THERMAL AND MULTIPHASE VALIDATIONS WITH THE LATTICE BOLTZMANN METHOD SOFTWARE XFLOW

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ABSTRACT

Traditional simulation tools for Computational Fluid Dynamics (CFD), based on solving the Navier-Stokes (NS) equations with numerical methods like Finite Volumes, have two big inconveniences: they require the user to spend countless hours preparing a suitable mesh and they have a very low efficiency for parallel computation.

The Lattice Boltzmann Method [1] (LBM) is an alternative scheme for CFD simulations that is based on solving the discretized Boltzmann equation with simplified collision dynamics:

$$F_i(x + \Delta x, t + \Delta t) - F_i(x, t) = Q_i \qquad (1)$$

Where F_i is the particle distribution function and Q_i the collision operator. This is a much simpler numerical scheme than solving NS, it is computed on a regular lattice and allows for tremendous parallel efficiency.

This project, proposed by the company Next Limit Technologies, consisted on simulating a series of test cases with their software XFlow, a young CFD code based on the LBM, with the objective of validating its results against experimental data and other numerical codes.

In particular, one thermal simulation (T-Junction [2]) and two multiphase test cases (Rising Bubble [3] and Rayleigh-Taylor instability [4]) were studied.

Overall, the obtained numerical results showed a mixed success, indicating a need for further enhancements in the implementation of the different numerical solvers involved.

Only a small subset of data is be presented here.

RESULTS

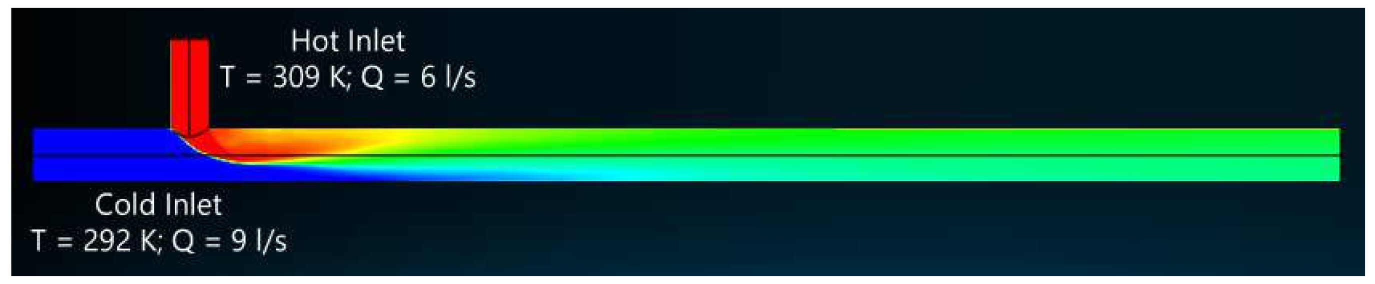

Fig. 1: Overview of the T-Juntion simulation. Averaged temperature field after 16s.

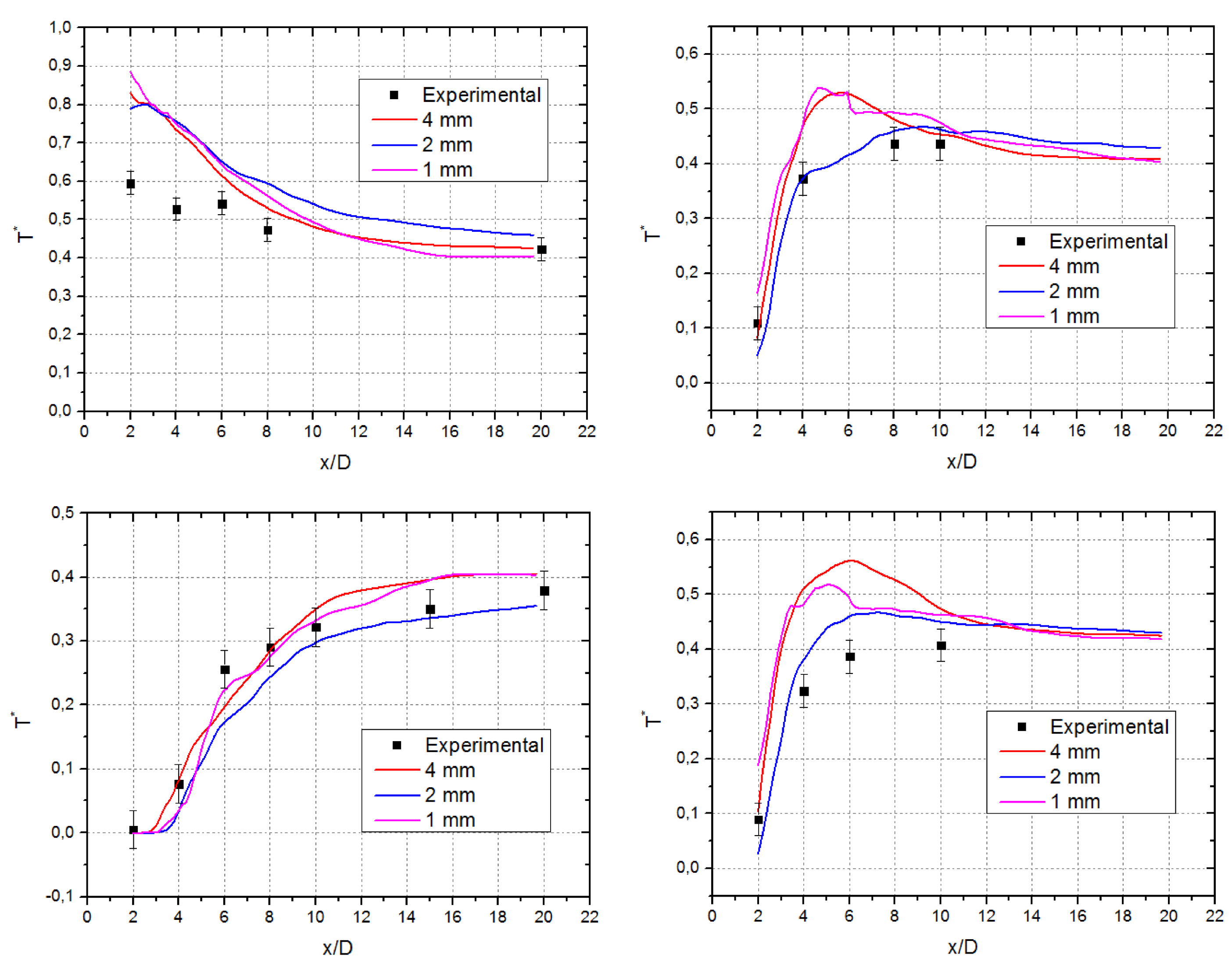

Fig. 2: Temperature profiles along the top, left, bottom and right sides of the pipe for different lattice resolutions compared against experimental data.

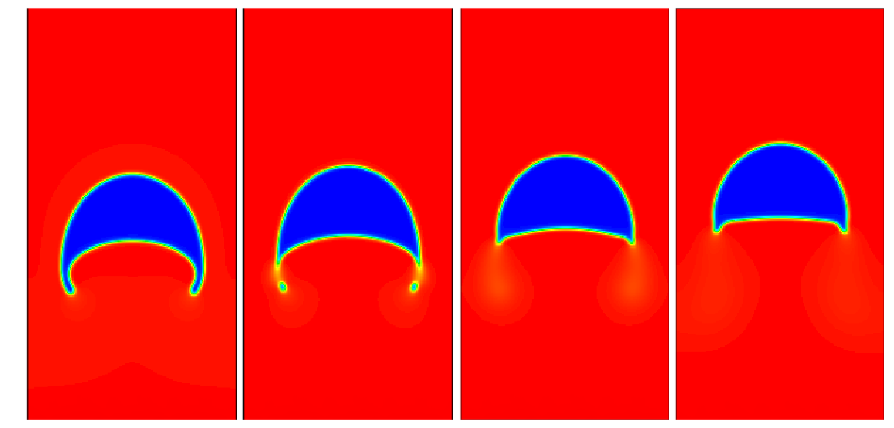

Fig. 3: Overview of the rising bubble case. Shape of the bubble at different time steps during the simulation.

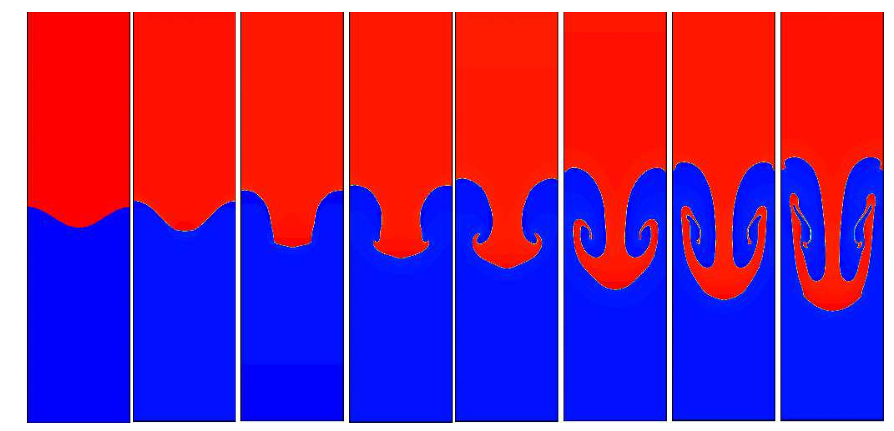

Fig. 4: Evolution of the Rayleigh-Taylor instability as obtained with XFlow.

REFERENCES

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