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Effect of plasma screening on pumping efficiency in the DEMO divertor

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The screening of a neutral gas by plasma from the top of the private flux region (PFR) of the latest DEMO divertor configuration without the dome structure is analysed. The effect of the neutral gas compression in the PFR is assessed by using the direct simulation Monte Carlo method (DSMC) and the ambipolar approximation for the simulation of neutral molecule dissociation and ionization as a result of collisions with plasma electrons.
Preliminary results without the divertor dome have been reported previously [1], in which the atomic and molecular processes as well as the interaction with plasma were neglected. It was shown that a strong neutral reflux from the private flux region towards the x-point occurs. The aim of the present work is to investigate the impact of neutral interaction with electrons on particle reflux. The plasma fan could impede the outflow of neutrals to the bulk plasma due to the sharp electron density and temperature drop towards the PFR, resulting in an effective neutral plugging.
The numerical analysis includes the calculation of neutral density, temperature and pressure in the divertor plenum and the overall conductance of the sub-divertor structure, which consequently affects the pumping efficiency. It is shown that plasma plugging is more efficient in the case of plasma attachment. Analysis of dome structure requirements for achievement of the effective pumping is extended by including the plasma effect as a plugging of neutrals in the PFR. The DEMO divertor cassette structure can be further optimized to ensure more efficient pumping and achievement of detachment conditions.

[1] Chr. Day, S. Varoutis, Yu. Igitkhanov, IEEE Trans. Plasma Science 44 (2016) 1636-1641.

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