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P3.163 Measurement and CFD simulation of flow mal-distribution in z-type manifolds of a fusion demo blanket

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The blanket system of Korean fusion demonstration reactor (K-DEMO) has a cooling channel through which pressurized water flows to cool down the heat from nucleate heating and plasma radiation. In order to evaluate the cooling performance of blanket, a computational fluid dynamics (CFD) code has been widely used as well as used in commercial heat exchangers. However, CFD can show a large difference in the analysis results for flow distribution in the manifold depending on the geometrical type and condition of the branch pipe. In particular, in the case of K-DEMO blanket, the cooling channel has a manifold structure, in which small rectangular channels are gathered and linked with narrow flow headers, in order to prevent neutron leakage and to ensure tritium breeding ratio (TBR) by adjusting breeding materials. This design can induce flow mal-distribution and secondary flow. These phenomena are strongly dependent on turbulence model and mesh structure in CFD analysis. Therefore, in order to ensure the reliability of the blanket thermal hydraulic analysis, validation of the CFD using the experimental data is important. In this study, flow measuring experiment was performed at room conditions by fabricating the cooling channels of K-DEMO blanket. For flow measurement, PIV technique, which is one of the non-intrusive methods, was adopted to avoid any additional pressure drop in measuring channel. In addition, the CFD analysis was performed for the experiment apparatus. Specifically, three turbulence models of standard k-ε, realizable k-ε, and k-ω shear stress transport were evaluated and mesh sensitivity analysis was performed. In result, realizable k-ε and k-ω shear stress transport models showed better predictions than standard k-ε model.

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