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Utilizing Agricultural By- Products for Removing Heavy Metals from Industrial Waste Water- A Comparative Study

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Abstract:
This article is about the removal of heavy metals from the industrial waste water which is taken from the electroplating industries. With the onset of industrialization mankind has witnessed various environmental issues in the society. This industrialization has not only brought development and prosperity but eventually disturbed the ecosystem. One of the impacts is visible, in form of water pollution. This article present about the heavy metals and their sources and their effects to the environment, and its removal by adsorption with the help of agricultural by-products such as Papaya carica seeds, Azadirachta indica barks, Cocos nucifera leaves. In the present study above low cost adsorbent has been reviewed as an abatement of heavy metal pollution from wastewater. These adsorbent were established as a potent adsorbent for heavy metals like Pb, Cr, Ni .The main objective of the project is to determine the effectiveness and feasibility of some low cost agricultural waste material (Papaya seed, Coconut leaves and Neem bark) in the process of removal of heavy metals from waste water.

Keywords: Agricultural waste materials, Globalization, Heavy metals, Industrialization, Waste water contamination.

1. INTRODUCTION

Waste water contamination is ever increasing problem which the whole world is now facing. Waste water comprises liquid waste discharged by domestic residence, commercial properties, industry and agriculture waste. Industrial waste constitutes the major source of metal pollution in natural water. Toxic heavy metals (Pb, Cr and Ni) are major pollutant of waste water which is very hazardous. Various methods are used for the removal of these heavy metal like chemical oxidation and reductions, ion exchange, Electrodialysis, Electro precipitation, liquid extraction, ultrafiltration etc. which are very costly as well as not completely remove the metal. Adsorption is potentially an attractive technology for treatment of waste water for retaining heavy metal form dilute solution. Adsorption has been suggested as cheaper, more effective and minimization of chemical and biological sludge. There are many natural adsorbent are present in our environment which have the capacity to remove heavy metal from waste water. Authors have claimed adsorption to be easiest, safest and most cost-effective methods for the treatment of waste effluents containing heavy metal. The key benefit of adsorption method for heavy metal removal is less initial as well as operation cost, unproblematic design and less requirement of control systems. Generally the heavy metals are present in the wastewater at low concentrations and adsorption is suitable even when the metal ions are present at concentrations as low as 1 mg/L. This makes adsorption an economical and favorable technology for heavy metal removal from wastewater. The adsorbent may be of mineral, organic or biological origin. It could be zeolites, industrial byproducts, agricultural waste, biomass and polymeric material. One of the conventional adsorbent, activated carbon has been extensively used in many applications. However, the high cost effectiveness of activation processes limits its usage in wastewater treatment processes. The present research activity aims toward contributing in the search for cost effective or low cost adsorbents of natural origin and their applicability in recovery as well as removal of heavy metals from the industrial wastewater. Now a days low cost adsorbent is gaining a much attention by researcher because it is very suitable for removing heavy metals like Lead, Chromium and Nickle at low cost.

II. INDUSTRIAL HEAVY METALS

Heavy metals are commonly released in the wastewater from various industries. Electroplating and surface treatment practices leads to creation of considerable quantities of wastewaters containing heavy metals (such as cadmium, zinc, lead, chromium, nickel, copper, vanadium, platinum, silver and titanium). Apart from this wastewater from leather, tannery, textile, pigment & dyes, paint, wood processing, petroleum refining industries and photographic film production contains significant amount of heavy metals. These heavy metal ions are toxic to both human beings and animals. The toxic metals cause physical discomfort and sometimes life threatening illness and irreversible damage to vital body system. The metals get bioaccumulated in the aquatic environment and tend to biomagnified along the food chain. Thus, the organisms at higher trophic level are more susceptible to be affected by their toxicity. There are 20 metals which are almost persistant and cannot be degraded or destroyed. Mercury (Hg), lead (Pb), cadmium (Cd), chromium (Cr [VI]), Zinc (Zn), Arsenic (As), Nickel (Ni) etc., are toxic heavy metals from ecotoxicoligal point of view. The table below shows Maximum Contaminant Level (MCL) standards for some heavy metals established by USEPA [5]. These heavy metals can lead to serious effects such

as stunted growth, damage to vital organs, damage to brain, cancer and in some cases death also. Health hazard related to heavy metal toxicity are not new. Human diseases like minamata, itaiitai, fluorosis, Arsenicosis etc. are due to heavy metal ingestion above permissible levels. Treating the industrial effluents contaminated with heavy metals within the industrial premises before being discharged is efficient way to remove heavy metals rather than treating high volumes of wastewater in a general sewage treatment plant. Thus it is advantageous to develop separate handling modus operandi for removal of heavy metals from the industrial effluents. The current work focuses on study of natural coagulants as an effective and economical alternative treatment process for heavy metals removal from industrial wastewater. (Table 1)

Table.1. Sources and impacts of heavy metals

S NO	HEAVY METALS	SOURCES	IMPACTS
1	Mercury(Hg)	Enters the environment through the leaching of soil due to acid rain, coal burning, or industrial, household, and mining wastes	Causes damage to nervous system, kidneys, and vision.
2	Lead(Pb)	Sources include paint, mining wastes, incinerator ash, water from lead pipes and solder, and automobile exhaust.	Causes damage to kidneys, nervous system, learning ability, ability to synthesize protein, and nerve and red blood cells.
3	Chromium (Cr)	Source includes cement industry, effluents from chemical plants, tobacco smoke and contaminated land fill.	Can Cause Pulmonary fibrosis, lung cancer
5	Nickle(Ni)	Sources include electro plating industries, Mining industries.	Cause toxic effects in the respiratory track and immune system

III. ADSORPTION

The term 'Adsorption' was first used in 1881 by German physicist HeinrichKayser. Adsorption is a surface phenomenon in which liquid or gaseous molecules adhere to the surface of the solid material. As discussed earlier, adsorption has emerged out as effective, economical and ecofriendly treatment technique. It is a process potent enough to fulfill water reuse obligation and high effluent standards in the industries. Adsorption is basically a mass transfer process by which a substance is transferred from the liquid phase to the surface of a solid, and becomes bound by physical and/or chemical interactions . It is a partition process in which few components of the liquid phase are relocated to the surface of the solid adsorbents. All adsorption methods are reliant on solid-liquid equilibrium and on mass transfer rates. The adsorption procedure can be batch, semi-batch and continuous. At molecular level, adsorption is mainly due to attractive interfaces between a surface and the group being absorbed. Depending upon the types of intermolecular attractive forces adsorption could be of following types:

A.PHYSICAL ADSORPTION

It is a general incident and occurs in any solid/liquid or solid/gas system. Physical adsorption is a process in which binding of adsorbate on the adsorbent surface is caused by van der Waals forces of attraction. Physical adsorption can only be observed in the environment of low temperature and under appropriate conditions, gas phase molecules can form multilayer adsorption. Commercial adsorbents utilize physical adsorption for its surface binding.

B. CHEMICAL ADSORPTION

It is a kind of adsorption which involves a chemical reaction between the adsorbent and the adsorbate. The strong interaction between the adsorbate and the substrate surface creates new types of electronic bonds (Covalent, Ionic). Chemical adsorption is also referred as activated adsorption. The adsorbate can form a monolayer. It is utilized in catalytic operations. In general, the main steps involved in adsorption of pollutants on solid adsorbent are: Transport of the pollutant from bulk solution to external surface of the adsorbent.

C.ADSORPTION BY AGRICULTURAL BY-PRODUCTS

Use of agricultural byproducts as low cost adsorbents [2] for heavy metal removal from industrial waste water has been increasing nowadays. Most of the studies were focused on plant wastes such as rice husk and Black gram husk , Waste tea [1], Turkish coffee, Walnut shell etc. Some more adsorbents like papaya wood, maize leaf, teak leaf powder, coraindrumsativum, lalang (Imperatacylindrica) leaf powder, peanut hull pellets, sago waste, saltbush (Atriplexcanescens) leaves, tree fern, grape stalk wastes, etc. are also studied in detail. The benefits of using agricultural wastes for wastewater treatment include easy technique, needs modest processing, superior adsorption ability, selective adsorption of heavy metal ions, economical, easy availability and easy regeneration. On the other hand, the use of untreated agricultural wastes as adsorbents can also fetch a number of problems such as small adsorption ability, elevated chemical oxygen demand (COD) and biological chemical demand (BOD) as well as total organic carbon (TOC) due to discharge of soluble organic compounds contained in the plant materials. The increase of the COD, BOD and TOC can cause diminution of dissolved oxygen (DO) content in water and can make threats to the aquatic life. Consequently, plant wastes require to be modified or treated ahead of being applied for the cleansing of heavy metals. New products such as papaya seed, coconut leaves and neem bark are also used for adsorbent for heavy metal elimination after chemical modifications.

Chemically modified agricultural wastes have been found to have enhanced chelating efficiency.

IV.EXPERIMENTAL METHODS

The agricultural by-products were collected from the surroundings of Sethu Institute of Technology, Tamil Nadu, India locality were used for the preparation of the adsorbent. The adsorbents were cleaned with distilled water and dried for one week under sunlight and further crushed and sieved to obtain the required sized pieces. The waste water samples were collected from the electroplating colony in T.Karisalkulam near Madurai district. The waste water samples were first diluted by adding 20% of distilled water. Then the initial concentration of the heavy metals present in the waste water were determined by the method of Atomic Absorption Spectrophotometer (AAS). Then it is found that 1mg of the adsorbent is for 10 ml of waste water were used for the process of adsorption of heavy metals at a constant p^H of 5 to 8.

PROCEDURE

The following are process done at the time of adsorption of heavy metals from the industrial waste water.

- 30 ml samples of solution which contains the high heavy metal concentration are taken.
- Then at constant pH of 5 the constant dosage of 3g of adsorbents are added for every 30 ml of samples are stirred by using magnetic stirrer.
- The influence of contact time on adsorption of heavy metal on the adsorbents are examined for 1hour ,5 hours and 24 hours.

ADSORPTION TEST

- The separation of bio adsorbent and solution was carried out by filtration with the Whatman filter paper. Then the filtrate was stored in the sample cans.
- The metal ion concentration of heavy metals such as Lead, Chromium and Nickle was tested using Atomic Absorbtion Spectrophotometer.
- The test was conducted using the samples of 25 ml samples without adsorbent and 25ml solution with adsorbents at constant dosage and various contact time.
- The final concentration of the heavy metals left in the waste water samples was determined by Atomic Absorption Spectrophotometer (AAS).
- The percentage of removal of heavy metals from the samples are determined by using the formula.

$$\text{Removal \%} = \frac{Ci - Cf}{Ci} * 100$$

Where

C_i is the initial concentration of heavy metals in the waste water samples.

C_f is the final concentration of heavy metals in the waste water samples.

EFFECT OF ADSORBENT DOSAGE

Dosage is an important factor in the adsorption. With the increase in the dosage there will be increase in adsorption. It depends on the saturation limit of the adsorbent. This helps us to get an idea about the amount adsorbed even with the smallest amount, which will be economical. For the above adsorption process it is found to 1mg of adsorbent is for 10 ml of the waste water.

EFFECT OF CONTACT TIME

Contact time is another factor which should be considered mainly for adsorption. While Contact time increases there might be chances of saturation. It is mainly due to the fact that adsorption sites may be filled with the molecules that are adsorbed. Contact time varies according to different adsorbents. It is because of the pores or the sites that are present in the adsorbent. For the above process it is found that 95% 0f adsorption was considerably increased after the 24 hours.

V. RESULT AND DISCUSSION

The analysis of the report before and after adsorption of heavy metals from the industrial waste water are shown in the table-2

Table.2. Comparision of concentration of heavy metals before and after adsorption process

S.NO	HEAVY METALS	PERMISSIBLE LIMITS	INITIAL COCENTRATION IN mg/l	FINAL CONCENTRATION IN mg/l		
				PAPAYA SEED	NEEM BARK	COCONUT LEAVES
1	Lead	0.006	35.32	1.72	5.80	9.38
2	Chromium	0.05	132	11.86	28.75	37.45
3	Nickle	0.20	73.46	5.92	12.87	23.20

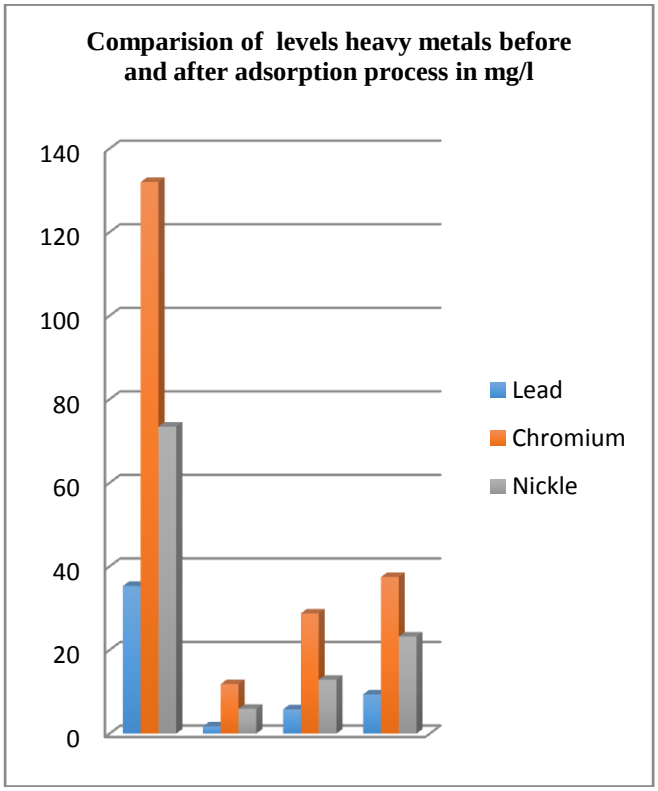

Figure.1. Comparision of concentration of heavy metals before and after adsorption process

VI. CONCULUSION

The levels heavy metals found in the waste water samples were found to be higher than the WORLD HEALTH ORGANIZATION'S permissible limit. These heavy metals in the water made it not suitable for driking purposes as well as domestic purposes. Furtermost, this project recommends Papaya carica plant species to be used in the removal of heavy metals of contaminated water with the higher removal percentage of upto 90%. Thus the removal of removal of heavy metals by utilizing agricultural by-products from the industrial waste water is the best and cost effective.

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