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Adsorption of Aqueous Solution of NO_2 by Mango Bark Powder

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Abstract:

The urbanization rate in India is very fast. It has increased from 10.84 to 28.5% upto 2001. Unregulated growth of urban area causes many problems. Due to increase in population, urbanization and industrialization, many air pollutants are entering into atmosphere and causing diseases. One of the most toxic air pollutant is NO_2. The present study deals with the adsorption of aqueous solution of NO_2 by mango bark dust. The adsorption experiments were conducted with respect to contact time, mango bark dust dosages, concentration and temperature. It was found that percentage removal increased with increase in contact time and with increase in adsorbent dosage. It follows first order kinetics. The amount of NO_2 gas adsorbed is more at lower concentration than at higher concentrations.

Keywords: Adsorption, Nitrogen dioxide, Mango bark powder, Contact time, Concentration, Dosage.

1. 0 Introduction:

The natural resources supporting life are air, water, soil and solar energy. Without air human beings cannot survive. Today, most of the natural resources are polluted due to increase in population and transportation and industrial development has resulted in the release of all kinds of pollutants into the environment. One of the major air pollutant is nitrogen oxides. Nitrogen dioxide is a reddish brown gas with pungent odour. The gas is corrosive, irritating and physiologically toxic. It reacts with water to form nitric acid, which may be a significant component of the acid rain. It is formed in the atmosphere primarily by photooxidation of NO. Emission of oxides of nitrogen from manmade sources varies in different areas. Nitrogen oxides are 10-100 times greater in the urban areas as compared to rural areas. Excess amount of NO and NO_2 may cause physiological and biochemical changes in living organisms. Within the last decade, data and methods have become available which allow for the quantification of adverse health effects associated with exposure to air pollution. It is apparent that such degradation of air quality could affect public health that is still increasing until today. Air pollution could influence public health, e.g. eye irritation, headache, and few respiratory diseases (Bovensman et al.1999; Branislav et al. 2009; Burrows et al. 1999; Crutzen et al. 1979).

Mango bark dust is a waste material collected from the Timber industry. Mango 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 mango bark dust is given by Cellulose-36.5% and Lignin-49.5%. The ligno-cellulosic components present in the mango bark dust are responsible for complete adsorption observed in the present 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 NO_2 (Ajmal et al. 1998; Kaushik et al. 2009; Dakiky et al. 2002; Suhail et al. 2010; Vinodhini et al. 2009).

2.0 Methods and Materials

2.1 Selection of Adsorbent

The present work, examines the possibility of using a well-known physicochemical method like adsorption for the removal of NO_2 from air. The initial screening studies have been carried by introducing a known amount of adsorbent into the aqueous solution of NO_2. It was found that mango bark dust has large capacity to adsorb NO_2. For the present studies adsorption techniques are selected because NO_2 gas is incombustible and it is present in very low concentrations. The experiments are carried with respect to contact time, with respect to initial concentration of NO_2 and with respect to mango bark dust dosages.

2.2 Effect of Contact Time

Contact time plays an important role in designing a system. The initial (before adsorption) and final (after adsorption) concentration is determined at regular intervals of time i.e. 5, 10, 15,30,45,60 and 120 minutes. The results are given in FIG 1.

2.3 Effect of Initial NO_2 Concentration

Different concentrations of NO_2 were studied, which consists of a fixed amount of adsorbent. The experiments are carried out with constant contact time and the contact time is fixed depending upon contact time experiments. The results are given in FIG 2.

2.4 Effect of mango bark dust Dosages

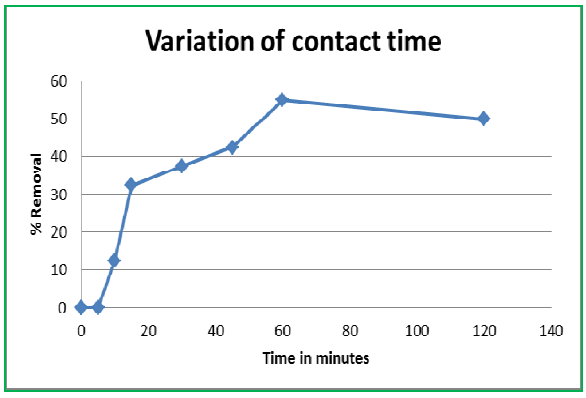
Definite concentration of NO_2 is studied with different amounts of adsorbent dosages i.e. 0.2 gms, 0.4gms, 0.6gms, 0.8gms respectively. The experiments are carried out with constant contact time of 60 minutes. The results are given in FIG 3.

3.0 Results and Discussions:

Mangoes have been cultivated in India for 4000 years. India shares about 50 % of total production in Andhra Pradesh. Mangoes are available mostly in summer season. The mango dust is collected from the mango trunk. The trunk is grey or greenish brown and coarse- textured. It is used for making agricultural implements, boats, window frames etc and the waste generated are dumped in various places which pose aesthetical problem to the environment. Taking that factor into consideration the mango bark dust is selected as an adsorbent.

3.1: Variation of Contact Time between Mango Bark Dust and No_2

Amount of Adsorbent: 1gm
Volume: 100ml
Concentration: 40 ppm

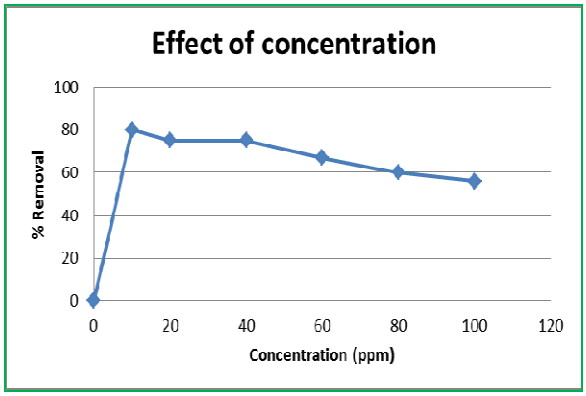


From the graph, it is evident that the %removal increases with increase in contact time. The optimum time for the removal of NO_2 is 60 minutes. The percentage removal of NO_2 increases with the increase in contact time and it follows a smooth curve which indicates that the process is of first order (Zhe Ming et al (2004)).

3.2: Variation of No_2 Gas Concentration on Mango Bark Dust

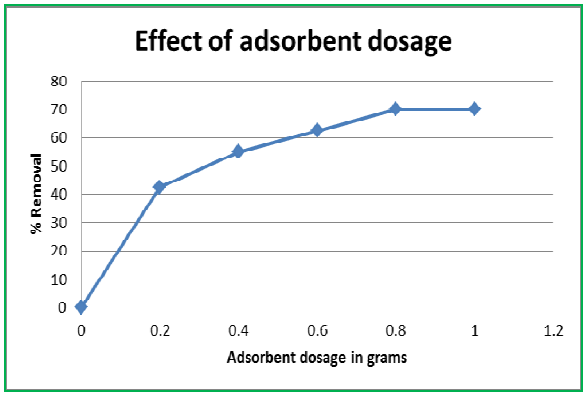
Amount of adsorbent: 1 gm
Volume: 100 ml
Contact time: 60 mins

From the graph, it is clear that the % removal decreases with increase in concentration. The number of gas molecules will be low at low concentrations and at the higher concentrations the number of gas molecules is more and so adsorption is less (Mittal et al. 1993).



3.3 Variation of Adsorbent Dosage

Concentration: 40 ppm
Volume: 100 ml
Contact time: 60 mins



From the graph, it is clear that the % removal increases with increase in adsorbent dosage. Greater the number of adsorbent sites, greater is the percentage of adsorption (Zhang et al. 1993).

4.0 Conclusions:

1) Mango bark dust has a capacity to adsorb NO_2.
2) The percentage removal of NO_2 molecules increased with the decrease in concentration, with the increase in adsorbent dosages and with the increase in contact time.
3) This study provides an economic solution for cleaning up environmental pollutant NO_2 and it is recommended to use this adsorbent in industries.

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