# A Multiphase MPS Method with Fluid-Solid and Solid-Solid interaction models for Simulating Melt Pool Formation inside RPV

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A multiphase MPS method is developed by coupling the passively moving solid model for fluid-solid interaction and discrete element method for solid-solid collision to simulate the melt pool formation from solidified debris blocks. The influence of debris size, decay heat power and thermal contact resistance on melt pool formation is investigated.

**Keywords:** MPS method; Multiphase flow; Fluid-solid interaction; Phase change; Melt pool formation

## 1. Introduction

In a postulated severe accident of a nuclear reactor, predicting the temperature and phase distributions of the melt pool with possible unmolten oxide debris is of great significance to understand the breach modes of the reactor pressure vessel (RPV). The melt pool formation involves fluid-solid interaction, solid-solid collision, heat transfer and phase change phenomena. Due to the Lagrangian nature, the moving particle semi-implicit (MPS) method is suitable for such complicated flow. Thus, a multiphase MPS method is developed in this study for the melt pool formation flow.

## 2. Numerical methods

The passively moving solid (PMS) model is capable to simulate fluid-solid interaction [1] in MPS. However, when there are multiple solid bodies, the overlaping of rigid bodies probably takes place. The discrete element method (DEM) can be employed to model solid-solid collision and avoid the overlapping issue [2]. In this study, the PMS and DEM models are coupled into the authors' previous multiphase MPS method with heat transfer and phase change [3]. The developed method is capable to simulate the melt pool formation process from solidified debris blocks under the effect of decay heat.

## 3. Simulations and discussion

During the process of melt pool formation, the heat transfer rate from the oxide debris with decay heat to the metal-rich debris can be significantly influenced by the relocation of melting debris, which is resolved by the fluid-solid and solid-solid interaction models in this study. Besides, the debris melting is significantly affected by the debris size, decay heat power and thermal contact resistance at the solid-solid contact area. Therefore, their influence is investigated one by one.

## 4. Conclusion

A new multiphase MPS is developed by coupling the PMS and DEM models for the fluid-solid interaction flows with heat transfer and phase change. The influence of debris size, decay heat power and thermal contact resistance on melt pool formation is investigated.

## 5. Acknowledgements

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