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REVIEW: ADSORPTION OF TOXIC METAL IONS BY EMPLOYING COIR PITH'

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***Abstract*—** Many water supplies are currently contaminated by sources like home and agricultural waste as well as industrial processes. Many adsorbents are used widely for removal of metal ions because of its convenient use. This paper reviews the methods of preparing adsorbent coir pith and its applications as capable component for removal of metal from waste water. It analyses the work of researchers in this field to adsorb metal using coir pith. The study of effectiveness of coir pith is inspected.

Keywords*—adsorption, coconut, coir pith , heavy metal, pH.*

I. INTRODUCTION

Toxic heavy metals are becoming an ecological threat with its increasing presence in pharmaceutical, chemical, textile industries, agricultural pesticides, fertilizers, and other industrial waste. The toxic metals include Nickel, Zinc, Lead, Copper, Arsenic, and Mercury. Heavy metal may result into neurotoxicity, liberates free radical, which in turn boost up damage of lipids, proteins and DNA. Chromium is carcinogenic in nature, causes cancer of lungs, digestive tract and even hemorrhage, diarrhea. Excess exposure of Copper may lead to respiratory problems, kidney and liver failure, headache, vomiting. Nickel is again carcinogen in nature leading to kidney and lung problems, gastrointestinal concern, skin inflammation and pulmonary fibrosis. Mercury is even neurotoxin, influences the central nervous system. Surplus exposure to zinc leads to stomach cramps, skin irritation, anaemia, etc. Exposure to these chemicals may lead to several medical issues to human, so extradition of these metal ions from water is very important. Regulation of laws is becoming rigorous in developed countries for heavy metal ions limit. Since the metallic impurities are non- biodegradable, its removal is necessary. Many techniques are available for treating these metal ions from waste like chemical coagulation, ion exchange, reverse osmosis, biochemical oxidation, and adsorption. Research adsorption method by using adsorbents like graphene, activated carbon, saw dust, carbon nanotubes, tree leaves and barks, silica, coir pith, resilient weed and other agricultural waste like wheat husk, rice husk corn, sugarcane husk, orange peel, banana peel, pinewood is gaining importance. Graphene is a two-dimensional carbon based nanomaterial, having adsorption capacity greater than other magnetic adsorbents like $FeFe_2O_3$, $MnFe_2O_4$. Activated carbon is also a better adsorbent because of its perfectly developed porous design and good surface area, which is the most required criteria for adsorption. Carbon nanotubes also acquire extensive surface area, exceptional mechanical, electrical, adsorption properties, and superior mesopores. Among the many biosorbents used, coir pith obtained from ripened coconut husk is a large area of research interest. Concern has grown regarding wastewater pollution's effects on the ecosystem. The contamination has been cleansed using a number of standard wastewater treatment treatments, including chemical coagulation, adsorption, and activated sludge, but there are still certain drawbacks, particularly the high running costs**..** Coir pith is alsoused for adsorption of toxic dyes. Nonetheless, cost effectiveness is a necessary tool for choice of an adsorbent for heavy metal eradication from wastewater. Commercial activated carbon is estimated to cost around Rs. 500/kg, but bioadsorbents cost between Rs. 4.4 and 36.89/kg, which is significantly less than the price of commercial adsorbents. [8-12]

II. COIR PITH

Coir pith was considered a waste product years before and discarded provoking large environmental issues. Coconut is used extensively in many parts of India and it is even common fruit in many other

Asian countries. 1.6 ton ofcoconut coir pith is procured from husk of 10000 coconuts. Coir pith is a light fluffy material. The dark, porous, lighter-weight particle that is released when the fibre is torn from the husk is known as coconut coir dust. The coir dust is about 70% of the weight of the coconut husk (Tejano, 1985). Coir dust is abundant in lignins and tannins. The adsorption capability of coir pith is due to the existence of hydroxyl and carboxyl groups [8]. Raw coir pith comprises 8.7% ash content, 25.2% lignin, 35.0% cellulose, 7.5% pentosans, 1.8% lipids and resins, and 11.9% moisture

content,10.6% other materials[7]. In consideration of its low cost, the statistic number of research by investigators isincreasing considerably.

Fig1 : Coir pith from coconut fruit

Characteristic	Content
Specific Surface Area (m^2/g)	167
Micro pore Area (%)	89.3
Micro pore Volume (%)	75
Moisture Content	6.35 ± 1.12
pH	5.68 ± 0.01
Ash (%)	47.11 ± 9.07
Porosity (%)	93.11
Organic matter (%)	52.89 ± 9.07
Total Carbon (%)	29.38 ± 5.04
Total Nitrogen (%)	0.44 ± 0.03
C/N ratio	66.13 11.3

Table 1: Characteristic of coir pith [6]

III. PREPARATION OF ADSORBENT

Coir pith obtained from coconut is washed well to discard clay, mud or any other waste attached. Later on it is dried and reduced to 2 mm grain size. Carbonization takes place in conventional electric furnace. On heating at 400° C and adding $ZnCl_2$, char is prepared. The mixture is dried and impregnated char is treated at 650° C [10].This is the general method of preparing coir pith, which can be varied.

The groundwork of coconut coir pith can also be done by washing many times with water, then sun dried for period of 3 days. The dehydrated matter is pulverized into powder using crusher to procure fragments of 100 μm size. The powder was dipped in 1 L of 4N H_2SO_4 for a day. The coir pith which is now activated is drained and washed with distilled water to achieve neutral pH. The acid treatment helps to eradicate mineral elements and to accelerate hydrophilic nature of adsorbent surface [13].

Preparation of coir can be executed likewise by immersing, cleaned and withered coconut coir in 10% potassium hydroxide solution and then washing with distilled water to discard free potassium hydroxide. Heating at 900°C for half an hour in environment of nitrogen is carried out. Washing of

carbon is done in distilled water, followed by 10% hydrochloric acid. Finally washing is given with distilled water to remove traces of free acid and dried. Crushing is done to obtain fine particle of 212-500 μm [5].

IV. APPLICATION OF COIR PITH FORADSORPTION OF METAL

Kitirote Wantala *et al.* performed research on adsorption of Zn (II) and Pb (II) using modified coir pith as adsorbent.The average adsorption capacity time for Zn was found to be120 min and Pb was 10 min. pH 5 was the optimum pH for adsorption. The results also correlate with Freundlich and Langmuir adsorption isotherm. The results obtained were 29.33 mg Zn(II)/g adsorbent and 36.50 mg Pb(II)/g adsorbent[1].

Amarasinghe had used artificial wastewater of $Cd(NO3)2\ 3H2O$ and $PbNO3$ in distilled water and maintaining pH as 5.5 .Batch adsorption test were operated for known metal ion concentration.31 % to 98% was the elevation in the elimination of lead ion just as the concentration of adsorbent was raised from 0.5"10.0 g/L. In contrast to lead, cadmium absorption was slightly lower. The amount of coir pith needed to remove 98% of the cadmium was 10.0 mg/L solution, which was less than Pb's adsorption capacity. For low ion concentrations, the proportion of surface operating sites to overall metal ions in the solution was steep, which indicates all metal ions must have come in contact with the adsorbent and been eliminated from the solution. The study's findings demonstrate that the highest adsorption was seen at pH 5.Adsorption in the initial period of 10 min was highest procuring 90% results. [2]

K. Kadirvelu *et al.* used coir to make activated carbon to adsorb metallic ions, specifically Cadmium from wastewater, which on experimental analysis gave good results. For the adsorption of Cadmium from waste solution, an activated carbon, which was prepared from agricultural solid waste, was used. Criterion like agitation time, adsorbent measure, pH and metal ion concentration were examined. The results for Langmuir adsorption isotherm were 93.4 mg Cd/g at pH 5 (30°C) and particle size was 250-500 μm. The percent extraction rose with pH from 2 to 4 andwas stable till pH 10. Hence, coir pith a waste from coir processing industry is found to be cost effective product for metal ion treatment from water [3].

Anirudhan *et al.* carried out adsorption of heavy metal ions like Pb, Hg, Cu by activated carbon obtained from coconut waste was carried out through batch adsorption process. Pb and Cu adsorbed best at pH 6 and Hg at pH 7. The adsorption capacities of activated carbon declined in the order, Pb > Hg > Cu. The experiment disclosed a good adsorption capacity for Pb(II) and Cu(II) at pH 6.0 and for Hg(II) at pH 7.0 [4].

M.Chaudhari *et al.* carried out batch adsorption test of lead nitrate with 0.1g of activated carbon. Adsorption was low at low acidic pH and increases up to 39.6 % for pH 5 and increased marginally till pH 6.The author had performed the experiment with coconut coir activated carbon (CCAC) and commercial activated carbon(CAC) ,and found CCAC had surface, micro pore area and micro pore volume and pore diameter greater than that of CAC. This in-turn increases the adsorption capacity of CCAC[5].

Adsorption experiment study of Co(II), Cr(III) and Ni(II) was carried out by Parab *et al.* in both single and multi- component systems . 12.82, 11.56 and 15.95 mg/g for cobalt, chromium and nickel, respectively were the adsorption capacity results by using coir. The most favourable pH values for maximal metal ion sorption were detected as 4.3 for cobalt, 3.3 for chromium and 5.3 for nickel.[11]

Namasivayam and Sureshkumar looked into whether coconut coir pith could be used as a biosorbent to remove Cr(VI) after being modified with a cationic surfactant called hexadecyl trimethyl ammonium bromide. The optimum pH for Cr(VI) adsorption was 2.0. During elimination, there was a small intensity reduction of Cr (VI) to Cr(III). The biosorbent's adsorption range was discovered to be 76.3 mg/g[7].

Kulkarni and co-workers (2013), executed his experiment on domestic waste water treatment. The aim of his experiment was to reduce COD and organic matter present in sewage water by application of adsorption technique .The adsorbent he had choose was coir from coconut fruit . The same adsorbent was used in batch and column process and gained clear positive result and removed 75-81% COD [10].

The maximum Cr (VI) biosorption was accomplished at pH 2, which is similar to the work of M.H. Gonzalez and his colleagues who were able to adsorb more than 95% of the possible analyte present in the solution. Cr waste sulphochromic solutions from soil fertility laboratory was used for the analysis. It was observed that adsorption of chromium increased with decrease in pH. The data was tested with various adsorption isotherms. The observation of Gonzalez was that 17% of Cr was eliminated by dried coir of coconut and 72% was removed by hydrated coconut coir. The adsorption time took for removal o*f* ions was 10 min [12].

The results of Sheel Ratan *et al.* of extradition of Nickel from water was 22.8117 % (2 g/L of adsorbate) and elevated to 75.8781 g/L (5 g/L of adsorbate). Batch adsorption test of lead nitrate with 0.2 g of adsorbent 100 ml of nickel solution was carried out and contact time, concentration of lead, pH favorability was observed. Lower pH favors adsorption hence, here the pH range studied was 2-10. Increased adsorption capacity was found at 6, and with increase in pH, the capacity was found to be decreasing. Thecontact time was taken as 2 hours. The results were plotted on Langmuir and Freundlich adsorption isotherm.[13]

EVALUATION

From the pH study variation, it was noticed that low pH favoured adsorption of metal ions .The results are in conformity with Freundlich adsorption isotherm. The interpretation from the research papers is found for the factors like pH, removal time. The ideal pH range for chromium adsorption was found as 1-2, range 4-7 for cadmium, 4.5-6 range for copper, for nickel it was found to be 4-6. The average adsorption time was found to be 120- 900 min, 5-120 min for cadmium, 120 min-12 hours forcopper [6].

V. FUTURE PERSPECTIVES

In this survey paper, the bioadsorbent used for eradicating of metal ions like chromium, nickel, cadmium, lead, mercury and copper is extremely economical adsorbent and is capable of and is a constructive replacement for commercially available adsorbents. The eviction efficiency isupgraded by modifying pH, concentration level and surface area. Still the research executed is less, so the future viewpoint will be definitely to surge the wide research pertinent in the field to remove metal ions from water in a broader sense. Eviction of heavy metal ions from wastewater will be a conclusive challenge, as it will demand huge amount of bioadsorbents.

VI. CONCLUSION

In today's world owing to the expeditiously developing technologies, toxic industrial by-products and practices ,are leading to the devastating situations of environment pollution and disrupting biological processes ,thus menacing public health. Because it offers design flexibility, high-quality treated effluent, is reversible, and may replenish the adsorbent, the adsorption approach is emerging as a potentially preferable choice for the eviction of heavy metals. Usage of biosorbents in the recent past for eviction of various pollutants from wastewater, adsorption of toxic dyes and metals is widely studied. However, application of coir pith by recycling the waste will scale down the environmental pollution, which can be caused by dumping of unwanted coir from coconut fruit after its main use. In spite of all the research activities performed still there is need for better research for preparation of high adsorable coir pith, producing high performance coir pith which can be applicable for bulk experimentation and the disposal of coir pith after use. This review paper puts a light on use of coir pith for the adsorption of metal ions from water on the ground of articleswritten.

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