International Journal of Latest Engineering Research and Applications (IJLERA) ISSN: 2455-7137

Volume – 02, Issue – 09, September – 2017, PP – 59-63

Experimental Analysis of Mass Transfer Studies In Three-Phase Fluidized Beds

[1]Vaishali Pendse, [1]Dr. Bidyut Mazumdar, [2]Dr. H. Kumar

1 Dept. of Chemical Engg, Natioanal Institute of Technology, Raipur (CG) 492100

2 Dept. of Chemical Engg, Raipur Institute of Technology, Raipur(CG) 492100

Abstract: Mass transfer characteristics of three-phase fluidization were determined in the present experimental work which was carried out in a vertical cylindrical acrylic column of 90mm internal diameter , 100 mm external diameter and height of the column is 1350 mm .Benzoic acid pellets, water and air were used as solid, liquid and gaseous phase respectively. Initially the superficial liquid velocity was maintained constant and superficial gas velocities varied. After attaining steady state, at a particular gas velocity, the fluidized bed height and manometer readings were recorded for pressure drop estimation. The above-mentioned procedure was repeated for four different liquid velocities in a fluidized bed. The effect on mass transfer for various specific liquid flow rates and gas flow rates were studied. It was observed that there is slight decrease in mass transfer with increase in gas flow rate and not significant difference in mass transfer by increasing liquid flow rate in cocurrent three-phase fluidized bed.

Keywords: three-phase fluidization, mass transfer, Gas velocity,liquid velocity, benzoic acid pellets

Introduction

Three phase fluidization is defined as an operation in which a bed of solid particles is suspended in gas and liquid upward flowing media due to the net gravitational force on particles. This enhances intimate contact among the three phases and provides substantial advantages for applications in physical, chemical or biochemical processing involving gas, liquid and solid phases. For design of three-phase fluidized bed, it is important to study the hydrodynamics and mass transfer characteristics. Research of mass transfer in liquid–solid systems is very important for equipment design for many applications. An industrial application of liquid–solid systems requires determination of transfer characteristics, especially mass transfer.

The most common technique for measuring solid- liquid mass transfer is the dissolution technique. In this technique, a sparingly soluble solid dissolves into the liquid phase. For measurements in the fluidized beds, the bed can be packed either fully or partially with the dissolvable or `active particles. The particles can be made up entirely of the dissolvable matter or can be coated with dissolvable material. Most studies have used benzoic acid since it is easy to pelletize and it has low solubility in water.

Experimental methodology

Preparation Of Raw Material- Raw material i.e benzoic acid pellets have been prepared by using pelletizing machine. Physical properties of pellets are showing in following table no. 1

Experimental Procedure -The experiment has been conducted by systematically varying liquid and gas velocities and measuring the rate of mass transfer by collecting samples directly from the outlet ports at the top. The liquid velocity is kept constant and the gas velocity is varied for each gas velocity the fluidized bed height and manometer readings are noted when steady state is attained. The same procedure is repeated for 4-5 different liquid velocities. Volumetric flow rate, superficial gas velocity and the corresponding bed heights are measured. After the fluidized bed has stabilized and the fluctuation in bed is minimum samples are collected and subsequently analyzed by volumetric titration method. Gas and liquid phases correspond to air and water where as in solid phase benzoic acid is used.

Data Collection & Data Analysis

Table 1: Physical Properties Of Benzoic Acid Pellets

Length	1.3 cm
Diameter	0.9 cm
Volume	0.827 cm^3
Mass of 1 pellet	1.2657 gm
Density	1.47 gm/cm^3
No. of pellets	130
Total weight of pellets	157.9421 gm

Observation tables

Table 1.1 Concentration of Benzoic acid for LFR 5 LPM

Liquid flow rate (LPM)	Gas flow rate (LPM)	Conc at 10 min Mol/L	Conc at 20 min Mol/L	Conc at 30 min Mol/L
5	5	0.02	0.02	0.02
	10	0.016	0.016	0.016
	15	0.01	0.009	0.009
	20	0.01	0.008	0.008

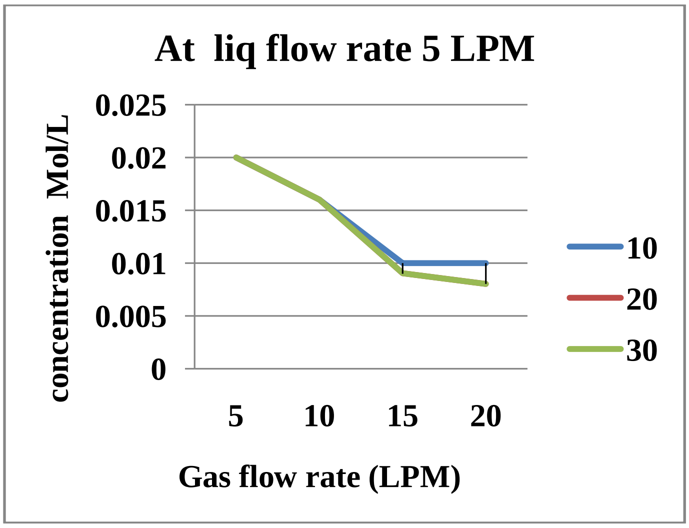


Figure 1.1 At liq flow rate 5 LPM

Table 1 .2 Concentration of Benzoic acid for LFR 10 LPM

Liquid flow rate (LPM)	Gas flow rate (LPM)	Conc at 10 min Mol/L	Conc at 20 min Mol/L	Conc at 30 min Mol/L
10	5	0.01	0.02	0.02
	10	0.01	0.009	0.008
	15	0.01	0.009	0.008
	20	0.0067	0.0067	0.0067

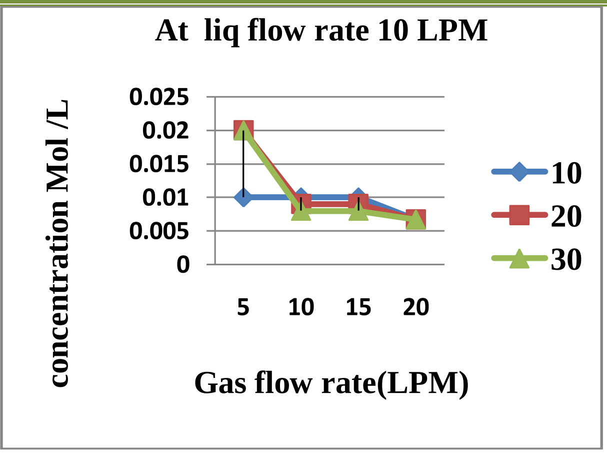


Figure 1.2 At liq flow rate 10 LPM

Table 1.3 Concentration of Benzoic acid for LFR 15 LPM

Liquid flow rate (LPM)	Gas flow rate (LPM)	Conc at 10 min Mol/L	Conc at 20 min Mol/L	Conc at 30 min Mol/L
15	5	0.01	0.01	0.01
	10	0.009	0.008	0.0077
	15	0.009	0.008	0.0067
	20	0.008	0.008	0.008

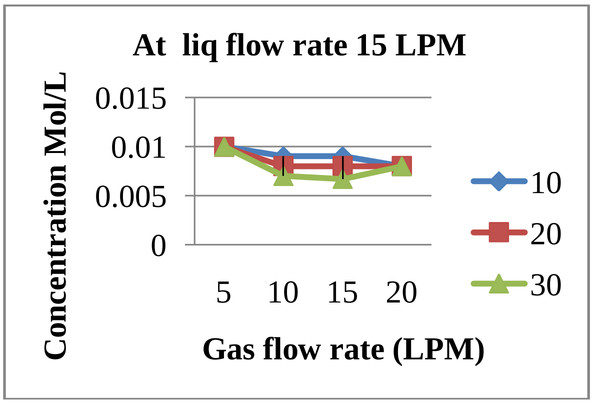


Figure 1.3 At liq flow rate 15 LPM

Table 1.4 Concentration of Benzoic ac

Liquid flow rate (LPM)	Gas flow rate (LPM)	Conc at 10 min Mol/L	Conc at 20 min Mol/L	Conc at 30 min Mol/L
20	5	0.0067	0.0067	0.0067
	10	0.0067	0.0071	0.0077
	15	0.0077	0.0077	0.0077
	20	0.008	0.008	0.008

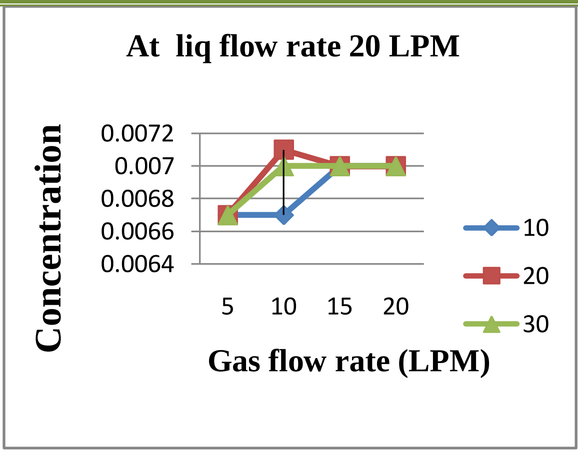


Figure 1.4 At liq flow rate 20 LPM

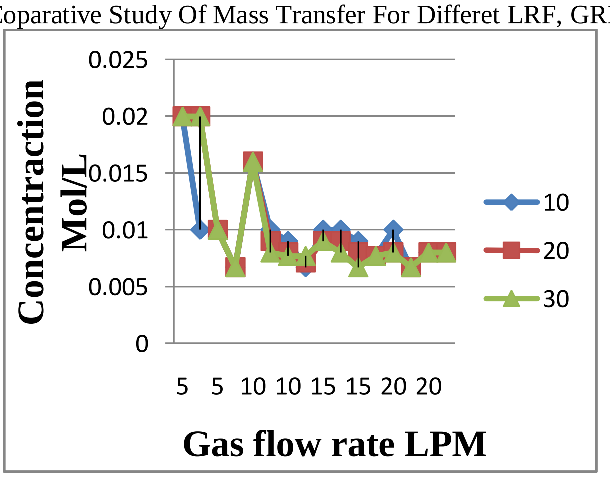
Result & Conclusion

From the experiment of Mass transfer in three phase fluidized bed using Benzoic acid pellet as solid material and air as gas and water as liquid, following result has been obtained.

Table 1.5

GFR (LPM)	LFR (LPM)	Conc at 10 min	Conc at 20 min	Conc at 30 min
5	5	0.02	0.02	0.02
5	10	0.016	0.016	0.016
5	15	0.01	0.009	0.009
5	20	0.01	0.008	0.008
10	5	0.01	0.02	0.02
10	10	0.01	0.009	0.008
10	15	0.01	0.009	0.008
10	20	0.0067	0.0067	0.0067
15	5	0.01	0.01	0.01
15	10	0.009	0.008	0.0077
15	15	0.009	0.008	0.0067
15	20	0.008	0.008	0.008
20	5	0.0067	0.0067	0.0067
20	10	0.0067	0.0071	0.0077
20	15	0.0077	0.0077	0.008
20	20	0.008	0.008	0.008

Figure 4.1 Coparative Study Of Mass Transfer For Differet LRF, GRF And Time



Conclusion

Experiments were carried out using benzoic acid pellet as solid phase for mass transfer studies in three-phase fluidization. It was observed from the investigation that the solid liquid mass transfer were influenced by gas flow rate and not very much by liquid flow rate.

References

[1]. Arters, D. C., & Fan, L. -S. (1986). Solid-liquid mass transfer in a gas-liquid-solid fluidized bed. *Chemical Engineering Science*, *41*, 107-115.

[2]. Arters, D. C., & Fan, L. -S. (1990). Experimental methods and correlation of solid-liquid mass transfer in fluidized beds. *Chemical Engineering Science*, *45*, 965-975.

[3]. D.-H. Lee, J.-O. Kim, S.D. Kim, Mass transfer and phase holdup characteristics in three-phase fluidized beds, Chem. Eng. Commun. 119 (1993) 179–196.

[4]. Dinesh v. kalaga, Anu Dhar, Sameer v. Dalvi, Jyestharaj B. Joshi, particle-liquid mass transfer in solid- liquid fluidized beds.

[5]. Hideki Miura, Takashi Katoh, Yoshinori Kawase - Gas–liquid mass transfer in co-current three-phase fluidized beds with non-Newtonian fluids: Theoretical models based on the energy dissipation rate.

[6]. Jena, H.M., Sahoo, B.K., Roy, G.K., Meikap, B.C., 2008b. Characterization of hydrodynamic properties of a gas–liquid–solid three-phase fluidized bed with regular shape spherical glass bead particles. Chemical Engineering Journal 145, 50-56.

[7]. Jena, H M ,2009 Hydrodynamics of a Gas-Liquid-Solid Fluidized and semi-fluidized beds , Ph.D Thesis., National Institute of Technology, Rourkela.

[8]. Jena, H.M., Roy, G.K., Meikap, B.C., 2009a. Hydrodynamics of a gas-liquid-solid fluidized bed with hollow cylindrical particles. Chemical Engineering and Processing: Process Intensification 48, 279-287.

