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Cylindrical waves at the interface of viscous immiscible fluids[1]

RATUL DASGUPTA, PALAS KUMAR FARSOIYA, Dept. Chemical Engineering, Indian Inst of Tech-Bombay — We conduct Navier-Stokes simulations of cylindrical, axisymmetric standing gravity waves at the interface of radially unbounded, immiscible viscous fluids. The fluid motion generated by these oscillations are studied. Results from the numerical solutions are compared to the analytical solution of an integro-differential equation representing the amplitude of motion of the interface. Standing waves are initiated at the interface as zeroth order Bessel's mode at rest i.e. $h(r,0) = H_0\,(1 + \epsilon J_0(kr))$ where H_0 is the undisturbed fluid depth in the simulation, chosen to be large enough for deep water approximation to hold. For small initial amplitudes (compared to $2\pi k^{-1}$), we obtain good agreement with the analytical solution at early times. As we increase initial amplitude, the time period of the first oscillation is found to increase. Diffusion of vorticity from the interface is studied as a function of initial amplitude. We compare our results to the analytical solution obtained from the corresponding planar problem (Prosperetti, 1981). We will discuss these results in the framework of the viscous Cauchy-Poisson (initial-value) problem between two fluids, and also compare our results to the viscous, single fluid case (Miles, 1968).

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