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Numerical simulation of the supercritical water flow in the Canadian SCWR fuel bundle

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ABSTRACT

Canada has participated in the Generation IV nuclear energy systems with a main focus on the SCWR (Supercritical Water-cooled Reactor) system. The 64-element fuel rods channel is applied in the Canadian SCWR. Despite the study of the heat transfer of the supercritical water in the SCWR has been paid attention, there are few experimental and numerical studies of the thermal - hydraulic behaviors of the supercritical water in the fuel channels with multiple fuel rods. Thus, a CFD study can provide a deep understanding of the fluid flow and heat transfer of the supercritical water in the fuel channels with multiple fuel rods. To this end, the behavior of the flow and heat transfer of the supercritical water in the 64 element fuel rods Canadian SCWR fuel bundle has been investigated numerically in this work. A detailed CFD analysis based on, a validated modified Reynolds stress model with variant turbulent Prandtl number model, was carried out in this study. The results show that the flow recirculation appear at the outlet of the fuel channel and the higher coolant temperature always exist at the region surrounded by fuel rods. The maximum cladding surface temperature gradient along the circumference at the select axial locations is 18.31K near the exit. And the wall temperature distribution of fuel rods along the axial location exhibit strong fluctuations.