

Hydrogen retention and outgassing analysis with examples from JET-ILW, including long-pulse discharges

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Plasma-wall interaction (PWI) plays a crucial role in plasma control in fusion devices. Apart from impurity generation and power exhaust issues, fuel recycling at plasma-facing components (PFCs) introduces additional challenges by affecting plasma density control and fueling efficiency. Hydrogen transport, retention and release from PFCs is influenced by the incoming ion and neutral particle fluxes, surface temperature and material properties. Thus fuel wall pumping and release vary both in location, as different PFC elements are exposed to different plasma conditions, and in time into the discharge, due to changes in fueling, surface temperature and, potentially, material microstructure.

Over 40 years of operation, JET accumulated a vast database on PWI, including deuterium-tritium (DT) campaigns and operation with the ITER-like wall (ILW), beryllium first wall and tungsten divertor, providing invaluable insights into fuel retention and recycling processes. In November and December 2023, almost at the very end of JET operations, several 30s and 60s long stationary heated discharges (compared to typical ≤ 20 s long discharges) were performed in JET-ILW [1, 2]. These specially developed extended discharges offer the opportunity for investigation of the pathway to plasma-wall equilibrium in terms of fuel retention and recycling. This contribution will briefly summarize the main key points and outcomes in view of fuel retention from PWI experiments in JET and present a comparison of conventional and long-pulse discharges in JET-ILW by in-vessel gas balance and post-discharge outgassing analysis. In particular, preliminary intra-shot gas balance analysis indicates faster wall saturation in high power (14-16 MW) 30s long pulses compared to lower power (6-7 MW) 60s pulses, in which wall saturation effects take onset only after 10-20s.

[1] D. King et al., Technical and Engineering challenges for long pulses on JET-ILW, this meeting

[2] E. Lerche et al., Long pulse operation with the JET ITER-Like Wall, this meeting

* For the list of JET contributors see C.F. Maggi et al., Overview of T and D-T results in JET with ITER-like Wall, accepted for publication in Nuclear Fusion (DOI: 10.1088/1741-4326/ad3e16)

** For the EUROfusion Tokamak Exploitation Team see E. Joffrin et al., Progress on an exhaust solution for a reactor using EUROfusion multi-machines capabilities, accepted for publication in Nuclear Fusion (DOI: 10.1088/1741-4326/ad2be4)

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