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P1.1099 Evaluation of tritium burn-up fraction for CFETR advanced scenario with the integrated simulations

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The next-step fusion facility China Fusion Engineering Test Reactor (CFETR) has been proposed to bridge the gaps between ITER and DEMO [1]. One of the most important missions for CFETR operation is tritium self-sufficiency, which is mainly determined by tritium burn-up fraction (fb) and the design of blanket and tritium reprocessing systems. Therefore, precise evaluation of tritium burn-up fraction is essential to physics and engineering design of CFETR.
The self-consistent core-SOL coupling COREDIV code [2] has been used to evaluate tritium burn-up fraction of CFETR advanced scenario with 1 GW fusion power. Simulations are firstly performed without consideration of impurities other than the fusion products, helium (He) impurity. The simulations indicated that higher He recycling will reduce tritium burn-up fraction due to the core plasma dilution by He impurity. But the influence is such slight that with increasing He concentration in the core from 0.9% to 4.5%, the corresponding fb is only reduced by about 13%. Higher fuel recycling can strongly increase tritium burn-up fraction due to the reduction of fuelling source. However, in order to obtain the minimal requirement of tritium burn-up fraction fb=3% for CFETR, fuel recycling needs to be higher than 0.996. Simulations also illustrate that tritium burn-up fraction can be effectively increased by reducing the ratio between particle and heat transport in the core ξ=Di/χe. The previous results are performed with ξ=0.35. For a lower ξ= 0.1, f_b can be higher than 3% when fuel recycling is higher than 0.96.
The existence of impurities in plasma is unavoidable during CFETR operations. The influence of both intrisic (W) and extrisic (Ne, Ar, Kr) impurities on tritium burn-up fration has been studied. As the first step, all of the considered impurities are assumed to be puffed from the wall. The preliminary results indicate that Ne mainly reduce tritium burn-up fracion due to plsama dilution. On the contrary, higher Kr and W source can increased tritium burn-up fracion by about a factor of 2, due to the reduction of transport with a fixed plasma confinement. In the case of Ar, there is almonst no change on the tritium burn-up fracion. More complicated situations such as different impurity seeding in a full W wall environment will also be presented. The results can provide important suggestions and implications for the optimization of tritium burn-up fracion for CFETR scenarios.

[1] V.S. Chan, A.E. Costley, B.N. Wan, et al., Nuclear Fusion 55(2015) 023017
[2] R. Zagorski, I. Ivanova-Stanik and R. Stankiewicz, Nuclear Fusion 53 (2013) 073030.

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