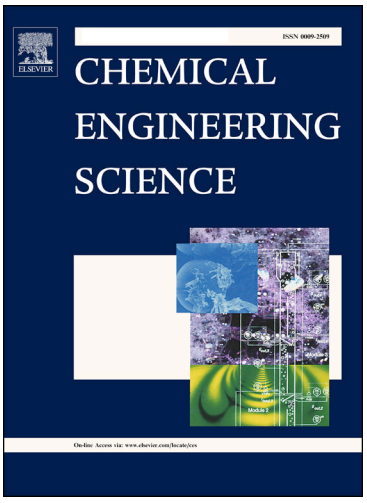

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Bubbly Flow in Stirred Tanks: Euler-Euler / RANS Modeling

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HIGHLIGHTS

- a previously established baseline model for bubbly flow is applied to stirred tanks
- one extension found necessary is the use of a Reynolds stress turbulence model
- a second extension is a correction factor to describe turbulence effects on drag
- model validation is performed with a rather comprehensive dataset
- phase velocity, turbulence and volume fraction are reasonably well reproduced

Abstract

Aerated stirred tanks are frequently used equipment in industries ranging from chemical engineering and biotechnology to minerals processing. In principle, CFD simulation of such equipment on industrial scales is feasible within the Euler-Euler framework of interpenetrating continua. Practical application, however, requires suitable closure models to account for phenomena on the scale of individual bubbles, which are not resolved in this approach. The present work applies a set of closure relations that was previously used with good success to describe bubbly flows in pipes and bubble columns. It turns out that model extensions are needed concerning turbulence and the drag force. To validate the model a comprehensive set of experimental data including gas fraction as well as liquid velocity and turbulence has been assembled from different literature sources. The finally proposed extended model compares reasonably well with this dataset.

Keywords: aerated stirred tanks, dispersed gas-liquid multiphase flow, Euler-Euler two-fluid model, closure relations, Reynolds-stress turbulence model, CFD simulation

1 INTRODUCTION

Mechanically stirred tanks are an important piece of equipment in many branches of industry like chemical engineering (Sommerfeld & Decker 2004), biotechnology (Kadic & Heindel 2014), and minerals processing (Evans et al. 2008). Typical applications comprise chemical reactions, growth of micro-organisms, and separation by flotation. For multiphase flows common to these applications, stirred tanks provide for good contact between the phases as well as intense mixing within the liquid phase. Computer simulation is recently becoming a more and more important tool to optimize the performance of both equipment and processes in all of the mentioned fields of application (Joshi & Nandakumar 2015, Werner et al. 2014, Sarhan et al. 2014).

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