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Effect of Solid Loading on Carbon Dioxide Absorption in Bubble Column

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Abstract

In the present work experiments were conducted to study the effect of solid loading (1,5 and 9 vol.%) on the enhancement of carbon dioxide absorption in bubble column at various volumetric gas flow rate (0.75, 1 and 1.5 m^3/h) and absorbent concentration (caustic soda)(0.1,0.5 and 1 M). Activated carbon and alumina oxide (Al_2O_3) are used as solid particles. The Danckwerts method was used to calculate interfacial area and individual mass transfer coefficients during absorption of carbon dioxide in a bubble column. The results show that the absorption rate was increased with increasing volumetric gas flow rate, caustic soda concentration and solid loading. Mass transfer coefficient and interfacial area were increased with increasing volumetric gas flow rate, and solid loading.

Keywords: *Carbon dioxide absorption, bubble column, danckwerts method, mass transfer coefficients and interfacial area.*

1. Introduction

Slurry bubble columns are intensively used as a multiphase contactors in the chemical, biochemical and petrochemical industries where heterogeneous gas-liquid or gas-solid reactions take place, particularly, in which the liquid phase controls mass transfer process due to the relation with solubility of gases[1, 2]. Important applications of three phase bubble column are in hydrogenation, oxidation, and waste water treatment and in biochemical applications [2].

The rate of acid gas absorption such as carbon dioxide absorption in a gas-liquid or gas-liquid-solid contactor may be enhanced considerably by the presence of particles in the liquid –phase. To be effective, the particles have to be considerably smaller than the gas-liquid film thickness and need to have a high affinity for the component to be transferred. Enhancement of the gas absorption rates due to the presence of small particles is explained by the so-called grazing or shuttle mechanism [3-6].

Sharma and Mashelkar (1968) [7] were the first to report an increase in the mass transfer in a bubble column by small particles. Similar effects were found later by Wimmers and Fortuin (1988) [8], Beennackers and van swaaij (1993) [6] and Marius et al (2007) [9].

Lindner et al (1988) [10] and Kluytmans et al (2003) [11] found that in non-coalescing liquids, e.g., concentrated salt solutions, fine activated carbon particles may hinder bubble coalescence and significantly increase the specific interfacial area.

Vandu and Krishnal (2004) [12] observed that addition of solids and high solid concentrations caused reduced values of mass transfer coefficients due to increased large bubble size.

Sumin et al (2007) [13], studied the absorption of carbon dioxide in carbonate solution (K_2CO_3) in the presence of activated carbon particles and found that the absorption rate enhanced significantly, and the maximum enhancement factor was 3.7.

The present work aimed to study the absorption rate of carbon dioxide in caustic soda (NaOH) solution 0.1, 0.5 and 1M at different volumetric gas flow rate 0.75, 1 and 1.5 m^3/h and carbon dioxide concentration of 10% by volume