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Modelling of heat flux deposition on the CFETR first wall with impurity seeding

Feifei Nian[1, 2], Jingbo Chen[1], Zhongshi Yang[1], Guojian Niu[1], Rui Ding[1], Guang-Nan Luo[1]

[1]Institute of Plasma Physics, Chinese Academy of Science, Hefei, Anhui 230031, PR China

[2]University of Science and Technology of China, 96 Jinzhai Road, Hefei, Anhui 230026, PR China

e-mail: feifei.nian@ipp.ac.cn

The heat flux deposited on the first wall is investigated for the steady-state China Fusion Engineering Test Reactor [1] (CFETR) with 1GW fusion power and the updated design scheme [2], where the computation for heat flux deposited on the first wall is completed by coupled modelling of SOLPS-ITER [3] and PFCFLUX [4,5]. Puffing neon gas for CFETR to increase radiation and mitigate the heat flux on divertor is considered as one of the possible operation scenarios for the protection of divertor, so the estimation of heat flux deposited on the first wall is implemented with impurity neon seeding. Simulations with different neon puffing rates are carried out on a standard divertor with lower single null configuration by SOLPS-ITER, which is employed to calculate the heat load on the first wall from neutrals and radiation instead of the integrated heat load on the first wall as the intrinsic defect of the SOLPS-ITER's computation grids, that the B2.5 simulation grids for plasma have not extended to the first wall, and the heat flux from charged particles orbited along magnetic lines is derived from PFCFLUX, a magnetic field line tracing code. In view of recent development of the double decay exponential model [6,7] and the PFCFLUX based on a single exponential decay model to trace charged particles and compute the heat load from charged particles, we attempt to optimize the PFCFLUX's calculation with a lower input power than single exponential decay model's, which is calculated with consideration of the narrow scrape-off layer (SOL) characteristic in the near SOL region. After coupled modelling of the two codes and energy analysis for results, the complete heat flux including neutrals, charged particles and radiation three parts and the peak heat flux distribution on the first wall are obtained with varied neon puffing rates. This modelling work studies whether impurity seeded at outer divertor location and seeding impurity or not have effect on the heat flux deposited on the CFETR first wall, and it also presents the highest heat flux location on the first wall under current magnetic equilibrium and the first wall design, so that to check if the first wall design and corresponding system design schemes like the blanket system meet heat exhaust requirement and engineering constraints.

References

[1] Wan, Y., et al. (2017). "Overview of the present progress and activities on the CFETR." Nuclear Fusion **57**(10).
[2] Zhuang, G., et al. (2019). "Progress of the CFETR design." Nuclear Fusion **59**(11).
[3] Bonnin, X., et al. (2016). "Presentation of the New SOLPS-ITER Code Package for Tokamak Plasma Edge Modelling." Plasma and Fusion Research **11**(0): 1403102-1403102.
[4] Firdaouss, M., et al. (2013). "Modelling of power deposition on the JET ITER like wall using the code PFCFLux." Journal of Nuclear Materials **438**: S536-S539.
[5] Maviglia, F., et al. (2017). "Effect of engineering constraints on charged particle wall heat loads in DEMO." Fusion Engineering and Design **124**: 385-390.
[6] Nespoli, F., et al. (2017). "Understanding and suppressing the near scrape-off layer heat flux feature in inboard-limited plasmas in TCV." Nuclear Fusion **57**(12).
[7] Kocan, M., et al. (2015). "Impact of a narrow limiter SOL heat flux channel on the ITER first wall panel shaping." Nuclear Fusion **55**(3).