Nonlinear Instability and Encapsulation of a Compound Liquid Jet

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Abstract

We analytically examine the breakup and encapsulation phenomena of a gas-cored compound liquid jet which consists of an inviscid and incompressible core gas and surrounding annular liquid. Applying the long wave approximations to both core and annular phases, a set of reduced nonlinear equations is derived for large deformations of the jet. Breakup of the jet is numerically examined in the equations when disturbances are given at a nozzle exit. It is shown that there exist the most dangerous frequency of the disturbances giving the minimum breakup time or length, where the frequency increases as the increase of the core velocity ratio and as the decrease of the Weber number. It is found that the frequency determines not only the shell formation period but also the produced shell size which is obtained through the volume conservation between the produced shell and one wave length of the disturbance with the dangerous frequency. These formation periods and sizes of the shells well agree with the results in the previous experiment and phenomenological model.

Key words: compound liquid jet, encapsulation, nonlinear, instability, long wave approximation

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