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Roland Rzehak, Eckhard Krepper

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Euler-Euler Simulation of Mass-transfer in Bubbly Flows

Roland Rzehak, Eckhard Krepper
Helmholtz-Zentrum Dresden – Rossendorf, Institute of Fluid Dynamics, Bautzner Landstrasse 400, D-01328 Dresden, Germany

Abstract
For practical applications the Euler-Euler two-fluid model relies on suitable closure relations describing interfacial exchange processes. Concerning pure fluid dynamics of dispersed gas-liquid multiphase flow, an ongoing effort has led to a validated set of closures that is applicable under a rather broad range of conditions. Similar results for the technologically even more important field of mass transfer remain to be achieved. Progress so far has been hampered by a lack of spatially resolved data including measurements of concentration, which are suitable for CFD model validation. In addition, correlations proposed to describe the mass transfer coefficient differ widely. Here, a preliminary study of axial concentration profiles in a bubble column is given, based on the available experimental data found in the literature. For this purpose the simplified assumption of a constant mass transfer coefficient throughout the column is made and experimentally determined values are used. New measurements will be needed to come to a final conclusion.

Keywords:
mass-transfer, dispersed gas liquid multiphase flow, Euler Euler two fluid model, closure relations, CFD simulation, model validation

1 NOMENCLATURE

Notation	Unit	Denomination
a_I	m^{-1}	interfacial area concentration
d_B	m	bubble diameter
D^A	$m^2\ s^{-1}$	diffusion coefficient of transferred species
D	m	column diameter
Eo	-	Eötvös Number
H	m	column height
He^A	-	Henry constant for transferred species
J_L	$m\ s^{-1}$	liquid volumetric flux = superficial velocity
k_L	$m\ s^{-1}$	mass transfer coefficient
M	-	molecular mass
Mo	-	Morton Number
P	$Pa = N\ m^{-2}$	pressure
R	$J\ K^{-1}\ mol^{-1}$	universal gas constant
Re	-	Reynolds number
Sc	-	Schmidt number
Sh	-	Sherwood number
T	K	temperature
u	$m\ s^{-1}$	phase velocity
x	m	coordinate along the main flow direction
X	-	mole fraction
Y	-	mass fraction
α	-	phase fraction
Γ	$kg\ m^{-3}\ s^{-1}$	mass source due to absorption
μ	$m^2\ s^{-1}$	dynamic viscosity