Removing of Heavy Metals using Bio-Based Composites

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Abstract— Heavy metal pollution is a major problem in the environment. The impact of toxic metal ions can be reduced by different technologies i.e. chemical precipitation, membrane filtration, oxidation, reverse osmosis, flotation and adsorption. But among them, adsorption was found to be very efficient and common due to the low concentration of metal uptake and economically convenient properties. Cellulosic materials are of low cost and widely used, and very promising for the future. These are available in abundant quantity, are cheap and have low or little economic value. Different forms of cellulosic materials are used as adsorbents such as fibres, leaves, roots, shells, barks, husks, stems and seed as well as other parts also. Natural and modified types of cellulosic materials are used in different metal detoxifications in water and wastewater. The elemental properties of cellulosic materials are also discussed along with their cellulose, hemicelluloses and lignin contents.

Keywords: Bio-Composites, Adsorptive Capacity, Cellulosic Adsorbents

I. INTRODUCTION

The primary objective is to design a process for removal of heavy metals using bio-composites. A bio composite is a composite material formed by a matrix (resin) and a reinforcement of natural fibres. These kinds of materials often mimic the structure of the living materials involved in the process keeping the strengthening properties of the matrix that was used, but always providing biocompatibility. Modern man-made composite materials, based on synthetic ingredients have potential to achieve weight reduction and part-count reduction (and hence cost reduction). They possess excellent mechanical properties significantly. This is partly due to the environmental concern about manmade composites. Natural fibres are biodegradable and are from a renewable resource. Secondly, natural fibres have a potential in cost and weight reduction. But in recent years, interest in natural fibre composites for industrial applications has increased. Contamination of water by toxic heavy metals due to urbanization is a world-wide environmental problem, which changes the chemical and biological properties of both surface and ground water. The heavy metals render the water unsuitable for drinking and are also highly toxic to human beings. Removal of heavy metals is therefore essential.

II. LITERATURE SURVEY

Title: Bio-Composites: Current Status and Future Trends
Author: Samuel Ariadurai
Description: This paper discusses about biopolymers and bio composites. Here it explains the applications of bio composites over various fields of engineering and its advantages and disadvantages. Discussion over the future trend of bio composite market is explained. Estimated global production capacity of Bio-plastics and market for natural fibre composite is explained via bar graph as shown in Fig 1.

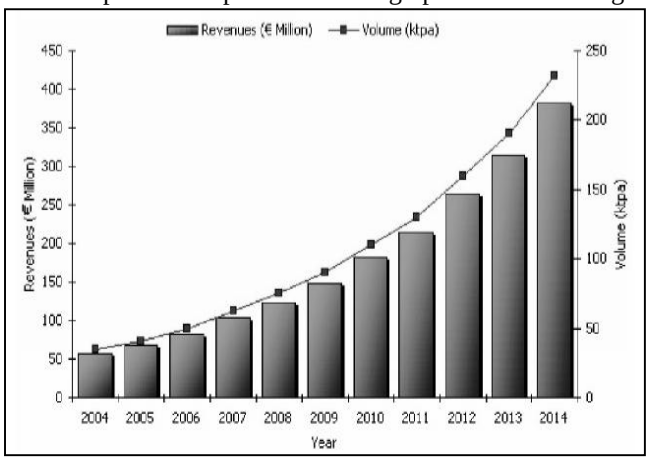

Fig. 1: Market for natural fibre composite

Title: Removal of Heavy Metals Using Rice Husk Author: Sneh Lata and S.R. Samadder
Description: The review paper summarizes the physiochemical characteristic of rice husk is given. Material and methods are discussed for the creation of treated and untreated adsorbent. Experimental data related to the adsorption capacity of treated and untreated adsorbent are given. Experimental data shows that rice husk helps in removal of various heavy metals as well as it is revealed that treated rice husk attracted more attention than untreated one due to comparatively higher adsorption capacity favoured by higher number of active binding sites, improved ion exchange properties and enhancement of functional groups after chemical treatment. The adsorption capacity differs with the different modifying agent.
Title: Application of bio composite materials based on natural fibers from renewable resources: A review
Author: Dr Bharath K N, Satyappa Basavarajappa
Description: In this review paper Classification of natural fibres, Chemical composition of natural fibres, Mechanical and structural properties of natural fibres are discussed. Explanation of various type of natural composite fibres applications are given for e.g. Coir fiber-reinforced composite applications, Kenaf fiber-reinforced composite applications, Chicken feather fiber-reinforced composite applications, Jute fiber-reinforced composite applications etc. From the point of view of substitution, natural fiber composites would enjoy wider acceptance and Value-added novel applications of natural fiber composites would also ensure international market for cheaper substitutes.

III. EFFECT OF HEAVY METALS ON HUMAN HEALTH

Alluri et al. (2006), said that heavy metals even at low concentrations can cause toxicity to humans and other forms of life, and their effects is shown in Table I as below:

Heavy Metals	Major Sources	Effect on Human Health
Arsenic	Pesticides, fungicides, metal smelters	Bronchitis, dermatitis
Cadmium	Welding, electroplating, pesticide fertilizer, nuclear fission plant	Kidney damage, bronchitis, gastrointestinal disorder, bone marrow, cancer
Lead	Paint, pesticide, smoking, automobile emission, mining, burning of coil	Liver, kidney, gastrointestinal damage, mental retardation in children Inhalation or contact causes damage to central nervous system
Manganese	Welding, fuel addition, ferromanganese production	Inhalation or contact causes damage to central nervous system
Mercury	Pesticides, batteries, paper industry,	Damage to nervous system, protoplasm poisoning
Zinc	Refineries, brass manufacture, metal Plating, plumbing	Zinc fumes have corrosive effect on skin, cause damage to nervous membrane

Table 1:

IV. RESEARCH METHODOLOGIES

A. Methodologies

There are several technologies in present scenario to remove heavy metal from waste water. Among them some popular techniques are chemical precipitation, ion exchange, ultra filtration, reverse osmosis, nanofiltration, adsorption, electro dialysis, coagulation, flocculation, floatation and electrochemical process. These all methods are used nowadays, it is reported that among all these methods adsorption seems to be very significant due to its wide application, such as ease of operation, economically feasibility, wide availability and simplicity of design.

B. Adsorption Technique

Adsorption is a very significantly economic, convenient and easy operating technique. It is becoming popular because in this process the adsorbent can be reused and metal recovery is possible. At present, Activated Carbon is mostly used adsorbent worldwide. Bio adsorbents are the best alternative for low cost adsorbents. Bio adsorbents are mostly generated from agricultural and plant waste. Bio adsorbents contains high amount of cellulosic content because it is made from agricultural and plant waste. It is observed that cellulosic adsorbent gives higher adsorptive efficiency in case of adsorption of heavy metals. Bio adsorbents produced from biomass is generally divided into three categories

1) Non-living biomass as such bark, lignin and squid etc.
2) algal biomass.
3) Microbial biomass. E.g. Algae, bacteria, fungi and yeast.

In order to remove heavy metals various methods are used for preparation cellulosic adsorbent for e.g. Rice husk as shown in Fig.2. Preparation of rice husk adsorbent is done in several steps as given below.

1) Rice husk which has average size of 7mm as shown in fig.3 is washed with distilled water for several times and it is dried in over at 60 degree Celsius.
2) After drying it is treated with citric acid and is shaken for 2 hours.
3) The solution is then filtered and rice husk is obtained which is dried at 60 degree Celsius for some time.

After the preparation of adsorbent, the effluent is placed with adsorbent for the adsorption process after which adsorption capacity is calculated with the help of spectrophotometer. Hence adsorptive capacity of cellulosic material is efficient and some modification in preparation of adsorbent will give more effective result. The adsorptive capacity of some cellulosic materials for different heavy metal is described in below Table II.

Cellulosic material	Heavy metal	Adsorption capacity(mg/g)
Rice husk	Cr	45.6
Wheat bran	Pb	62.0
Mango peel	Ni	39.75
Sugarcane bagasse	Zn	31.11
Sunflower stalk	Cd	69.80
Chestnut shell	Cu	12.56
Pine leaf powder	As	3.27

Table 2: Adsorptive Capacity

Fig. 2: Rice Husk

Fig. 3: Size Estimation of Rice Husk

V. EXPECTED OUTCOME

Adsorption is an efficient technique in heavy metal removal rather than coagulation, flocculation, ion exchange, precipitation, osmosis and flotation. These conventional techniques are not suitable for the removal of heavy metal ions from wastewater at trace concentrations. The use of commercially activated carbons for wastewater treatment leads to increase in the cost of treatment, and, hence, researchers are focusing on the use of feasible cellulosic low-cost adsorbents for metal adsorption. Cellulose, being a natural, abundant and renewable material, can play a dominant role in the treatment of wastewater from a multitude of sources. By accepting this technique it can help in boosting immune system as due to heavy metals immune system is damaged to a greater extent in human beings. Research has shown that cellulose can be modified physically and chemically to form different materials, which can be used for waste treatment. Most of these cellulosic wastes are rich in cellulose, hemicelluloses and lignin content which adhere to toxic pollutants on the surface. It is evident that most of the cellulosic adsorbents applied for metal isolation exhibited efficient adsorption capacity. Cellulose- based materials are viable alternative to commercially available activated carbons as well as for wastewater treatment in developing countries as they arise from waste sources.

VI. CONCLUSION

This concept of bio-based materials has now become of key importance due to the need to preserve our environment. Bio composites offer opportunities for environmental gains and reduced energy consumption. With the help of bio composites it could give us a natural resource substitute. Cellulose-based materials have natural binding capacity for heavy metals. There are huge differences in result of treated and untreated bio composites as treated bio composites shows a better result in removal of heavy metals compared to treated one. Treated bio composite has high adsorption capacity. More research is needed on cellulose-based materials for large scale adsorption of heavy metals from wastewater. Bio composites contains of more value-added novel applications and a good period of sustained growth.

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