Removal of Cu(II) from aqueous solution using tea waste as an adsorbent: A Comprehensive Review

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Abstract - Copper is a heavy metal that can harm the human's body through water if present in excessive amount. Human activities have caused extensive contamination of both surface and ground water with toxic heavy metals. Regulation of drinking water and waste water standards are require and contamination of heavy metal reduced up to few parts per million. Copper is an essential trace element for animals and humans, excessive copper intake may cause adverse health effects. The hazardous effects of heavy metals on the environment, human health and effects on living organisms, is a serious matter concerns, due to other activities such as industrial operations, mining, agricultural processes and disposal of industrial waste materials. These concentration has increased to particular level, In the access of particular limits of Copper has been reported to cause neurotoxicity commonly known as "Wilson's disease" due to deposition of copper in the lenticular nucleus of the brain and kidney failure. Biosorption is emerging as a sustainable effective technology. There are many Several process available to reduce the concentrations of heavy metals in wastewater, like precipitation, flotation, ion exchange, solvent extraction, adsorption, cementation onto iron, membrane processing, and electrolytic methods. There are many utilization techniques performed for various low cost agro waste by-products like sugarcane bagasse, rice husk, almond, sawdust, soyabean hulls, cottonseed hulls, orange peels, rice husk, coconut husk, sago waste, banana pitch carbon, coconut husk, palm pressed fibre, clay and some bio adsorbents etc. which are abundantly and easily available in India for the elimination of heavy metals from wastewater.

Key Words: Copper, Biosorption, Different parameter, Wastewater, Tea Waste, etc…

INTRODUCTION

Removal of heavy metals from wastewater is a major problem. Highly toxic metal ion and pollutant released from various chemical industries like electroplating, petrochemical process, battery manufacturing etc [kamal rana et al., 2014]. Now a day metals found in industrial effluent are beyond permissible limit which may be attributed to improper treatment process, non-degradable and creates disposal problems. That are major concern across the globe [Sureshkumar Halnor et al., 2013; Hanit Kumar Thapak et al., 2016].

Toxic metal, or metalloid such as heavy metals chromium, copper, cobalt, nickel, copper, zinc, arsenic, selenium, silver, cadmium, antimony, mercury, thallium and lead are commonly present in the waste water [Sarma, P.J. et al.,2015; Hanit kumar thapak et al., 2015]. Living organism and human body can not digest heavy metals so these metals create hazardous disease to human such as stomach and intestinal cancer, liver and also kidney damage. World Health Organization (WHO) has set provisional guideline limits of 0.01 mg/L and 2 mg/L for lead and copper, respectively, in drinking water [Chuan-Wei Oo et al., 2013; Sajjad Golkhah et al., 2017]. Contaminate industrial effluents in aquatic systems pollute the water streams naturally.

However millions of people worldwide are suffering from shortage of fresh and clean drinking water. Water pollution raises a great concern now a day due to rapid industrialization e.g. metal mining operations, fertilizers, agricultural wastes, sewage, domestic wastes etc. pesticides which have largely discharged various types of pollutants into environment and cause disorder into ecosystem [Jyoti shah et al., 2016]. So the waste water containing heavy metals needs to treat before discharging in any of the disposing site.

The heavy metals are removed using many methods have been undertaken in the process to remove these unwanted contaminants such as chemical precipitation, membrane filtration, ion exchange, coagulation, flocculation, electrochemical technique, and co-precipitation, physiochemical methods, various biological methods and to large extent Nano based techniques and chemicals like silica, activated carbon use.

Parameters such as equilibrium time, effect of temperature, effect of pH, contact time, adsorbent dose and initial concentration of adsorbate were studied for the removal of metal [Pooja D Taralgatti, 2016; M. Madhava Raoa et al. 2006]. Some of these techniques are very costly as well as not completely remove the metal. Biosorption is potentially effective technology for treatment of waste water to retaining heavy metal form dilute solution. Biosorption has been suggested as cheaper, more effective and minimization of chemical and biological sluge [GHAZY, S. E. et al.,2008; Wiwid Pranata Putra, and Azlan Kamari , 2014].

Agricultural waste normally contains a variety of organic compounds (lignin, cellulose and hemicelluloses) and functional groups (hydroxyl, carbonyl and amino). Both organic compounds and functional groups have great affinity for metal ion complexation [Samiksha V. et al.,2014]. Natural bisorbent which have the capacity to remove heavy metal from waste water presents in our environment. Tea is the most widely consumed beverage in the world. Tea waste is gaining a much attention because of suitable biosorbent for removing heavy metals like Iron (II), Cr (VI), Lead and Nickel. Tea waste is capable of binding appreciable amounts of heavy metal from aqueous solutions [Meenakshi Nandal et al.,2014; B.M.W.P.K. Amarasinghe et al.,2007].

In recent years, various adsorbents have been used for the removal of Cu(II), such as Pumice [Dilara Öztürk, Tekin Şahan,2015], tree leaves [Mohamed Sulyman et. al., 2016], Borasus Flabellifer Coir Powder [Darapureddi Krishnaa et al.,2014], heavy metal using tea waste [Shraddha Rani Singh, and Singh, 2012], Baobab fruit shell [Nargawe Tarachand, and Sharma, 2016], rice husk [Hengpeng Ye et al.,2012] etc.

ADSORPTION METHOD

Adsorption is a process, similar to absorption, by which substance in a gas or liquid becomes attached to a solid. The substance can be a pollutant called an adsorbate, which is attached to the surface of a special solid. Industrialists used adsorption methods to clean up hazardous waste or purify drinking water.

Tiny suspended chemical particles in another phase of matter, meaning in the air as a gas or in water as a liquid, are sometimes considered contaminants. These tiny suspended particles can be separated from that phase, called the adsorbent, to enter a different phase.

Another phase material, like the solid carbon, preferentially targets these particles and bonds the adsorbate to its surface. The remaining liquid or air has been purified. This differs from adsorption where the particles never change phase, but enter pores of the solid along with the accompanying air or water. Two type of existing attraction forces between adsorbent and adsorbate, classified:

Physisorption or Physical adsorption

When intermolecular force of attraction existing between adsorbate and adsorbent are weak vanderwaal forces of attraction, the process is called Physisorption or Physical adsorption. It takes place with formation of multilayer of adsorbate on adsorbent.

Chemisorption or Chemical adsorption

When the chemical interaction between the solid and the adsorbed substance or force of attraction existing between adsorbate and adsorbent are chemical, the process is called Chemisorption or Chemical adsorption. It takes place with formation of unilayer of adsorbate on adsorbent (M.Yasmin Regina et all, 2015).

Table -1: Advantages and disadvantages of some conventional & non-conventional method (Barkat et al., 2011)

S. No.	Treatment method	Advantages	Disadvantages
1	Chemical precipitation	Low capital cost Simple operation Requires low maintenance	Generation of large volume of sludge extra operational cost for sludge disposal
2	Adsorption with new Adsorbents	Low-cost easy operating conditions having wide pH range high metal-binding capacities	Low selectivity production of waste products
3	Membrane filtration	Small area requirement Low pressure high separation selectivity	High operational cost due to membrane fouling
4	Electrodialysis	High separation selectivity	High operational cost due to membrane fouling and energy consumption
5	Reverse Osmosis (RO)	Minimum maintenance Effective	Not cost efficient
6	Ion Exchange	Effective Pure effluent metal recovery is possible	Expensive resins Highly sensitive to PH of solution
7	Electrochemical treatment	Pure metal can be recovered for recycle No reagents involved	Require quite amount of electricity

Factors affecting the adsorption process

Adsorption process is mainly influenced by the nature of solution in which the contaminants are dispersed and the nature of adsorbent used. Some parameters should be considered during the adsorption process between adsorbent and adsorbate which are given below.

1. pH of solution: pH is determination of adsorption in terms of hydrogen ion concentration. The adsorptive capacity of metal cations increase with increasing pH of the sorption system, but not in linear relationship. Sorption not occurs at highly acidic and alkaline conditions because hydrogen ions and hydroxyl ions compete for active sites on adsorbent surface respectively.

2. Degree of ionization of the adsorbate: More highly ionized molecules are adsorbed to a small degree than neutral molecules. The degree of ionization of a species is affected by the pH.

3. Particle size: It is the size of the molecule with respect to size of the pores. Smaller particle sizes reduce internal diffusion and mass transfer limitation to the penetration of the adsorbate inside the adsorbent i.e. equilibrium is more easily achieved and nearly full adsorption capacity can be attained.

4. Surface area of adsorbent: Large surface area provides greater adsorption capacity. Smaller the particle size and greater the surface area of the adsorbent more is the adsorption.

5. Temperature: Adsorption reactions are normally exothermic, so adsorption capacity increases with decrease of temperature. In the range of 15-40ºC, the maximum

equilibrium adsorption capacity for Ni (II) ions by the wood ash was reached at temperature of 25ºC (Parmar and Thakur, 2013).

6. Effect of adsorbent dose: The percent removal of heavy metals increases rapidly with increase in concentration of adsorbents But after certain concentration of adsorbent further increase in biomass concentration has no effect on removal percentage because no metal ions left to be adsorbed on the empty active sites after equilibrium point is achieved.

7. Effect of initial concentration of metal ion: The initial concentration of metal ion provides an important driving force to overcome all mass transfer resistance of metal between the aqueous and solid phases. There is a decrease in resistance for the uptake of solute from solution with increase of metal ion concentration.

8. Contact time: Longer the contact time or retention, more complete adsorption will be achieved. But after the equilibrium has been achieved there is no increase in percent removal of metal ion.

9. Solubility of solute: Substances slightly soluble in water will be more easily removed from water than substances with high solubility.

10. Effect of agitation rate: Agitation means proper mixing of adsorbate and adsorbent. The adsorption removal efficiency is increased weakly with increasing agitation rate (Rajeev Sharma, et al. 2016).

LITERATURE

kamal rana et al., 2014

Recently kamal rana et all work on adsorption of copper cu $^{(2+)}$ metal ion from waste water using sulphuric acid treated sugarcane bagasse. In the process batch experiments of adsorption apply to wastewater on the adsorbent as Decided concentration (5, 10, 15, 20 ppm), ph (2, 3, 4, 5), contact Time (30, 60, 90,120 min), Adsorbent doses (0.5, 1.0, 1.5, 2 gm) at 25^{0}c. Maximum % removal of cu (ii)by sugarcane is Obtained 94.4 % at contact time 120 min, ph 5, Adsorbent dose of 2 gm for 5 ppm concentration. After ph 5 removal is decreased and also removal Is decreased with increase in concentration. experiment show the removal of copper (cu^{2+}) by Activating sugarcane bagasse is satisfactory. The Study indicated that adsorbent prepared from Sugarcane bagasse could be used as an effective Adsorbent material for the treatment of aqueous Waste streams containing copper. The adsorption of Copper using sugarcane bagasse is found to be Concentration, time, and ph dependent.

Sureshkumar Halnor et al., 2013

Sureshkumar work on the effect of pH, temperature, adsorbent dose, contact time, and initial concentration of adsorbate for the removal of copper (II) by PJLP. Batch experiments were carried for adsorption kinetics and isotherms. Adsorption capacity found to be enhanced by increasing temperature and adsorbent dose. Equilibrium data were well represented by the Freundlich and Langmuir isotherm model for all tested adsorption systems. Thermodynamic study show that the Cu (II) adsorption phenomenon onto PJLP was favorable and spontaneous. Adsorption with low cost adsorbent is not only cheaper but requires less maintenance and supervision. It is possible to remove about 89 % Cu (II) from industrial waste water at adsorbent dose (1gm/100ml). Research show that the suggested sugarcane bagasse for removal of Cu (II) from industrial waste water is an effective and low cost process.

Hanit Kumar Thapak et al., 2016

Investigat about Removal of Copper from Industrial Waste Water by Coconut Husk as a Low Adsorbent . Adsorption is best way for effective purification and separation technique used in industry especially in wastewater treatments. Coconut husk use as a adsobent which not only eradicate heavy metal but also removed harmful impurities from waste water. Experiment showed that maximum removal of copper ion by coconut husk adsorbent (6 pH, 120 min. Contact time, 0.6gram adsorbent dose and 10ppm concentration) is 89%.

Sarma, P.J. et al.,2015

Sarma, P.J. et al work on Batch and Continuous Removal of Copper and Lead from Aqueous Solution using Cheaply Available Agricultural Waste. Rice husk was found to be the best among the tested biosorbents with a maximum removal of 72.17 % and 85.87 % for copper and lead, respectively.. Dynamic removal of copper and lead by rice husk was examined as a function of different bed height and flow rate using fixed-bed columns, which yielded a maximum saturation time of 14 hours. Asorption data of batch correlated well with SIPS, Freundlich, Redlich-Peterson, and Langmuir isotherms models. The simulation of breakthrough curve for the metals was successful with BDST, Yoon-Nelson and Clark models. From the loaded column, removal of bound lead and copper was finally achieved by using 0.1M HCl as the eluant, which yielded complete desorption of the metals in nearly 60 min. In the column experiments, an increase in the feed flow rate decreased the remaining time to breakthrough of the metal ions, whereas an increase in the bed depth led to an increase in the remaining time to breakthrough. Finally, desorption proved highly effective for continuous recovery of bound metals from the biosorbent using 0.1MHCl in their respective column.

Hanit kumar thapak, and sumint singh trivedia, 2015

Hanit kumar thapak work on tea Waste adsorbent for the removal of Chromium and Copper from Synthetic Wastewater, and found the removal efficiency of tea waste as a low cost adsorbent is fruitful to neutralized heavy metal like Chromium and Copper. The experiment showed that maximum removal of Copper and Chromium ion by tea waste is 90% and 92%. showed that maximum removal of copper ion and chromium by tea waste is (4.5 pH, 120 min. Contact time, 0.6gram adsorbent dose and 10ppm concentration) is 91% and (7 pH, 40 min. Contact time, 0.6gram adsorbent dose and 10ppm concentration) is 94%.

Chuan-Wei et al., 2013

The Uptake of Copper(II) Ions by Chelating Schiff Base Derived from 4-Aminoantipyrine and 2-Methoxybenzaldehyde The equi- librium adsorption data for copper(II) ions were fitted to Langmuir, Freundlich and Dubinin-Radushkevish isotherm models. The maximum monolayer adsorption capacity found from Langmuir isotherm was 5.64 mg/g. Kinetic data well related with the pseudo second-order kinetic model that indicate chemical adsorption was the rate limiting step. Present study showed that SB has a monolayer adsorption capacity of 5.64 mg/g for copper(II) ions. Chemisorption of copper(II) ions could be occurred through the interaction of copper(II) ions with the methoxy and imine groups on SB. Copper(II) ions also can be removed via physical adsorption.

Jyoti shah et al., 2016

This experiment related to removal of nickel from aqueous solution by using low cost adsorbents various agricultural, microbial, synthetic, natural and Other adsorbents used for removing Ni(II) from aqueous solution, optimum parameters and their Removal efficiency from aqueous solution have been discussed. The adsorption depends on both ph and concentration with optimum pH 4–5 and the equilibrium data followed the Langmuir Isotherm model. Waste biomass such as babul bark and wheat stem was used to remove nickel from electroplating industry effluent and removal of nickel Achieved was 2–10% less as compared to synthetic solution under similar conditions. Wheat Straw activated carbon could remove 100% Ni(II) from initial nickel concentration of 25 mg/l at Ph 4.0 in 4 h at room temperature. Although the amount of Available literature data on the use of low cost adsorbents in water and waste water treatment is increasing at a tremendous pace, there are still several gaps which need to be filled

Pooja D Taralgatti, 2016

The study shows Removal of copper from Waste water by using potato and banana peels as bio-adsorbent. Removal of metal ions was found to be 91.532 % for copper with banana peels, at (2mg/L). Bio-sorption equilibrium isotherm were plotted for metal uptake capacity (q) against residual metal concentrations (C_f) in solution. The (q) versus (C_f) sorption isotherm mathematically relations was expressed by Langmuir and Freundlich models. The factor values of separation found between zero and one indicating favorable sorption for tested metal on the bio-sorbent. The non-living biomass of potato (Solanum tuberosum) was found to be more efficient in removing lead at low concentrations. Highest experimental solution concentration used (50 mg/L) and the removal was 57.66% for copper with banana peel. The removal of metal ions were 91.532 % for copper with banana peels, while at lowest experimental solution concentration (2mg/L). Result show that the carbonated banana peel powder has greater bio-sorption potential than potato peel powder. But overall non carbonated and carbonated peel powder have no significant change in results.

M. Madhava Raoa et al., 2006

Removal of copper and cadmium from the aqueous solutions by activated carbon derived from Ceiba pentandra hulls. The adsorbent exhibited good sorption potential for copper and cadmium at pH 6.0. The research data was analyzed using Freundlich and Langmuir isotherm models. The maximum adsorption capacity (respectively 20.8 and 19.5 mg/g) of copper and cadmium was calculated from Langmuir isotherm. The sorption kinetics analysis of copper and cadmium occurred by Lagergren pseudo-first and second-order kinetic models. The desorption studies were carried out using dilute hydrochloric acid solution and the effect of HCl concentration on desorption was also studied. Maximum desorption of copper and cadmium was calculated 90% and 88% with 0.2M HCl, respectively. Copper and cadmium adsorption on activated carbon is found to be contect time, pH, concentration, and dose dependent. In the study kinetics of sorption, the pseudo-second-order model provides better correlation of the sorption data than the pseudo-first-order model, this suggests that the rate-limiting step may be chemical sorption rather than diffusion. The material under consideration is not only economical, but also an agricultural waste product.

GHAZY, S. E. et al., 2008

Work on ion flotation of copper(II) and lead(II) from Environmental Water Samples. Research based on the lead, copper ions, diphenylcarbazone (HDPC) and with oleic acid (HOL) by flotation. The different parameters (like; HDPC solution pH, HOL, copper and lead concentrations, temperature, ionic strength and the presence of foreign ions) influencing the flotation process were examined. Nearly, 100% of Cu^{2+} and Pb^{2+} ions were removed from aqueous solutions at pHs 6 and 7, respectively at room temperature (~25°C). Flotation mechanism is suggested for metal removal in wastewater systems, due to the rapid, simple and economic nature of the procedure.

Wiwid Pranata Putra, and Azlan Kamari, 2014

Work on biosorption of Cu(II), Pb(II) and Zn(II) Ions from aqueous Solutions using Selected Waste Materials. Batch adsorption studies for evaluate the effects of solution pH and initial concentration of metal on adsorption capacity. The optimum condition of biosorption was found at 90 min equilibrium time, pH 6.0, and at 0.1 g biomass dosage. The resulted data from adsorption were fitted to the Freundlich and Langmuir isotherm method and The adsorption capacity of CTS, ES and SB were evaluated from the Langmuir isotherm model and resulted maximum adsorption capacities 'Q' for Copper(II), lead(II) and Zn(II) were 3.89, 25.00 and 23.81 mg/g for CTS, 34.48, 90.90 and 35.71 mg/g for ES, and for SB 3.65, 21.28 and 40.00 mg/g, respectively. The follwing studies were performed using Scanning Electron Microscope (SEM), Energy Dispersive X-ray Spectrometer (EDX), and Fourier Transform Infrared Spectrometer (FTIR). Interaction with metal ions led to the formation of discrete aggregates on the biosorbents surface.

Samiksha V et al., 2014

Samiksha et al, work on adsorption of copper from aqueous solution using mango seed powder. During the batch experiments the influences of contact time, adsorbent doses & temperature were studied at room temperature. The results showed that the percentage removal of copper increases with increase in the contact time and during first 45 minutes adsorption was rapid & equilibrium was reached in 90 minutes. The results also showed that the percent removal of copper & temperature increases with increase in the adsorbent doses. Thus mango seeds (as a low-cost biosorbent) have the potential to remove heavy metal contamination in waste water.

B.M.W.P.K. Amarasinghe et al., 2007.

Amarasinghe et al work on the removal of Cu and Pb from wastewater using tea waste as a low cost adsorbent. According to result the adsorption capacity was highest at solution pH range 5–6. The adsorbent to solution ratio and in the solution the metal ion concentration affect the degree of metal ion removal. From the result highest metal uptake of 48 and 65 mg/g were observed for Cu and Pb, respectively. Under all experimental conditions Pb showed higher affinity and adsorption rate compared to Cu.The result revealed that Pb and Cu uptake was fast with 90% at first 15–20 min of contact time. The kinetic data fits to pseudo second order model with correlation coefficients greater than 0.999. when both Cu and Pb ions are present in the solution total adsorption capacity was observed highest. Higher adsorption rate and capacity were found for smaller adsorbent particles.

Dilara Öztürk, Tekin Şahan, 2015

Dilara and sahan work on adsorption of copper by pores stone (pumice stone) analyzed in batch system. Optimization of medium conditions was studied through experimental design. To optimize medium condition for response surface methodology apply central composite design for response surface. Significant parameters apply to this process such as initial Cu(II) concentration, pH of various sample, adsorbent dosage, and temperature. The excellent conditions were evaluated for initial Cu(II) concentration 47.14 mg/l, pH 5.31, temperature 38.30 and adsorbent dosage 3.14g. Research show that the optimum condition of adsorption capacity such as 95.10% and 1.43 mg/g, respectively. From the results, it can be concluded that RSM is an efficient statistical method for optimization of experimental conditions, and pumice is a convenient adsorbent for the removal of Cu(II) from aqueous environments due to its significant adsorption capacity, natural abundance, and low cost.

Mohamed Sulyman et. al., 2017: Various case studies are supplied in this research. These record have pointed toward's the efficient removal of heavy metal ions from aqueous solutions by using agricultural by-products wastes in the form of a raw material, signifying spent tea leaves (STL) as a good example. The efficient ion removal by AC (produced from these agricultural by-products wastes) has also given in detail, suggesting a variety of AC agricultural by-products wastes sources. Both type of adsorbent are widely used adsorbents in the treatment of wastewaters. Many physical, chemical features show in this review paper and adsorbents characteristic by that make them widely used adsorbents in the treatment of wastewaters. The adsorption efficiencies which depend on the physical and chemical properties of the precursor (i.e., agricultural by products wastes) were also affected by the characteristics of AC, as well as on the activation method applied, which is either chemical or physical.

Darapureddi Krishnaa et al., 2014;-

Darapureddi Krishnaa work on response Surface Modeling and Optimization of Cu(II) removal from waste water borasus flabellifer Coir Powder use as a adsorbent. The effect of various parameters such as pH (5-7), initial Cu (II) concentration (20-60 mg/L), and biomass dosage (10-14 g/l) on Cu (II) removal have been investigated using response surface methodology. The Box-Behnken experimental design in response surface methodology was used for designing the experiments as well as for full response surface estimation and 15 trials as per the model were run. The selectable input parameters for maximum removal of Cu (II) from an aqueous solution of 20 mg/L were as follows pH (6.30642), biomass dosage (12.3646 g/L), and initial Cu(II) concentration (25.0414 mg/L). The model and the experimental data showed Borasus flabellifer coir powder removing efficiency from waste water is good.

Shraddha Rani Singh, and Akhand Pratap Singh, 2012; Work on Adsorption of Heavy Metals from Waste Waters on Tea Waste. The aim of this study is to use the tea waste as a low cost adsorbent for the removal of metal concentration in industry effluents. The effect of variation in different parameters like initial concentration of metals in solution, adsorbent amount and contact time were investigated. The adsorbent is very effective for lower concentration of metal solutions, and the adsorbance increases with increase in adsorbent dose. Around 96% removal of lead, 78% removal of nickel and 63% removal of cadmium is obtained using 0.5 gm of adsorbent and the efficiency is increased to 100% for Pb, 87% for Ni and 83% for Cd, by using 1.5 gm of the adsorbent. As this adsorbent is cheap and easily available, it can be used in little excess amount to obtain higher percentage of metal removal. A comparative study for removal efficiency for Pb, Ni, Cd is also discussed. The adsorbent prepared from tea waste is efficient and it is proposed that it can be conveniently employed as a low cost alternative in the treatment of waste water for heavy metal removal.

Nargawe Tarachand, and Sharma, 2016;- Nargawe tarachand, and Sharma use baobab fruit shell as a Natural Adsorbent for Copper and Lead Removal from Industrial Effluent, The experiment is a bench scale type and analysis have performed by using different division (>200 μm and 200 μm fraction) of baobab fruit shell (Adansonia digitata) for copper removal. The detected treatment efficiency is 86.1% at 0.5 mg/L metal concentration, while the lead is 86.9%. In the Adsorption treatment process adsorbent treatment efficiency decrease to 71.76% for Cu and 86.76 % for Pb, with Increasing metal ion concentration in the solution. Treatment efficiency increases by 6–1% for copper, and 8–9% for lead at smaller division (200 μm) of baobab fruit shell (Adansonia digitata). Baobab fruit shells can be used as a cost effective adsorbent for the removal of lead(II) and copper(II) ions from wastewater in the treatment of industrial effluent.

Hengpeng Ye et al., 2012;- Work on the removal of copper (Cu) and lead (Pb) from industrial effluent has been investigated by using baobab fruit shell (Adansonia digitata) as a natural adsorbent. The experiment is a bench scale type and analysis have performed by using different division (>200 μm and 200 μm fraction of baobab fruit shell (Adansonia digitata) for copper removal the treatment efficiency is 86.1% at 0.5 mg/L metal concentration, while the lead is 86.9%. treatment efficiency decreases to 71.76% for Cu and 86.76 % for Pb with increasing metal concentration in the adsorbent solution and smaller division (>200 μm) are used in baobab fruit shell (Adansonia digitata) treatment efficiency increases by 6–1% for copper, and 8–9% for lead. Baobab fruit shells can be used as a cost effective adsorbent for the removal of lead(II) and copper(II) ions from wastewater in the treatment of industrial effluent.

CONCLUSIONS

In this review briefly discussions on various low cost adsorbents used for the effective removal of heavy metal like copper from waste water. Paper describes about the removal of copper, toxicity of copper, sources, pollution, effect of copper on human bodies and environment, and removal methods at low cost adsorbent etc. The present survey highlights on efficiency of different materials for the removal of copper from water. The most important results of extensive studies on applied various significant key factors such as pH, contact time, initial copper concentration, and different dose, and also fluctuate copper removal capacity of materials are reviewed.

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