Short Communication

Sulphur dioxide adsorption using *Macrotyloma uniflorum* Lam. seed powder

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Abstract
Removal of sulphur dioxide from aqueous solution of sulphur dioxide using *Macrotyloma uniflorum* Lam. (horse gram) seed powder as an adsorbent was carried out in present study. The results showed that percentage removal by *M. uniflorum* seed powder at low concentration was 98% and 90% at high concentration. Batch adsorption was conducted with respect to contact time, concentration, and *M. uniflorum* seed powder dosage. It was shown that the optimum dosage was 0.4 g and optimum absorption time was 20 minutes.

Keywords *Macrotyloma uniflorum*; adsorption; unimolecular layer; contact time; adsorbent dosage.

1 Introduction

Sulphur dioxide (SO_2) is a colorless gas. It can be oxidized into sulphur trioxide. In the presence of water, the vapor is readily transformed to sulphuric acid mist. SO_2 can be oxidized to form acid aerosols. SO_2 is a precursor to sulphates and one of the main components of respirable particles in the atmosphere. It is estimated that SO_2 remains in air for an average of two or four days (Atanasova et al., 1999). SO_2 is emitted primarily during the combustion of fossil fuels and the processing of sulphur containing ores. The major source of sulphur dioxide is fossil fuels burning power plants (generating, electricity) and industrial boilers. Another source of sulphur dioxide is vehicular exhaust emissions. It is emitted into the atmosphere either or through oxidation of H_2S obtained from decomposition of organic matter. The natural sources such as biological decay and sea spray emit about 130 million tons of sulphur each year and the anthropogenic sources such as coal combustion, petroleum and smelting operations release an additional 132 million tons of sulphur dioxide annually into the atmosphere (Agrawal et al., 2004). The largest contribution to the anthropogenic emission (about 70%) is made by coal combustion. The natural sources of sulphur dioxide are probably present in gases emitted through volcanic activity. This study aimed to test the removal of sulphur dioxide from aqueous solution of sulphur dioxide using *Macrotyloma uniflorum* Lam. (horse gram) seed powder as an adsorbent.

2 Methods and Materials

Macrotyloma uniflorum Lam. is commonly known as horse gram, which belongs to the family Fabaceae. Polyphenols present in seed extract of *M. uniflorum* were water soluble, heat stable, polar, non-tannin and non-protein in nature. Taking all these factors into consideration *M. uniflorum* seed powder was selected as an adsorbent. We tried to examine the possibility of using a well-known physicochemical method as adsorption for the removal of SO_2 from aqueous SO_2 solution. The initial screening study has been carried by mixing a known amount of *M. uniflorum* adsorbent into the aqueous solution of SO_2 (Angold, 1997).

The adsorption experiment is carried out with respect to contact time between aqueous solution and adsorbent, with respect to effect of aqueous SO_2 concentration, and with respect to adsorbent dosage.

3 Results and Discussion

3.1 Effect of contact time

We measured the effect of contact time on the batch adsorption of aqueous solution of SO_2. At initial concentration it indicated that the increase in contact time from 3 to 20 minute enhanced the percent removal of aqueous SO_2 solution significantly (Sakai et al., 2002). The initial rapid adsorption showed a very slow approach to equilibrium. The nature of adsorbent and its available sorption sites affected the time needed to reach the equilibrium. For horse gram seed powder this time was 20 minutes. Results are given in Table 1 and Fig. 1.

Table 1 Removal effect of SO_2 under different contact durations (amount of adsorbent: 1g; volume of aqueous SO_2 solution: 100 ml; surface area: 2.41 square centimeters).

S. NO	Contact time (mins)	Initial Conc. mg/m^3	Final Conc. mg/m^3	Amount of SO_2 absorbed per mg/m^3	%Removal	%removal per square centimeters
1	3	104	15.6	88.4	85	35.26
2	5	104	14.3	89.7	86	35.68
3	10	104	10.4	93.6	90	37.34
4	20	104	10.4	93.6	90	37.34

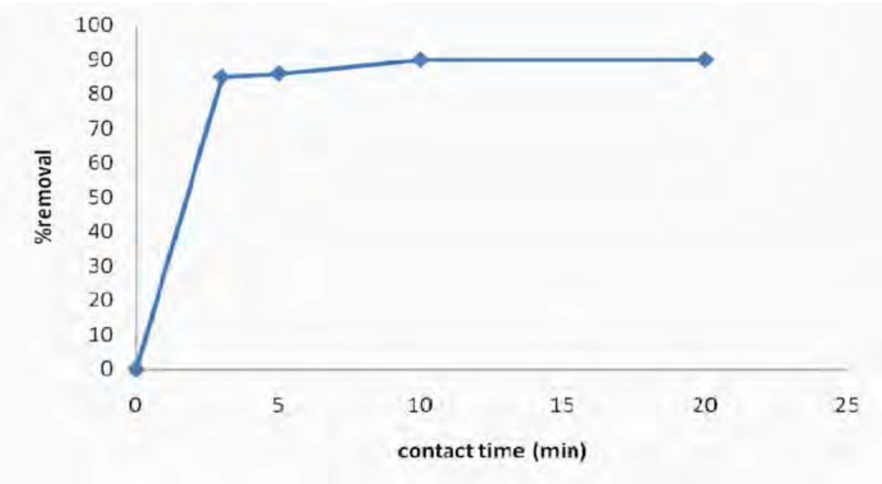

Fig. 1 Removal effect of SO_2 under different contact durations (Amount of adsorbent: 1g; volume of aqueous SO_2 solution: 100ml; surface area: 2.41 square centimeters).

From Table 1 we find that the adsorption of SO_2 increased with the increase of contact time. In Fig. 1 it is a smooth curve which indicates that the percentage removal increased with increase of contact time. The optimum contact time is 20 minutes.

3.2 Effect of concentration of aqueous SO_2 solution

Different concentrations of aqueous solution of SO_2 were mixed with a fixed amount of adsorbent. The experiment was conducted with contact time has been fixed. The results are given in Table 2 and Fig. 2.

Table 2 Removal effect of SO_2 under different initial concentrations of horse gram seed powder (amount of adsorbent: 1g; volume of aqueous SO_2 solution: 100 ml; surface area: 2.41 square centimeters).

S. NO	Initial Conc. mg/m^3	Final Conc. mg/m^3	Amount of SO_2 adsorbed m g/m^3	%removal	%removal per square centimeters
1	52	2.6	49.4	95	39.41
2	104	9.1	94.9	91	37.75
3	156	15.6	140.4	90	37.34
4	208	19.5	188.5	90	37.34

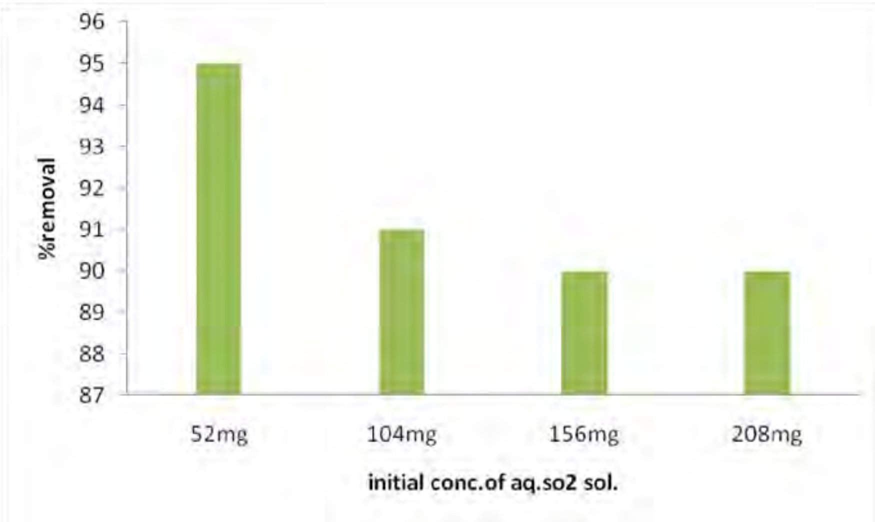

Fig. 2 Removal effect of SO_2 under different concentrations of horse gram seed powder (amount of adsorbent: 1g; volume of aqueous SO_2 solution: 100 ml; surface area: 2.41 square centimeters)

The percentage removal of aqueous solution of SO_2 decreased with increase in concentrations, as indicated in Table 2. The maximum percentage removal of SO_2 was observed at the lower concentrations as compared to higher concentrations (Ning et al., 1994).

3.3 Effect of horse gram seed powder dosages

Given concentration of aqueous solution of SO_2 was made to flow through different amounts of adsorbent dosages, i.e. 0.2 g, 0.4 g, 0.6 g, respectively. Contact time was 20 minutes. Results in Fig. 3 and Table 3 showed that the percentage removal of SO_2 from aqueous solution increased with the adsorbent dosage and reached the optimum at 0.4 g of absorbent dosage.

Table 3 Removal effect of SO_2 under different dosages of horse gram seed powder (volume of aqueous SO_2 solution: 100 ml; surface area: 2.41 square centimeters).

S.NO	Amount of horse gram powder in gms	Initial conc.in mg/m^3	Final conc. mg/m^3	Amount of SO_2 adsorbed	%Removal	%Removal per square centimeters
1	0.2	104	62.4	41.6	40	16.59
2	0.4	104	52	52	50	20.74
3	0.6	104	52	52	50	20.74

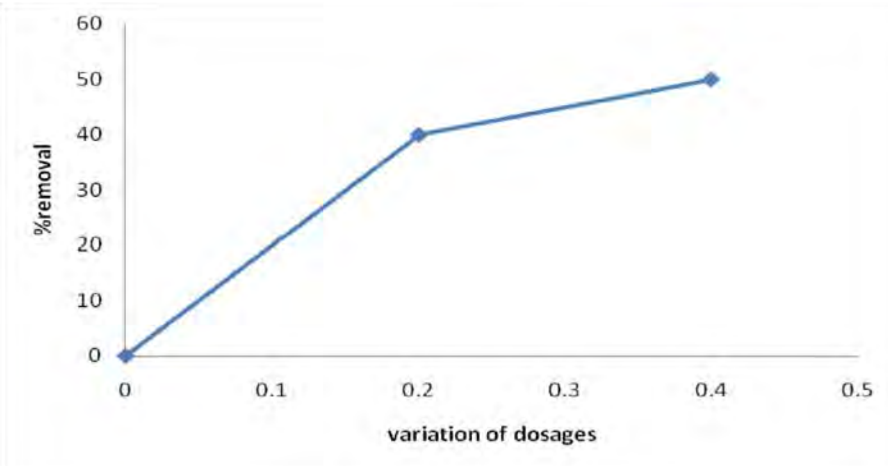

Fig. 3 Removal effect of SO_2 under different dosages of horse gram seed powder (volume of aqueous SO_2 solution: 100 ml; surface area: 2.41 square centimeters).

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