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EX/P5-07: In Vessel Fuel Inventory Build-up in Tokamaks: Lessons Learnt from Tore Supra

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For next step fusion devices, fuel retention by the vessel walls is a crucial issue, as the tritium inventory will be limited for safety reasons. The rate at which the in vessel fuel inventory builds up will have a strong impact on the device operation, as it determines the number of discharges allowed before reaching the tritium safety limit and the frequency of shutdowns eventually needed for plasma facing components (PFC) detritiation processes. Extensive studies performed on Tore Supra have allowed to gain a global view on these issues, taking advantage of the long pulse capability of the device to cumulate ITER relevant particle fluence on PFC within a reasonable operation time. This paper presents an overview of the results obtained in terms of fuel retention under long pulse operation in Tore Supra, showing a consolidated carbon and deuterium balance. In particular, the critical importance of taking into account long term outgassing between discharges when assessing fuel inventory build up over long periods is outlined. This result is based on the recent extension of the analysis carried out in terms of fuel retention and carbon balance for a dedicated wall inventory campaign in 2007 to the full period preceding the extraction of in vessel samples for post mortem analysis (2001-2007). Special care was taken to assess the amount of deuterium outgassed during the nights and weekends of the experimental campaigns and during vents. In particular, dedicated experiments have been performed during the last Tore Supra vent to estimate the deuterium recovered during the process. While the impact of vents is rather moderate, it is shown that the outgassing during nights and weekends is the main process that reconciles both the post mortem and gas balance estimates of fuel retention as well as the coupled carbon-deuterium balance. Results from Tore Supra and present day devices are extrapolated to derive estimates of the fuel inventory build up in ITER over an experimental campaign, for different wall materials options and taking into account different operational scenario. In particular, the potential impact of long term outgassing on the fuel inventory build up is assessed, showing that it remains modest for high fuel uptake during plasma / high repetition rate of discharges, while it can play a significant role for lower fuel uptake / lower repetition rate.

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