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Comparison of H-Mode Plasmas in JET-ILW and JET-C with and without Nitrogen Seeding

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In high confinement mode plasmas with edge localized modes in JET [1], the fluid edge code EDGE2D/EIRENE predicts transition to nitrogen induced detachment at the low-field side target plate when more than 40% of the power crossing the separatrix is radiated. This is observed both in the ITER-like wall and in the previous carbon wall environments and is consistent with experimental observations. When the carbon wall is replaced with the ITER-like wall, a factor of two reduction in the divertor radiated power and 60% increase in the power deposited to the outer plate is predicted by EDGE2D/EIRENE for unseeded plasmas consistent with the experiments. This observation is attributed to the higher radiative potential of carbon compared to beryllium in the simulated divertor conditions. At the radiation levels required for detachment, EDGE2D/EIRENE shows that nitrogen is radiating 80% of the total divertor radiation with the ITER-like wall with beryllium contributing less than a few %. With the carbon wall, nitrogen radiation contribution is around 65% with carbon providing 20% of the total radiation. When the divertor radiation levels in the ITER-like wall simulations due to nitrogen injection reach the predicted carbon wall levels, the outer divertor temperatures and total plasma currents are the same within 10% between the two materials configurations through the following nitrogen injection scan. Therefore, the lower intrinsic divertor radiation with the ITER-like wall is compensated by stronger nitrogen radiation contribution in the simulations leading to detachment at similar total divertor radiation fractions, as well as to very similar outer plate conditions, as is predicted in the full carbon environment. The neutral deuterium flux crossing the separatrix in the carbon wall simulations exceed those in the ITER-like wall simulations by 5 − 10%, due to a factor of 2 higher molecular fractions in the recycling fluxes emitted from carbon surfaces.

[1] C. Giroud, et al., Nucl. Fusion 53 (2013) 113025

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