

Evaluation of the Use of the MPS Method in Simulating the Centralized Sloshing Phenomenon in an SFR Reactor

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The Indonesian government aims to incorporate nuclear energy into its Net Zero Emission 2060 strategy, with nuclear power plant operations projected to begin by 2032. The Sodium Fast Reactor (SFR) system stands out across various aspects. However, using liquid sodium as a coolant in SFRs presents thermohydraulic safety challenges, particularly in Unprotected Loss of Flow (ULOF) scenarios. Previous studies have shown that ULOF can lead to centralized sloshing, increasing the risk of recriticality.

This study evaluates the Moving Particle Semi-implicit (MPS) method for simulating the centralized sloshing phenomenon in SFRs, using Maschek's (1992) experiment as a benchmark. The research incorporates modifications to the MPS method proposed by Kondo and Koshizuka (2020) to address known limitations of the classic MPS algorithm, such as pressure fluctuations and singularity issues in the weighting function. Initial surveys indicate that smaller particle sizes yield more accurate results. The 'WP Modification' within Kondo's MPS improvements significantly enhances accuracy by improving particle compactness and thrust. The study also includes a size parameter survey and a 2D beta and gamma survey for time efficiency, comparing the best beta and gamma formulations with classical methods based on accuracy, pressure analysis, velocity vectors, and non-dimensional flow characteristics. The optimal results are then compared with the Smoothed Particle Hydrodynamics (SPH) method. The findings suggest that the MPS method with Kondo's improvements effectively simulates centralized sloshing, leading to denser particle motion and more accurate pressure, with accuracy dependent on the proper selection of beta and gamma parameters.

Technical Track

Safety and Severe Accidents

Primary author: SATRIO, Aziz (Bandung Institute of Technology)

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