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Chemical Engineering Science

www.elsevier.com/locate/ces

PII: S0009-2509(16)30299-8
DOI: http://dx.doi.org/10.1016/j.ces.2016.06.002
Reference: CES12982

To appear in: *Chemical Engineering Science*

Received date: 11 February 2016
Revised date: 25 May 2016
Accepted date: 1 June 2016

Influence of orifice type and wetting properties on bubble formation at bubble column reactors

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Abstract

We show a Direct Numerical Simulation (DNS), which is capable of describing immiscible two–phase flow including surface tension and the dynamics of partial wetting. Our investigation focuses on the initial bubble formation process at the inlet and analyzes the dynamics of the bubble detachment. It is shown, how orifice geometry and wetting properties influence size and surface of the bubble. This approach has a high potential for liquid–liquid reactions and high pressure gas–liquid reactions.

The use of different materials for an orifice like stainless steel or ptfe is considered by taking their distinct wetting properties into account. The investigated orifice types range from an injector nozzle over a regular capillary to a diffuser. Furthermore the influence of different volume fluxes in the feed is analyzed and a systematic comparison with respect to a desired bubble volume is given.

The physical model is implemented in the Lagrangian Smoothed Particle Hydrodynamics (SPH) method, which is, due to its mesh-free nature, particularly suitable for moving interfaces.

Keywords: SPH, two–phase flow, surface tension, moving contact line, dynamic contact angle, CSF, CLF, bubble column reactor, orifice, nozzle, diffuser, capillary

1. Introduction

Lots of industrial applications with respect to gas–liquid or liquid–liquid reactions are realized by column reactors, (sparged) stirred tank reactors or spray reactors [1]. These reactors have in common, that depending on the process conditions and the utilized fluids, bubbles or droplets are formed right at the inlet and that the bubble/droplet size is a crucial quantity in the overall process an its reaction yield. As most of the literature and many investigations are published for gas–liquid reactions in bubble column reactors, we stick to that application, although the approach we introduce and demonstrate here is

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