Investigation of Neutral Penetration Depths Variation with Fueling Intensities of SMBI

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Plasma fueling with high efficiency and deep injection is very important to enable fusion power performance requirements. It is a powerful and efficient way to study neutral transport dynamics and find methods of improving the fueling performance by doing large scale simulations (figure 1). Two basic fueling methods, gas puffing (GP) and supersonic molecular beam injection (SMBI), are simulated and compared in realistic divertor geometry of the HL-2A tokamak with a newly developed module, named trans-neut, within the framework of BOUT++ boundary plasma turbulence code [1-2]. Transport dynamics and profile evolutions of both plasma and neutrals are simulated and compared between GP and SMBI in both poloidal and radial directions, which are quite different from one and the other [3]. It finds that the neutrals can penetrate about four centimeters inside the last closed (magnetic) flux surface during SMBI, while they are all deposited outside of the last closed flux surface (LCFS) during GP (figure 2). It is the radial convection and larger inflowing flux which lead to the deeper penetration depth of SMBI and higher fueling efficiency compared to GP. Besides, we study the molecular penetration depth variation with the SMBI fluxes [4]. It is found that the penetration depth of molecules strongly depends on the radial convective transport of SMBI and it increases with the increase of the injection velocity (figure 3). The penetration depth does not vary much once the SMBI injection density is larger than a critical value due to the dramatic increase of the dissociation rate on the fueling path.

Key words: plasma fueling, SMBI flux,, gas puffing, neutral transport, penetration depth

References

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Figures

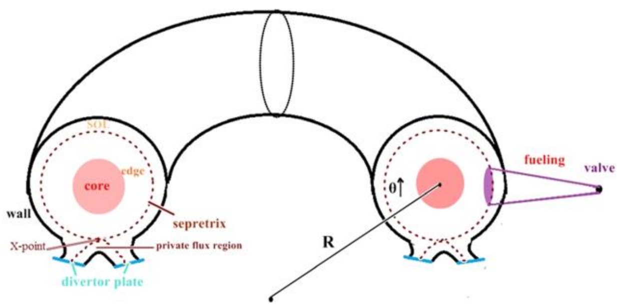

Figure 1. A fueling configuration in HL-2A and different regions on tokamak poloidal cross-section

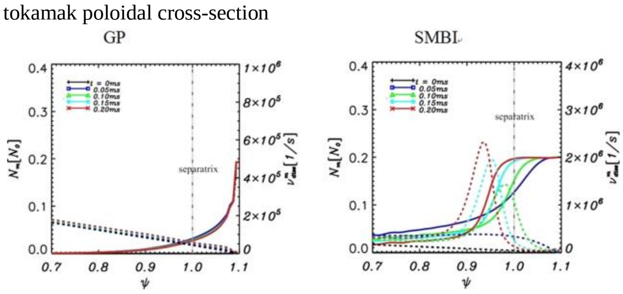

Figure 2. The time evolution of the molecular density Nm (solid curve) and the molecular dissociation rate (dashed curve) within 0.2 ms, along the injection channel of molecules

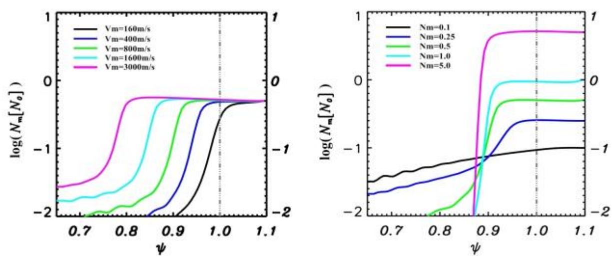

Figure 3. SMBI with different injection flux (different injection velocity and density respectively)