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Impact of divertor geometry on separatrix density in JET H-mode plasmas and derivation of a scaling law as a function of engineering parameters

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A viable magnetic fusion power plant has to combine very high plasma density and temperature in the core region, in order to maximize fusion reactions, with cold plasma conditions in the peripheral region compatible with long life expectancy of plasma-facing components. In this contribution, taking inspiration from recent work on DIIID tokamak (see ref. 1), we examine this crucial issue for magnetic fusion research by adopting an approach based on the analysis of a large set of experimental data on H-mode plasmas from JET tokamak. In order to obtain a scaling law for the relationship between top pedestal density and separatrix density at the outer midplane (OMP) as a function of engineering parameters more than ninety discharges have been considered. The choice to examine this density ratio is motivated by the fact that, on the one hand, the density at the top pedestal is an indicator of core confinement and device performance, and on the other hand, the separatrix density has a strong impact on divertor conditions, indicating whether safe conditions for divertor targets are achievable or not.

After a short description of the dataset under consideration and the power balance method used for the determination of the separatrix position [2], two main engineering parameters have been identified and used for the scaling law on the density ratio, namely the plasma current IP and the total injected power PTOTAL. This first scaling law seems to predict the experimental data quite well for low and medium values of the separatrix density, while at high density a strong discrepancy appears. In order to get further insight on such behavior the discharges were analyzed in terms of divertor magnetic configuration. A clear difference is observed between experiments with a corner-corner divertor configuration compared to the horizontal-vertical or vertical-vertical ones. This result suggests the introduction of a parameter taking into account the quality of confinement. In this way, a better agreement between predictions from the scaling law and experimental results is obtained for both low and high-density values [3]. Finally, numerical investigations for representative JET H-mode discharges in the three divertor configurations have been performed using the SOLEDGE code to analyze plasma conditions in the divertor region as well as in the main chamber and their impact on pedestal and separatrix density.

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