Role of neutrals on the confinement of hybrid scenario in JET-C and JET-ILW


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In the carbon wall, JET-C had carried out in 2008 dedicated power scans ($\beta_N$~2 to ~3) experiments at constant density in both low ($\delta$=0.2) and high shape ($\delta$=0.4) with the initial objective to determine the role played by the pedestal in the observed H-factor increase ($H=1$ to 1.4) in the hybrid scenario [1]. From the analysis done at the time, the dependence of the confinement time with the input power behaved differently with the plasma shape: $\tau_E \propto P^{-0.3}$ for the low shape and $\tau_E \propto P^{-0.77}$ for the high shape. Revisited investigation of these discharges is indicating that for high triangularity, the determination of the power dependence can be impacted by the increase of neutral recycling as the power is increased. D$\alpha$ light data in the area of the secondary X-point (top of the vessel) and in the main chamber are showing an increase of recycling flux with power and is correlated with a saturation of the pedestal pressure measurements. This suggests that the analysis of core confinement neglecting the effect of recycling could produce inconsistent results unless edge recycling is taken into account as an additional variable in the scaling law. The impact of neutral on confinement in hybrid discharges in the carbon wall has been further evidenced in the comparison of high shape hybrid discharges with different wall clearance operated at identical normalised pressure ($\beta_N$). Consistently with the recycling flux measurements, calculation with the EDGE2D code is predicting a large difference in neutral pressure in the main chamber close to the secondary X-point which could explain the difference in confinement between the hybrid scenario ($\beta_N=2.8$, $H=1.1$) in 2003-6 and the same scenarios carried out in 2008 with a larger clearance in the area of the secondary X-point but reaching $H>1.3$ for identical $\beta_N$ [2].

More recently, an identical power scan has been carried out in the JET ITER-like wall for the hybrid scenario at high triangularity for identical magnetic field and plasma current than in the carbon wall. This time, the pedestal pressure rises faster with power in the ILW and shows a stronger dependence with power than in the JET-C. In addition, the recycling flux in the area of the secondary X-point is not varying with the input power. The change of the wall composition is most likely at the origin this difference. Be and W plasma facing components do not have the same affinity to neutrals than carbon thus giving more ground to the interpretation that neutrals at the edge play a non-negligible role in the confinement of hybrid discharges. Core transport analyses of identical discharges in ILW and C-wall are carried out to assess the relatively importance of core and edge for both cases. In addition, this paper proposes a modified test confinement scaling expression taking into account the $n_{eSOL}/n_e \propto \Gamma_{D\alpha}^{1/2}/n_e$ as additional variable (where $\Gamma_{D\alpha}$ is the total recycling flux in the chamber).

[1]: D.C. McDonald, 12th International Workshop on H-mode Physics and Transport Barriers, Princeton 2009;
[2]: Joffrin E et al, 23rd Fusion Energy Conf. (Daejeon, Korea, 16–21 October 2010) EX/1-1