Global particle balance measurements in DIII-D H-mode discharges

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Abstract

Experiments are performed on the DIII-D tokamak to determine the retention rate in an all graphite first-wall tokamak. A time-dependent particle balance analysis shows a majority of the fuel retention occurs during the initial Ohmic and L-mode phase of discharges, with peak fuel retention rates typically $\sim 2\times10^{21}$ D/s. The retention rate can be zero within the experimental uncertainties ($< 3\times10^{20}$ D/s) during the later stationary phase of the discharge. In general, the retention *inventory* can decrease in the stationary phase by $\sim 20-30\%$ from the initial start-up phase of the discharge. Particle inventories determined as a function of time in the discharge, using a "dynamic" particle balance analysis, agree with more accurate particle inventories directly measured after the discharge, termed "static" particle balance. Similarly, low stationary retention rates are found in discharges with heating from neutral-beams, which injects particles, and from electron cyclotron waves, which does not inject particles. Detailed analysis of the static and dynamic balance methods provide an estimate of the DIII-D global co-deposition rate of $\leq 0.6-1.2\times10^{20}$ D/s. Dynamic particle balance is also performed on discharges with resonant magnetic perturbation ELM suppression and shows no additional retention during the ELM-suppressed phase of the discharge.

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