Contribution ID: **86** Type: **Oral**

Physics basis and design of tungsten divertor for CFETR

Monday, 7 November 2022 11:00 (30 minutes)

Significant advances have been made on the physics design of full tungsten divertor and the edge modeling for Chinese Fusion Engineering Testing Reactor (CFETR). CFETR is proposed by Chinese fusion community to bridge the gap between ITER and DEMO with fusion power up to GW level [1]. One of the key challenges is that the divertor solution for CFETR must meet requirements beyond that of ITER due to higher duty cycle and higher power across separatrix per unit major radius. Taking into account the engineering requirements, a conventional full tungsten (W) divertor with long divertor leg length and V-shape corner structure has been proposed [2]. The SOLPS-ITER code package with full drifts and currents are employed to evaluate the divertor performance of two candidate radiation impurity species, argon (Ar) and neon (Ne), with two divertor geometries (baseline and long leg divertor) [3]. The self-consistent core-edge integrated code COREDIV coupling with the iteratively calculations of core plasma within the OMFIT framework are used for core-edge integration simulations, which helps to set requirements for SOLPS edge modelling [4], such as the separatrix plasma density, impurity concentration etc. The modeling results show clearly that increasing the seeding rate of Ar or Ne can reduce the target electron temperature and heat flux, which can be reduced further by higher D2 injection rate. Similar core plasma and divertor conditions, as well as radiated power fraction, can be achieved with 2-3 times less Ar seeding rate than the Ne seeding. In spite of better argon radiation efficiency, no significant increase of core radiation with argon seeding is observed compared to neon seeding, which is due to better argon compression near the divertors caused by its smaller first ionization potential. Longer divertor leg length has a distinct advantage on radiation losses, which has been adopted for the current engineering design. Based on the background plasma from the SOLPS modeling, W erosion and edge transport has been estimated by using the DIVIMP code. The W sputtering is mainly contributed by impurity ions at the far SOL region due to high electron and ion temperature there, but the W net erosion rates at both divertor targets are below the target lifetime requirements for CFETR operation. Shaping of W plasma-facing components (PFCs) is designed to avoid leading edges due to misalignment, which can increase the stationary heat flux by ~49%. Transient heat flux has been calculated using the BOUT++ simulations, which shows a grassy ELMy characteristic for hybrid scenario. The small ELM size will not melt the W PFCs even the shaping effects are considered. The possible divertor solution was obtained for CFETR which can meet the physics requirements on target heat flux, target lifetime and core compatibility.

[1] G. Zhuang, et al., Nuclear Fusion 59 (2019) 112010
[2] X. J. Liu et al., Physics of Plasmas 27 (2020) 092508
[3] H. Si et al., Nuclear Fusion 62 (2022) 026031
[4] H. Xie et al., Nuclear Fusion 60 (2020) 046022

Speaker's Affiliation

Institute of Plasma Physics, Chinese Academy of Sciences

Member State or IGO

China, People's Republic of

Primary authors: Dr DING, Rui (Institute of Plasma Physics, Chinese Academy of Sciences); Dr SI, Hang; Dr LIU, Xiaoju; Dr SANG, Chaofeng; Dr JIA, Guozhang; Dr MAO, Shifeng; Dr XIE, Hai; Dr XU, Guoliang; Dr LI, Changjun; Dr SENICHENKOV, Ilya; Prof. ROZHANSKY, Vladimir; Dr LI, Zeyu; Mr NIAN, Feifei; Dr LI, Hang; Dr DU, Hailong; Dr XIA, Tianyang; Dr YANG, Zhongshi; Dr WANG, Liang; Dr PAN, Yudong; Prof. GUO, Houyang; Prof. CHAN, Vincent; Prof. LI, Jiangang

Presenter: Dr DING, Rui (Institute of Plasma Physics, Chinese Academy of Sciences)

Session Classification: DEMOs and Next Step Facilities

Track Classification: Divertors for DEMO and Next-Step Facilities