3D Simulation of a High Pressure Water Injection into a Circular Cold Leg Pipe Flow

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Injection of a water stream into a circular pipe flow of a different orientation appears in many important engineering applications, such as in nuclear reactor safety analysis, the mixing of two fluids at a T-shaped junction, etc. In this regard, the analysis of pressurized thermal shock (PTS) in the nuclear industry is a special issue. One of the major efforts concerning this issue is to predict the mixing behavior and stratification of a round cold jet from the safety high-pressure injection (HPIS) line with a hot loop flow circulating in the cold-leg pipe. Typically, in Westinghouse pressurized water reactor (PWR) systems, high-pressure water from 60° injector is charged into the horizontal cold leg.

IThe paper will discuss the 3D finite volume simulation, using CFD (computational fluid dynamic) code FLUENT, of the EPRI/Creare experimental results (one-fifth-scale model of PWR HPIS and cold-leg mixing), test numbers 42 and 46. The reason for this work is to validate FLUENT capability on benchmarked test results, as a preparation for its use in the more complex 3D finite volume analysis of full scale water mixing in the reactor vessel downcomer. It is part of the study mentioned to observe the most severe design basis accident sequences conditions for NPP Krško and re-evaluate their PTS potential. The most important factors needed for PTS analysis are the following: the final temperature in downcomer, the temperature decrease rate, non uniform cooling of the reactor pressure vessel wall (characterized by cold plume of SI water) and the RCS pressure.

Keywords: thermo-hydraulic analysis, simulation, flow mixing, stratification, pressure thermal shock, nuclear power plant