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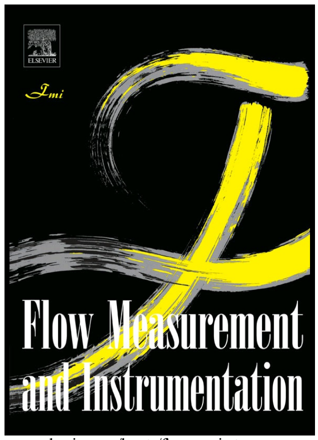

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T. Chekifi

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Computational Study of Droplet Breakup in a Trapped Channel Configuration Using Volume of Fluid Method

T. Chekifi * [1 2]
1 University Tahri Mohamed Bechar, ENERGARID laboratory, 08000 Bechar, Algeria
2 Research Center in Industrial Technologies CRTI, P.O. Box 64, Cheraga Algiers,
chekifi.tawfiq@gmail.com

Abstract Computational Fluid Dynamics is performed to numerically investigate the droplet breakup of water in oil in trapped channel configuration. The volume-of-fluid (VOF) method based the commercial code FLUENT is adopted to track the interface. Two designs are suggested to study the effect of flow conditions parameters and outer channel size on the droplet breakup mode, droplet generation frequency and size. As a function of the velocity ratio, droplets are formed in two modes, dripping mode: droplets were generated closed to the nozzle, it was identified at low capillary number (Ca<0.005) and jetting mode: droplets were produced after a long jet, where the capillary number Ca varies from 0.01 to 0.025. The numerical results indicated the collection channel diameter plays potential role in the determination of droplet size and droplet generation frequency, the shear forces excreted by the continuous phase on the dispersed thread are reduced in the wider model leading to have droplets much bigger than the narrow model, the latter produced small droplets due the high shear stress generated in the confinement region. Furthermore, the droplet frequency and size are found to be strongly dependent on the capillary velocity ratio. However, increasing the flow velocity ratio in both models leads droplets to be generated in high frequency, while the droplet length was decreasing. This work also demonstrates that the VOF method is an effective way to simulate the droplets breakup in trapped channel geometry.

Keywords: Droplet breakup, CFD, VOF (volume-of-fluid) method, Multiphase flow and trapped channel

Nomenclature

C: the volume fraction of one fluid (%)	α : phase fraction
D: diameter (mm)	B: incline angle of the straight attachment wall
F: the surface tension force	σ: the surface tension coefficient
fr: frequency (Hz)	τ: time (s)
h: grid size (mm)	CFD: Computational Fluid Dynamics
n: unit vector normal to the interface.	VOF: Volume-of-Fluid
U: velocity (m/s)	HF: height function
ρ: density (kg/m^3)	**Subscript**
μ: dynamic viscosity ($kg/m^{-1}.s^{-1}$)	Atm: atmosphere
	O: oil
	Out: outlet
	W: water

1. Introduction

Droplet generation in immiscible fluids has applications in many fields including pharmaceuticals [1-4], biology [5-7], medicine [8-10], foods [11-13] and cosmetics [13-15]. Different microchannel configurations have been used to generate droplet, such as T-junction [16-22], flow focusing [23-29], cross junction [30-32] trapped channel (called also co flowing channel) [33-37]. In these devices, droplets are generated by the shear stress applied by the continuous phase to the dispersed phase [34, 38-42], the droplet size and the generation frequency can be controlled by adjusting the flow conditions of the two phases [23, 39, 41-47]. Many works have been made to study the droplet generation by trapped channel configuration [34-37, 48, 49]. Umbanhowar et al. [49],

* Corresponding Author. ENERGARID, Mechanical Engineering Department, University Tahri Mohamed Bechar, Bp. 417, route de Kenadsa, 08000 Bechar, Algeria. Tel.: +21349 815581/91, fax: +21349 815244; Email: chekifi.tawfiq@gmail.com