

Recent Developments of Smoothed Particle Hydrodynamics Models for Simulating Violent Free-Surface Flows

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ABSTRACT

Smoothed Particle Hydrodynamics (SPH) has become a powerful tool for the simulation of violent free-surface flows, with applications ranging from coastal and offshore engineering to energy systems and aerospace technologies. In recent years, the development of SPH models has moved beyond traditional conservative formulations toward non-conservative approaches, in which carefully designed corrections are introduced. Although these modifications deliberately break strict conservation, they effectively address some of the main limitations of classical SPH schemes, such as tensile instability, while also improving accuracy and enabling the use of particles of different sizes without the need for buffer zones. In this context, the RHOD-SPH model, developed in 2023, represents a significant step forward in this new generation of non-conservative SPH formulations. The Plenary Lecture will present the rationale behind these methodological advances, compare several state-of-the-art models, and highlight their advantages through selected applications. Particular attention will be given to emerging fields, including the analysis of sloshing phenomena in cryogenic tanks, where these new SPH strategies show remarkable potential.

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