

PE11) ClO₂에 의한 SO₂ & NO_x 동시 제거 반응에서 물질전달 특성 Mass Transfer Characteristics for Removal of SO₂ & NO_x using Aqueous Chlorine Dioxide Solution

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1. Introduction

For the efficient removal of SO₂ and NO_x in the continuous stirrer tank reactor (CSTR), mass transfer rate between gas and liquid phase is the rate limiting step. Therefore, it is very important to determine the mass transfer coefficients for the lab scale bubbling reactor.

The study on the simultaneous removal of SO₂ and NO_x was investigated using chlorine dioxide in the lab-scale bubbling reactor.

2. Experimental Section

The gas phase mass transfer coefficients, $k_g a$ were measured by absorbing sulfur dioxide from SO₂/N₂ mixture into NaOH solutions (0.2M), where the liquid-phase mass transfer resistance can be considered negligible. The liquid phase mass transfer coefficients, $k_l a$ were measured by absorbing O₂ from air into degassed distilled water with a low concentration of O₂, assuming the gas-phase mass transfer resistance to be negligible as O₂ has a low solubility in water and its concentration in atmospheric air is as high as 20 Vol%.

3. Results and discussion

The values of $k_g a$ were calculated from the SO₂ absorption rate as follows:

$$r_{(SO_2)} = k_g a \cdot p_{(SO_2)av} \quad (1)$$

where $p_{(SO_2)av}$ the gas-liquid driving force for absorption. Alternatively, from the two film theory (O. Levenspiel, 1972), the experimental absorption rate of SO₂ can be calculated as:

$$r_{(SO_2)} = Q_l \cdot C_{SO_2}^2 / V_R \quad (2)$$

where Q_l is the liquid flow rate, $C_{SO_2}^2$ is the conc. of sulfite, and V_R is the reactor volume. Now comparing Eq. (1) with Eq. (2), we get:

$$k_g a = \frac{Q_l \cdot C_{SO_2}^2}{V_R \cdot p_{(SO_2)av}} \quad (3)$$

The values of $k_g a$ were determined from Eq. (3) and it is correlated to gas flow rate (Qg), absorption driving force ($P_{(SO_2)av}$), and agitation speed (N) as follows:

$$k_g a = k_1 \cdot Q_g^{k_2} \cdot P_{(SO_2)av}^{k_3} \cdot N^{k_4} \quad (4)$$

Since absorption rate of SO₂ was found independent of agitation speed. Thus neglecting the term N^{k_4} and taking logarithm on both sides, the value of k_1 , k_2 , and k_3 can be calculated by plotting the graph $\log k_g a$ vs. $\log Q_g$ or $\log p_{(SO_2)av}$ as shown in the Figure 1, and the correlation equation was obtained as:

$$k_g a = 3.80231 \times 10^{-6} \cdot Q_g^{1.26} \cdot p_{(SO_2)av}^{0.2811} \quad (5)$$

Data for $k_g a$ were obtained by absorbing O_2 from air into degassed distilled water. The dissolution rate of O_2 in distilled water can be expressed as:

$$dC/dt = k_1 a (C_s - C) \quad (6)$$

Experiments were carried out at different O_2 gas flow rates and agitation speeds and the values of $k_g a$ were obtained from Eq. (6).

The $k_g a$ value can be correlated to gas flow rate (Q_g) and agitation speed (N) as follows:

$$k_g a = k_1 \cdot N^{k_2} \cdot Q_g^{k_3} \quad (7)$$

Taking logarithm of Eq (7), value of k_1 , k_2 , and k_3 can be calculated by plotting the graph $\log k_g a$ vs. $\log Q_g$ or $\log N$ (Figure 2) and the correlation equation was obtained as:

$$k_g a = 6.395 \times 10^{-4} \cdot N^{0.452} \cdot Q_g^{0.3198} \quad (8)$$

Using the this result, Figure 3 and 4 appear relation between gas film control and physical absorption on the ClO_2 - SO_2 - NO system.

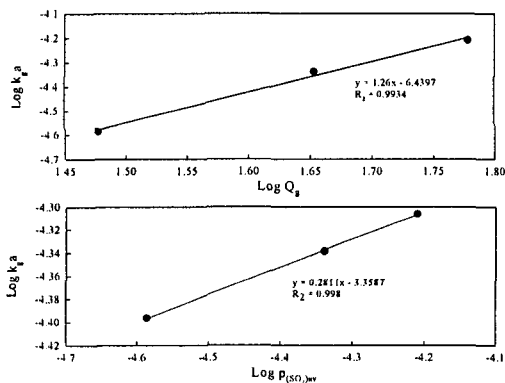


Fig. 1. Graph of $\log k_g a$ vs. $\log Q_g$ or $\log p_{(SO_2)av}$.

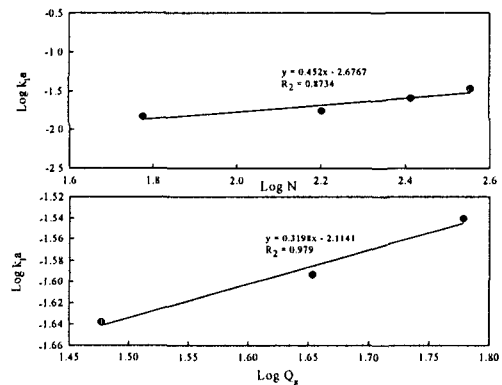


Fig. 2. Graph of $\log k_g a$ vs. $\log Q_g$ or $\log N$.

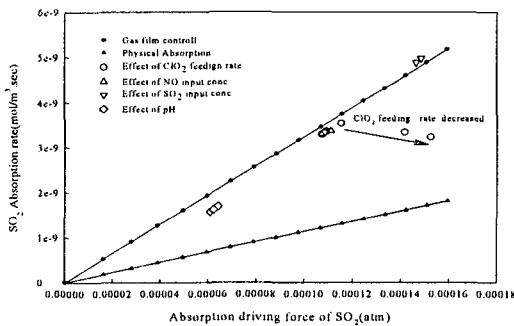


Fig. 3. Absorption rate vs. ab. driving force.

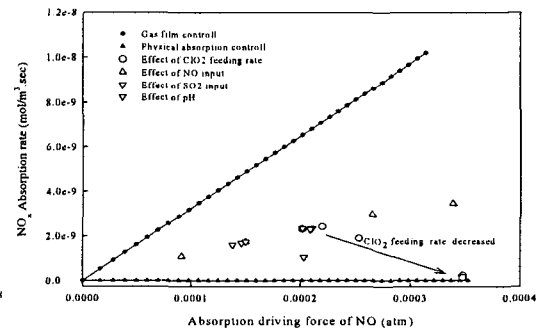


Fig. 4. Absorption rate vs. ab. driving force.

References

O. Levenspiel (1972) Chemical Engineering Science, 2nd Ed., John Wiley & Sons, Inc., New York.