XVIII International Conference on Water Resources
CMWR 2010
J. Carrera (Ed)

A HYBRID LEVEL-SET METHOD FOR FREE-SURFACE FLOWS

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Summary. Two-phase Navier-Stokes models are becoming increasingly popular for modeling free-surface flows and hydrodynamic processes. They hold particular appeal for problems where full vertical resolution is required in velocity and pressure, (e.g., short-wave phenomena, flow around coastal structures and levees, and extreme erosion processes). Level-set and volume-of-fluid formulations are the two most common approaches for modeling two-phase flows and both can be used across many flow regimes. Both share an advantage over front-tracking methods in that they are robust through changes in connectivity of the phases such as during bubble formation and wave breaking.

However, standard level-set methods do not conserve mass. The conservation errors are the result of describing interface dynamics using a level-set formulation and are not specific to the discrete approximation. Since conservation errors accumulate to produce qualitatively incorrect solutions, several researchers have attempted to address this issue by using hybrid level-set/volume-of-fluid and hybrid level-set/particle-tracking approaches. In this work we present a method for correcting the level set in order to control mass conservation error. The correction is defined as the solution of a nonlinear reaction-diffusion equation and can be applied to higher order finite element methods on unstructured meshes. Numerical results are presented for linear and quadratic approximations of incompressible air/water flows.