Prediction of energy dissipation in violent 3D sloshing flows by Smoothed Particle Hydrodynamics

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The present work aims to investigate the use of fuel sloshing to reduce the design loads on aircraft wings. These are highly flexible structures, that can deform significantly under certain loading. Wings house the fuel tanks, and generally carry an amount of fuel comparable in weight to that of their structural components. In the present research the SPH model is adopted to investigate the damping effect of fuel sloshing on the dynamics of flexible wing-like structures. This represents a quite challenging task for SPH and more in general, for CFD tools, being the fuel tank under study subjected to vertical accelerations as high as 10g. The resulting flow is extremely complex due to the highly turbulent flow, the violent impacts and intense fragmentation of the air-liquid interface. In previous work by [1] the experiments in [2] are reproduced in the two-dimensional numerical simulations comparing the flow evolution and the obtained forces and dissipated energy. In the present work three-dimensional simulations are considered and 3D effects on the energy dissipation mechanisms are investigated.

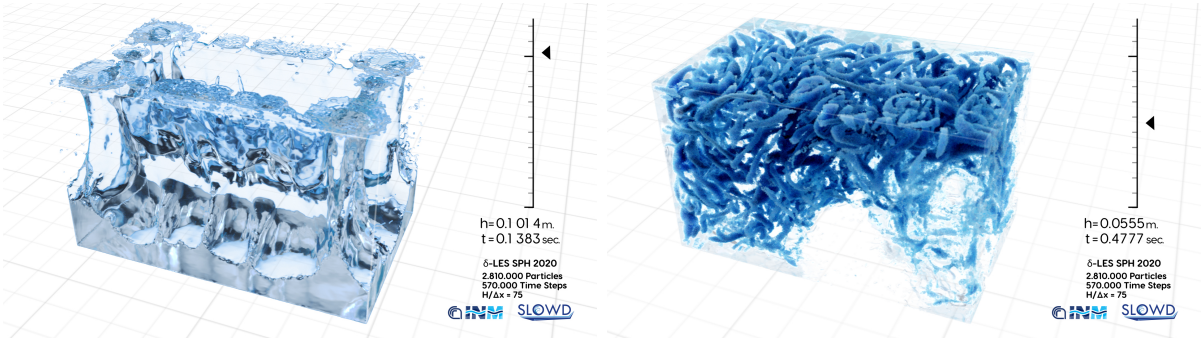

Figure 1: *Two representative time instants of the violent vertical sloshing flow. Left: representation of the air-water interfce during the initial Rayleigh-Taylor instability; right: flow impact against the tank ceiling and vortical structures detected through Q-criterion.*

References

[1] S. Marrone, A. Colagrossi, L. González-Gutiérrez, J. Calderon-Sanchez, and J. Martinez-Carrascal. Prediction of energy dissipation in violent sloshing flows simulated by Smoothed Particle Hydrodynamics. In *15th ERCOFTAC SPHERIC International Workshop*, 2021.

[2] J. Martinez-Carrascal and L. M. Gonzalez-Gutierrez. Experimental study of the liquid damping effects on a sdof vertical sloshing tank. *Journal of fluids and structures*, 100, 2021.