

The new progress of detachment feedback control by N₂ seeding under H-mode long-pulse plasma on EAST

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The plasma facing materials (PFCs), especially the divertor targets, are facing the continuous excessive heat strike issue, which will be more severe in the future fusion reactors like ITER. Generating the stable detached plasma is an acknowledged way to solve this problem and has been applied in the different tokamaks. On EAST, the ITER-like tungsten divertor and long-pulse discharge (over 1000s) can play an essential role to develop the detachment feedback control method which is suitable for ITER. Boronisation of the first wall gives more choices for the impurity species, the nitrogen (N₂) was firstly applied on the detachment feedback control on EAST. Using N₂ seeding, a feedback control duration of 70s of the divertor electron temperature ($T_{e,div}$) was achieved. During the control phase, the $T_{e,div}$ near the strike point of the lower outer divertor was lowered to 5eV stably, the divertor heat load was mitigated effectively. The increment of the radiated power is about 200kW, most of which was contributed from the divertor region. The N₂ seeding has almost no influences on the ring-averaged core density and the loop voltage, so the recycling effect from N₂ in one shot was not strong in such discharge conditions. Besides, the integrated detachment feedback control was also achieved by N₂: the localized radiated power (P_{rad}) around X-point was in the feedback control phase, while $T_{e,div}$ monitor estimated the divertor detached situation synchronized. Once the divertor plasma arrived at the detached phase, the target value of the X-point radiated power feedback control was lowered automatically, to reduce the impurity seeding volume but still keeping the detachment. Under the different plasma current (I_p) stage of 450, 500, 550kA, this integrated control was applied successfully. The radiation around X-point was increased about 15-20kW/m², the $T_{e,div}$ near lower outer strike point was lowered to about 5eV, and the core confinement has no degradation during the feedback control phase, the robustness of the detachment feedback control was improved effectively.

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