Abstract

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Monolith reactors are being used in many process industries as an efficient three-phase chemical reactor since last few decades. Monolith reactor consist of large number of small diameter parallel channels in single structure or block in which gas and liquid flow co currently / counter currently while the solid catalyst is coated on channel wall. In this work hydrodynamics and mass transfer study of Taylor flow in small diameter channel have been conducted. A new approach was presented in which solid particles were kept dispersed in liquid instead of being coated on channel wall. This concept makes monolith a slurry type reactor. Hydrodynamics studies for two-phase gas-liquid flows are well developed while mass transfer studies still need improvement.

Hydrodynamics of three-phase gas-liquid-solid flows have been performed in this study. System used for three-phase Taylor flow was air-water-coal in which coal was in form of fine particles. Experiments were performed on different solid loading (0%, 2%, 4% and 6%) in circular (2.75 mm) and square (3 mm) cross sections. Solid loadings showed no considerable rise in pressure drop up to 6% which makes the use of slurry type monolith reactors possible with less energy input. Regarding gas-liquid mass transfer phenomena in Taylor flow, contradictions can be found in the previous literature and therefore needs to be improved. Also these studies were based on single channel or on the whole monolith block. There is no such study which determines mass transfer at single slug scale. This work is aim to determine overall liquid side volumetric mass transfer coefficient experimentally for co-current Taylor flow moving upward in a glass tube of internal diameter 3mm. Experiments are performed for physical absorption of oxygen in 20% aqueous solution of ethanol. Shadowgraph technique was deployed for precise measurements of bubble lengths and velocities. Contributions of two possible mass transfer mechanisms (bubble-slug and bubble-lubrication film) are discussed, as well as the influence of hydrodynamic parameter on mass transfer coefficient. Experimental data was compared with values issued from the correlations given in literature. It is observed that none of the tested models gives satisfying representation of experimental determined mass transfer coefficient. A new correlation was proposed for the estimation of mass transfer coefficient for various superficial velocities of gas and liquids. Planar laser induced fluorescence (PLIF) quenching by oxygen" technique was also deployed for visualization and local measurement of mass transfer in a single liquid slug.

This study contributes the hydrodynamic feasibility for slurry type monolith reactor, present an overall volumetric gas-liquid mass transfer coefficient and visualization and local measurement of mass transfer direct from flowing liquid slug using PLIF quenching by oxygen technique.