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REMOVAL OF COPPER AND ZINC USING NEEM AND BABOOL BIOMASS –A REVIEW

Bhagyashree Prajapati[1], Rakhi Baghel[2], PROF. Dr Anjani Kumar Diwedi[3]

[1,2]M. Tech. scholar, Department of Chemical Engineering, Ujjain Engineering College, Ujjain.
[3] Professor, Department of Chemical Engineering, Ujjain Engineering College, Ujjain(M.P),456010,India.

Abstract - *Heavy metal presence in water has become a serious issue for ecology globally. Effluents from industries reaching to ground water bodies, lake, pond in turn pollutes drinking water . Water containing metals beyond permissible limit is considered to be polluted. Various methods are used to treat effluents from heavy metal industries. The objective of this study is to review the effectiveness of bio-adsorbent to remove heavy metals. Various parameters such as pH, contact time, adsorbent dosage are being studied to measure promising conditions for metal removal. a Metal concentration was determined using Atomic Adsorption Spectroscopy (AAS). Effect of adsorbent dosage, contact time, and effect of pH is studied.*

Keywords **–** *Bio Adsorption, copper, zinc, Waste water technology*

1. INTRODUCTION

Environmental pollution control and optimum methods for removal of heavy metals from industrial water is two major requirements which are needed to be addressed. Adsorption is considered to be very effective and efficient method for removal of heavy metals [9,10]. Trace amount of heavy metals when discharged to water, deposited after a long period of time, can create various environmental problems. Therefore removal and recovery of these metals is essential. Electroplating, textile industry, fertilizer and pesticide industries uses Zn and Cu for various purposes. For treatment of wastewater new adsorbents are being studied and widely used for treatment of such metal contaminated wastewater [11]. In present study Neem and Babool leaves efficiency to remove Cu and Zn from synthetic wastewater is studied. Synthetic water is prepared in laboratory for the same.

1.1 Heavy metals- Those metals that have specific gravity more than 5 times that of water are termed as heavy metals. The effluents from mining operations, tanneries, batteries, paper industries, pesticides, galvanizing plants, pigment manufacture, fertilizer industries, etc are source of heavy metals. [12] in developing nations direct discharge of heavy metals into water bodies is more frequent. Due to their non-biodegradability and toxicity, they accumulate in living beings. For good quality water treatment of effluents having heavy metals is important.[10]

Copper- In building construction, For power generation and transmission, production of industrial machineries and transportation vehicles copper is widely used. The wide applicability of copper is due to higher electrical and thermal connectivity, good corrosion resistance, ready availability, high recyclability, and attractive appearance (13). Intake of copper metal exceeding permissible limit can causes hemolysis, hepatotoxic and nephro toxic affects vomiting, cramps, convulsions, or even death (14).

Zinc- Alloys such nickel silver, brass and aluminum solder, oxides of zinc is used in manufacturing of paints, rubber, cosmetics, pharmaceuticals, plastics, inks, soaps, batteries, textiles, and electrical equipments are prepared by zinc. Having molecular weight of 65.37 zn is a bluish white metal. Excessive intake of zinc can cause toxic effects such as teratogenesis, mutagenesis and carcinogenesis as a result of bioaccumulation. (15).Processes used to remove heavy metals from wastewater include ion exchange, precipitation and coagulation, membrane filtration , electro dialysis, flotation, reverse osmosis, and adsorption (16). Generally these processes are not cost effective. Adsorption is generally used as a high cost effective water treatment method. Adsorption is done using many adsorbents such as activated carbon, Sarsaparilla roots (17) , chitosan (18) , Modified sugarcane Bagasse (19), rise husk ash (20), and lignite (21). There are many adsorbents available and new adsorbents are being introduced due to high demand for water treatment.

Table1. Permissible limit for Cu and Zn according to Indian Standard (IS 10500: 2012) **and WHO**

Name of metal	Indian standard for drinking water	WHO/EPA standard for drinking water	Reference
Cu	0.05-1.5 mg/L	2 mg/L	Indian STD for Drinking water(IS 10500 : 2012)
Zn	5-15 mg/L	3 mg/L	WHO /EPA STD for drinking water(1)

2. Different techniques for waste water treatment

There are three methods to treat to Aqueous hazardous waste- Chemical, biological and physical waste water treatment processes.

Chemical method- Oxidation or reduction, flocculation, ion exchange, chemical precipitation are used in chemical methods of waste water treatment. These methods convert hazardous waste to less hazardous substance. .

Biological Treatment-In biological treatment of wastewater, microorganism are used to degrade the organic compounds present in waste water stream.

Physical Treatment –Phase change system, like air stripping of volatiles from liquid waste,Gravity separation, filtration operation, which includes adsorption are example of physical treatment.

Methods to remove heavy metals from water and wastewater are as follows-chemical precipitation, adsorption, ion exchange, reverse osmosis, are used for this purpose. The metal type and its amount in wastewater is important factor determine the applicability of these processes. Following are the details of heavy metal removal processes and their limitations.

Reverse osmosis process-reverse osmosis is a technique to terminate undesirable material from water using semi-permeable membrane. This method separates anions when pressure is applied. It describes that the percentage dismissal of pb, cr, and Cd by reverse osmosis is 93, 95, and 95% [25,26]. Main drawback of this process is that it is costly.

Ion Exchange Method- The ion exchange process can draw soluble ions from the liquid condition to the solid condition, which is the most commonly used method in the water purifying industries.[27,28] heavy metal withdrawal by ion exchange works better in acidic environment with pH ranging from 2 to 6. Secondary effluents from wastewater are required to be pretreated and suspended solids from wastewater should be removed. Furthermore appropriate ion availability for heavy metals, funds required and running cost is high.

Chemical Precipitation- Chemical precipitations are a widely used method in the industry. The chemical precipitation method works with a chemical using heavy metal ions to insolvable precipitates. Resulting precipitates can be removed from the water by sedimentation or filtration process.[29,30] the main setbacks of this process are huge sludge formation that needs more treatment, the rising price of sludge discarding, poor settling.

None of the above methods are economic, and also produce secondary sludge, which can cause environmental issues.

Adsorption-

Adsorption method -Adsorption is a method in which the atoms, ions, or molecules of dissolved solids from the liquid grabs on the surface of a solid; i.e. it is a method of mass transfer where the soluble solids from liquid gets collected on the surface of solid because of physical or chemical actions[31,32] Adsorption is applicable in every natural, physical, biological, and chemical processes, and is thoroughly applied in industrial processes such as activated charcoal, synthetic resins, and water filtration.

Adsorption is termed as the method in which a solute is removed from the liquid phase by the contact of a solid adsorbent that has an affinity for a particular solute (22). The phenomenon of the deposition of chemical matter on the surface of a solid is called 'adsorption'. All adsorption methods primarily rely on solid liquid equilibria and on mass transfer rates (23). The reversal of adsorption is termed as 'Desorption'. Most adsorbents are highly porous materials, and adsorption occurs completely on the walls of the pores or at the specific sites within the atom. Adsorption can occur as an outcome of differences in atomic weight, structure or form of an atom, and polarity that can cause some atoms to dominate strongly on the surface than that of others or due to the pores are very small to pass the larger atoms. The gross adsorption rate is governed by the rate of diffusion of solute in the capillary inlets of the adsorbent and differs with root of the exposure time with the adsorbent. The adsorption method may be batch, semi-batch and continuous. Batch processes are generally performed when little quantity are to be processed. Equilibrium rely on the exposure time in batch operation (24).

3. OPERATING PARAMETER EFFECT ON PERFORMANCE OF ADSORPTION PROCESS –

Wastewater purification by adsorption depends upon numerous parameters. Such as contact time, pH, temperature, adsorbent dosage. Effects of such parameters are discussed below.

Effect of pH

pH is a key factor that can influence removal efficiency. At acidic pH the biosorption happens fast and eliminates the metal ions to the largest extent. Exact pH in the range (1.0-7.0) vary with the nature of various biosorbent. 56% removal of Zn(II) was gained at pH 1.0 by the processing with sawdust. 56.5% removal of Zn(II) was gained at pH 1.0 by the treatment with neem leaves powder.[2] so the results from both adsorbent seems close.The results imply

that Zn (II) removal was enhanced to maximum and then declines with pH variation from 2 to 10 holdings all remaining parameters constant (adsorbent dose = 0.2 g, initial Zn (II) concentration = 50 ppm, exposure time= 60 min, agitation rate = 120 rpm and Temprature = 30°C). The highest percentage removal of Zn (II) was around 92.40% at pH 4. At pH 3.0, H+ ions engage with Zn(II) ions for the top of the adsorbent that would retard Zn(II) ions from reaching the binding locations of the adsorbent due to the repulsive forces. Nonetheless, the metal removal is low probably due to the increased competition of proton to zinc ions for ligand binding sites and complex formation. $Zn(OH)_2$ precipitate formed when Zinc(II) ions get precipitated due to hydroxide anion formation at pH 7.0. Because of this, the optimal pH value was found to be 5.0.[3] . At low pH, adsorption of Cu(II) is insignificant because the H+ ion concentration is higher than the ions of metal on the top of the powder which restricts the entry of metal ions on the surface of particles of the adsorbent. When the pH grows, the effect of struggle from H+ ions reduces, and the cations take their places on the facet. It was found that as pH goes from 3 to 9 adsorption of cu goes from 25-81.7%.[4]

Effect of contact time

as the exposure time increases removal of metal from water reaches an equilibria state. It was found that copper (II) removal was enhances with exposure time. The % removal of copper(II) stays same (76.32 percent),that indicates that equilibrium was obtained at 90mins.[5] An experiment conditions of (pH 5, 25 mg/L Zinc (II), Temprature of 30^0C) was taken and it is obvious that rise in exposure time from 0.5 to 2.0 h improves significantly the % removal of Zinc(II). The nature of adsorbent and its accessible sorption sites influence the time required to obtain the equilibrium. Neem bark, an exposure time of 4 hours is required for equilibrium to be established. [6]

Effect of dosage

Rise in adsorbent concentration generates a rise in percent removal of Zinc(II). There is no remarkable growth in removal efficiency was found after certain adsorbent dosage. At 5 g/L of adsorbent dosage level the removal of Zinc(II) was found to be 78.4% (neem bark). It was found that for all the adsorbents highest removal efficiency was obtained at an adsorbent dosage level of 10 g/L.[6] Prominent rise in adsorption of Zn is seen by increasing the concentration of biomass from 0.2 g (Zn 44.3%) to 2 g (Zn 86.9%) [7] Highest adsorption capacity was found to be 140 mg/g of copper when a dosage of 0.4 g/L of NLP was used. The equilibrium adsorption capacity for 0.4 g/L of NLP was found to be 100 mg/g. This equates to an adsorption percentage of 40 %. Similarly, for the other NLP dosages (0.6, 0.8, 1.0, 1.2 g/L), the copper adsorption capacity was obtained to be 30, 24, 20 and 16 % respectively.[8]

4. CONCLUSIONS

Studies suggest that adsorption is one of the most suitable method for removal of heavy metals. Heavy metals are recovered using bio - adsorbents, different adsorbents are studied for this purpose. The review implies the importance of different parameters such as pH, contact time, adsorbent dosage and their effect is discussed and results are found to be impactful. Research work is done on laboratory basis. Hence there is vast potential in bio-adsorption technology to apply it on wastewater management of ore industries at bigger scale.

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