Spectroscopic investigation of N_2 and Ne seeded induced detachment in JET ITER-like wall

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The degree and operating space for nitrogen and neon impurity seeded induced detachment in JET with ITER-like wall (JET-ILW) L-mode discharges in the high-recycling divertor regime is shown to be regulated mainly by the combined effect of i) the local radiative cooling efficiency in the outer divertor; and ii) the degree of ionization front incursion towards the X-point with increased impurity seeding. Quantitative spectroscopic analyses show that at the onset of detachment the net particle balance at the outer target is dominated by a marked decrease in the ionization source between the X-point and the target with increased nitrogen and neon seeding, and only a marginal increase in the volume recombination rate. Local radiated power dissipation (nitrogen only) and upstream P_{SOL} reduction (both nitrogen and neon) with increased seeding leads to a reduction in the outer target T_e and an inward shift of the ionization front away from an enhanced ionization region at the strike point caused by observed high Lyman series opacity. For the same power flow into the divertor, an additional 30% reduction in the outer target ion current was observed for nitrogen seeding, and is attributed to local radiative dissipation not observed in the neon seeding cases.

Spectroscopic measurements of the nitrogen radiation pattern and plasma parameter estimates from deuterium radiation were used to constrain EDGE2D-EIRENE simulations. The large drop in ionization source with increased impurity seeding is only recovered if the simulations include an *ad-hoc* opacity treatment informed through measurement of the Ly_β/D_α ratio. A novel N II spectral line ratio technique was also used to constrain the prescribed radial impurity transport in the SOL. Inferred T_e and n_e estimates from N II 4f$\rightarrow$3d and 3p$\rightarrow$3s transitions are consistent with low transport close to ionization balance (residence time $\tau\sim\infty$), while the EDGE2D-EIRENE simulations with prescribed cross field transport ($D_\perp$=1.0 m^2s^{-1}) yield a shorter N^{1+} residence time ($\tau\sim$0.1 ms). EDGE2D-EIRENE simulations show that a decrease in the prescribed radial nitrogen transport coefficient from $D_\perp$=1.0 to 0.1 m^2s^{-1} results in a redistribution of the radiated power in the divertor towards lower ionization stages (from $N^{3+,4+}$ to $N^{1+,2+}$), which leads to a factor of two increase in the nitrogen concentration needed to reach the same total radiated power. The impact of including the full photon transport model in EIRENE, as well as the effects of convective transport on the impurity radiation distribution in the divertor and X-point regions will be presented.

* See the author list of "Overview of the JET results in support to ITER" by X. Litaudon *et al*. 2017 *Nucl. Fusion* 57 102001.