AIR ENTRAINMENT BY A LIQUID JET PLUNGING INTO A LIQUID POOL

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ABSTRACT.

When a liquid jet impinges on liquid pool, with a velocity higher than a critical velocity, a thin air film es entrained by the jet. The thickness h_a of the air film, and thus the air mass entrained by the jet, is a function of its radius a and velocity U. This function, for the realistic small values of the capillary number $\epsilon = \mu_a U/\sigma \ll 1$ (based on the air viscosity μ_a and surface tension σ), turns out to be of the form $h_a/a = F(a/a_c, \epsilon)$, where $a_c = \sqrt{\sigma/\rho_l g}$ is the capillary length (based on the acceleration of gravity and liquid density ρ_l). An analysis based on lubrication theory, similar to the analysis of Landau and Levich for the dragging of liquid by a plate moving out of a liquid pool, shows that the dependence of h_a/a on ϵ is of the form $h_a/a = \epsilon^{2/3} f(a/a_c)$, where f, given by the analysis, is of order unity for $a/a_c \ll 1$ and $f \approx a_c/a$ for large values of a_c/a