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Nuclear analysis of structural damage and nuclear heating on enhanced K-DEMO divertor model

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Studies to investigate the feasibility of the divertor system have been proceeding since the pre-conceptual design study on the Korean fusion demonstration reactor (K-DEMO) was initiated in 2012. The divertor is one of the main components and biggest challenges for a tokamak reactor. Its major function is the emission of the heat flux, helium and impurities from the plasma, and also the divertor should be able to endure the large plasma power and high radiation conditions inside the tokamak reactor. Previously, main parameter calculations were carried out to predict key neutronic parameters in an overall K-DEMO model, but the nuclear analysis for individual components such as the divertor was not yet demonstrated. In this paper, the enhanced K-DEMO divertor model was created by a commercial CAD program with based on a preliminary developed K-DEMO. Then, the enhanced K-DEMO divertor was integrated into a previously developed K-DEMO neutronic analysis model by the help of the Monte Carlo Automatic Modeling (MCAM) program, and a series of nuclear analyses were performed by MCNP Monte Carlo simulations with FENDL-3.0 nuclear data library. The preliminary calculation results indicate that the maximum nuclear heating deposited over the tungsten armoured HHF units with values between 6˜14 W/cm3, and the highest damage seems to be appeared in the support structures of the outboard target in Reduced Activation Ferritic Martensitic (RAFM) materials with about 6 dpa.

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Primary author: Mr PARK, JongSung (National Fusion Research Institute (NFRI))

Co-authors: Dr IM, Kihak (National Fusion Research Institute); Dr KWON, Sungjin (National Fusion Research Institute (NFRI))

Presenter: Mr PARK, JongSung (National Fusion Research Institute (NFRI))

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