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Free surface flow with an oscillating cylinder based on a two-fluid model

An accurate computational method for a viscous incompressible fluid flow past a circular cylinder beneath the free surface is presented. The method is designed for studying free surface problems with arbitrary moving circular cylinders. The method of solution is based on a finite volume discretization of the two-dimensional continuity and unsteady Navier–Stokes equations in their pressure-velocity formulation on a fixed Cartesian grid. Well-posed boundary conditions are enforced at the inflow and outflow boundaries since they ensure correct physical development of the flow near the computational domain boundaries. The free surface boundary conditions are applied implicitly by using a two-phase flow technique which treats the air phase and the fluid phase as a single fluid with variable material properties. The displacement of a free surface is tracked by using the volume of fluid method. The fractional area/volume obstacle representation method is combined with the cut cell method to improve the accuracy of the spatial discretization of a fluid-body interface. The numerical algorithm is verified by applying it to the special case of uniform flow past a cylinder undergoing forced oscillations in streamwise direction in the presence of a free surface.

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