International Journal of Chemical, Materials and Biomolecular Sciences
ISSN: 2415-6620
Vol:1, No:5, 2007

The Effect of vibration on the absorption of CO_2 with chemical reaction in aqueous solution of calcium hydroxide.

B. Sohbi, M. Emtir, M. Elgarni

Abstract**—**An interesting method to produce calcium carbonate is based in a gas-liquid reaction between carbon dioxide and aqueous solutions of calcium hydroxide.

The design parameters for gas-liquid phase are flow regime, individual mass transfer, gas-liquid specific interfacial area. Most studies on gas-liquid phase were devoted to the experimental determination of some of these parameters, and more specifically, of the mass transfer coefficient, k_La which depends fundamentally on the superficial gas velocity and on the physical properties of absorption phase.

The principle investigation was directed to study the effect of the vibration on the mass transfer coefficient k_La in gas-liquid phase during absorption of CO_2 in the in aqueous solution of calcium hydroxide. The vibration with a higher frequency increase the mass transfer coefficient k_La, but vibration with lower frequency didn't improve it, the mass transfer coefficient k_La increase with increase the superficial gas velocity.

Keywords**—**Environment technology, mass transfer coefficient; absorption; CO_2; calcium hydroxide.

I. Introduction

Bubble column reactors are mainly used in various industries such as: chemical, Petrochemical, biological, bioenergetics…etc, due to their simple construction and their low operating costs. Important applications of bubble columns include oxidation, hydrogenation, ozonolysis, alkylation, column flotation, wastewater treatment, and absorption of sulphur dioxide and carbon dioxide in the separation technology.

The bubble size and gas holdup are important parameters for the study of the flow patterns in a bubble column. They depend on some parameters such as: column geometry, operating conditions, physicochemical properties of the two phases put in contact and the type of gas sparger [1-3].

In the Literature there are different ways to remove the pollutant gases emitted by chemical industries.

The mass transfer processes had great importance in industrial processes to remove contaminant gases, such the use of aqueous solution of amines to remove carbon dioxide [4, 5].

Manuscript received July 30, 2007. This work was supported by Libyan Petroleum Institute. Department of Separation technology

Several authors has studied the calcium carbonate precipitation process in relation with the kinetics of the nucleation and growth process [6] using a mixture of carbon dioxide and nitrogen as gas phase and calcium hydroxide as liquid phase.

In [4] the influence of the gas/liquid mass transfer process and the connected parameters and variables upon the calcium carbonate precipitation process have been analysed.

For the use of the vibration in chemical engineering process several authors has studied the effect of vibration in bubble column, the vibration minimized the time for the chemical reaction [7] and enhancement the mass transfer coefficient in bubble column in absorption process [8].

In the present paper, the Effect of vibration on the absorption of carbon dioxide with chemical reaction in aqueous solution of calcium hydroxide has been investigated.

II. Experimental Apparatus and Procedures

A bubble column reactor (BCR) of internal diameter 8.7 cm and height 200 cm has been used.

As shown in Fig.1 The pure carbon dioxide to be absorbed was passed through two humidifiers and then entered the (BCR) at a constant flow rate, the experiment were carried out at 25 C.

The carbon dioxide was passed through two humidifiers to prepare the gas phase and to prevent equimolecular contra diffusion.

The gas outflow was measured with flow rate before the gas released into atmosphere.

The data of gas inflow and outflow were saved in P.C. The pulsation device was put on the top of the bubble column reactor (BCR), the pulsation rates were changed used the frequencies control.

The gas absorption rate was calculated as the difference between inflow and outflow rates.

Aqueous solution of calcium hydroxide were prepared in the stirred vessel in the present of an inert atmosphere to prevent a possible nucleation process by a reaction between the solute and the carbon dioxide existent in the laboratory air.

A carbon dioxide streams, with different values of flow rates (18- 30L/h), was fed to the contactor when the solution was obtained perfectly.

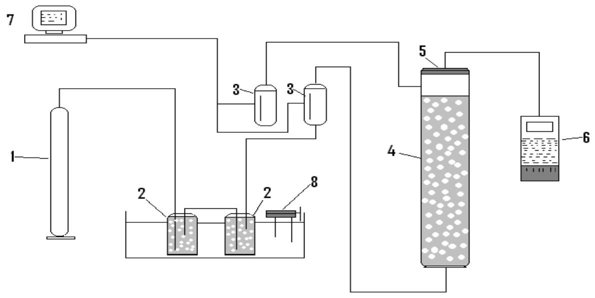

Fig. 1 Schematic diagram for experimental set-up

1- Carbon dioxide, 2- humidifiers, 3- gas flow rates, 4-bubble column, 5-pulsation device, 6- frequencies control, 7- PC., 8-thermostat.

III. Results and Discussion

In the present paper, the effect of the high and low vibration was investigation. The absorption experiments were carried out on the basis of the differences between the gas inflow and outflow.

Fig. 2 shows an example of the experimental data obtained without pulsation. The evolution of molar flow along the operation time indicates that when the time increases, the outlet stream increases until the value corresponding to the inlet gas flow.

The difference between these two molar flows allows calculate the value of the molar flow of carbon dioxide absorbed.

Along the time the concentration difference between interface and bulk liquid decreases and the molar flow absorbed decreases too.

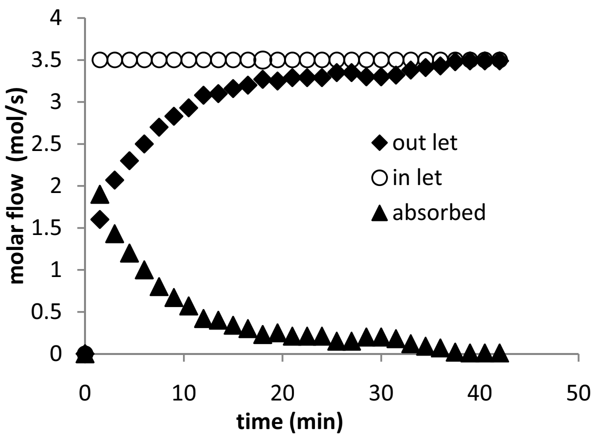

Fig. 2 Evolution of carbon dioxide absorption process without pulsation

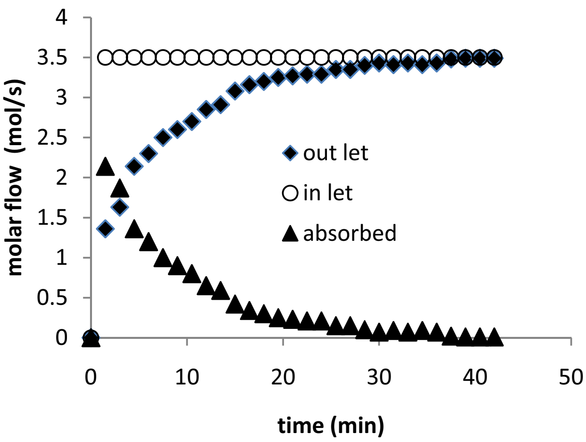

Fig. 3 Evolution of carbon dioxide absorption process with pulsation (3.8 Hertz)

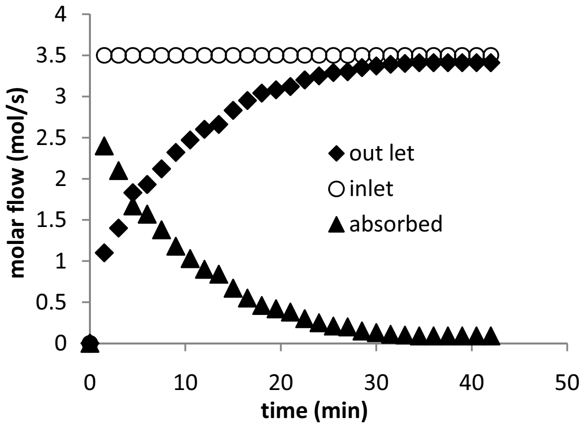

Fig. 4 Evolution of carbon dioxide absorption process with pulsation (6.8 Hertz)

Fig. 3 shows the effect of the pulsation on the absorption of Carbon dioxide with low frequent.

Where the Fig. 4 and Fig. 5 show the effect of the pulsation on the absorption of Carbon dioxide with high frequent.

As result the high frequent increase the absorption of Carbon dioxide but the low frequent doesn't increase it. The absorbed molar flow of Carbon dioxide increase with high frequency.

The pulsation with high frequent decrease the bubble size which due to increase the mass transfer coefficient.

Fig. 6 shows the effect of different values of flow rates on the absorption process of carbon dioxide, as result the absorption of carbon dioxide increase with increase the superficial gas velocity.

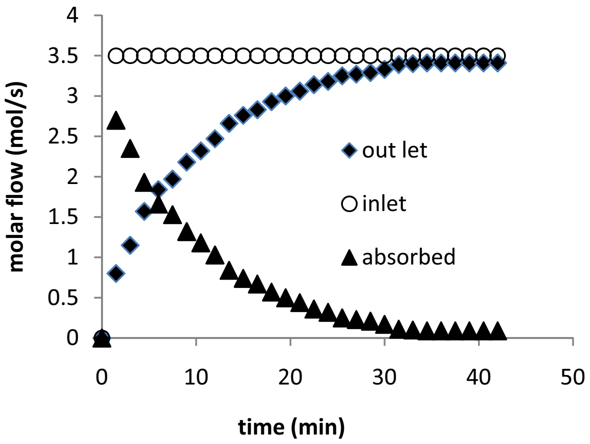

Fig. 5 Evolution of carbon dioxide absorption process with pulsation (10.8 Hertz)

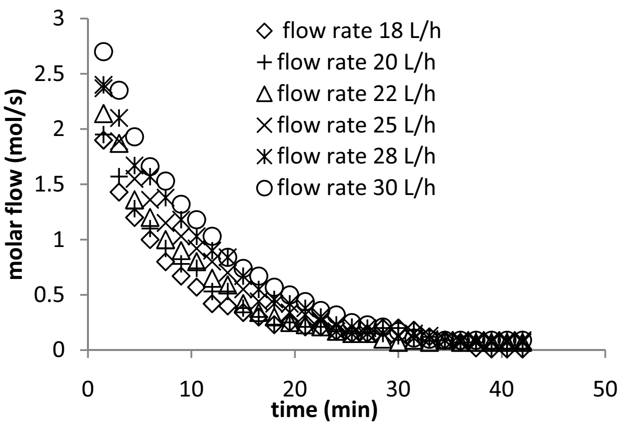

Fig. 6 Evolution of carbon dioxide absorption process with different values of flow rates (18- 30L/h).

IV. CONCLUCION

The principle investigation was directed to study the effect of the vibration on the mass transfer coefficient k_La in gas-liquid phase during absorption of CO_2 in the in aqueous solution of calcium hydroxide.

The vibration with a higher frequency increase the mass transfer coefficient k_La, but vibration with lower frequency didn't improve it, the mass transfer coefficient k_La increase with increase the superficial gas velocity.

V. REFERENCES

[1] Kaidi, F., Rihani, R., Ben Amira, E., Naceur, M.W., Bensmaili, A., (2006) 17th International Congress of Chemical and Process Engineering 27 - 31 August 2006, Prague - Czech Republic, Conference proceeding
[2] Camarasa, E, Vial, C, Poncin, S., Wild, G, Midoux, N, Bouillard, J, (1999). Chemical Engineering and Processing 38, 329-344.
[3] Sohbi ,B., Edreder, E.,(2006) 17 th International Congress of Chemical and Process Engineering 27 - 31 August 2006, Prague - Czech Republic, Conference proceeding
[4] Gomez-Diaz, D., Navaza, J.M., Sanjurjo, B., (2005), 8 th conference on Process Integration, Modelling and Optimisation for Energ Saving and Pollution Reduction
15-18 May 2005, Giardini di Naxos, Italy, Conference proceeding
[5] Yoon, S.J., Lee, H., Yoon, J.H., Shim, J.G., Lee, J.K., Min, B.Y., and Eum, H.M.,(2002) Ind. Eng. Chem. Res. 41, 3651
[6] Kotaki, Y., and Tsuge, H., (1990) J.Cryst. Growth. 99,1092.
[7] Hatami, R. (1979) Industriefeuerung, 15, S. 47
[8] Ostrowsiky, G.M; Malyschev, P.A. ; Aksenova, E.G. Tekhnologii, Tom 24, Akademia Nauk SSSR, Moskva 1990, S. 835.

B. Sohbi (Dr. Eng.) in chemical Engineering processes. Senior Member in Libyan Petroleum Institute (LPI) in Tripoli /Libya .PhD from martin luther university/Germany. Department of chemical Engineering processes. e-mail: bsohbi04@yahoo.com.
M. Emtir (Dr. Eng.) in chemical Engineering processes. Senior Member in Libyan Petroleum Institute (LPI) in Tripoli / Libya.
M. Elgarni (Dr. Eng.) in chemical Engineering processes. Senior Member in Libyan Petroleum Institute (LPI) in Tripoli / Libya.