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Modeling of Proposed Passive Heat Pipe Loops Cooling System

Abstract

Heat-pipes are passive heat transfer devices, which have very long lives when properly designed and fabricated. Fuel pool Heat should be removed to keep fuel temperature within safe limit. A gravity assisted two-phase closed heat-pipe loop (GTPCHL) as a passive cooling system could be used to remove this heat. This paper proposes a completely passive cooling system using loop heat-pipe for cooling and dissipation the heat. The design is focus on heat removal from the pool of the small reactor to be in safe mode. The model considers natural convection by air for the condenser part of the heat-pipe loop to confine the heat. A numerical simulation using special design of (GTPCHL) were used to investigate the thermal performance. The effects of evaporator and condenser configuration, atmospheric air temperature, and heat load were analyzed. Demineralized water was used as the working fluid. The atmospheric air was circulated around the condenser as a heat-sink. The results show that the best thermal performance was obtained at a low atmospheric air temperature, biggest evaporator and condenser surface area, and a high evaporator heat load. The simulation model showed a pattern that can be used to predict the heat transfer phenomena of (GTPCHL) with varying inputs. A theoretical network model has been proposed to predict the transient response of (GTPCHL) at different heat loads (100, 200, 300, 400 and 500 kW). From this model wall and fluid temperatures, heat transfer coefficients, time constants, and other thermal characteristics have been estimated. The transient response of (GTPCHL) was found to depend mainly on the average evaporator thermal resistance. Increasing the heat loads causes a reduction in thermal resistance and in time constants, which leads to better performance of the heat pipe. The evaporator and condenser heat transfer coefficients were found to increase with increasing power.

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