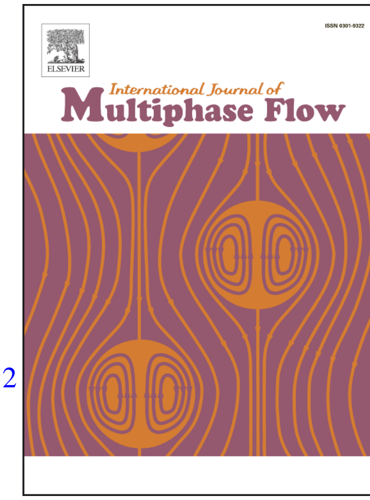
Accepted Manuscript



Bubble formation in a planar water-air-water jet: effects of the nozzle geometry and the injection conditions

C. Gutiérrez-Montes, R. Bolaños-Jiménez, A. Sevilla, C. Martínez-Bazán

PII: S0301-9322(14)00093-7
DOI: http://dx.doi.org/10.1016/j.ijmultiphaseflow.2014.05.012
Reference: IJMF 2049

To appear in: *International Journal of Multiphase Flow*

Received Date: 9 December 2013
Revised Date: 2 April 2014
Accepted Date: 18 May 2014

Please cite this article as: Gutiérrez-Montes, C., Bolaños-Jiménez, R., Sevilla, A., Martínez-Bazán, C., Bubble formation in a planar water-air-water jet: effects of the nozzle geometry and the injection conditions, *International Journal of Multiphase Flow* (2014), doi: http://dx.doi.org/10.1016/j.ijmultiphaseflow.2014.05.012

Bubble formation in a planar water-air-water jet: effects of the nozzle geometry and the injection conditions

C. Gutiérrez-Montes[a], R. Bolaños-Jiménez[a], A. Sevilla[b], C. Martínez-Bazán[a,*]

[a] *Área de Mecánica de Fluidos, Departamento de Ingeniería Mecánica y Minera. Universidad de Jaén. Campus de las Lagunillas, 23071, Jaén, Spain.*

[b] *Área de Mecánica de Fluidos, Departamento de Ingeniería Térmica y de Fluidos. Universidad Carlos III de Madrid, 28911 Leganés, Spain.*

Abstract

The present study describes the influence of the nozzle geometry and the injection conditions on the dynamics of a planar water-air-water jet discharging into stagnant air. An exhaustive numerical study, previously validated with experimental results, has been conducted to assess the effects of the air injector wall thickness, $\beta = H_i/H_o$, the water-to-air thickness ratio, $h = H_w/H_o$, the tip shape of the air injector, the water velocity profile at the exit slit, and the air feeding conditions, on both the destabilization of the air sheet and the formation of bubbles. As a result, it has been found that the air sheet becomes more unstable for thinner air injectors and water sheets. However, the bubbling frequency does not exhibit a monotonic behavior with β, increasing initially and barely changing for $\beta > 0.54$. Moreover, the transition from jetting to bubbling has been described in terms of the stability analysis proposed in Bolaños-Jiménez et al. (2011), showing that the model is able to capture the effects of h and β. Our results also indicate that the water-air-water sheet becomes more unstable and the bubbling frequency increases when a rounded air injector lip is used. On the other hand, increasing the boundary layer of the water stream stabilizes the flow since the shear at the air-water interface is reduced, attenuating the Kelvin-Helmholtz instability, but increases the bubbling frequency due the decrease in the liquid momentum near the interface. Finally, we show that bigger bubbles are generated when the gas is fed at constant pressure rather than at constant flow rate, thus revealing the importance of the injection system in the bubbling process.

*Corresponding author

Email addresses: cgmontes@ujaen.es (C. Gutiérrez-Montes), rbolanos@ujaen.es (R. Bolaños-Jiménez), asevilla@ing.uc3m.es (A. Sevilla), cmbazan@ujaen.es (C. Martínez-Bazán)