# A STABILIZED FINITE ELEMENT METHOD FOR A TIME-DEPENDENT INCOMPRESSIBLE TWO-PHASE FLOW MODEL

**Tamás Bányai**, Hungary
Supervisors: H. Deconinck & D. Vanden Abeele

In the past decades the increase of the computational power has allowed to deal with more and more complicated flow models. One member of that family is the model of two-phase flow. Over the last years the VKI has been actively involved in the development of tools for the simulation of two-phase flow in electrochemical reactors, most recently in the context of the IWT-SBO-project MuTEch (Multiscale approach to Transport phenomena in Electrochemical processes).

In the present work, an incompressible laminar two-phase flow solver, based on an Eulerian-Eulerian two-fluid model represented the point of beginning. The base of this two-fluid model is the Navier-Stokes and continuity equations for incompressible flow. The closure of the system is obtained by the equations for the volume fractions. Interactions between the phases are taken into account by means of drag, lift and virtual mass force. The discretization used in the is solver is based on finite elements.

The main task in the present project was to develop the unsteady (time accurate) version of the code. Two time discretization methods have been implemented, namely the family of Θ–schemes (including Cranck-Nicholson) and the explicit Adams-Bashforth scheme. By finishing the implementation of all the force terms now the full physical model is available. Also additional improvements have been made to improve the stability and robustness of this solver. The PSPG stabilization has been changed to a more consistent formulation, leading to a much more smooth volume fraction field. A kind of shockwave capturing feature is now under development to overcome the FEM discretization's backdraw, the lack of monotonicity.

Concerning the validation, various test cases have been used to test the software. The code is validated against well known problems taken from literature or in-house derivation of analytical solution. The water faucet, the phase separation with extra force term and the oscillating manometer test cases have been investigated. The results show good agreement with the references as illustrated with the water faucet problem (Figure 1.a) showing a moving contact discontinuity. Research has also been made towards more realistic time dependent problems like a two-phase flow past a cylinder (Figure 1.b.).

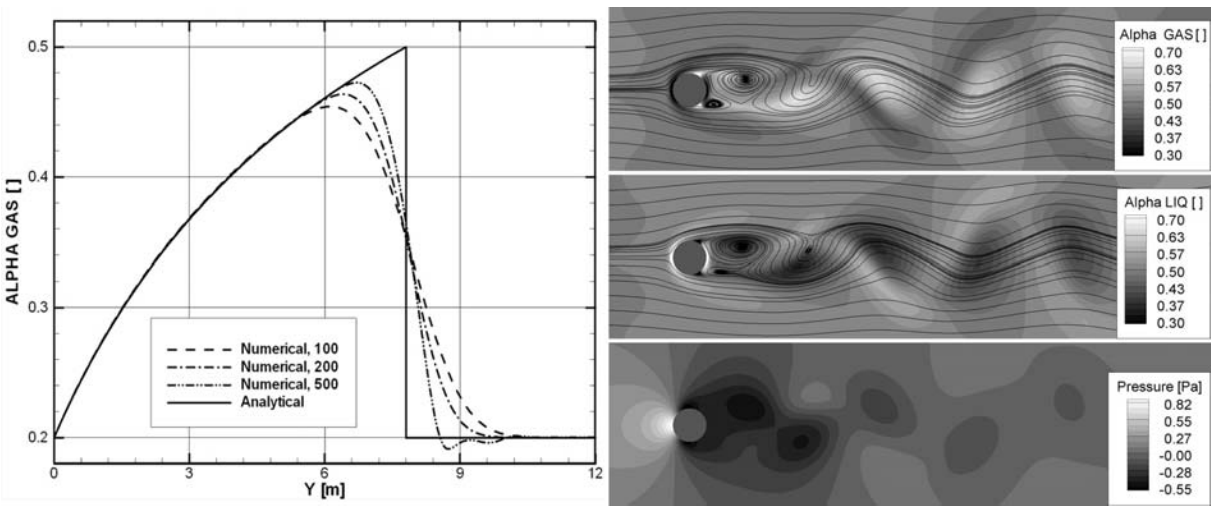


*Figure 1: (a) Water faucet validation testcase (b) Two-phase von Kármán vortex street past a cylinder with 50% gas fraction at the inlet*