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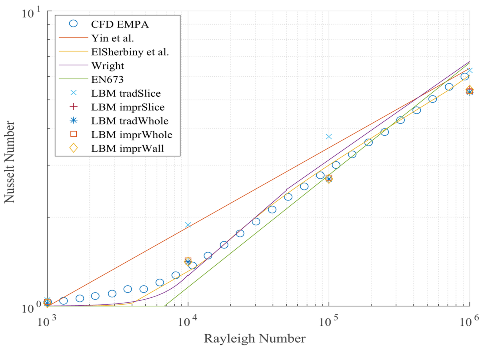
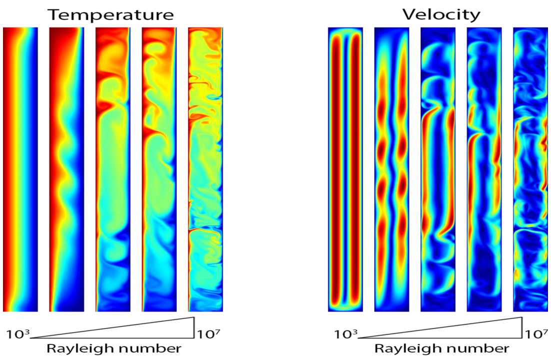
Topic	Environmental Engineering
Project Partners	TetraPak It , Modena IT

Thermal simulations at low to modest Reynolds number using the Lattice Boltzmann method

A comparison to conventional CFD



Results of heated cavity test case and comparison of different Nusselt calculations with varying Rayleigh numbers.

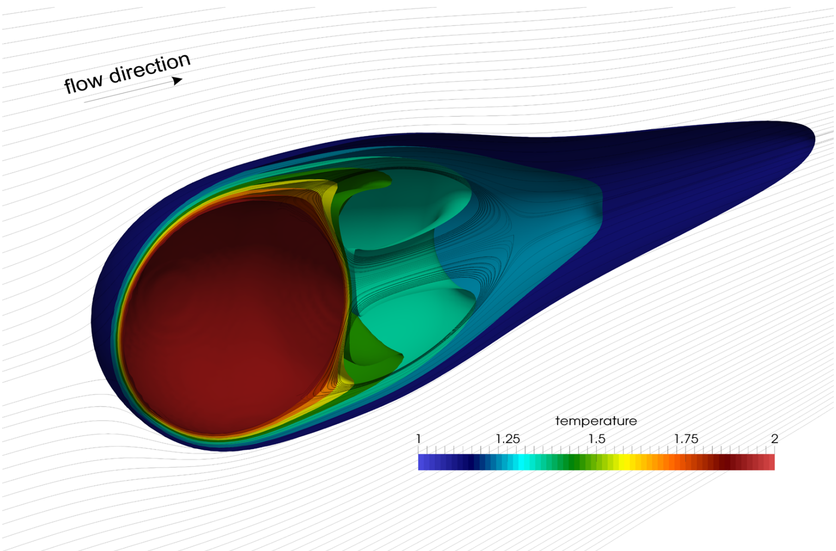


Temperature and velocity contours of a heated cavity for different Rayleigh numbers (red = hot/high velocity, blue = cold, low velocity

Introduction: The Lattice Boltzmann method is a modern approach in Computational Fluid Dynamics to solve the incompressible, time-dependent Navier-Stokes equations numerically. Unlike classical macroscopic Navier–Stokes methods, which solve the conservation equations of macroscopic properties (i.e., mass, momentum, and energy) numerically, the Lattice Boltzmann method uses a mesoscopic simulation model to simulate fluid flow. It uses modeling of the movement of fluid by performing repeated propagation and collision processes of particles to capture macroscopic fluid quantities, like velocity and pressure. In this approach, the fluid domain is made discrete in uniform Cartesian mesh, each node holds a fixed number of distribution functions that represent the number of fluid particles moving in these discrete directions.

Objective: The capabilities of LBM are tested with different validation cases like heated cavity or flow over a heated sphere in a channel and compared to analytical and numerical results. The final goal of the thesis is to apply LBM to analyse the flow pattern, temperature field and pressure drop inside an evaporator used by TetraPak. The used evaporator consists of a very complex geometry for which the mesh generation with conventional CFD tools proves to be difficult and time consuming. By comparing the Lattice Boltzmann method with conventional CFD Simulations and measurements, it is to be investigated, if the Lattice Boltzmann method is an alternative method to be used by TetraPak.

Result: The thesis has shown that LBM is a powerful and capable alternative to conventional CFD. Its fundamental advantage is efficiency and the capability to fully resolve flow through complex geometries and coupled flow with heat transfer.



Temperature contours around an isothermal heated sphere at low Reynolds number (laminar)