Effects of drift on the tungsten impurity accumulation in the core of tokamak during insert gas seeding

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Tungsten (W) is taken as the main candidate for the plasma-facing materials (PFMs) of the future fusion devices such as ITER, DEMO and CFETR. However, as high-Z impurity, W is incompatible with the main plasma due to its strong bremsstrahlung radiation. The acceptable central concentration of W should be strictly controlled below 10^{-5} in ITER. Therefore, the understanding of the W impurity accumulation in the core plasma and its main influencing factor becomes to one of the most important issues in fusion community. It is well known that the classical drift flow has great impact on the edge plasma, e.g. causing the in-out divertor asymmetry, which may influence the W target erosion. Meanwhile, the plasma flow and drift also change the transport of the W impurity. These together alter the W accumulation in the core. However, the investigation of the role of drifts on the W accumulation is still hard. On one hand, the fluid model requires huge computational resources and faces numerical convergence problem. On the other hand, the widely used guiding center approximation 2D Monte Carlo such as DIVIMP does not include drifts naturally.

In this report, we present the investigation of the W impurity accumulation in the core plasma with the consideration of classical drifts. A two-dimensional impurity transport code based on the guiding center approximation and full-orbit is developed [1,2], which has been validated by the benchmark against DIVIMP [4]. Three methods, fluid code SOLPS-ITER [3], the guiding center approximation code [1], and full-orbit code [2], are used in the presented work to show the difference and limitations of each model. The background plasma during Ne and Ar seeding of EAST are provided by the SOLPS-ITER modeling [3]. The simulation shows that the guiding center approximation model can be applied to simulate drifts effectively via adding the drift velocity manually. While the qualitative difference between the guiding center approximation and full-orbit methods on the W impurity transport is illustrated.

The drifts play important role on the W impurity distribution. The simulation results indicate that drift could influence W transport via W impurity retention and redistribution in the divertor, and the leakage from the divertor. In forward B_t, the eroded W flux at the outer target is increased remarkably. Drifts drive the W impurity from the common flux region of the outer divertor to the private-flux region and inner divertor, thus, leading to the strong poloidal asymmetry. Both W source and transport alter the W impurity penetration rate and influences the concentration in the core region. The effects of B_t direction on the W accumulation is also evaluated in different divertor operation regimes. The present work will improve the understanding of the W impurity behavior to suppress W impurity accumulation in the core.

References

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