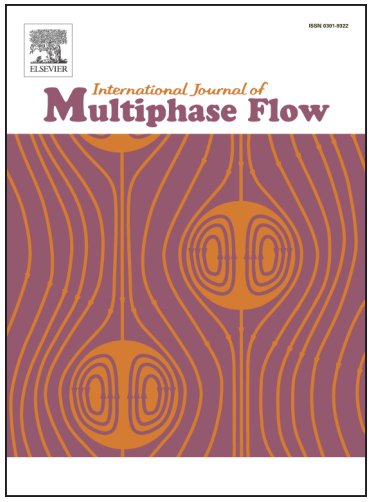

Ascent modes of jets and plumes in a stationary fluid of contrasting viscosity

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Ascent modes of jets and plumes in a stationary fluid of contrasting viscosity

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Abstract

Using multi-phase numerical experiments based on the Volume of fluid (VOF) methods we show the ascent behaviour of a fluid injected into another immiscible fluid with higher viscosity. Our VOF models reveal that the injected fluid forms jets characterized by a large head trailing to a slender tail, which do not break up, but ascend in two principal modes, *Mode 1*: *continuous* and *Mode 2*: *pulsating*. In Mode 1, their heads grow continuously either by volume expansion, forming balloon-shaped geometry (*Mode 1a*) or by curling, forming mushroom-shaped geometry (*Mode 1b*). In contrast, Mode 2 jets ascend in pulses, forming multiple heads, leading to pinched-off geometry. In this study we show the viscosity ratio (R) between the injecting and the ambient fluids as a crucial parameter in controlling the ascent modes, and provide an estimate of critical R for the Mode 1 to 2 transition under varying fluid injection rates (non-dimensionalized as Reynolds number, Re). From the entrainment velocity field we explain that the transition of continuous to pulsating process results from the flow convergence at several locations along the upwelling direction. We have also discussed the effects of buoyancy on the ascent modes in case of plumes.

Keywords: Jet shapes, fluid model, viscosity contrast, Reynolds number, flow perturbations, entrainment.

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