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Numerical simulations of transient air entrainment by rough and smooth plunging jets KEN KIGER, University of Maryland, NABIL KHAROUA, LYES KHEZZAR, The Petroleum Institute — Plunging jets are intimately linked to the process of air or gas entrainment into liquid pools, and can play either a beneficial or detrimental role in many environmental and industrial flows. The purpose of the present work is to assess the capability of combined LES/VOF algorithms to simulate water/air plunging jet flows, starting with the transient impact of the free jet, initial cavity formation, pinch off, and evolution towards a continuous entrainment phase. We focus on what happens in the transient impact phase for weakly and highly disturbed jets, operating with impact conditions of $Re = UD/\nu = 10,500$, $We = \rho U^2 D/\sigma = 300$ and $Fr = U^2/gD = 83$. In particular, the study investigates the ability of the simulations to capture liquid surface instabilities and the influence of the exiting jet turbulence content on the entrainment behavior. The results indicate that the qualitative behavior of the entrainment process follows very closely what is observed in experiments, with the rough jet exhibiting surface instabilities at impact that are not present in the smooth jet. These have an effect on the development of the initial air cavity and interfacial area, leading to a doubling of the interfacial area for a nominally similar entrained volume of air.

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