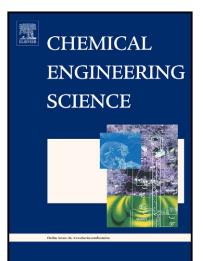
## Author's Accepted Manuscript

The impact of Marangoni convection on fluid dynamics and mass transfer at deformable single rising droplets – A numerical study

R.F. Engberg, M. Wegener, E.Y. Kenig



www.elsevier.com/locate/ces

PII:S0009-2509(14)00181-XDOI:http://dx.doi.org/10.1016/j.ces.2014.04.023Reference:CES11605

To appear in: Chemical Engineering Science

Received date: 11 February 2014 Revised date: 15 April 2014 Accepted date: 16 April 2014

Cite this article as: R.F. Engberg, M. Wegener, E.Y. Kenig, The impact of Marangoni convection on fluid dynamics and mass transfer at deformable single rising droplets – A numerical study, *Chemical Engineering Science*, http://dx.doi.org/10.1016/j.ces.2014.04.023

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting galley proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

## The impact of Marangoni convection on fluid dynamics and mass transfer at deformable single rising droplets – A numerical study

R.F. Engberg<sup>a</sup>, M. Wegener<sup>b</sup>, E.Y. Kenig<sup>\*,a,c</sup>

<sup>a</sup>Chair of Fluid Process Engineering, University of Paderborn, Pohlweg 55, 33098 Paderborn, Germany

<sup>b</sup>Chair of Chemical & Process Engineering, Technische Universität Berlin, Ackerstraße 71-76, 13355 Berlin, Germany

<sup>c</sup>Gubkin Russian State University of Oil and Gas, Moscow, Russian Federation

## Abstract

In this paper, fluid dynamics and mass transfer of single droplets rising in a quiescent ambient liquid are considered. For the first time, full three-dimensional simulations of a deformable droplet dominated by Marangoni convection induced by concentration gradients were performed. A level set based code accounting for the mutual coupling of mass and momentum transfer was developed and implemented in the open-source computational fluid dynamics (CFD) package OpenFOAM<sup>®</sup>. The liquid/liquid extraction test system toluene/acetone/water was investigated, and numerical results were compared with experimental data from literature. The code captures and reproduces the characteristic experimental results: the two step acceleration behaviour, the temporary reduction of the drop rise velocity, and the enhancement of mass transfer depending on the initial solute concentration. The lateral break-out in the drop path at the instant of reacceleration has only been observed experimentally so far. Our simulations reproduce this phenomenon, confirming the existence of pressure gradients across the droplet. Furthermore, our results reveal that the break-out effect is governed by rear vortex detachment.

*Key words:* droplet, Marangoni convection, mass transfer, CFD, level set, extraction

Preprint submitted to Chemical Engineering Science

<sup>\*</sup>Corresponding Author

Email addresses: roland.engberg@uni-paderborn.de (R.F. Engberg),

mirco.wegener@alumni.tu-berlin.de (M. Wegener), eugeny.kenig@uni-paderborn.de (E.Y. Kenig)

Download English Version:

## https://daneshyari.com/en/article/6591016

Download Persian Version:

https://daneshyari.com/article/6591016

Daneshyari.com