World Academy of Science, Engineering and Technology
International Journal of Mechanical and Industrial Engineering
Vol:11, No:05, 2017

Study on the Thermal Mixing of Steam and Coolant in the Hybrid Safety Injection Tank

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Abstract : In such passive safety injection systems in the nuclear power plant as Core Makeup Tank (CMT) and Hybrid Safety Injection Tank, various thermal-hydraulic phenomena including the direct contact condensation of steam and the thermal stratification of coolant occur. These phenomena are also closely related to the performance of the system. Depending on the condensation rate of the steam injected to the tank, the injection of the coolant and pressure equalizing timings of the tank are decided. The steam injected to the tank from the upper nozzle penetrates the coolant and induces a direct contact condensation. In the present study, the direct contact condensation of steam and the thermal mixing between the steam and coolant were examined by using the Particle Image Velocimetry (PIV) technique. Especially, by altering the size of the nozzle from which the steam is injected, the influence of steam injection velocity on the thermal mixing with coolant and condensation shall be comprehended, while also investigating the influence of condensation on the pressure variation inside the tank. Even though the amounts of steam inserted were the same in three different nozzle size conditions, it was found that the velocity of pressure rise becomes lower as the steam injection area decreases. Also, as the steam injection area increases, the thickness of the zone within which the coolant's temperature decreases. Thereby, the amount of steam condensed by the direct contact condensation also decreases. The results derived from the present study can be utilized for the detailed design of a passive safety injection system, as well as for modeling the direct contact condensation triggered by the steam jet's penetration into the coolant.

Keywords : passive safety injection systems, steam penetration, direct contact condensation, particle image velocimetry
Conference Title : ICTHT 2017 : International Conference on Thermophysics and Heat Transfer
Conference Location : Amsterdam, Netherlands
Conference Dates : May 14-15, 2017