

Optimisation of JET-DT and ITER operation by developing an understanding of the role of low-Z impurity on the H-mode pedestal

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Impurity seeding via injection of neon (Ne) or nitrogen (N) will be mandatory in ITER Q=10 reference scenario to reduce inter-ELM power load to the divertor within the engineering limits. The challenge is achieving the scenario requirement of $H_{98(y,2)}=1$, $\beta_N=1.8$, $\frac{\langle n \rangle}{n_{GW}}=0.85$, $\delta=0.4$, with a high radiative divertor. These conditions necessitate a high pedestal temperature which leads the pedestal to playing a key role in this challenging integration. Unravelling the mechanism that, in the absence of carbon in the plasma composition leads to a decrease in the pedestal temperature is critical in predicting the pedestal pressure in ITER. It is important to learn how to use the extrinsic impurity to optimise the pedestal temperature in high radiative scenarios. This paper aims at (1) reviewing our understanding of the effect of carbon (C), N and Ne-seeding on the pedestal pressure and temperature, (2) assessing whether the peeling ballooning stability limits the pedestal pressure, and (3) determining which instabilities are causing heat and particle transport.

In JET-ILW this limitation on the pedestal temperature is alleviated with the injection of nitrogen, or C in low and high- β_N plasmas. Seeding Ne can result in opposite behaviour on the pedestal density depending on the collisionality ν_e^* and β_N , but in all cases seeding Ne does not lead to an increase of temperature, unlike N or C. A detailed analysis of the differences in the electron and ion pedestal profiles in the high- β_N plasmas indicate that the difference between C and Ne-seeding can be down to the value of collisionality ν_e^* , but also the value of ExB shear considering the difference in $\nabla T_{i,\alpha_{max}}$ and $\nabla \Omega_{tor,\alpha_{max}}$ at the position of the maximum normalised pressure gradient. Similarly, seeding CD_4 in the low- β_N plasmas increases $\nabla T_{i,\alpha_{max}}$ and $\nabla \Omega_{tor,\alpha_{max}}$. Detailed analysis with the GENE code will clarify which instability is at the origin of the difference in the pedestal temperature. The peeling ballooning stability has been assessed with MINERVA-DI code. The plasmas considered have the operational points (OP) of the high and low- β_N plasmas within 20% of the stability boundary.

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