Simulation of a Lock Exchange Gravity Driven Flow using OpenFoam

Subham Kumar Das
Fourth Year B.Tech Student
Department of Chemical Engineering
National Institute of Technology Durgapur

ABSTRACT

The primary objective of the proposed project will be to capture the the currents produced in a gravity driven lock exchange flow. In such a flow, fluids of different densities initially at rest are separated by a vertical barrier, like the lockgate of a dam. The barrier is removed to allow the two fluids flow in opposite directions under the influence of gravity. The hydrostatic pressure cause the denser fluid to flow in one direction along the bottom boundary of the tank, while the lighter fluid flows in the opposite direction along the top boundary of the tank. We will visualize the phase fraction contours showing the movement of gravity currents and aim to comment on the physics of the gravity currents produced.

We will simulate both the initial conditions mentioned in [1] and use adaptive mesh refinement to capture the interface between the two fluids effectively. We will simulate three pairs of fluids with density ratios of

a) 1:1.05 (negligable density difference, like freshwater and seawater)

b) 1:100 (high density difference)

c) 1:10000 (very high density difference, like air and mercury)

The OpenFoam solver interFoam will be used for the problem. It is a multiphase Solver for two incompressible, isothermal immiscible fluids using a VOF (volume of fluid) phase-fraction based interface capturing approach.

References

1. Shin, J., Dalziel, S., & Linden, P. (2004). Gravity currents produced by lock exchange.

Journal of Fluid Mechanics, 521, 1-34. doi: 10.1017/s002211200400165x