can be only ensured by pellets injected from the magnetic high field side (HFS) [1]. In this communication, we use a set of initial simulations with the HPI2 pellet ablation-deposition code [2] for determining the constraints resulting from this physics on the DEMO pellet injection system. Work hypotheses are a pellet particle content identical to that of the ITER pellets (6×10^{21} atoms) and an injection velocity compatible with the presently available injector technology ($\leq$ 1.5-2 km/s) and limitation due to the use of curved guide tubes in a HFS injection configuration. Both DEMO1 and DEMO2 configurations were used as input parameters for the background plasma. Calculation results show that pellets injected from the HFS, at a vertical position closer than the 2/3 of the vertical plasma extent with respect to the equatorial plane, and with the maximum velocity allowed by the curvature of the guide tube – whatever the resulting injection angle – can deposit the fuel inside the pedestal (normalized radius $\rho \sim 0.85$), with a radial extent of the deposition profile $\delta\rho \sim \pm0.1$. Results from the presented initial simulations allowed to derive optimization constraints for the injection geometry applied now in the next step of working out a detailed conceptual design for the DEMO core particle fuelling system.

[1] P.T. Lang *et al.*, Fusion Eng. Des. **96–97** (2015) 123

[2] B. Pégourié *et al.*, Plasma Phys. Control. Fusion **47** (2005) 17 - B. Pégourié *et al.*, Nucl. Fusion **47** (2007) 44