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Research Article – Chemistry

Application of bioadsorbent in control of atmospheric pollution

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Abstract

A material that has the ability to extract certain substances from gases, liquids, or solids by causing them to adhere to its surface without changing the physical properties of the adsorbent. Rapid urbanization, population growth, industrial expansion and waste generation from domestic and industrial sources have rendered waste which are hazardous to man and other living resources. Plants absorb carbon dioxide and supply us with oxygen in the process of photosynthesis. At the same time, they reduce pollutants in water and soil. They also remove significant amounts of gaseous pollutants and particles from the air. The microscopic plants in soil also reduce air pollutants and degrade many toxic chemicals that enter the soil.

Key words: Bioadsorbant, Pollution, Air, Water, Noise.

Introduction

Pollution control is the process of reducing or eliminating the release of pollutants (contaminants, usually human made) into the environment. It is regulated by various environmental agencies that establish limits for the discharge of pollutants into the air, water, and land. A wide variety of devices and systems have been developed to control air and water pollution and solid wastes. In order to mitigate environmental pollutant and to protect the biosphere from the adverse effects of pollution four important issues should be highlighted explicitly these issues include changing life style to control or decrease the emission of pollutant developing technologies to avoid or mitigate emission making rule and regulate to reduce emission decontamination of existing pollutant in the environment. Among the various form of pollution, water pollution is of great concern since water is the prime necesity of life and extremely essential for the survival of living organism. Water pollution is a major global problem which requires ongoing evaluation and revision of water resource policy at all levels (international down to individual aquifers and wells). It has been suggested that water pollution is the leading worldwide cause of deaths and diseases,[1][2] and that it accounts for the deaths of more than 14,000 people daily.[2] An estimated 580 people in India die of water pollution related illness every day.[3] About 90 percent of the water in the cities of China is polluted.[4] As of 2007, half a billion Chinese had no access to safe drinking water.[5] In addition to the acute problems of water pollution in developing countries, developed countries also continue to struggle with pollution problems. For example, in the most recent national report on water quality in the United States, 44 percent of assessed stream miles, 64 percent of assessed lake acres, and 30 percent of assessed bays and estuarine square miles were classified as polluted.[6]Among various water and wastewater treatment technologies, the adsorption process is considered better because of lower cost, simple design and easy operation. Activated carbon (a universal adsorbent) is generally used for the removal of diverse types of pollutants from water and wastewater. Research is now being directed towards the modification of carbon surfaces to enhance its adsorption potential towards specific pollutants. However, widespread use of commercial activated carbon is sometimes restricted especially

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in developing or poor countries due to its higher costs. Attempts are therefore being made to develop inexpensive adsorbents utilizing abundant natural materials, agricultural and industrial waste materials. Use of waste materials as low-cost adsorbents is attractive due to their contribution in the reduction of costs for waste disposal, therefore contributing to environmental protection. This e-book explores knowledge on recent developments in adsorbents synthesis and their use in water pollution control. This handy reference work is intended for researchers and scientists actively engaged in the study of adsorption and the development and application of efficient adsorption technology for water treatment. This e-book covers a wide range of topics including modeling aspects of adsorption process and the applications of conventional and non-conventional adsorbents in water remediation emphasizing sorption mechanisms of different pollutants on the adsorbents. Adsorbent materials used for treating industrial pollutants are reviewed. The article consists of two parts. The first part considers new trends in traditional adsorbents such as activated carbons and zeolites. New low-cost adsorbents such as waste materials and clay minerals are discussed in the second part.

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Sources of surface water pollution are generally grouped into two categories based on their origin.

Point Sources

Point source water pollution refers to contaminants that enter a way from a single, identifiable source, such as a pipe or ditch is an example of water pollution. Examples of sources in this category include discharges from a sewage treatment plant, a factory, or a city storm drain. The U.S. Clean Water Act (CWA) defines point source for regulatory enforcement purposes.[9]

Non-Point Sources

Nonpoint source pollution refers to diffuse contamination that does not originate from a single discrete source. NPS pollution is often the cumulative effect of small amounts of contaminants gathered from a large area. A common example is the leaching out of nitrogen compounds from fertilized agricultural lands.[11] Nutrient runoff in storm water from "sheet flow" over an agricultural field or a forest are also cited as examples of NPS pollution.

Causes of Pollution?

Water pollution-Most water pollution doesn't begin in the water itself. Take the oceans: around 80 percent of ocean pollution enters our seas from the land. Virtually any human activity can have an effect on the quality of our water environment. When farmers fertilize the fields, the chemicals they use are gradually washed by rain into the groundwater or surface waters nearby. Sometimes the causes of water pollution are quite surprising. Chemicals released by smokestacks (chimneys) can enter the atmosphere and then fall back to earth as rain, entering seas, rivers, and lakes and causing water pollution. That's called atmospheric deposition. Water pollution has many different causes and this is one of the reasons why it is such a difficult problem to solve.

Air pollution- can result from both human and natural actions. Natural events that pollute the air include forest fires, volcanic eruptions, wind erosion, pollen dispersal, evaporation of organic compounds and natural radioactivity. Pollution from natural occurrences is not very often.

Emissions from industries and manufacturing activities-long tubes (called chimneys) erected high into the air, with lots of smoke and fumes coming out of it. Waste incinerators, manufacturing industries and power plants emit high levels of carbon monoxide, organic compounds, and chemicals into the air.

Burning of Fossil Fuels

After the industrial age, transportation has become a key part of our lives. Cars and heavy duty trucks, trains, shipping vessels and airplanes all burn lots of fossil fuels to work. Emissions from automobile engines contain both primary and secondary pollutants. This is a major cause of pollution and one that is very difficult to manage. This is because humans rely heavily.

Household and Farming Chemicals

Crop dusting, fumigating homes, household cleaning products or painting supplies, over the counter insect/pest killers, fertilizer dust emit harmful chemicals into the air and cause pollution.

In many cases, when we use these chemicals at home or offices with no or little ventilation, we may fall ill if we breathe them.

and even pets barking in the middle of the night. All of these have become a part of the urban culture and rarely disturb us. However, when the sound of the television keeps you from sleeping all night or the traffic starts to give you a headache, it stops becoming just noise and start turning into noise pollution. For many of us, the concept of pollution is limited to nature and resources. However, noise that tends to disrupt the natural rhythm of life makes for one solid pollutant.

Controlling Adsorption

The amount of adsorbate adsorbed by an adsorbent from adsorbate solution is influenced by a number of factors as discussed below:

1. Nature of Adsorbent The physico-chemical nature of the adsorbent. Adsorbents differ in their specific surface area and affinity for adsorbate. Adsorption capacity is directly proportional to the exposed surface. For the non-porous adsorbents, the adsorption capacity is inversely proportional to the particle diameter whereas for porous material it is practically independent of particle size. However, for porous substances particle size affects the rate of adsorption. For substances like granular activated carbon, the breaking of large particles to form smaller ones open up previously sealed channels making more surface accessible to adsorbent.
2. pH of Solution The surface charge as well as the degree of ionization is affected by the pH of the solution. Since the hydrogen and hydroxyl ions adsorbed readily on the adsorbent surface, the adsorption of other molecules and ions is affected by pH. It is a common observation that a surface adsorbs anions favorably at low pH and cations in high pH range.
3. Contact Time In physical adsorption most of the adsorbate species are adsorbed within a short interval of contact time. However, strong chemical binding of adsorbate with adsorbent requires a longer contact time for the attainment of equilibrium. Available adsorption results reveal that the uptake of adsorbate species is fast at the initial stages of the contact period, and thereafter, it becomes slower near the equilibrium.
4. Initial Concentration of Adsorbate A given mass of adsorbent can adsorb only a fixed amount of adsorbate. So the initial concentration of adsorbate solution is very important. The amount adsorbed decreases with increasing adsorbate concentration as the resistance to the uptake of solute from solution of adsorbate decreases with increasing solute concentration. The rate of adsorption is increased because of the increasing driving force [3]. Temperature dependence of adsorption is of complex nature. Adsorption processes are generally exothermic in nature and the extent and rate of adsorption in most cases decreases with increasing temperature. This trend may be explained on the basis of rapid increase in the rate of desorption or alternatively explained on the basis of Le-Chatelier's principle.

Air Pollution- Most of us are very used to the sounds we hear in everyday life. Loud music, the television, people talking on their phone, the traffic

Table 1. Some common adsorbent used for pollution control and its property

Adsorbent	Nature	Average pore diameter (mM)	Particle porosity (%)	Surface area ($m^2 g^{-1}$)	Sorptive capacity ($kg\ kg^{-1}$)
Activated alumina	Hydrophilic amorphous	4-14	50	320	0.1-0.33
Activated carbon	Hydrphobic adsorbent	1-4	40-85	200-1200	0.3-0.7
Molecular sieve carbon	Hydrphobic adsorbent	0.3-0.6	35-50	400	0.2-0.5
Molecular sieve zeolite	Hydrophilic amorphous	0.3-1	20-50	600-700	0.12-0.42
Polymeric adsorbent	Hydrphobic adsorbent	4-25	40-60	80-700	0.45-0.55
Silica gel	Hydrophilic amorphous	2 -5	47-71	300-850	0.35-0.5

Materials and Methods

The whole study is based on the literary material collected from classical books, modern books and magazine and internet sources. Selection of Plant species for pollution control While selecting the species for pollution control the following are the

important characteristics could be considered. Plants should be evergreen, large leaved, rough bark, indigenous, ecologically compatible, low water requirement, minimum care, high absorption of pollutants, resistant pollutants, agroclimatic suitability, height and spread.

Azadirachta indica A. Juss Neem has been referred as an "air purifier". It absorbs some of the environmental pollutants (SO2), and act as an "air freshener" by releasing oxygen and odorous principles. Neem tree growing in a highly polluted area is not affected by various gases. It has a greater ability to adapt to stress from exposure to air pollution. Neem is tolerant to most soil types including dry, stony, shallow soils, lateritic crusts, highly leached sands and clays. With an extensive and deep root system, the hardy Neem can grow and flourish even in marginal and leached soils.

Holoptelea integrifolia Planch it is a fast growing tree with a good canopy. It is resistant to gaseous pollutants. Due to the rough leaf surface it traps dust and particulate pollutants. It is good for plantation on Roadside as well as in the Greenbelt around Thermal power plants. *Ficus religiosa* Linn. It is a common tree of roadside with a good canopy. It is resistant to gaseous pollutants. The leaves of this tree are known to emit a lot of oxygen into the environment. It can be used as biomarkers and mitigators of pollutant coming out of automobile exhaust It is good for plantation on Roadside especially highways.

Dalbergia sissoo Roxb - Higher chlorophyll content in plants favors tolerance to pollutants. Ascorbic acid is an antioxidant that is found in growing parts of the plant and influences resistance to adverse environmental conditions, including air pollution. The sawdust works in the absorption of nickel ions and has the potential of removing these heavy metals from industrial and commercial waste water sources. *Dalbergia sissoo* is an ideal tree species to monitor and indicate the Pb concentration in air. Plants hold topsoil in place. Thus, they reduce sediment and excess nutrients which pollute water. Plants also make effective sound barriers, and so reduce noise pollution.

Thevetia neriifolia Juss it has been recommended for growing along roadsides in areas polluted by automobile emissions. The tree is very popular and can be found in every homestead. It is a tough, drought and termite resistant species with a high rate of survival.

Plants act as filters because they absorb the toxins through their leaves, especially those with the largest leaves. The theory is that if the plants do the absorbing first, our nose and lungs take on less of a burden. That means reduced incidence of asthma, allergies, reactions to mold and other particles, and immuno-suppressed illnesses.

Conclusion

The APTI was calculated by using the following formula (Singh and Rao, 1983).

APTI= [A (T+P) + R] /10

Where, A= Ascorbic acid (mg/g dry wt.) T= Total Chlorophyll (mg/g dry wt.) P= pH of leaf extract. R= Relative water content of leaf tissue (%).

Based on the APTI value the plants were conveniently grouped as follows (Kalyani and Singaracharya, 1995): APTI value Response 30 to100 Tolerant, 29 to17 Intermediate, 16 to 1 Sensitive.

Holoptelea integrifolia Planch – 55.8 very high, *Azadirachta indica* A juss -30.5 high tolerance, *Ficus religiosa* Linn-25.77 moderate Tolerane (in descending order). Therefore highly tolerant, moderately tolerant and intermediately tolerant species effective "green belt" around the polluted area.

Conclusion

The importance of trees in urban environment is now widely recognized that they too cleanse the particular air pollution and help to make cities and town more agreeable places to dwell upon. The study concluded that judicious onment placement of plants in urban canyons can reduce the pollution The present pamper recommends various tree species for urban planting so that a wider usage of local as well as exotic tree species can be explored for controlling various environmental born pollution in urban climate environment.

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