Removal of Zinc from waste water by using Low Cost Adsorbent: A comprehensive Review

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Abstract - Heavy metals are highly toxic to the living organism, to reduce heavy metal research on an innovative process for removal of heavy metals to reduce containment in water at low cost. The heavy metal like zinc is a highly toxic and harmful to environmental to create hazardous disease on the living organism, zinc is present in high concentration in wastewater in various industries like electroplating galvanizing meta metallurgical, electroplating, mining, ceramic, paints, pigments, pulp, paper, pharmaceuticals and food processing industries. Various process apply to removal of zinc metals in industries like precipitation, ion exchange, reverse osmosis, electro dialysis, electrochemical treatment, membrane separation ultra - Nano filtration, but these methods are highly expensive costly, work on the particular condition and proper setup. Adsorption has been a most popular process and inexpensive mass transfer operation to remove heavy metals from wastewater create a sludge free clean environment. The researcher has been interesting to natural and bio-degradable adsorbents process. In this work various type adsorbent use in removal of heavy metals like brick powder, activated carbon, natural source adsorbents (bentonite, clay zeolite etc.), bio sorbents (black gram husk, sugar-beet pectin gels, citrus peels, banana and orange peels, carrot residues, cassava waste, algae, algal, marine green macro algae, etc.) and by-product adsorbents (sawdust, lignin, rice husk, rice husk ash, coal fly ash,). Study on various adsorbent and their functional group using FTIR that's adsorbed heavy metals from water. The study focus on various available low-cost adsorbent processes that's adsorbed heavy metals (zinc) from wastewater. Bio adsorbent is easily degradable and make sludge free environment. Experimental procedure of zinc influenced by various parameters like pH, adsorbent dosage, metal ion concentration, temperature, and contact time of adsorbent.

***Key* Words: Bio-adsorbent, Orange peel, Zinc, Heavy metal, Organism, Wastewater.**

1. INTRODUCTION

Environmental pollution is one of the main problems of the society in the 21st century, Water is the most essential substance for all life on earth [1] [49]. The major pollutants include toxic metals, the quantity of which permanently increases in the environment as the result of increased industrial activity [2] [3].Industries these refuge Heavy-metal contamination in environment by aqueous waste stream such as metal plating, mining, tanneries, painting, and car radiator manufacturing, as well as agricultural sources, where fertilizer and fungicidal spray are intensively used. The major constituents in the wastewater being generated from the metal finishing processes are cyanides, various metal ions [Fe, Cu, Ni, Ag, Mn, Pb, Zn and Cr(VI)] oils and greases, organic solvents, acids and alkalies [4][5][20-24][45].Rapid industrialization and urbanization have resulted in the discharge of various toxic pollutants into the water bodies [6][43]. Heavy metals are elements having atomic the weight between 63.5 to 200.6 and specific gravity more than 5.0, unlike organic contents, are not bio-degradable, the presence of heavy metals in water resources is ever growing concern due to their lethal effects on all living organisms through food chain [7][8]. Industrial and domestic wastewater refuge after improper treatment hence various water resource unfit slowly also effected by improper disposal of waste material, waste material mix with fresh rainy water and water going through sewage and sewage water mix with river and dam, these water is also mix with heavy metals and they polluted to fresh water [9][46]. The optimization of wastewater purification processes requires a development of new operations based on low-cost raw materials with high pollutant removal efficiency [10]. It is well known that 70 to 80% of all illnesses in developing countries are related to water contamination, particularly susceptible children and women [11].In the case of Zn, the main activities that produce contaminated residues are steel work, mining, petrochemical industries, agriculture and cattle-raising [12] [35]. Zinc is an essential metal and is the constituent element of human diet, its daily requirement 10 to 20 mg, surface water is 5.0 mg/l but an excess amount of zinc dose causes a number of alminates. The metal works exposed to zinc fumes suffer from high fever, shivering, dryness of mouth zinc compounds are astringent corrosive to skin, eyes and mucous membranes and causes a special types of dermatitis known as 'zinc pox' its irritating to the digestive tract causing nausea and vomiting and in extreme cases even renewal failure, zinc occurs widely in nature primarily sphalerite, zincite, smithsonite franklinite and willemite etc [13] [14] [36] [39] [38] [47]. The widespread industrial use of low-cost adsorbents for wastewater treatment is strongly recommended at present, due to their local availability, technical feasibility, engineering applicability and cost-effectiveness. Therefore, many people tried hard to find efficient and low-cost materials. Most agriculture wastes or by-products are considered to be low-value products [15] [16] [18-19]. Low cost bio adsorbent is easily available in local market like banana, orange, lemon, mango, pomegranate peel, etc. Agriculture and food processing industries generated shell, seeds, peels and biomass these materials used as bio adsorbent to removal of heavy metals from wastewater[18][20][24][31][42][42][43][45].

1 Industrial source

Table 1-Various industries refuse heavy metals in environment

Industries refuse heavy metals	
Metals	Industry
Zinc	Batteries, electroplating industries, phosphate fertilizers, detergents, Rubber industries, paints, dyes, wood preservatives and ointments.
Copper	Electroplating industry, plastic industry, metal refining and wire.
Nickel	Galvanization, paint and powder, batteries processing units, metal refining and super phosphate fertilizers.
Aluminum	Industries preparing insulated wiring, ceramics, automotive parts, aluminum phosphate and pesticides.
Arsenic	Automobile exhaust/industrial dust, wood preservatives and dyes.
Chromium	Chrome plating, petroleum refining, electroplating industry, leather, tanning, textile manufacturing and pulp processing units. It exists in both hexavalent and trivalent forms.
Lead	Petrol based materials, pesticides, leaded gasoline, and mobile batteries.
Iron	From metal refining, engine parts.
Mercury	Thermometers, adhesives and paints.
Cadmium	Refined petroleum products, paint pigments, pesticides, galvanized pipes, plastics, polyvinyl and copper refineries.

2. Adsorption

The classical mechanism of adsorption is divided into three steps in (Fig.1) (a) diffusion of adsorbate to adsorbent surface, (b) migration into pores of adsorbent (c) monolayer build-up of adsorbate on the adsorbent. Fig.1 presents the process of adsorbate distribution. In step1 occurs diffusion occurs of adsorbate on the adsorbent surface by intermolecular forces between adsorbate and adsorbent. The 2 step involves migration of adsorbate into pores of adsorbent. During 3 step, when the adsorbate particles are distributed on the surface and filled up the volume of pores, particles of adsorbate are building up the monolayer of reacted molecules, ions and atoms to the active sites of adsorbent[25][28].

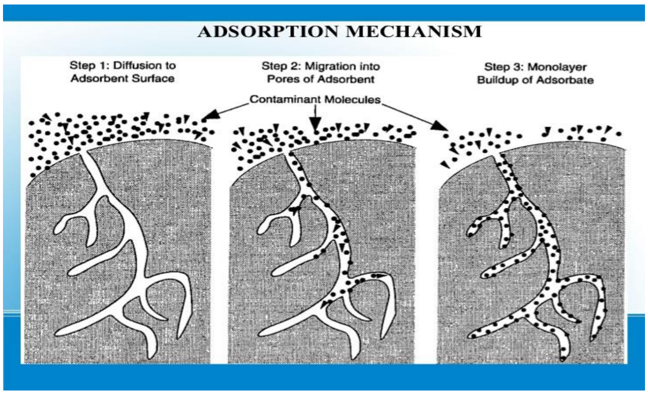

Figure (1): Steps of adsorption mechanism, (1) diffusion of adsorbate to adsorbent surface (2) Adsorbent migrate in to the pores (3) Monolayer buildup of Adsorbate [53]

Types of adsorption

The nature of adsorption depends upon the forces which act between adsorbent and adsorbate's. The adsorption forces are a key factor in defining whether the adsorption is physical or chemical. Occasionally, it is complicated to identify what type of adsorption is predominating in a certain situation. Sometimes it might be a combination of chemisorption and physisorption.

Physical adsorption

Physical adsorption, show in fig. (2) Is reversible and rapid. Molecules are holding to the surface by van der Waals forces of attraction (intermolecular forces and interatomic interactions with the energy of 10-20 kJ/mole). Therefore, the lack of interaction energy may break the bond between adsorbent and adsorbate, for example by mechanical movement of the interface. Consequently, the most valuable parameters for physisorption are the pore size, pore structure, pore volume, and surface area. Physisorption prevails at low temperatures, and activation energy is 5-10 Kcal/mole [29] [45].

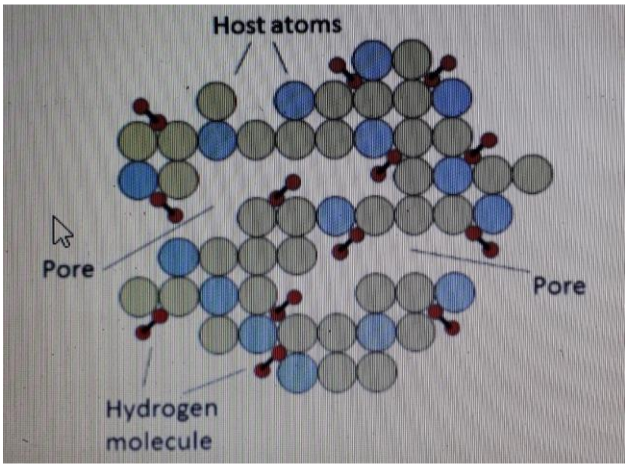

Figure (2): Mechanism physical adsorption [29]

A mechanism of hydrogen storage on the surface of highly porous material is shown in Figure (2). The molecules of hydrogen accumulate at the surface of the porous material without reacting chemically with it. [53]

Chemical adsorption

A specific surface area of phases, types of active sites, number of active sites, and stability of active sites are predominantly valuable for chemisorption. Chemical adsorption show in fig. (3) Occurs as a result of chemical reaction between molecules and atoms of the adsorbate and adsorbent. Chemisorption is irreversible because chemically adsorbed molecules are not able to move on the surface of within interface. The main advantages are high selectivity of separation and the ability to treat exceptionally small concentrations of solute. Chemisorption accelerates by elevated temperature where activation energy varies between 10-100 Kcal/mole [29].

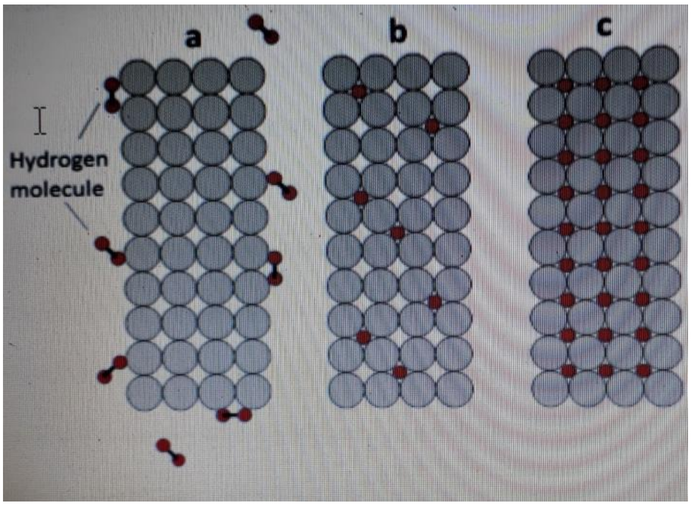

Figure (3): Chemical adsorption mechanism. [29]

A mechanism of hydrogen storage by using chemisorption onto certain metals was taken as example, in figure (3) hydrogen molecules attached on the surface of the material. Then molecules split into separate atoms. The hydrogen atoms distribute randomly in the structure of material. Finally, hydrogen compounds adopt an ordinary arrangement and form ionic, covalent or metallic bonds with the metal atoms.

Active and passive methods

The list of well-known active methods includes neutralization, filtration, ion exchange, electro dialyses, solvent extraction, freeze separation and adsorption etc., (Table 2 (a)). The word "active" implies that active methods require a lot of maintenance and external energy to carry a treatment process. Passive wastewater treatment methods are less efficient than active wastewater treatment methods and usually used as addition to active methods. Passive methods include constructed wetlands, limestone drains and reactive barriers (Table 2 (b)). Passive wastewater treatment requires less of technical maintenance than active ones, which extends the durability of the certain method, but usually service is infrequent [25].

Table 2- Active and passive wastewater treatment technology

Active wastewater treatment (a)	
Neutralization	Treatment with alkalis, acids, lime, soda, ammonia, or etc. to provide desired pH value.
Filtration	For suspended and dissolved solids; Filtration occurs by filters from 10^2 to 10^{-4} µm of particle size.
Ion exchange	A reversible chemical reaction in where occurs exchange of ions between a solid substance and the electrolyte solution.
Adsorption	Adhering of contaminant(s) on surface of material with adsorption properties.
Freeze separation	Separation of two liquefies substances based on varied melting points.
Solvent extraction	Based on relative solubility of a contaminant in two immiscible liquids.
Electrodialysis	Based on a concentration changing of the electrolyte solution by influence of current; used for the desalination of water, i.e. from toxic metal salts.
Passive waste water treatment technology (b)	
Reactive barrier	Underground barrier/wall with organic or inorganic reactants which is constructed on highly contaminated groundwater flow.
Limestone drains	Closed channels filled with limestone to increase alkalinity of wastewater.
Constructed wetland	Artificial wetland with plants which can retain contaminants on their roots.

2 Waste Water Treatment Technologies and Comparison

In this study, adsorption is chosen as a method of toxic metals removal from aqueous phase because it has significant benefits among other wastewater treatment methods. On the one hand, operating costs are low and utilization is simple; on the other hand, adsorption is a highly efficient method in removing very low levels of toxic metals from dilute solutions. High selectivity, minimum production of by-products such as chemical sludge, and regeneration ability are the most valuable point for adsorption[26-27, 32,37,42,47].Concentration of zinc in human and animals tissues [mg/kg dry weight][40] [41][49][50].

Table 3- Waste Water Treatment Technology and Comparison

Technique	Advantage	Disadvantage
Adsorption	1The high cost of activated carbon to adsorption of heavy metals in waste water. 2 Various low cost adsorbent developed to removal of heavy metals from wastewater. 3Biosorption is a relatively new process that has proven very promising for the removal of heavy metals from wastewater. 4) Simplicity.	1) Removal of heavy metals from low wastewater concentration. 2) Adsorption of capacity of heavy metals depends on type of adsorbent and their functional group.
Electrochemical	1) Regarded as rapid and well controlled which requires fewer chemicals. 2) Refuge very less sludge and provide good reduction yield.	1) Investment cost is very high to setup machinery and instrument. 2) Electric supply is expensive.
Flotation	1) High metal selectivity. 2) Removal efficiency is very high. 3) Low detention period.	1) High initial investment cost. 2) High maintenance and operation cost.
Coagulation flocculation	Sludge settling capacity and dewatering characteristics is very good.	1) It involves chemical consumption. 2) Increased sludge volume generation.
Chemical precipitation	1 Inexpensive capital investment. 2 Adapted to treat high heavy metal ion concentration.	1 Ineffective when low metal ion concentration. 2) Not economical. 3) Produce large amount sludge.
Ion-exchange	1Widely applied for heavy metal removal. 2Ion exchange resin can be regenerated.	1) Secondary pollution can be caused due to regeneration by chemical agents. 2) Highly expensive when treating large amount of waste water so can't be used at large scale.
Membrane filtration	High removal efficiency to heavy metals.	1 Costly and complex. 2 Membrane fouling has limited heavy metal removal.

Zinc properties

Zinc imparts an undesirable astringent taste to water. Tests indicate that 5% of a population could distinguish between zinc-free water and water containing zinc at a level of 4 mg/litre (as zinc sulfate). The detection levels for other zinc salts were somewhat higher. Water containing zinc at concentrations in the range 3–5 mg/litre also tends to appear opalescent and develops a greasy film when boiled.

Major uses

Zinc is used in the production of corrosion-resistant alloys and brass, and for galvanizing steel and iron products. Zinc oxide, used in rubber as a white pigment, for example, is the most widely used zinc compound. Perioral zinc is occasionally used to treat zinc deficiency in humans. Zinc carbonates are used as pesticides (54).

Wetlands

Constructed wetlands are defined as engineered wetlands that utilize natural process involving wetland vegetation, soil, and microbial community associated to assist, at least to some extent, in treating wastewater or other polluted sources [51].The number of constructed treatment wetlands has increased to more than 20,000 across the world in receiving wastewater from municipal, industrial, agricultural and storm water sources (52). Constructed wetlands are quit feasible approach to the treatment of wastewater in terms of cost effectiveness feasibility

A) Construction cost is lower than other treatments options and required minimum operation and maintenance.

B) Operation and maintenance is not maintenance basis (no daily operations).

C) Wetlands are able to tolerate fluctuations in different influent concentration, hydraulic and organic loading rates.

D) The water being treated via the system can be recycled or reused.

E) It provides habitat for many habitat not only for wildlife habitat and enhanced the aesthetic beauty and fit harmoniously into the landscape.

Wetlands have been known to be effective in treating biochemical oxygen demand (BOD), suspended solids, nitrogen and phosphorus, as well as decreasing the concentrations of metals, organic chemicals and pathogens. However, effective wetlands performances depend on adequate pre-treatment, hydraulic loading rates, the collection of monitoring, information assess system performance and a successful operation strategies.

3. RELEVANT LITERATURE

Karri and Sahu, (2018)

Research on the development a model and optimize by particle swarm implanted neural system for adsorption of zinc (II) by palm kernel shell based activated carbon from aqueous environment In this regard , palm oil kernel shell a low-cost adsorbent generated by agricultural waste is examined for its efficiency to remove Zn (II) from wastewater and aqueous solution. Research effected by various parameter like pH, contact time, initial concentration, temperature and dosage of activated carbon on the removal of Zn (II) by palm kernel shell-based AC from batch adsorption process are studied systematically. Design of experimental by 50 experimental runs is performed with each process variable in the experimental range. The optimized trained neural network well depicts the testing data and validation data with R^2 equal to 0.9106 and 0.9279 respectively. The outcomes indicate that the superiority of ANN-PSO based model predictions over the quadratic model predictions provided by RSM. The particle swarm optimization which is a meta-heuristic optimization is embedded in the ANN architecture to optimize the search space of a neural network. The optimized values of pH, residence time, ISC, AC dosage and process temperature for 90% Zn removal are 5.0, 53.2min, 44.8 mg/L, 15.5 g/L and 40 ^{0}C respectively. The optimal ANN architecture was found to be 5-7- 1 topology and the maximum number of iterations in the implementation of ANN-PSO is 500. With seven neurons in the hidden layer provided higher R^2 and lower MSE. The optimized trained neural network well depicts the testing data and validation data with R^2 equal to 0.9106 and 0.9279 respectively. Pearson's Chisquare measure which provides a good measurement scale to weigh the goodness of fit is found to be 0.197 and 0.028 for RSM and ANN-PSO respectively. The outcomes indicate that the superiority of ANN-PSO based model predictions over the quadratic model predictions provided by RSM.

Ribeiro et al., 2018

Study on heterogeneous surface and co-operative sorption, in this study experimental data described by Generalized Elovich kinetic model and the favourable isotherm profile by Langmuir-Freundlich isotherm (=15.38 mg g^{-1})and. Development of biological model of Zn species along with the leached species determine that, study dependent on different pH, the bio sorption was the most likely phenomena rather than precipitation. Finally, the hybrid neutralization/bio sorption process showed great potential since both the Zn concentration levels and the pH reached the legislation standards (C. Zn=4 mg L^{-1}, pH=5) industry effluent characterization, a highly acidic (pH ≈ 1) and elevated contents of Zn (II) in solution (60 mg L-1), which were above the legislation standards, was observed. The physicochemical and morphological characterization of the proposed bio sorbent material (residual fish scales) pointed out different potential active sites for the heavy metal removal, in both organic and inorganic phases (e.g. amide, hydroxyl – from collagen; and phosphates and carbonates – from apatites). Thus, a strong heterogeneity of sites was observed for the FS bio sorbent. The bio sorption experiments have indicated a strongly pH dependent process, which can be much likely ascribed to the electrostatic interactions changes in the functional groups (e.g. phosphate protonation for pH < (pKa1 = 2.2), causing the anionic character weakening). The bio sorption mechanism was investigated through mathematical modeling, wherein the Zn (II) bio sorption by the FS kinetic experimental data was adequately described by the Generalized Elovich model which is associated to heterogeneous surfaces, as verified by the different structures (i.e. apatites and collagen) and their functional groups identified by FTIR and XRD analysis.

Agwaramgbo et al., (2016)

Studied on the copper and Zn removal from contaminated water using coffee waste. As the adsorbent dose increased from1gm to 4gm the % of metal removal increased from 73 to 92%, for copper and 50 to 74%, for zinc from single metal solution and from 26 to 78% for copper, 18 to 58% for zinc from binary metal solution. the presence of another metal as impurity increased metal adsorption hence more adsorption occurred from binary metal solution and the adsorption of zinc decreased in the binary metal system the studied showed the nature and mechanism of the adsorption of a specific metal ion from a binary metal solution may change or may be different from that of the single metal system.

Singh and Verghese, (2016)

Studied at various easily available methods as chemical precipitation: low cost novel adsorption through coconut shell, bagasse's waste tea leaves, wood barks and USAR soil membrane process which are capable of 90 to 100% removal of these metals, bio removal methods removal by minerals and removal by newer technique as semiconductor photo catalysis technology. They observed increasing ecological and global public health concern associated with environmental contamination by heavy metals but as exposure to them are unavoidable due their use in several industrial, agricultural, domestic and technological applications they present inescapable recovery and removal requirement. Heavy metal recovery techniques from waste streams generated from electroplating industry have gain importance and are equally significant as their detection in industrial effluents. The research showed techniques which are cost effective as the material used for the purpose are easily available and their use in heavy metal removal has not been explored on large scale and in the larger interest. These techniques have the future prospect of the strong foundation of green chemistry revolution in India.

Petersen et al., 2015

Studied on bio sorption of heavy metals from aqueous solutions, this process continues until equilibrium is achieved between the dissolved and solid-bound sorbate. The adsorption isotherms represented by langumuir equilibria for Cu, Pb and Cd and the capacity of fresh alga for Cu, Pb and Cd was approximately 85-94 mg/g, 227-243 mg/g, and 83.5 mg/g, by way of comparison with conventional ion exchange technologies, the performance of the seaweed was slightly better than that of a chelating C467 resin (approximately 80 mg Cu/g) and worse than that of a strong acid IR120 resin (about 101 mg Cu/g) for copper. Cu and Zn with a total concentration of 100 mg/L were passed through the column at a flow rate of approximately 15 BV (bed volume). For all practical purposes, 100% of the Pb and Cr were removed with approximately 95% of the Cu and 75% of Zn and Ni. Sorption equilibrium was reached within 10 minutes for all heavy metals. The Pb and Cr removal remained constant at close to 100%, whereas the other heavy metals peaked close to 90% and then decreased steadily afterward. The decrease in Ni and Zn concentrations could be attributed to the displacement of these heavy metals with Pb and Cr. This shows that the seaweed is very selective for Pb and Cr and to a lesser extent for Cu. By using a 2M HCl solution, 95% of the Cr and Pb could be removed within 120 minutes. Initial heavy metal removal was fast, with more than 70% being removed within the first 20 minutes of operation.

Darge and Mane, 2015

Study at treatment of Industrial Wastewater by using Banana Peels and Fish Scales. Banana peel which is a discarded fruit waste and Fish scales which are readily available waste in the market were used to prepare environment benign bio-adsorbent for the adsorption of impurities from aqueous solution. Banana peels and fish scales were washed, dried and ground to 150- 200 μm and to 160 μm respectively, before being used for treatment of pharmaceutical waste water. The combination of both these bio sorbent was used for treatment of waste water with different proportion of adsorbents, variation of pH and contact time. It is found that the maximum efficiency of removal of heavy metal is 60% and 70%respectively. Efficiency of removal of heavy metal concentration is more with banana peel and then with fish scale. Mixture of both the adsorbents gives more efficiency. The bio-adsorbents once used could be-used through desorption methods for a certain period of time and this could be employed commercially in the future.

Pragati, (2015)

Studied on the removal of zinc from synthetic wastewater by sawdust as an adsorbent, There are so many alternative present in our environment which can easily replace this activate carbon traps all the impurities presents in the wastewater in the form of heavy metal like Zn. For the development of advanced technology, the removal of heavy metal ion from waste water is very useful sawdust is one of them as it contains lignin and cellulose which easily traps all the impurities present in the waste water in the wastewater in the from heavy metal like Zn^{+}, by this experiment 90% Zn^{+} ion removed. The taste showed sawdust is a cheap and effective adsorbent for the removal of zinc from wastewater by this experiment maximum zinc ion removed from wastewater at 5 pH and the contact time 120 minute, adsorbent dosage 0.5gm/100ml by this studied for the development of advanced technology, the removal of the heavy metal ion from waste.

Modrogan C. et al., (2014)

Analyze on the kinetic of zinc metal (ion) adsorption from water and wastewater by ion exchanges resin. In the experiment, the capacity of ion exchange resins, purolite MN 500 and purolite C 100 H, for removal of the Zn^{2+} ion from aqueous solution have been investigated under different conditions namely initial solution pH, initial metal ion concentration, and contact time. The equilibrium data on to Zn^{2+} ion by obtained this study was well fitted to Langmuir and Freundlich models and order of affinity was followed as c100 H>MN 500. Adsorption of Zn^{2+} follows a first-order reversible kinetics. They observed MN 500 and CH 100 H cation exchange resin is effective in the removal of the Zn^{2+} ion from the aqueous solution; the data is useful in fabrication and designing of wastewater treatment plant. Kinetically, adsorption of Zn^{2+} was predicted by using the pseudo-second-order model with higher correlation coefficients (r^2> 0.98 from C 100 H and > 0.95 from MN 500 respectively). The initial adsorption rate, h (mg/g min) linearly increased. As a result, obtained from a large-scale reactor in series, the removal efficiency of Zn^{2+} ion was approximately 78 to 98%.

Rajoriya and Kaur, (2014)

Research on the adsorptive removal of zinc from wastewater by natural bio sorbents. In this work lemon peel and banana peel are effective bio sorbents to achieve desired objective, under suitable experiments specifically the following conclusion can be drawn from the result of this study zinc adsorption on these bio sorbents is highly dependent upon solution pH, pH 4 is an optimum pH, removal efficiency 87.5% to 90.5% in respectively 1g/100 ml adsorbent dosage for bio sorbents is an optimum dosage to removal of zinc from wastewater. Adsorption capacity and removal of zinc decrease with increasing temperature and optimum contact time of lemon peel and banana peel are 260 minutes.

Jain G., (2013)

The studied represent adsorption suitability of a novel indigenous adsorbent, chitosan used in the removal of heavy metals (zinc and copper) from wastewater. Optimum condition obtained by batch experiment procedure to the removal of copper and zinc metals from wastewater. Adsorption process affected by different parameters like pH, contact time, temperature, adsorbent dose, and initial metal ion concentration were also determined. Optimum condition to adsorption of zinc and copper in chitosan were 360min contact time, at 5pH, 200 mg adsorbent for copper and 360 min contact time 7 pH and 200 mg adsorbent dosage for zinc metal ions. Langmuir, Freundlich and Temkin isotherm model describe of adsorption behavior to zinc and copper, adsorption data well fitted in the Langmuir isotherm model for zinc and copper metals. The maximum adsorption capacity of heavy metals (copper and zinc) in chitosan (89 and 96.97%) in chitosan.

Li et al., (2013)

Investigated on the Applications of nanotechnology in water and wastewater treatment, Nano technology holds great potential in advancing water and wastewater treatment to improve treatment efficiency as well as to augment water supply through safe use of unconventional water sources. The discussion covers candidate Nano materials, properties and mechanisms that enable the applications, advantages and limitations as compared to existing processes, and barriers and research needs for commercialization. Nanotechnology for water and wastewater treatment is gaining momentum globally. The unique properties of Nano materials and their convergence of current treatment technologies present great opportunities to revolutionize water and wastewater treatment. Among them, three categories show most promise in full scale application in the near future based on their stages in research and development, commercial availability and cost of Nano materials involved, and compatibility with the existing infrastructure: Nano adsorbents, nanotechnology enabled membranes, and Nano photo catalysts.

Kanwade and gaikwad, 2011

Studied aims at the removal of zinc from electroplating industrial wastewater using a cheap adsorbent, cork powder. The maximum adsorption (92%) was obtained at a pH of 6 and the adsorption decreased with an increase or decrease in pH. The maximum adsorption was found at a contact time of 100 minutes. A contact time of 1 hour was provided and the obtained results are shown 81% removal was observed at an initial concentration of 6mg/l. hour. The maximum percentage removal of zinc of 100% was obtained at an adsorbent dosage of 100mg. Removal of heavy metals (zinc) from waste water by Corck powder, cork powder was to be a very good adsorbent for the removal of zinc. In synthetic wastewater 98% of zinc removal was found whereas the removal percentage of the electroplating industrial wastewater was observed to be 91%.

Atieh M.A., 2011

Studied at removal of zinc from water using modified and non-modified carbon Nano fibers, high removal of zinc from wastewater was achieved using acid treated Carbon Nano fibres'. Maximum percentage of zinc removal achieved by acid treated carbon Nano fibers. A capacity of zinc adsorption from wastewater influenced by pH, adsorbent dosage (CNFs), contact time and agitation speed. The morphology of the Carbon Nano fibers (CNFs) was characterized by using field emission scanning electron microscopy (FESEM) in order to measure the diameter and the length of the CNFs. The diameter of the Carbon Nano fibers was varied from 100-200 nm and 30 micrometers in length. A Final result of the study showed 97% of zinc removed by using COOH-CNFs at pH 7, 150 rpm, and 2 hours. Physical and chemical properties of carbon Nano fibers attributed to the maximum removal affinity of zinc. The optimum pH found in this study is pH 4 in which it gave 23% removal of Zn ions by using R-CNFs and 90 % of Zn ions by using M-CNFs from aqueous solution. High removal percentage of zinc increase slightly to an increase in agitation speed from 100 to 200 rpms.

Markovic, et al., 2011

Research on the low-cost wasted materials for heavy metals removal of the mine wastewater. The results of chemical analysis of effluent obtained obtained from oak as manganese was not changed and the content of the zinc was decreased but the concentration was over the maximum allowed value. In this study Opportunity and limitation to further capitalize on these unique properties for sustainable water management. The adsorption material, zinc and manganese concentration in the effluent was near the start values and copper and iron content was decreased but the values were higher than allowed. Using the cardboard, the copper adsorption degree was up to 95 mass %s, iron content was under the limit value for the applied chemical detection method. By the use of sawdust from fir-wood indicate that the values of iron and nickel ions were lower than allowed values by the legislative direction. The highest value for copper adsorption degree of 98.31% was achieved at pH value of 7.94. The content of manganese in the effluent and at the end of the process where near the initial value, using the sawdust.

Alfaya et al., (2009)

Studied on the removal of copper, zinc, cadmium and mercury ions from aqueous solutions using rice straw as bio-sorbents aqueous solution makes in room temperature generally taken as about 20^{0}C.Freundlich equation used to analyze adsorption isotherms, experimental data fit in the Freundlich equation. Metal ions adsorbed on the rice straw, determine adsorption order for rice straw was Cd (II)>Cu (II)>Zn>Hg (II).In the 1.5h quick adsorption get the equilibrium condition. They found maximum adsorption at pH 5.0; they investigated thermodynamics aspects for the adsorption process.

OBOH et al., 2009

Studied on the bio sorption technology to the removal of heavy metal ions from synthetic wastewater, Neem leaves to use as a bio sorbents. After the experimental procedure, the following conclusion can be drawn. The ground Neem leaves was very effective in the removal of Ni^{2+} ions from the synthetic wastewater. The ground Neem leaves is very efficient and effective bio sorbents material to the removal of heavy metals (Ni^{2+}) from synthetic wastewater. Industrial wastewater containing heavy metal ions can be effectively removed by biomaterial neem leaves. The experimental result (data) obtained after contacting with bio sorbents (Neem leave) from synthetic wastewater contact in 120 minutes showed that Neem leaves achieved the percent removal of 76.8, 67.5, 58.4 and 41.45 for Cu^{2+}, Ni^{2+}, Zn^{2+} and Pb^{2+} ions respectively. The percent removal of Ni^{2+} ions was 68.75 with an effective dose of 1.0 g of bio sorbent (Neem leave). This process can be effectively used in the heavy metals removal of industrial wastewater.

Viraraghavan and Dronamraju, (2008)

Studied on the removal of copper, nickel, and zinc from wastewater by adsorption using the feat. The effectiveness of peat in adsorbing copper, nickel, and zinc from wastewater was studied. Adsorption data carried out by Batch experiment, kinetic and isotherm study influenced by following parameters like contact time, pH, initial concentration of the adsorbate, and temperature on adsorption. It was found that a contact time of two hours was necessary for the adsorption to reach equilibrium. The optimum pH was found to be between 4.5 and 5.0. Experimental data obtained for the adsorption of copper, nickel and zinc ions fit into the Langmuir and Freundlich model equations. Langmuir and the Freundlich models well describe adsorption data. The adsorption process was found to be exothermic.

Sharma and Singh 2008

studied on removal of zn^{2+} ion from aqueous solution by rice (Oryza Sativa) husk in sequential bed adsorption column ,in this study removal of Zn^{2+} ion used a sequential bed adsorption column and result compared to those obtained by using vertical column, by the batch adsorption study main removal parameters contact time metal ion concentration and pH. They observed the maximum zinc removed at 8 pH in concentration at 30 to 300mgl^{-1} in 2.5h. Sequential bed adsorption column.

Amuda et al., (2007)

Desorption studies were carried out with NaOH and quantitative recovery of the metal was evident. The dominant sorption mechanism is ion exchange. Agricultural waste like (coconut shell) and aquatic waste (chitin) use to produce activated carbon potentially leads to the production of a highly effective adsorbent generated from less expensive raw materials that are from renewable resources. Raw material coconut shell and aquatic waste chitin is an inexpensive and easily available bio material's to produce activated carbon at very low cost. A highly effective adsorbent as well as producing activated carbon processed from renewable resources instead of non-renewable ones.

Ngah and Hanafiah (2007)

Studied on this review paper we be can used various type bio adsorbent material like that's material maximum use in food processing plants. Bio adsorbent material like rice husk, spent grain, sawdust, bagasse, fruit wastes, weeds and other biodegradable materials. Although chemically modified plant waste adsorbed heavy metals. These materials is a very good adsorbent to the removal of heavy metals like Cd, Cu, Pb, Zn, and Ni etc. study shows heavy metals adsorbed effectively in these bio adsorbent. use in In this study, an extensive list of plant wastes as adsorbents including rice husks, spent grain, sawdust, sugarcane bagasse, fruit wastes, weeds and others has been compiled. Since modification of adsorbent surface might change the properties of adsorbent, it is recommended that for any work on chemically modified plant wastes, characterization studies involving surface area, pore size, porosity, pH ZPC, etc. should be carried out. Spectroscopic analyses involving Fourier transform infrared (FTIR), energy dispersive spectroscopy (EDS), wastes. X-ray absorption near edge structure (XANES) spectroscopy and extended X-ray absorption fine structure (EXAFS) 0spectroscopy are also important in order to have a better understanding on the mechanism of metal adsorption on modified plant.

Meikap et al., 2005

Studied on the adsorption of chromium (VI) metals from aqueous solution by activated carbon, Terminalia arjuna nuts used to developed activated carbon, Terminalia arjuna nuts activated with zinc chloride. The most important parameter in chemical activation was found to be the chemical ratio (activating agent/precursor, g/g). Carbonization temperature and time are the other two important variables, which had the significant effect on the pore structure of the carbon. A high surface area of 1260 m^2/g was obtained at a chemical ratio of 300%, carbonization time and temperature of 1 h and 500 ^0C, respectively. Cr (VI) is easily adsorbed in the activated carbon, developed activated carbon from Terminalia arjuna is efficiently adsorbing Cr (VI) ions aqueous solution. The parameters studied include pH, adsorbent dosage, contact time, and initial concentrations. The kinetic data were best fitted to the Lagergren pseudo-first-order model. The isotherm equilibrium data were well fitted by the Langmuir and Freundlich models. The maximum removal of chromium was obtained at 99% for the adsorbent dose of 2 g/l and 10 mg/l initial concentration). The uptake of the Cr (VI) was greatly affected by the solution pH. The cost of removal is expected to be quite low, as the adsorbent is cheap and easily available in large quantities as compared and reported in the literature. This study demonstrated that $ZnCl_2$ is a suitable activating agent for the preparation of high porosity carbons from Terminalia arjuna nut. For the carbonization of the $ZnCl_2$ treated sample, $ZnCl_2$ plays an important role in retarding tar escape during carbonization.

Gupta and Sharma, (2002)

Analyzed on the removal of cadmium and zinc from aqueous solutions using red mud, Red mud, Red mud obtained from Hindustan Aluminum Company (HINDALCO) (Renukoot, India) an aluminum industry waste, material converted into an inexpensive and efficient adsorbent. Batch and column operations used in this experiment and product characterized in the batch experiment. Removal percentage of zinc and cadmium determine under column and batch operation procedure at various range of initial metal ion concentration like (1.78 $\times 10^{-5}$ to 1.78 $\times$ 10^{-3} M for Cd^{2+} and 3.06 ×10-5 to 3.06 ×10-3 M for Zn^{2+} contact time, 24 h) adsorbent dose (5×20 g/L), and pH (1.0×6.0).At low concentration, Cd^{2+} and Zn^{2+} metal ion completely removed from the aqueous solution, while it was 60-65% at higher concentrations at optimum pH's of 4.0 and 5.0, respectively, with 10 g/L of adsorbent in an 8-10 h equilibration time. A 1.0 g sample of activated red mud was stirred with de-ionized water (100 mL, pH 6.8) for 2 h and left for 24 h in an airtight, stopper, conical flask. An increase in pH to 7.5 was noticed. Activated red mud was found stable (did not dissolve, degrade, or change) in water, salt solutions, dilute acids, dilute bases, and organic solvents in the temperature range of 30-50 ^{0}C and pH range of 1.0-6.0.The adsorption was decreased with increase in temperature. The analyzed data used to describe the mechanism of adsorption, the research showed research chemical regeneration of the columns achieved with 1% HNO_3.

Rigola and Arotla (1992)

Investigated on selection of optimum biological sludge for zinc removal from wastewater by a bio sorption process by bio sorption of zinc by sludge microorganisms obtained from different steps of a conventional SWT plant has been studied. The best types of activated sludge for the process were found to be thickened, anaerobic and dewatered sludge giving up to 90-98 % of metal elimination when working at initial zinc concentration lower than 50 mg/l.In the first series of tests, pH was maintained at a fixed value (5 or 6) in order to determine the influence of this factor. Dewatered sludge was thermally dehydrated (at 105^{o}C for 24 hours).To determine the influence of sludge concentration on the equilibrium removal, the aerobic sludge concentration on the laboratory reactor was increased by a factor of four, from 0.38 to 1.50 g/l, when treating water with initial metal concentration under 50 mg/l. The effect of particle size, contact time, and surface loading of zinc and cadmium on the adsorbent for their removal have been studied at the optimum pH (6.0 for $Zn^{2+}$and 5.0 for $Cd^{2+)}$.Column operations were also performed in an attempt to simulate industrial conditions. The variation in the removal of Zn and Cd with pH can be explained by considering the surface charge of the adsorbent material, i.e., the slag. The uptake of metal ions is *75* to 90% at low concentrations and 28 to 55% at higher concentrations. This initial rapid adsorption subsequently gives way to a very slow approach to equilibrium, and saturation is reached in 6-8 hours. Vertical glass columns (dimension 40x 0.5 cm) packed with known amounts of slag (mesh size 200-250) was used for the removal of Zn^{2+} and Cd^{2+}. The column capacity of zinc slag (37.98mg.g-1) and cadmium-slag (33.0mg.g^{-1}) systems is found to be greater than the batch capacity (i.e., 17.66and 18.72mg.g-1 for zinc and cadmium, respectively). The removal of Zn^{2+} and Cd^{2+} was found to be almost 98%.

Edith Luef et al., (1991)

Studied on the removal of zinc by bio adsorption, Fungal mycelial used as Bio adsorbent materials. Many industrial fermentation plants like (Aspergillus niger, Penicillium chrysogenum, Clavicepspaspali) refuge waste mycelia and it's a very cheap material were used as a bio sorbent for zinc ions from aqueous environments, both batch wise as well as in a column mode. With all mycelia tested, bio sorption per biomass dry weight was a function of pH (increasing with increasing pH between 1.0 and 9.0), biomass concentration (decreasing at high biomass concentrations) and the zinc concentration. Appropriate incubation time 180 minute to bio sorption, maximum adsorption capacity in pH 4 at 15-30 temperature. Virtually all zinc could be desorbed from NaOH treated A. (Aspergillus) niger, whereas lower values were obtained with other mycelial preparations. The degree of bio sorption in these experiments was significantly higher than that established by NaOH treatment, the high pH of the samples, which is beneficial for bio sorption.

4. CONCLUSION

The study of review paper based on zinc removal and purification of waste water by bio sorbents zinc is toxic metal for human and our environment. At least 20 metals are classified as toxic and half of these are emitted into the environment in quantities that pose risks to human health. Industrial waste constitutes the major source of various kinds of metal pollution in natural waters. The need for technological innovation to enable integrated water management cannot be overstated. Providing clean and affordable water to meet human needs is a grand challenge of the 21st century. Worldwide, water supply struggles to keep up with the fast growing demand, which is exacerbated by population growth, global climate change, and water quality deterioration.

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