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SOLPS modeling of the divertor plasma and its impact on the upstream plasma condition

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Control of heat flux and erosion at plasma-facing components (PFC), especially, divertor target plates, is a major issue for design and operation of next-step high-power steady-state fusion devices. This necessitates the achievement of highly dissipative or detached divertor conditions to maintain both the heat flux below 10 MW/m^2 (i.e., within the power exhaust capability for solid both graphite and tungsten) and divertor plasma temperature below 5 eV to suppress sputtering at the PFC surface [1]. On one hand, experimental studies of divertor closure on the plasma solutions in DIII-D indicated that the onset of divertor detachment occurs at lower pedestal plasma density for a closed divertor [2]; SOLPS modeling also confirm that the closed divertor could help to achieve plasma detachment at lower upstream density than that of the open divertor [3]. On the other hand, the compatibility of divertor plasma and upstream (or main) plasma is one of the most important issues remained to be solved for the future long-pulse high power fusion device, such as ITER.

SOLPS modeling [4] is carried out to study the divertor plasma and its impact on the upstream plasma. In this work, we first analysis the divertor in-out asymmetry of a closed outer divertor geometry. Significant asymmetry is observed. It is found there is a more obvious flux reversed region appear near the separatrix of the inner divertor than that of the outer divertor. By comparing the High-Field Side (HFS) and Low-Field Side (LFS) outer mid-plane profiles, we find the inner divertor plasma has greater impact on the HFS than the outer divertor plasma on the LFS. Then, two cases are simulated with the identical input parameters but different neutral baffling to create an open and a closed outer divertor. The impact of divertor closure on the divertor plasma and upstream plasma is thus studied, mainly by analyzing the fuel and impurities ions fluxes, and ionization rate.

References

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