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Experiments and simulations of neon seeded radiative divertor in EAST

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Power exhaust will be a critical issue for EAST and future tokamak devices with high heating power. Seeding the noble extrinsic impurities to increase the radiation in divertor and Scrape-Off Layer (SOL) regions through ionizations and charge exchanges, namely realizing the radiative divertor plasma operation, can effectively mitigate the high particle and heat fluxes and promote the divertor detachment to avoid overheating of the targets. To systematically investigate the behavior of Neon injection for power exhaust, both experimental and numerical simulation studies have been carried out on EAST during the past years.

Ne/D_2 mixture with different ratios was seeded from the divertor region as the radiators, and the divertor plasma detachment and the reduction of the heat flux on the targets can be achieved effectively as a result. Different gas puffing methods have also been investigated. Based on the experiences of different proportions and different injection methods, we successfully realized the feedback control of the total radiation power and the electron temperature near the strike point on the target with the simultaneous Ne seeding from the divertor gas puff inlet and midplane SMBI. Tungsten sputtering was also investigated during the neon seeding experiments. By using the lower Ne impurity ratio mixture with divertor detachment operation and better wall conditioning, the sputtering of tungsten could be suppressed greatly.

The Ne seeded radiative divertor experiments in EAST were also validated by SOLPS modeling. The simulation results basically agreed well with the experiments which show that Ne have relatively good performance in reducing particle fluxes and heat load on targets. Although the simulated midplane plasma parameters perfectly matched the experimental results greatly, it is still difficult to match parameters well on both targets when ignoring drifts. Through reconstruction of radiation distribution by SOLPS code, most of the radiation caused by Ne impurity distributed in the region inside the separatrix in agreement with the AXUV measurements. On one hand, the above experimental and simulation results could extend our understandings of impurity seeding scenarios and underlying physics. More importantly, reasonable predictions of impurity seeding regimes in future devices, such as ITER and CFETR, can be deduced from these studies.

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