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Experimental and Modelling Results on Wall Conditioning for ITER Operation

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Wall conditioning will be required in ITER to control fuel - and impurity recycling and to improve plasma performance and reproducibility. In the nuclear phase, wall conditioning will also contribute to the control of the tritium (T) inventory within the fuelling cycle. This paper reviews experimental and modelling research activities on wall conditioning in preparation of ITER operation.

Baking and Glow Discharge Conditioning (GDC), the primary wall conditioning techniques that ITER will use for cleaning, have been in particular studied in JET-ILW, providing results of particular relevance to ITER operation. The use of Be as PFC material lead to significant reduced needs for wall conditioning after the initial plasma restart, following baking at 200°C and D2-GDC, dramatically contrasting with restart and operation in JET-C with CFC-dominated walls. A novel 2D multi-fluid model has been developed and benchmarked against experimental data, with the aim to assess uniformity and wall coverage with the ITER glow discharge system currently re-designed. We present benchmarking results either from a small laboratory chamber or from large toroidal machines and show that H2-GDC in ITER will be fairly homogeneous in terms of electron density and temperature and toroidal distribution of the ion fluxes to the wall, determining the rate of cleaning.

The efficiency of isotopic exchange with GDC or Ion Cyclotron Wall Conditioning (ICWC) for Tritium removal has been assessed in various devices, in particular JET-ILW and ASDEX-Upgrade. A 1D model of isotope exchange in Be has been developed. The model includes processes like hydrogen implantation, trapping to the ion-induced trap sites, detrapping to a solute (mobile) state, diffusion in Be and recombination to molecular form at the surface. Calculated hydrogen depth profiles are compared with those obtained on the linear plasma device PISCES-B. Extrapolation to the ITER, from a database on fuel removal efficiency of isotopic exchange experiments with Ion Cyclotron Wall Conditioning on current tokamaks, in particular JET-ILW and ASDEX-Upgrade, indicates that up to 0.4 gT could be removed between pulses, whereas the estimated T-retention lies between 0.14 and 0.5 gT per 400 s long ITER D:T shots.

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