FINITE ELEMENT BASED SOLVER FOR TWO-PHASE FLOW

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Over the last years the von Karman Institute has been actively involved in the development of tools for the simulation of two-phase flow in electrochemical reactors, in the context of two European Union 5th framework projects (DESINER and SPECTRUM).

In the past, the approach followed was based on extending compressible flow algorithms to these incompressible flow applications. In the present project a new path is taken by developing a fully incompressible two-phase flow solver. The model starts from an Eulerian approach for the two phases, based on the incompressible flow equations for laminar viscous flow. Interactions between the phases are taken into account by drag, lift and virtual mass forces.

A Finite Element (FE) approach has been adopted, in the discretization, for different reasons. One is related to the successful background of SUPG and PSPG stabilization techniques connected with this method; our attention has particularly focused on these stabilization methods adapted to the present governing equations for two-phase flow. The second reason is the possibility of coupling this two-phase flow solver with the FE electrochemistry solver developed by VKI contract partners.

Development, implementation, and validation of the algorithm are presented. The first step was the development of a single-phase solver, which constitutes the basis for the introduction of the two-phase model. Then the equations describing the two-phase flow are presented and a well-suited stabilization is designed. Finally, the obtained two-phase flow solver is validated through comparisons on the simulations of well-known test cases. The figure shows the void fraction (gas phase concentration) contours and the velocity streamlines for a T-junction with developed two-phase flow (50% gas) imposed at the inlets on the left and below. Gas accumulates on the bottom wall behind the junction due to its lower inertia.

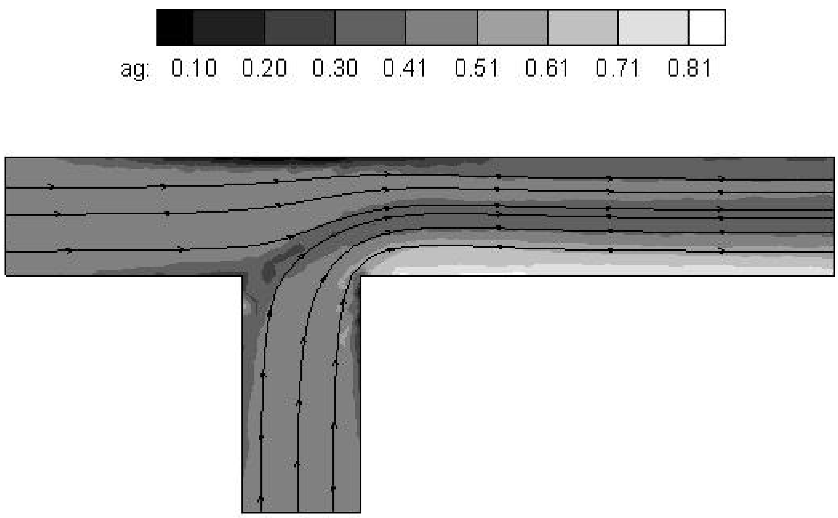

Figure 1: Void fraction contour plot along the T-junction, Re=150