Numerical Analyses on a High-recycling Divertor Operation Regime in KSTAR Tokamak

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Abstract

The operation space in a high-recycling divertor regime of the KSTAR tokamak is obtained in terms of the upstream density and the input power by numerical simulations with a two-dimensional two-fluid edge plasma transport code, EDGETRAN. The source terms for particles, momentum and energy in the edge transport equations for the EDGETRAN code are provided by a two-dimensional Monte Carlo recycling neutral transport code, NTRAN, in which the two major mechanisms by the recycling neutrals, i.e., electron impact ionization and charge exchange, are taken into account. The two major high-recycling characteristics of the parallel temperature gradient and the plasma pressure conservation are identified in this operation space along the magnetic flux tubes between the upstream position and the divertor target plate in the KSTAR tokamak. In addition, plasma temperatures T_t and densities n_t at the target plate and upstream temperatures T_u are scaled with the upstream plasma density n_u, and these scaling results are compared with those in a simple one-dimensional analytic plasma transport model, the so-called two-point model. Finally, the simulation shows that the peaked feature of the upstream ion temperature profile adjacent to the separatrix affects the distribution of the divertor heat flux. This implies that the ion parallel heat conduction near the separatrix plays an important role in determining the radial profile of the heat flux onto the divertor target as the electron parallel heat conduction does in this conduction-limited regime. It is therefore, suggested that modifying the upstream plasma property profiles makes it possible to control the power distribution at the divertor plate.