Control of edge plasma by plate biasing in SOLPS-ITER modeling

A. A. Shirobokov, E. G. Kaveeva, V. A. Rozhansky

Peter the Great St. Petersburg Polytechnic University, St. Petersburg, Russia

e-mail: shirobokov@edu.spbstu.ru

Several experiments on the electric biasing of the divertor target plates have been conducted on tokamaks DIII-D, TdeV, JFT-2M [1, 2, 3]. The corresponding electrode configurations were different in these experiments, so the results also varied. On DIII-D the application of a voltage difference between the two ends of a flux tube was implemented using toroidally symmetrical electrode, that drives a current parallel to the magnetic field in the Scrape-Off Layer (SOL). On TdeV the radial electric field and the poloidal component of the *ExB* drift were controlled by applying the same voltage to both ends of a SOL flux tube relative to a grounded vacuum vessel.

In the years when these experiments were performed the code SOLPS-ITER didn't exist. In this report, we analyze the effect of the electric biasing of divertor plates in a tokamak using SOLPS-ITER modeling with account of drifts and currents in the SOL. The ASDEX Upgrade geometry and transport parameters adjusted for modeling of semi-detached nitrogen-seeded plasma of shot #28903[4] are used in analysis. The additional voltage is applied to outer target with respect to main chamber and inner target. The effect of an additional parallel current and redistribution of electrostatic potential on the plasma distribution within the SOL is discussed.

When a negative voltage is applied to the outer divertor plate, the plasma fluxes in the divertor and Private Flux Region (PFR) change significantly, which leads to the disappearance of the High Field Side High Density (HFSHD) region [5] near the inner plate and significant redistribution of the nitrogen within the SOL. At positive voltages on the outer plate, the HFSHD region grows and the cold dense front moves closer to the X-point, which leads to large radiation losses inside the separatrix.

Additionally, applying a voltage to the divertor plates affects the radial electric field near the separatrix, which leads to a change of the poloidal rotation shear.

References

[1] M. J. Schaffer et al 1992 Nucl. Fusion 32 855.

[2] R. Décoste et al 1994 Phys. Plasmas 1 1497.

[3] T. Shoji et al 1995 Journal of Nuclear Materials 220-222 357-360.

[4] I. Yu. Senichenkov et al 2019 Plasma Phys. Control. Fusion 61 045013.

[5] S. Potzel et al 2015 J. Nucl. Mater. 463 541-545.