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Simulations and Validations of Transport during Fueling by SMBI in HL-2A Tokamak

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Plasma fueling with higher efficiency and deeper injection is crucial to enable fusion power performance requirements at high density for next generation devices such as ITER. In BOUT++ code framework, a new module (named trans-neut) has been developed to deal with neutrals and plasmas transport during fueling of supersonic molecular beam injection (SMBI) or gas puffing(GP). It modifies the BOUT++ code of boundary plasma turbulence to study the dynamics of neutrals transport and their interactions with plasma during fueling. Results of calculations have been done for the realistic divertor geometry of the HL-2A tokamak. A seven-field fluid model coupling plasma density, heat, and momentum transport equations together with neutral density and momentum transport equations for both molecules and atoms has been developed. Collisional interactions between molecules, atoms, and plasma have been included such as dissociation, ionization, recombination and charge-exchange reactions. During SMBI, neutral molecules and atoms propagate inwards continuously across the separatrix and penetrate about 4cm inside the separatrix where the propagating front of molecules stagnates due to the total molecule dissociation rate balancing with the molecule injection rate. Both positive and negative parallel ion velocities are driven near SMBI region due to parallel pressure gradient, which provides convection for parallel plasma density transport. The poloidal propagation of plasma density blobs (i.e., source) and ion temperature holes (i.e., sink) has been observed. The simulations of mean profiles variations during SMBI have been compared and validated with HL-2A experiment results which are consistent qualitatively well with each other.

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