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FTP/P1-05: Comparative Study of Chemical Methods for Fuel Removal

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To extend the availability of ITER, tritium stored in the vessel has to be removed on a regular basis. The research on the fuel removal at Forschungszentrum Jülich has been concentrated in recent years on chemical methods including thermo-chemical erosion (TCE) also known as baking in reactive gases, glow-discharge conditioning (GDC) and ion-cyclotron wall conditioning (ICWC). The studies were conducted in the tokamak TEXTOR and in laboratory devices using pre-characterized samples with deuterated carbon layers. GDC, in contrast to TCE and ICWC, is not applicable in the presence of the nominal magnetic field. Our investigations showed that GDC can be operated at a magnetic field of up to 10 mT and is therefore compatible with the ferritic inserts foreseen in ITER. The TCE using oxygen as the removal gas can effectively be employed at elevated temperatures of at least 300□C. Plasma-based GDC and ICWC can also be applied at lower wall temperatures. TCE is equally efficient in cleaning from the wall surface as from the remote areas such as gaps of castellations. GDC is homogeneous along the wall surface except for small recessed areas like gaps. ICWC is typically inhomogeneous along the poloidal circumference. Applying the radial magnetic field, we were able to control the poloidal position of the main IC plasma production. Thus, some wall regions, e.g. the divertor, can selectively be exposed to ICWC. Owing to higher ion fluxes to the wall, ICWC activates a larger amount of neutrals than GDC, which then penetrate in gaps and clean gap walls efficiently. Removal rates with oxygen were typically by a factor of 3 - 10 higher than with hydrogen and ammonia and 10 - 30 than with nitrogen. The estimates using the highest removal rate for ICWC show that about 2 hours are needed to remove the layer deposited within one ITER pulse. The application of ammonia in TCE led to the pealing-off of layers, which is a potential dust production mechanism. However, it appears to be suitable for the non-oxidizing cleaning of metallic mirrors envisaged for optical diagnostics in ITER.

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