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Effects of the Flow Direction on the Fluid Flow and Heat Transfer in the Rod Bundle

Authors : Huirui Han, Chao Zhang

Abstract : The rod bundle is used in the fuel assembly of the supercritical water-cooled nuclear reactor. In the rod bundle, the coolant absorbs the heat contributed by the fission process. Because of the dramatic variations in the thermophysical properties of water at supercritical conditions, it is essential to investigate the heat transfer characteristics of supercritical water in the rod bundle to ensure the safety of the nuclear power plant. In this study, the effects of the flow direction, including horizontal, upward, and downward, on the fluid flow and heat transfer of the supercritical water in the rod bundle were studied numerically. The results show the possibility of gap vortices in the flow subchannels of the rod bundle. In addition, the distributions of the circumferential wall temperature show differences in different flow direction conditions. It was also found that the circumferential cladding surface temperature distribution in the upward flow condition is extremely non-uniform, and there is a large difference between the maximum wall temperatures for different fuel rods.

Keywords : heat transfer, rod bundle, supercritical water, wall temperature
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