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Numerical Simulation Study of Ar and Ne Injection in the End-cell of GAMMA 10/PDX

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In toroidal fusion devices, reduction of heat load on to the target plate is one of the most important issues. The divertor is exposed to high heat load. Therefore, it is necessary to reduce heat load on to the target plate. Gas injection into a divertor plasma is one possible idea to reduce the heat load on divertor plates, since impurity gas causes radiative power loss and decreases electron temperature, expected to result in plasma detachment.

GAMMA 10/PDX is the world's largest liner device. In the GAMMA 10/PDX, divertor simulation experiments have been started by using D-module [1]. A V-shaped target made of tungsten in has been installed in this module. It has been aimed to study the physics of plasma detachment. In order to investigate the physics of radiation cooling and plasma detachment, impurity injection experiments into the D-module is going on [2-4].

A numerical simulation study by using a multi-fluid code [5-6] has been started in order to understand the various physical mechanism of plasma detachment in GAMMA 10/PDX. The mesh structure has been designed according to the magnetic field structure of the GAMMA 10/PDX. Moreover, a tungsten target has been assumed to be designed at the end of the mesh. The plasma parameters at the main plasma upstream region are defined as fixed boundary. In addition, Neuman condition is applied for peripheral boundary. For ion velocity along with magnetic field line, Bohm condition near the sheath entrance is adopted. We applied divertor boundary condition on the target plate. This research investigates the role of radiator gas for obtaining detached plasma by using a multi-fluid code. The atomic processes of Ar, Ne have been included in the present code. In addition, recycling hydrogen molecules and atoms by the target plate have also been included in the present model. It is found that the electron temperature on the target plate reduces as the radiator gas density increases. It is also observed that the electron temperature reduction in the case of Ar injection is higher than that of the Ne injection. The electron density rises at the lower gas injection. However, increase in the electron density during Ar injection is higher than that of the Ne injection. Tendency of saturation in the electron density is observed at higher Ar injection. These results indicate that the end-loss plasma approaches towards the plasma detachment state during Ar injection.

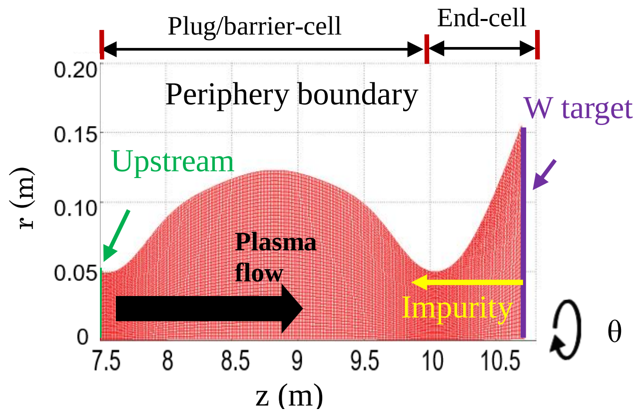

Fig. 1. Mesh structure of the simulation area.

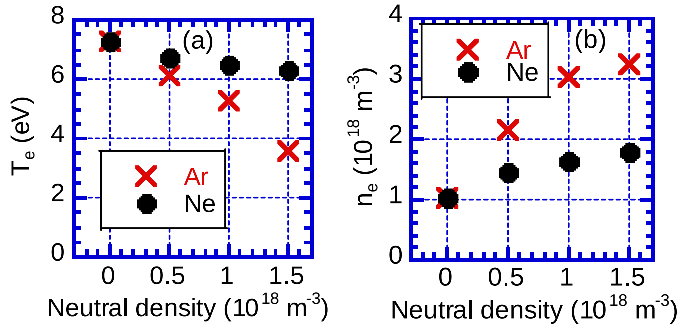

Fig.2 The dependence of (a) electron temperature, T_e (b) electron density, n_e as a function of the injected neutral Ar and Ne density.

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