Optimization of the Flow Distribution Plate of SMART Using Computational Fluid Dynamics

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Abstract

The SMART is an integral type pressurized water reactor with a rated thermal power of 330MWt, currently under development at KAERI (Korea Atomic Energy Research Institute). In SMART design, the uniform distribution of the primary coolant is required at the entrance region of the reactor core. Therefore, the throttling orifices, the comb assembly, and the flow distribution plate (FDP) are installed at the bottom of steam generator (SG) cassettes, the bottom region in the downcomer, and the plenum below the core, respectively. The previous studies on the primary coolant circuit of SMART show that the FDP plays the most important role in the flow distribution in the lower plenum. The shape of the FDP is similar to the honeycomb with many small holes. And also, in general, larger pressure drop induced by the FDP tends to give a more uniform flow distribution in the lower plenum. However, the large pressure drop through the FDP may give adverse effects on the coolant flow during the natural circulation mode, and require more MCP power. Therefore, the design optimization of the FDP is needed to provide the uniform flow distribution with the reasonable pressure drop to the entrance region of the reactor core. Based on the primary system design, 5 cases were selected for the optimization of the FDP. The analysis was performed using computational fluid dynamics code CFX4.4 because the CFD requires less cost and time than the experimental method. The hydraulic resistance value of the FDP may be reduced to 50% of a nominal value, and may be reduced to 75% if the diameter of small hole on the center region in FDP is properly adjusted. These results will be used at the design optimization of the primary coolant circuit of SMART after performing the mechanical structure analysis.