

SPH modelling of the interfacial gas-liquid flows with regime transition

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ABSTRACT

Smoothed Particle Hydrodynamics (SPH) is a meshless, particle-based method for fluid flow modelling. Its main advantage over Eulerian approaches in multiphase flows computations lies in the fact that the shape of the interphacial surface can be determined explicitly from positions of the particles of different phases. Therefore, there is no need to reconstruct the interface. The multiphase SPH formalism of [2] has been further extended in many ways. While SPH yields accurate results for simulations of single bubbles/droplets [5], its performance in more complex cases is still object of research. Also, model extensions are proposed for specific applications such as the wetting phenomena [3].

The present study builds on — and considerably improves — our first attempt to investigate the applicability of SPH for modelling two-phase interfacial flow in a channel [4]. The topic has gained recent interest [1]. The gas-liquid flow systems feature bubbly, slug, annular and churn patterns. Our main focus here is to simulate those different flow regimes (Fig. 1) and to capture the transition between them, depending on the conditions in the channel. We present qualitative and quantitative results of SPH simulations compared with experimental reference data, including the so-called flow regime maps. We also discuss the difficulties in the multiphase SPH and possible remedies.

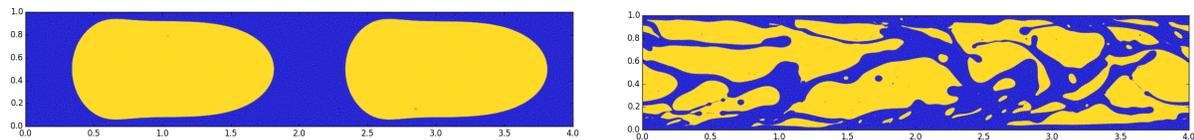


Figure 1: Two-phase flow patterns (slug and churn) in a channel obtained through SPH simulation.

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REFERENCES

- [1] Douillet-Grellier, T., De Vuyst, F., Calandra H. and Ricoux P. Simulations of intermittent two-phase flows in pipes using SPH. *Comp. Fluids*, Vol. **177**, pp. 101–122 (2018).
- [2] Hu, X.Y. and Adams, N.A. A multi-phase SPH method for macroscopic and mesoscopic flows. *J. Comp. Phys.*, Vol. **213**, pp. 844–861 (2006).
- [3] Olejnik, M. and Pozorski, J. A robust method for wetting phenomena within Smoothed Particle Hydrodynamics. *Flow Turb. Combust.*, under review (2019).
- [4] Olejnik, M., Szewc, K. and Pozorski, J. Modelling of the flow regime transition with the SPH. *9th International Conference on Multiphase Flow*, Firenze, Italy; Proceedings, paper #1037 (2016).
- [5] Szewc, K., Pozorski, J. and Minier, J.-P. Simulations of single bubbles rising through viscous liquids using Smoothed Particle Hydrodynamics. *Int. J. Multiphase Flow*, Vol. **50**, pp. 98–105 (2013).