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Development of Helium Electron Cyclotron Wall Conditioning on TCV for the operation of JT-60SA

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Wall conditioning will be required in JT-60SA to control fuel and impurity recycling and to improve plasma performance and reproducibility. In addition to glow discharge cleaning, operable only in the absence of toroidal field, Electron Cyclotron Wall Conditioning (ECWC) plasmas created with its ECRF launchers are envisioned. ECWC has been successfully operated in Helium at the first harmonic in JT-60U, allowing recovering from disruptions. However, in JT-60SA (R = 2.96 m, a = 1.18 m, B_T= 2.25 T), with gyrotrons frequencies f = 110 or 138 GHz, ECWC discharges will have to be operated at the second harmonic of the EC wave.
This paper reports on Helium ECWC experiments on TCV in support of JT-60SA operation. About forty discharges have been produced in TCV, at a toroidal field B_T = 1.3-1.54 T, with gyrotrons at 82.7 GHz in X2 mode. Hence, the cold ECR layer lies in TCV at R = 0.78-0.92 m, mimicking operation in JT-60SA. Helium pressures ranged between 0.5 and 2x10ˆ-ˆ2 Pa and ECRH powers up to 480 kW, using different launchers. Horizontal and vertical poloidal fields with amplitudes typically 0.1 to 2% of B_T have been used, aiming at extending the discharge vertically and radially. Discharge homogeneity was estimated from the electron density radial profile measured with Far Infrared Interferometry (FIR) and from visible CCD images, while wall coverage was assessed from the ion saturation current measured by the TCV array of wall-mounted Langmuir probes located at the high and low field sides, and at the bottom of the device. Electron densities of 5-15x10ˆ18 mˆ-ˆ2 and temperatures of 20-40 eV have been measured with the TCV FIR and Thomson Scattering systems. Typical edge temperatures were found to be 3 eV at the probes.
The efficiency of ECWC was assessed from the amount of released D_2 fuel, measured in the exhaust gas using optical Penning gauges connected to the vacuum vessel. About 2x10ˆ2ˆ0 D_2 molecules could be removed with the forty He-ECWC discharges operated in TCV. Despite this, the initiation of a standard ohmic D2-plasma could not be sustained after conditioning. Thus, demonstration of the ability of ECWC, operated in X2 mode, to recover to normal operation still remains to be done. For this, a larger operational domain will need to be investigated, e.g. higher pressures, different field patterns, and longer ECWC operation will be needed.

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