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Study of detached H-modes in full tungsten ASDEX Upgrade with N seeding by SOLPS-ITER modeling

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Our current understanding of divertor physics indicates that at least partial detachment will be a necessary condition for operation of future fusion power devices such as ITER, DEMO and beyond. In recent years a divertor operation with complete detachment was achieved in full tungsten ASDEX Upgrade with nitrogen seeding [Potzel et al Nucl. Fusion 54 (2014) 013001, Reimold et al Nucl. Fusion 55 (2015) 033004, Kallenbach et al Nucl. Fusion 55 (2015) 053026]. Simultaneously, modeling with the SOLPS5.0 transport code reproduced the main features of these experiments [Reimold et al J. Nucl. Mater. 463 (2015) 128–134], e.g. reduction of the target heat and particle fluxes, strong X-point radiation and moderate pedestal pressure loss. In parallel, additional modeling, aimed at understanding the transition to the detachment regime [Senichenkov et al, submitted to Nucl. Fus.], and using the SOLPS-ITER version of the code [Wiesen et al J. Nucl. Mater. 463 (2015) 480–484], was performed, however assuming carbon walls, which corresponds to the ASDEX Upgrade experimental condition before changing to full tungsten walls. This work demonstrated the key role played by the electric field near the X-point [Senichenkov et al, EPS conference 2015, ECA Vol. 39E P5.191]. The possible effect of the detached divertor on the radial electric field in the confined region was reported [Sytova et al, H-mode workshop, 2015].

In the present paper the SOLPS-ITER simulations and a modeling results analysis as from above are revisited, but now considering full tungsten ASDEX Upgrade walls with nitrogen seeding. The main features observed earlier in the simulations with carbon as the (main) impurity are reproduced. They are in particular the development of strong electric field in the divertor region in the detached regime, cooling of the confined region near the X-point, reduction of the thermoelectric current between the divertor plates, redistribution of poloidal fluxes and reduction of the radial electric field (in absolute value) in the confined region. The influence of deuterium-impurity friction on the nitrogen impurity distribution in the SOL and in the confined region is also investigated.

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