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Study of impurity transport in the HL-2A ECRH plasmas with MHD instabilities

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In next-generation fusion devices the reduction of impurity concentration in core plasmas is of great importance not only for the decrease in the line radiation loss but also for mitigation of the fuel dilution and the bremsstrahlung radiation to achieve high-performance plasmas in the high density regime. In experiments, the electron cyclotron resonance heating (ECRH) has been widely applied as an effective tool to control impurity accumulation in the plasma core. An increase in the central impurity diffusivity and suppression of the convective pinch, sometimes even a reversal to the outward convection, has been observed. The possible interpretation for the strong increase of impurity diffusivity and positive (outward) convection could be due to an enhancement of turbulence. Recently, a long-lasting m/n=1/1 MHD activity was observed in the AUG experiment when the ECRH was applied. The relation between the saturated MHD activity and the impurity density profile has also been discussed.
In the HL-2A tokamak (R/a = 165/40cm), the impact of ECRH on the impurity transport has been studied with trace impurity injection and variation of the ECRH power deposition, whilst the MHD instabilities and density fluctuations are also measured. The experiment results show that the impurity transport has been strongly enhanced with inner-deposited ECRH than outer-deposited ECRH. The V is reversed to the outward direction (positive) with ECRH in comparison with ohmic discharges where the V normally directs inwards (negative). Both D and V are increased when the ECRH deposition position shifts toward the plasma center. The calculated impurity density profile also confirms that the central peaked profile has been effectively flattened with central ECRH. Using the SXR measurement the MHD activities with relation to the ECRH (various deposition) and ohmic discharges are analyzed. The sawtooth oscillation is presented normally in the central channel for the outer-deposited ECRH discharge but becomes reversed for the inner-deposited ECRH. In case of inner-deposited ECRH a long-lasting m/n=1/1 mode is observed in-between the sawtooth crashes. When this mode is presented an outward heat flux has been observed by the ECE measurement. The turbulent transport as density fluctuations measured by the reflectometer has also been discussed.

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