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SOL impurity transport and effects on H-mode pedestal in closed divertors

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Impurity seeding studies were performed for the first time in the slot divertor at DIII-D, showing that with suitable use of radiators, full detachment is possible without degradation of core confinement [1]. First ever multi species SOLPS-ITER simulations including full cross-field drifts and neutral-neutral collisions activated in DIII-D demonstrate the importance of target shaping and plasma drifts on divertor impurity leakage. The inclusion of the drifts in the
simulations enabled to study the behavior of these flows in a highly closed divertor showing the relevant role of convection on divertor asymmetry and divertor detachment in these conditions. The recycling source is affected by the superposition of the closure effect and plasma drifts. This results in a redistribution of plasma flow in the SOL and divertor plasma. Flow reversal [2] is found for both main ions and impurities affecting the SOL impurity transport and explaining the
dependence on strike point location of the detachment onset and impurity leakage found in the experiments. In addition to target shaping, the effect of different radiative species on power dissipation has been evaluated by replacing nitrogen with neon. The experimental results show
that Ne dissipates further upstream than N as confirmed by SOLPS-ITER modeling and analytic calculations using the 2-point model [3]. The two routes for dissipation identified here (using N through divertor radiation and with Ne radiating mantle upstream) lead to different pedestal responses. While Ne readily enters the pedestal, N remains compressed in the divertor without significantly affecting the profiles. This different leakage behavior is consistent with the higher
ionization potential for Ne compared to N. Neon injection leads to a reduced core ion transport as supported by TRANSP and GYRO simulations. The resulting increase in pedestal Ti improves pedestal stability through increased diamagnetic stabilization allowing higher pedestal pressure gradients. A self-enhancing mechanism of Ne build up has been identified as due to the increased pedestal stability and the radiative mantle. The findings of this work demonstrate that enhanced divertor dissipation and improved core-edge compatibility can be obtained by choosing appropriate radiative species for pedestal conditions, as well as by optimizing divertor geometry and tailoring drifts for particle entrainment.

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