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Controlling SO_2 by Using Low Cost Adsorbents

N. Gandhi,[1] V. Mary Priyanka[2] and D. Sirisha [1]
[1] *Center for Environment and Climate Change, School of Environmental Science, Jawaharlal Nehru Institute Of Advanced Studies (JNIAS) Hyderabad, A.P*
[2] *Sri Padmavathi Mahila Visva Vidyalayam Thirupathi, A.P*

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Sulphur oxides are formed during high temperature combustion processes from the oxidation of sulphur in the air. The principal source of sulphur oxides is sulphur oxide (SO) and sulphur dioxide (SO_2), collectively known as SO_x. SO and SO_2 concentrations are therefore the highest in industrial area. Other important sources are power stations, heating plants, and industrial processes. Long-term exposure to sulphur dioxide may affect lung function, and that exposure to sulphur dioxide enhances the response to allergens in sensitized individuals. The feasibility of using waste materials as adsorbent for air pollutant SOx was evaluated in the present study. The experiments were carried out in laboratory on certain waste materials like Neem leaf powder, orange peel powder, custard apple leaf powder, Horse gram seed powder, Ragi seed powder, mango bark dust, mixed algae, and Neem bark dust. The experimental investigations were carried out by traditional adsorption studies, and they showed that all substances had certain capacity to adsorb SO_x from aqueous solution of SO_x. The order of adsorption by different low cost materials is Mango bark dust > Orange peel powder >Custard apple leaf powder> Neem leaf powder> Horse gram seed powder> Ragi seed powder> Neem bark powder, mixed algae by 98%>95%>88%>82%>80%>78%>77%>74%, respectively. At lower concentration the adsorption is more compared to higher concentration. It is found that the adsorption increases with an increase in surface area.

Key words: *Sulphur dioxide, adsorption, low cost adsorbents, Neem bark, Orange peel.*

1. Introduction

Sulphurdioxide is a colorless gas. It smells like burnt matches. It can be oxidized to sulphur trioxide, in the presence of water vapor it 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 respiratory particles in the atmosphere. It is estimated that SO_2 remains in the air on an average for two or four days.

$SO_2$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 directly by fuel combustion, petroleum refining and smelting operations, etc., 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 per 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. The largest signal contribution to the anthropogenic emission about 70% is made by coal combustion. The natural sources of sulphur dioxide are probably present in gases emitted all through the volcanic activity.

SO_2 and its derivatives produce strong irritation on the eyes and nasal passageways. It causes intense irritation to the eyes and respiratory tract. It is absorbed by the nasal system, leading to swelling and stimulated mucus secretion. SO_2 damages lung tissues and causes and promotes respiratory diseases. Raised levels of SO_2 in the atmosphere may also cause lung

cancer. Higher concentration of SO_2 induces desquamation or peeling of the surface epithelium in the mucosa and cilia, which protects the respiratory tract. SO_2 also induces an involuntary coughing reflex. The taste threshold limit is 0.3 ppm while SO_2 produces an unpleasant smell at 0.5 ppm.

2. Methods and Materials

Adsorption methods are adopted for non-combustible gas and these methods are suitable when pollutant gases are present in low concentrations. In this paper an attempt has been made to suggest certain waste materials as effective adsorbents of SO_x. The adsorbents primarily screened were Neem bark dust, Orange peel powder, Custard apple leaf powder, Neem leaf powder, Ragi seed powder, and Horse gram seed powder, Mango bark dust, mixed algae. Initially, all the sorbents are screened by adding 1 gm of each adsorbent to 100 mL of aqueous solution of SO_2 gas. For this purpose, an aqueous solution of 100 mL of SO_2 of various concentrations is taken in 100 mL stoppered bottles and 1 gm of adsorbent is added to the solutions. Batch adsorption experiments are carried out at a room temperature, a contact time of 24 hr is maintained. The initial and final concentrations of aqueous solution of SO_2 were determined by Spectrophotometer and percentage removal of SO_2 was determined.

Table 1. Percentage removal of SO_2 with different adsorbents

S.No	Con. of SO_2 µg/m^3	Mango bark dust	Neem bark dust	Mixed algae	Ragi seed powder	Horse gram seed powder	Orange peel powder	Neem leaf powder	Custard apple leaf powder	Pine apple peel powder
	5	100	100	90	90	98	100	92	95	90
	10	100	98	86	87	95	100	90	95	86
	20	100	91	80	84	91	98	87	92	82
	30	99	82	78	81	84	96	86	91	79
	40	98	77	76	78	80	95	84	88	77

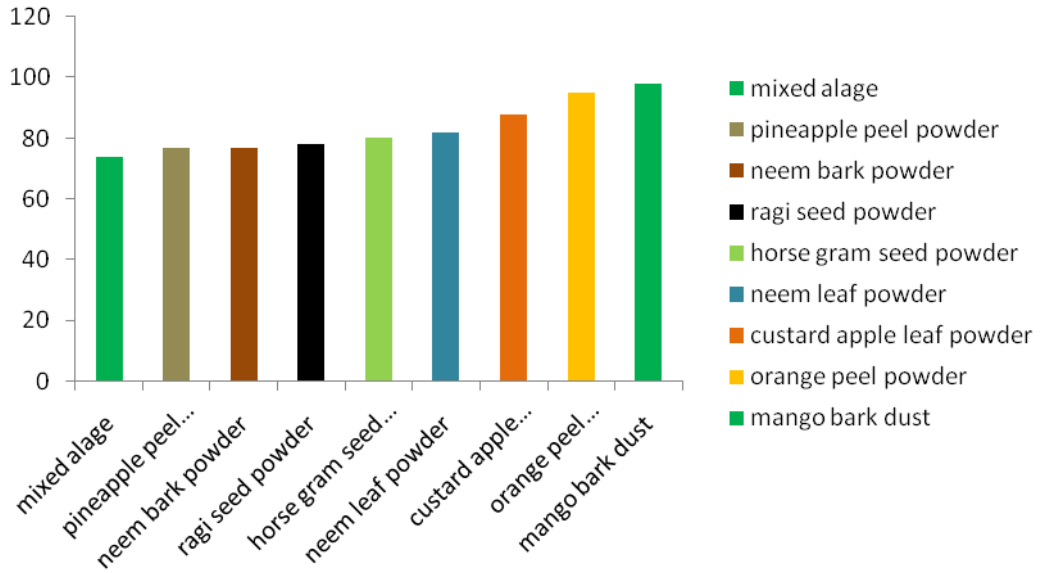

Fig. 1. Order of effectiveness of Adsorbents: Mango bark dust > Orange peel powder >Custard apple leaf powder> Neem leaf powder> Horse gram seed powder> Ragi seed powder>pine apple peel powder> Neem bark powder> mixed algae

3. Results and Discussion

The adsorbents selected for the present study Neem bark dust, Mango bark dust, mixed algae, Ragi seed powder, Horse gram seed powder, Orange peel powder, Neam leaf powder, and Custard apple leaf powder are presented in Table 1.It is observed that the order of adsorption is as follows: Mango bark dust, Orange peel powder, Custard apple leaf powder, Neem leaf powder, Horse gram seed powder, Ragi seed powder, Neem bark dust, Mixed algae. The adsorption capacity is greater at lower concentrations compared to higher ones. In the present study it is observed that physical adsorption is taking place.

Mango bark dust is waste material collected from timber industry. Mango bark dust is a bio

adsorbent and it consists of lignin and cellulose and many hydroxyl groups such as lumens or phenolic compounds. The composition of Mango bark dust is formed by 36.5% of cellulose and 49.5% of lignin. The ligno-cellulosic components present in Mango bark dust are responsible for complete adsorption observed in this study. Mango bark dust is a cheap material and the adsorption capacity of the mango bark dust is high compared to other adsorbents, hence, it can be used as an effective adsorbent for removal of SO_2.

Neem bark dust is waste material collected from timber industry. Neem bark dust is a bio adsorbent and it consists of lignin and cellulose and many hydroxyl groups such as lumins or phenolic compounds. The composition of Neem bark dust is the same as that of Mango-bark dust: cellulose – 36.5% and lignin – 49.5%. The ligno-cellulosic components present in the Neem bark dust are responsible for complete adsorption observed in this study. Neem bark dust is a cheap material and the adsorption capacity of the Neem bark dust is high compared to other adsorbents, hence, it can be used as an effective adsorbent for removal of SO_2.

Orange peel (Citrus sinensis) is waste material collected from fields. Orange peel is a bio adsorbent and it consists of cellulose, essential oils, proteins and some simple carbohydrates. The cellulosic material is responsible for complete adsorption, hence, it can be used as an effective adsorbent for removal of SO_2.

Algae are waste material collected from ponds. It acts as a bio adsorbent for the removal of SO_2. It consists of proteins, carbohydrates, lipids and nucleic acids.

Horse gram (Macrotyloma uniflorum) seed powder is collected from fields. It is a bio adsorbent and it consists of higher trypsin inhibitor, haemagglutinin activities, and poly phenols. These materials are responsible for complete adsorption observed in this study. Hence, it is an effective adsorbent for removal of SO_2.

The most significant part of Neem (Azadrirachta indica) is a neem leaf which is collected from neem plant. It consists of iron and fibres, where SO_2 reacts with iron and forms iron oxide. It acts as a catalyst for SO_2 removal. Hence, it can be used as its effective adsorbent.

Custard (Annona squamosa) apple leaf is waste material collected from garden. It consists of volatile oils and alkolids which act as catalyst for removal of SO_2.

Ragi (Eleusine coracana) seed is collected from fields. It consists of fibers which act as catalyst for the removal of SO_2. Hence, it is considered as good adsorbent for SO_2

Pine apple (Ananas cosmosus) peel powder is waste material collected from fields. It consists of cellulose and Hemi cellulose. The cellulosic material present in that waste is responsible for complete adsorption of SO_2.

4. Conclusions

For survival of the mankind, environmental researcher must control ill effects caused by air pollution. For this reason, the present study has made an attempt to help controlling the air pollution caused by SOx. Among eight different adsorbents studied, Mango bark dust proved to be the most effective adsorbent of SO_2 from aqueous solution of SO_2. Thus, our study proves that the effect of harmful chemicals like SOx can be reduced by using naturally available waste materials like Mango bark dust, Orange peel powder, Neem bark dust, Custard apple leaf powder, Neem leaf powder, Horse gram seed powder, Ragi seed powder and mixed algae. Hence, this study provides an economic solution for cleaning up environmental pollutant SOx and recommends these adsorbents to be used in industries.

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N. Gandhi – Research scholar, Center for Environment and Climate Change, School of Environmental Sciences, Jwaharlal Nehru Institute of Advanced Studies, Hyderabad, A.p
E-mail: gandhinenavath@yahoo.com

V. Mary Priyanka – Department of Biotechnology, Sri Padmavathi Mahila Visva Vidyalayam, Tirupathi, Andhrapradesh
E-mail: priyanka.biotech5555@gmail.com

D. Sirisha – Head, Center for Environment and Climate Change, School of Environmental Sciences, Jwaharlal Nehru Institute of Advanced Studies, Hyderabad, A.p
E-mail: sirishadavid@gmail.com

SO_2 reguliavimas naudojant pigius absorbentus

N. Gandhi,[1] V. Mary Priyanka[2], D. Sirisha[1]

[1] *Aplinkos apsaugos ir klimato kaitos centras, Aplinkos mokslų mokykla, Jawaharlal Nehru pažangių studijų institutas, Indija*
[2] *Sri Padmavathi Mahila Visva Vidyalayam Thirupathi universitetas, Indija*

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Sieros oksidai susidaro aukštos temperatūros degimo procesuose oksiduojantis sierai. Didžiąją dalį sieros oksidų (SO_x) sudaro sieros oksidas (SO) ir sieros dioksidas (SO_2). Didžiausios SO ir SO_2 koncentracijos yra pramoniniuose rajonuose. Kiti svarbūs šaltiniai: energijos jėgainės, šilumos įrenginiai ir kiti pramoniniai procesai. Ilgalaikis sieros dioksido poveikis gali neigiamai veikti plaučius, o sieros dioksido emisijos ore gali turėti įtakos padidėjusiam žmonių jautrumui aplinkos alergenams. Straipsnyje nagrinėjama galimybė panaudoti atliekas kaip SO_x absorbentą. Laboratorinėmis sąlygomis buvo atliekami eksperimentai, naudojant skirtingas atliekų rūšis: indinio nimbamedžio susmulkintus lapus, susmulkintas apelsino žieveles ir pan. Atlikti tyrimai rodo, kad visi tirti absorbentai geba kaupti tam tikrą SO_x kiekį vandeninėje aplinkoje. Nustatyta, kad absorbcijos galimybės kyla didėjant absorbento paviršiaus plotui.