University of Alberta

Mechanical Engineering

Numerical Simulation of Complex Flows

MECE 738

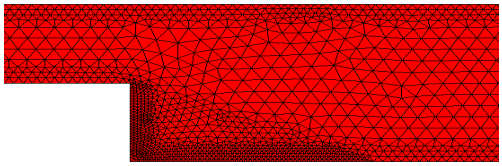
Students interested in CFD (Computational Fluid Dynamics) will find advanced topics on numerical simulation of complex flows in this course. In particular, they will learn how to simulate two important classes of fluid flows, namely non-Newtonian flows and multiphase flows.

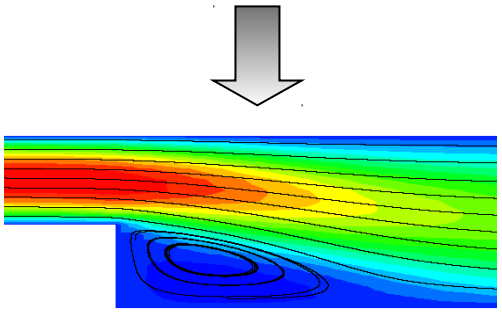
$$\frac{\partial \rho}{\partial t} = \frac{1}{c^2}\frac{\partial p}{\partial t} = -\frac{\partial U_i}{\partial x_i}$$

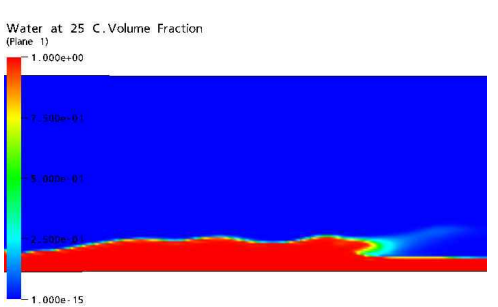
$$\frac{\partial U_i}{\partial t} = -\frac{\partial}{\partial x_j}(u_j U_i) + \frac{\partial \tau_{ij}}{\partial x_j} - \frac{\partial p}{\partial x_i} - \rho g_i$$

$$\tau + \lambda \frac{\partial \tau}{\partial t} = -\eta \dot{\gamma}$$

Common examples of non-Newtonian fluids are blood, molten polymers, as well as bitumen and heavy oil. The numerical simulation of non-Newtonian flows has many applications in the oil and polymer industries, and the food industry, for example. Numerical simulations of multiphase flows (e.g. particles in air, surface waves or bubbles in water) are also found in a wide range of applications, from biomedical engineering to environmental pollution, from energy generation to disaster prevention.







Instructors: Dr. Abazar Shamekhi and Dr. Carlos Lange

Objectives:

Learn and understand methods for modelling, discretization and solution of non-Newtonian flows and multiphase flows.

Topics covered:

- ✓ Introduction to non-Newtonian Fluid Mechanics
- ✓ Classification of non-Newtonian fluid flows
- ✓ Generalized Newtonian fluid models
- ✓ Order fluid models
- ✓ Viscoelastic fluid models
- ✓ Classification of multiphase flows
- ✓ Lagrangian Particle Tracking model
- ✓ Eulerian Multicontinua model
- ✓ Volume of Fluid method