Natural Convectionin Rectangular Pool with Volumetric Heat Sources

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Abstract

Natural convection plays an important role in determining the thermal load from debris accumulated in the reactor vessel lower head during a severe accident. Recently attentions are being paid to the feasibility of external vessel flooding as a severe accident management, and to the phenomena affecting the success path in retaining the molten core material inside the vessel. The heat transfer withinside the molten core material can be characterized by the strong buoyancy-induced flows resulting from internal heating due to decay of fission products. The thermo-fluid dynamic characteristics of the molten pool such flow depend strongly on the thermal boundary conditions. The spatial and temporal variation of heat flux on the pool wall boundaries and the pool superheat are mainly characterized by the natural convection flow inside the molten pool. In general, the natural convection heat transfer phenomena in involving the internal heat generation is delineated in terms of are represented by the modified Rayleigh number, Ra′, which quantifies the internal heat source and hence the strength of the buoyancy force. The test section is of rectangular cavity whose length, width, and height are 500mm, 80mm, and 250mm, respectively. A total of twenty-four T-type thermocouples were installed in the test loop to measure temperature distribution. Four T-type thermocouples were utilizedsed to measure the temperatures on the boundary temperature. A direct heater heating method was adopted in this test to simulate the uniform heat generation. The experiments covered a range of Rayleigh number, (Ra,) between 4.87×10^{7} and 2.32×10^{14} and Prandtl number, (Pr,)between 0.7 and 3.98. Tests were conducted with water and air as simulant. The upper and lower boundary conditions were maintained at a uniform temperature of 10C.