Isotope exchange experiments on ITER-like wall in JET

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Fuel recovery by isotopic exchange using (i) tokamak plasmas, (ii) ion cyclotron wall conditioning plasmas (ICWC) and (iii) DC glow discharges (GDC), is studied on the ITER-like wall in JET with beryllium main wall and tungsten divertor (JET-ILW). The experiments, exchanging the stored fuel content in the plasma facing components (PFC), provide insight on the sizes of the accessible fuel reservoir for each technique and their applicability for mitigating the tritium inventory build-up on ITER. The results, based on gas balance analysis, are complemented by in vessel Be deposition patterns obtained by ex-situ surface analysis of retrieved wall and divertor tiles.

The reservoir accessible by the three techniques, applied with the first wall at 200°C, and the divertor at about 100°C amount respectively to (i) ~3×10²², (ii) ~7.5×10²² and (iii) ~10²³ fuel isotope atoms. The accessible reservoirs are exchanged by removal from and implantation in both PFC and codeposited layers, as well as by erosion of deposits and codeposition of isotopes with Be. In tokamak plasma discharges, fuel recycling is governed by plasma wall interaction in the scrape of layer. Fuel atoms retained within the ion implantation range remain accessible to the fuel recycling process. Permanent retention occurs mainly in codeposited layers at constant rates of 0.5 to 1×10²⁰ H s⁻¹. These deposits appear accessible by ICWC, deduced from the larger amount of removable isotopes. Isotope exchange by ICWC followed by tokamak discharges could be an attractive scenario for T inventory control in ITER, and could be applied without penalizing DT-operation. While the accessible fuel reservoir is highest for standard GDC on JET, GDC discharges can only be produced in absence of magnetic fields and can therefore not be used between ITER plasma pulses for T inventory control. The “good housekeeping approach” for ITER should however foresee frequent long (one day) GDC operation, when possible in combination with baking.