# FEM SIMULATION OF COUPLED FLOW AND SCALAR TRANSPORT IN HYDROPOWER PLANT RESERVOIRS

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A numerical model is proposed for solving the Navier-Stokes equations coupled, through the physical properties of the fluid, to the transport equation of chemical species and energy, to simulate the complex fluid flow and transport in hydropower plant reservoirs. The Finite Element Method is employed in the problem discretization using a tetrahedral mesh with MINI element. This type of element fulfills the LBB condition and assures the stability of the numerical procedure.

The code is developed using the object-oriented paradigm, for easier maintenance and further development. Spatial discretization of the diffusion and pressure terms is made through the Galerkin method whereas the substantial derivative is treated through a semi-Lagrangian technique [1], using a first-order backward Euler implicit scheme. This technique hides the non-linearity of the convection term. The large systems of coupled linear equations are solved through the discrete projection method based on the LU decomposition [2], resulting in symmetric positive-definite system matrices. The method proved to be stable in all CFL and Reynolds conditions, not showing spurious oscillations or excessive numerical diffusion even under large Reynolds number conditions. The code is part of a system developed to analize the water quality during the filling of hydroelectric power plants reservoirs.

**References**

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[2] J. B. Perot, "An analysis of the fractional step method," *Journal of Computational Physics*, v. 108, p. 51-58, 1993.