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VALIDATION OF AN IN-HOUSE LATTICE BOLTZMANN SOLVER FOR A MULTIPHASE FLOW APPLICATION

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Multiphase flows is one of the main research areas of Lattice Boltzmann Method (LBM). The main reason is the flexibility of LBM formulations in comparison with Navier-Stokes solvers when dealing with complex physical phenomena such as multiphase flows. The traditional Navier-Stokes equations techniques: Volume of Fluid (VOF), Eulerian-Eulerian and Lagrangian-Eulerian approaches involve the solution of a set of non-linear partial differential equations for each phase or component. In contrast, the LBM techniques for multiphase flows deal with only one partial differential equation for each fluid phase to describe the evolution of a particle function distribution. Since the emergence of LBM for multiphase flows in the late 1980s, the validation of different methods was carried out on theoretically well-known solutions such as the Laplace's law for the calculation of the surface tension [1], the layered two phase flow in a channel [2], or relying on Jurin's and Wahsburn's laws [3]. In this work, the evolution towards equilibrium of a two-dimensional bubble is analysed in the context of investigations performed to validate an in-house parallelised LBM solver for multiphase flow applications. The numerical experiment consists of a heavy and elliptic bubble immersed in a lighter fluid which oscillates until reaches the equilibrium state. The initial curved interface induces a damped oscillating movement whose frequency can be calculated analytically for inviscid two-dimensional flows [4, 5]. This theoretical prediction requires to know a priori the surface tension value of the interface which is taken from the numerical method. Hence, this numerical experiment allows to validate the performance of the in-house LBM code to reproduce an unsteady process in which case the surface tension is taken into account.

REFERENCES

[1] A. K. Gunstensen, D. H. Rothman, S. Zaleski and G. Zanetti, Lattice Boltzmann model of immiscible fluids. *Phys. Rev. A.* **43**, 4320, 1991.

[2] H. Huang, L. Wang and X. Lu, Evaluation of three lattice Boltzmann models for multiphase flows in porous media. *Comput. Math. Appl*. Vol. **61**, pp. 3606–3617, 2011.

[3] S. Leclaire, A. Parmigiani, O. Malaspinas, B. Chopard and J. Latt, Generalized three-dimensional lattice Boltzmann color-gradient method for inmiscible two-phase pore-scale imbition and drainage in porous media. *Phys. Rev. E.* **95**, 033306, 2017.

[4] A. Toutant, Modélisation physique des interactions entre interfaces et turbulence, Ph.D. thesis, *Institut National Polytechnique de Toulouse*, 2006.

[5] H. Lemonnier and D. Jamet, Test-cases for interface tracking methods, *Test Case 5: Oscillation of an inclusion immersed in a quiescent fluid (PA)*, pp. 41–47, 2004.