

# Parallelization of an experimental multiphase flow algorithm

**keywords:** multiphase flow, navier stokes, level set, volume of fluid, domain decomposition, preconditioning

## Introduction

In the past few decennia, the interest in the simulation of multiphase flows (i.e. the combined flow of two or more different fluids) has greatly increased due to a growing variety of dedicated numerical methods and the associated capacity of computational resources. In industry, examples of multiphase flows are ubiquitous: boilers, cavitation, mixers and transport of hydrocarbons through pipelines are but a few of them.

At Delft University, a dedicated algorithm for two-phase, immiscible and incompressible flows has been developed: the Mass Conserving Level Set (MCLS) method. It broadly consists of a flow solver that is coupled with an interface model that comprises a coupling between the Level Set method and the Volume of Fluid method on uniform Cartesian meshes. Recently, the original MCLS method has been modified and extended to axisymmetric and fully cylindrical domains to study the onset of two-phase flow instabilities in straight pipe sections.

## Project description

In this project, the cylindrical MCLS algorithm will be parallelized to speed up computations on fine grids. A domain decomposition is to be performed after careful observation of the dependencies of the implemented sub-algorithms. Furthermore, a significant amount of CPU time is spent on solving the pressure Poisson equation. Because the coefficients of the Laplacian are not constant, Fourier methods cannot be used and a preconditioned (Incomplete Cholesky) Conjugate Gradient method is implemented instead. The large jumps in the coefficients (in the order of ratio of the fluid densities) make preconditioning essential. Since the Incomplete Cholesky preconditioner is hard to parallelize, an alternative has to be sought. To validate the result, the parallel algorithm will be used to simulate a well known bench mark case.