MATHEMATICAL THEORY AND NUMERICAL SIMULATION OF BUBBLY CAVITATING FLOWS

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Unsteady quasi-one-dimensional and two-dimensional bubbly cavitating nozzle flows are considered using a homogeneous bubbly flow model. For quasi-one-dimensional nozzle flows, the system of model equations is reduced to two evolution equations for the flow speed and bubble radius and the initial and boundary value problems for the evolution equations are formulated. Results obtained for quasi-one-dimensional nozzle flows capture the measured pressure losses due to cavitation, but they turn out to be insufficient in describing the two-dimensional structures. For this reason, model equations for unsteady two-dimensional bubbly cavitating nozzle flows are considered and, by suitable decoupling, they are reduced to evolution equations for the bubble radius and for the velocity field, the latter being determined by an integro-partial differential system for the unsteady acceleration. This integro-partial differential system constitutes the fundamental equations for the evolution of the dilation and vorticity in two-dimensional cavitating nozzle flows. For non-cavitating flows, they reduce to the classical Cauchy-Riemann equations of inviscid flow (the existence of complex velocity potential). The initial and boundary value problem of the evolution equations are then discussed and a method to integrate the equations is introduced. A discussion of real cavitating flows will also be presented.