Role of the divertor neutral pressure on power exhaust and operational limits in ASDEX Upgrade

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The divertor neutral pressure, p_0, has been found to be an important parameter for inter-ELM power exhaust as well as H-mode performance in ASDEX Upgrade. p_0 exhibits a close connection to the upstream separatrix density, $n_{e,sep}$, which in turn determines the H-L density limit [1]. For a closed divertor configuration and active pumping, the neutral pressure can be regarded as an engineering parameter, since it is largely determined by the gas puff rate. Experimentally found relationships are $n_{e,sep} \propto p_0^{0.31}$ [2], $n_{e,sep\,H\text{-}L} \approx 0.5\, n_{Greenwald}$ [1] and $P_{sep,detach} \propto p_0$ [3], where $P_{sep,detach}$ is the maximum separatrix power where detachment is still obtained for a given p_0. For impurity seeded cases, p_0 is a weighted neutral pressure sum of deuterium and seed impurities. These relationships allow the integration of H-L and power dissipation limits into an operational boundary for the neutral divertor pressure. Analytical models are used to extrapolate ASDEX Upgrade experimental results to future devices like ITER and DEMO. An important parameter is the exponent of the neutral pressure in relation to the separatrix density. The weaker experimental $n_{e,sep}$ dependence on the neutral pressure, namely $p_0^{0.31}$ versus the analytical high recycling dependence, $p_0^{0.5}$, allows thus for higher p_0 and hence results in favorable exhaust conditions. Possible reasons for the observed dependence and implications for divertor operation will be discussed.

[1] T. Eich et al., submitted to Nuclear Fusion
[2] A. Kallenbach et al., submitted to Plasma Phys. Contr. Fusion
[3] A. Kallenbach et al., PPCF **58** (2016) 045013.