Controlling technologies of SO$_2$ by adsorption techniques

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ABSTRACT

The present studies deals with the adsorption of SO$_2$ by manganese oxide *i.e.*, Pyrulusite ore. Pyrulusite is used as an adsorbent for the present studies. It is found that the percentage removal of SO$_2$ increases with the increase in contact time, follows first order kinetics and a unimolecular layer is formed during the process. The percentage removal of SO$_2$ increases with increase in dosages and decreases with increase in concentration. Thermodynamic parameters such as enthalpy, entropy and free energy of the process were determined which indicates that the process is spontaneous and exothermic in nature. The negative values of S indicate the increased randomness at the solid interface during the adsorption of SO$_2$.

Key words: SO$_2$, adsorption techniques, Pyrulusite.

INTRODUCTION

SO$_2$ and its derivatives produce strong irritation on the eyes and nasal passage ways. It causes intense irritation even at 2.5 ppm levels to the eyes and respiratory tract.[1-3] It is absorbed by the nasal system leading to swelling and stimulated mucus secretion and it causes lung cancer[4-6]. The accumulation of transport vehicles such as automobiles at the signal points on the main arteries of the city and the consequent emission of exhaust of considerable quantity is everyday sequence. So the present study deals with controlling technologies of SO$_2$ by batch adsorption by using MnO$_2$ as an adsorbent.

METHODS AND MATERIALS

Selection of the adsorbent

Manganese dioxide is selected as an adsorbent for the present studies. MnO$_2$ is amphertic in nature and it is a good oxidizing agent. It can easily to take an atom of oxygen. Due to the oxidizing nature of MnO$_2$ a reaction takes place between them. Taking that factor into consideration MnO$_2$ is selected as an adsorbent.

The present studies are conducted by batch adsorption techniques. These methods are selected because SO$_2$ is present in low concentrations and it is noncombustible. The experiments are conducted with respect to contact time concentration, adsorbent dosage and with respect to temperature.

Experimental procedure
Effect of contact time and particle size on adsorption of SO$_2$:

To study the effect of contact time, SO$_2$ gas diluted with N$_2$ gas is made to pass through a catalytic tube, which is maintained at a constant temperature. The catalytic tube is filled with a fixed amount of 0.8gms. The flow rate of 60 ml/min. was maintained. The experiments are conducted with 500mic. and 250mic. The results are shown in fig.1.

Effect of concentration
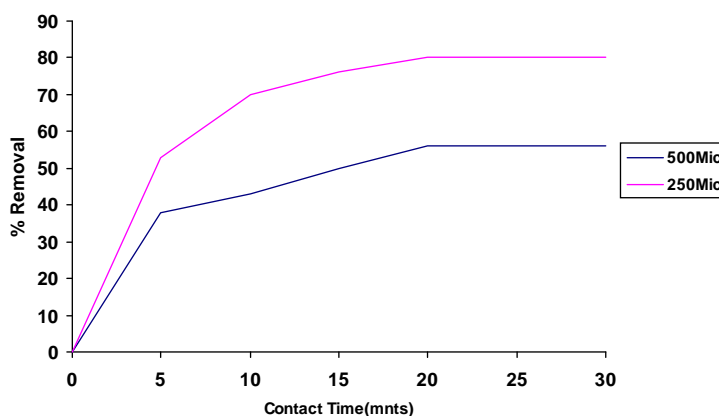
Different concentrations of SO$_2$ diluted with

Fig. -1: Variation of contact time between MnO$_2$ and SO$_2$

N$_2$ gas are made to pass through a catalytic tube, which consists a constant amount of MnO$_2$. The concentration of the gas is determined before and after adsorption of SO$_2$ by using SO$_2$ analyzer. The experiments are conducted with respect to 250 MIC and 500 MIC particle size. The results are shown in fig.2

Effect of adsorbent dosages

To study the effect of MnO$_2$ dosages, definite concentration of SO$_2$ is made to pass through a catalytic tube which consists of adsorbent. The adsorbent dosages are varied and initial conc. of SO$_2$ and final conc. of SO$_2$ are determined by using SO$_2$ analyser which is based on west-Gaeke method. The results are shown in fig.3.

Effect of temperature

To study the effect of temperature, the experiments are conducted at three different temperatures i.e., 45^{0}C, 65^{0}C and 85^{0}C.

RESULTS AND DISCUSSIONS

Fig . -1 shows that initially the percentage removal of SO$_2$ increases with the increase in contact time[7-8]. The optimum time for the removal of SO$_2$ is 20 min. The percentage removal of SO$_2$ increases with decrease in particle size[9-10]. The percentage removal of SO$_2$ increases with increase in contact time and it follows a smooth curve which indicates that the process is of first order[11]. Initially the adsorption capacity is practically proportional to contact time initially the MnO$_2$ surface is free from SO$_2$ once equilibrium is established adsorption no longer depends on the surface area.

Fig.2 represents the percentage removal of SO$_2$ decreases with the increase in concentration[11-12]. The number of gas molecules will
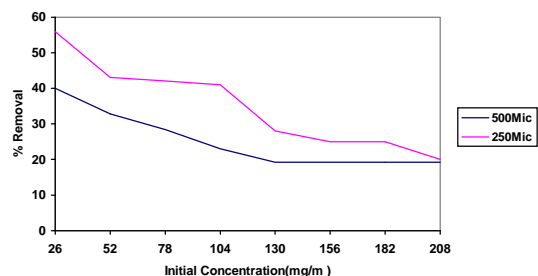

Fig. -2: Variation of initial concentration
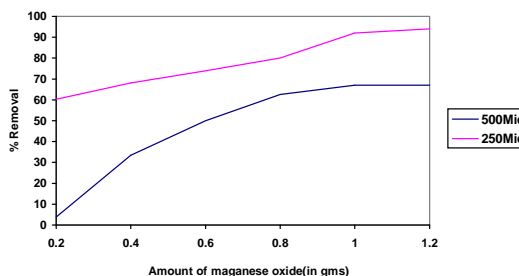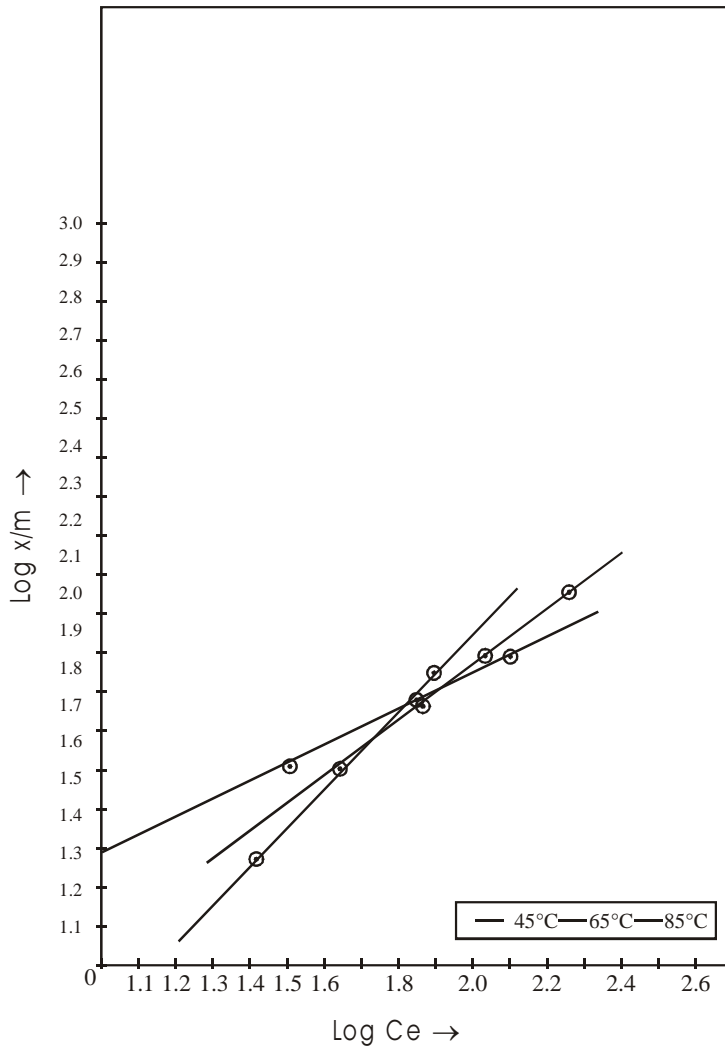

Fig. -3: Variation of adsorbent dosages

Fig. -4: Relationship between Log x/m and log Ce

be low at low concentrations and at the higher concentrations the number of gas molecules is more so adsorption is less.

Fig.3 represents that the percentage removal of SO_2 increases with the increase in adsorbent dosage[13-14]. Greater the number of adsorbent sites, greater is the percentage of adsorption.

Fig.4 represents that adsorption process follows Freundlich adsorption isotherm.[15]

It is observed the adsorption capacity increases with increase in temperature i.e., 85^0C. Thermodynamic parameters are calculated by plotting $\log k_c$ verses $1/T$.

A straight line is obtained. The negative 43, slope of the straight line indicates that the process of adsorption is exothermic in nature. The free energy of the process is negative which indicate that process is feasible and spontaneous in nature,
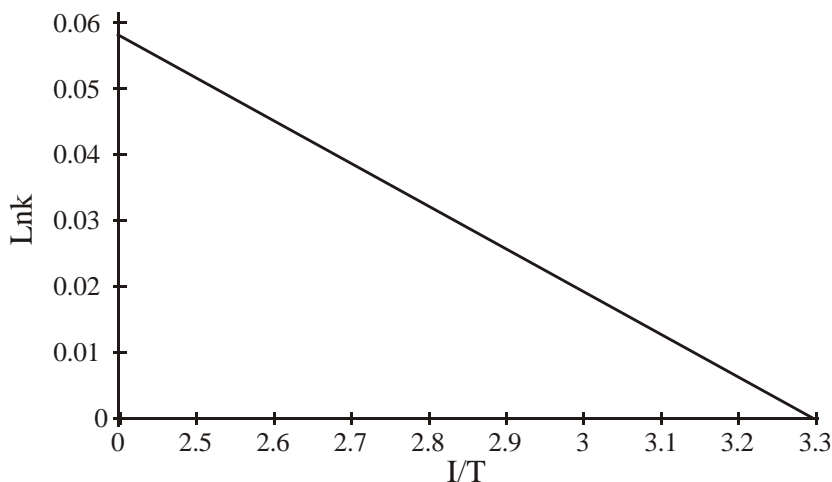
Fig. -5: Relationship between 1/T and Ln K

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