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PE12) ClO_2에 의한 SO_2 & NO_x 동시 제거 반응에서 SO_2 & NO의 유입 농도와 pH에 따른 영향

Effect of various parameters on Simultaneous Removal of SO_2 & NO_x by ClO_2

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1. Introduction

Chlorine-dioxide is yellowish green gas which has emerged as highly efficient chemical agent for bleaching, oxidation, and disinfection. In this study, Chlorine-dioxide has been generated by reduction of sodium chlorate with sodium chloride in a relatively concentrated acid solution in the manner described by Deshwal and Lee [2004] and Hong et al. [1967]. The general stiochiometry of this reaction can be expressed as follows:

$$2NaClO_3 + 2NaCl + 2H_2SO_4 \rightarrow 2ClO_2 + Cl_2 + 2Na_2SO_4 + 2H_2O \quad (1)$$

The object of the present study is to investigate the effect of various operating variables viz. input NO, input SO_2 concentration, and pH of solution in the simultaneous removal of SO_2 and NO_x.

2. Experimental Section

Chlorine-dioxide generation unit is composed of a well stirred and sealed reactor having total volume of 2.5L. Concentrated sodium chloride solution (1M) was continuously injected into reactor at suitable flow rates (1ml/min) by syringe pump. The reactor was filled with 1.5L sodium chlorate solution (0.2M) in a relatively concentrated sulfuric acid (~12N).

Flue gas treatment unit is composed of simulated flue gas supply system, bubbling reactor, pH control system, ClO_2 absorber, data acquisition system, and sampling cum analysis system. The simulated flue gas was obtained by controlled mixing of SO_2, NO, N_2 and O_2 using mass flow controllers. Continuous stirring was provided by mechanical agitator with a speed of 250rpm. Temperature of the reaction vessel was controlled within 45±0.1℃. The pH of solution was controlled by using an auto-pH control system by continuous addition of NaOH (0.2M) solution with the help of peristalsis pump. The ClO_2 absorber (2L vessel) consisted of ca. 2% carbonate buffered potassium iodide solution (1.5L). Samples from reactor and absorber were analyzed using either ion chromatograph (IC) or iodometrically with the help of auto-titrator (Metrohm-Swiss).

3. Results and discussion

Fig. 1 displays effect of input NO concentration on the removal efficiencies of SO_2 and NO_x. SO_2 removal was found about 98%. NO_x was removed about 70% at input NO concentration of 150, 250, 350 and 450ppm. However it decreased to 66% at the input NO concentration of 550ppm. It is because input ClO_2 concentration of 1mmol/min was not sufficient to oxidize NO into NO_2 completely at input NO concentration of 550ppm. NO was oxidized completely to NO_2 at 150, 250, 350 and 450ppm NO input concentration using ClO_2. When ClO_2 feeding rate was enhanced to 2.03mmol/min, it was observed that NO_x removal effciency increased to ~68%. Input NO concentration has negligible effect on the NOx removal efficiency.

In Fig. 2, the removal efficiency of NO_x is plotted against the various input SO_2 concentrations. In absence of input SO_2 i.e. NO-ClO_2-$NaOH$ system, NO_x removal was found around 66%, but it increased to around 70% at input SO_2 concentration of 250, 500ppm in the SO_2-NO-ClO_2-$NaOH$ system. The sharp decrease in NO_x removal to 38% in Fig. 2 at input SO_2 concentration of 750ppm is because of insufficient ClO_2. When ClO_2 feeding rate was increased from 1.11mmol/min to 2.03mmo/min, removal efficiency of NO_x increased to about 70%. In Fig. 3, removal efficiency of NO_x and output concentration of NO_x is plotted against various pHs. NO_x removal was about 70% at pH of 3.5, however, it decreased to 68% at pH of 5 and 6.5 and further when solution changed from acidic to alkaline medium, NO_x removal decreased to about 66% at the pH 8. NO was oxidized completely to NO_2 at all pH conditions using ClO_2. Fig. 4 shows the comparison of input chlorine-dioxide with accumulated chloride, chlorate, and output chlorine dioxide.

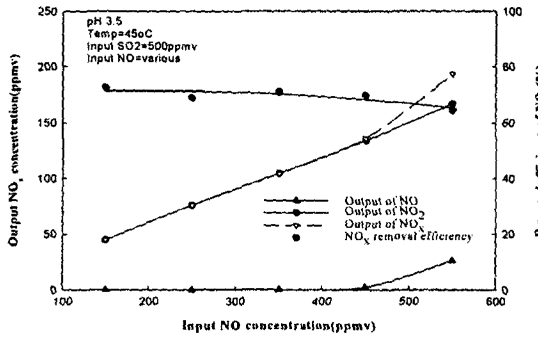

Fig. 1. Removal efficiency & Output concentration of NO_x at various input NO conc.

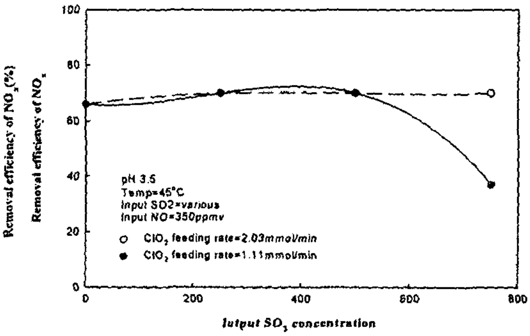

Fig. 2. Removal efficiency of NOx at various input SO_2 concentration.

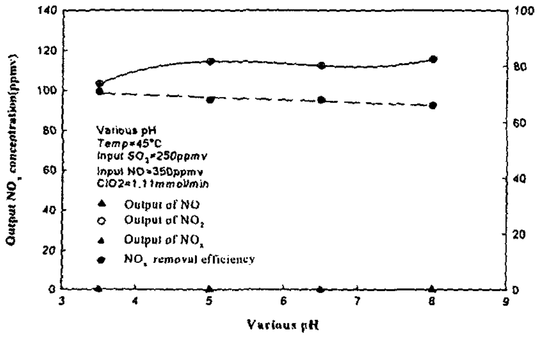

Fig. 3. Removal efficiency & Output concentration of NOx at various pH.

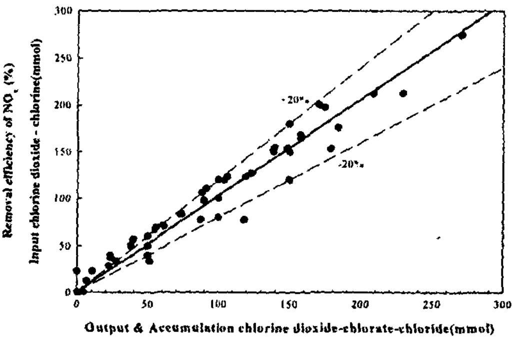

Fig. 4. Comparison between input chlorine dioxide-chloride and output chlorine dioxide, accumulated chloride & chlorate.

References

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