Breakup Behavior and Encapsulation Regime of a Non-Newtonian Viscous Compound Liquid Jet

T.Yoshinaga* and K.Matsumoto
Department of Mechanical Science, Osaka University, Osaka 560-8531, Japan
yoshinag@me.es.osaka-u.ac.jp

Abstract

We analytically examine breakup and encapsulation phenomena of a viscous compound liquid jet which consists of core and surrounding annular phases. Considering the non-Newtonian viscosity described by the Carreau model, a set of reduced nonlinear jet equations is analytically derived by means of a long wave approximation. The equations are numerically solved when the jet is semi-infinite and sinusoidal disturbances are applied at a nozzle exit of the jet. Typical breakup profiles are shown for the surface tension ratios, Reynolds and Weber numbers when the liquid viscosity is pseudo-plastic, Newtonian and dilatant. It is found that the non-Newtonian effects are salient for low Reynolds numbers when the surface tension ratio is not sufficiently small. Then, there is a tendency that the jet breaks up through disintegration of the annular phase for the pseudo-plastic, while the breakup appears through ballooning or closing of the annular phase for the Newtonian and dilatant, where the closing which leads to the encapsulation is more dominant for the dilatant. It is also found that influence of the non-Newtonian viscosity significantly appears near the breakup of the jet.

---

*Corresponding author: yoshinag@me.es.osaka-u.ac.jp