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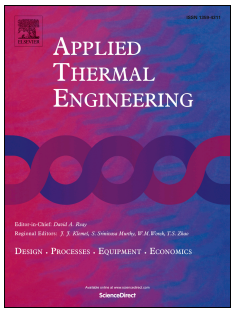

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Hybrid Heat Pipe Based Passive In-core Cooling System for Advanced Nuclear Power Plant

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Abstract

After the Fukushima accident in 2011, passive safety of nuclear reactors available under station blackout accidents like Fukushima has become the most pressing issue in the nuclear energy industry. For passive In-core cooling system (PINCs), the concept of a hybrid heat pipe, which is the combination of the heat pipe and neutron absorber was proposed to enhance the safety of advanced nuclear power plants. With the unique features of heat pipe and control rod, the hybrid heat pipe can remove decay heat directly from the core as it is inserted into the reactor pressure vessel with the same drive mechanism of a control rod. In this study, a two-step numerical analysis was performed for evaluating the concept of the hybrid heat pipe and its applications. The thermal performance of a single hybrid heat pipe was numerically analyzed using a commercial CFD code for designated designed features under reactor operation conditions. As a result, the hybrid heat pipe concept was found to remove 18.20 kW per rod with total thermal resistance of 0.015 °C/W. Using MALTAB, the one-dimensional thermal hydraulic analysis of reactor was conducted for the proposed PINCs to calculate the coolant temperature for evaluating the cooling performance of hybrid heat pipe. It revealed that the hybrid heat pipe was able to delay core heat-up at the station blackout accidents and extensions. If the hybrid heat pipe had enhanced heat removal capacity, it could continue cooling the core during accidents while preventing the core uncovery.

Keyword: Heat pipe, Passive IN-core Cooling systems (PINCs), Hybrid heat pipe, CFD

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