Research on Removal of Chromium From Wastewater By Using Different Types of Adsorbents

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Abstract- *Today heavy metal pollution has become one of the most serious environmental problems. The treatment of heavy metals is special concern due to their recalcitrance and persistence in the environment. It is highly toxic metal ions and act as a priority pollutant released from various chemical industries like electroplating mixing activities, smelting, battery manufacture and tanneries. Effluents have been excessively released in to the environment due to rapid industrialization. Organic wastes, chromium effluents are non biodegradable and they can be accumulated in living tissue causing various diseases and disorder. Therefore it must be removed before discharge(1)*

Keywords- Heavy metals, wastewater treatment, Low cost Adsorbents

I. INTRODUCTION

Environmental pollution was increased exponentially in the past few years and reached alarming levels in terms of its effects on living creatures. Toxic heavy metals are considered one of the pollutants that have direct effect on man and animals. Rapid growth in human population is one of the major causes of environmental pollution. Increased industrialization and urbanization throughout the world results in consistent release of toxic effluents, several industrial processes generate metal containing wastes.

Heavy metals are non-degradable metals. Several industrial wastewater streams may contain heavy metals such as Cr, Cu, Pb, Zn, Ni, etc., including the waste liquids generated by metal finishing or the mineral processing industries. Heavy metals are natural components of the Earth's crust. They cannot be degraded or destroyed. To a small extent they enter our bodies via food, drinking water. Heavy metals can enter a water supply by industrial and consumer waste, or even from acidic rain breaking down soils and releasing heavy metals into streams, lakes, rivers, and groundwater.

Heavy metals pollution can originate from natural and anthropogenic sources. Heavy metal pollution of surface and underground water sources results in considerable soil pollution. Heavy metals are dangerous because they tend to bioaccumulate. Bioaccumulation means an increase in the concentration of a chemical in a biological organism over time, compared to the chemical's concentration in the environment. These heavy metals are persistence, accumulate and not metabolized in other intermediate compounds and do not easily breakdown in the environment. These metals are accumulating in food chain through uptake at primary producer level and then through consumption at consumer level.

Major types of adsorbents are activated alumina, silica gel, activated carbon, molecular sieve carbon, molecular sieve, zeolites and polymeric adsorbents.most adsorbents are manufactured (such as activated carbons), but a few such as some zeolites occur naturally. Each material has its own characteristics such as porosity, pore structure and nature of its adsorbing surfaces.

II. METHODS OF REMOVAL

Following are the Methods to remove chromium from wastewater

1. Chemical precipitation
2. Ion-exchange
3. Adsorption
4. Membrane filtration
5. Coagulation–flocculation
6. Flotation and Electrochemical methods

Maha M. ElShafei et.al (2011) was found that low-cost adsorbents like peanut husk charcoal, fly ash and natural zeolite are effective for the removal of Cu^{2+} and Zn^{2+} ions from aqueous solutions. The batch method was employed parameters such as pH, contact time, adsorbent dose and metal concentration were studied at an ambient temperature 27 ± 2 °C. The optimum pH corresponding to the maximum adsorption of copper and zinc removal was 6–8. Copper and zinc ions were adsorbed onto the adsorbents very rapidly within the first 30 min while equilibrium was attained within 2–3 h for copper and zinc ions using different adsorbents. The Langmuir isotherm better fitted the experimental data since the correlation coefficient for the Langmuir isotherm was higher than that of the Freundlich isotherm for both metals.

Tonni Agustiono Kurniawan et.al (2003) was reviewed that technical feasibility of various low cost adsorbents for heavy metal removal from contaminated water. Instead of using commercial activated carbon inexpensive materials such as chitosan, zeolites and other adsorbents which have high adsorption capacity and are locally available. The results of their removal performance were compared to that of activated carbon and are presented in this study. Adsorbents that stand out for high adsorption capacities were chitosan (815, 273, 250 mg/g of Hg^{2+}, Cr^{6+}, and Cd^{2+}, respectively), zeolites (175 and 137 mg/g of Pb^{2+} and Cd^{2+}, respectively), waste slurry (1030, 560, 540 mg/g of Pb^{2+}, Hg^{2+}, and Cr^{6+}, respectively) and lignin (1865 mg/g of Pb^{2+}). These adsorbents were suitable for inorganic effluent treatment containing the metal ions mentioned. adsorption capacities of the adsorbents presented in this was vary depending on the characteristics of the individual adsorbent the extent of chemical modifications and the concentration of adsorbate.

Nadhem K. Hamadi et.al (2001) was investigated that batch removal of hexavalent chromium (Cr(VI)) from wastewater under different experimental conditions using economic adsorbents. These adsorbents were produced from the pyrolysis and activation of the waste tyres (TAC) and from the pyrolysis of sawdust (SPC). The performance of these adsorbents against commercial activated carbon F400 (CAC) had been carried out. The removal was favoured at low pH with maximum removal at pH=2 for all types of carbon. The effects of concentration, temperature and particle size have been reported. All sorbents were found to efficiently remove Cr(VI) from solution. batch sorption kinetics have been tested for a first-order reversible reaction a first-order and second-order reaction. The rate constants of adsorption for all these kinetic models had calculated. The applicability of the Langmuir isotherm for the present system has been tested at different temperatures.

David Kratochvil, Bohumil Volesky (1998) were observed that the biosorption of heavy metals by certain types of non-living biomass is a highly cost-effective new alternative for the decontamination of metal-containing effluents. the mechanisms of metal biosorption now allows the process to be scaled up and used in field applications with packed bed sorption columns being perhaps the most efficient for this purpose. Regenerating the biosorbents increases the process economy by allowing their reuse in multiple sorption cycles. The process results in metal-free effluents and small volumes of solutions containing concentrated metals which can be easily recovered.

Naiqin Zhao (2005) was found that the commercially available activated carbon was oxidized with different oxidizing agents such as HNO_3, H_2O_2 and $Fe(NO_3)_3$ and then followed by heat treatment at different temperatures in order to introduce more surface oxygen complexes. The effects of the oxidizing agent treatment on the surface chemical nature were characterized by ultimate Boehm titration and X-ray photoelectron spectrometer. The application of the chemically modified ACs in wastewater containing Cr (VI) was tested. Effects of surface oxygen groups of activated carbon on Cr (VI) adsorption were investigated. The results showed that the adsorption of Cr (VI) ion was more effective for the chemically treated ACs. The extent of adsorption and reduction of ACs to Cr (VI) depends on the adsorption time, pH value and the quality of activated carbon in the Cr (VI) solution.

Saad S. M. Hassan (2006) was examined Sorel's cement [$3Mg(OH)_2 \cdot MgCl_2 \cdot 8H_2O$],is used as a new adsorbent material for removal of chromium(VI) ion from wastewater effluents. Parameters including contact time, adsorbent dosage and pH are examined and optimized. The equilibrium data are fitted very well to the Langmuir and Freundlich isotherms rather than linear. The adsorption isotherm indicates that the monolayer coverage is 21.4 mg Cr(VI) ion per g of Sorel's cement. The adsorbent is considered as a better replacement technology for removal of Cr(VI) ion from aqueous solutions due to its low cost, good efficiency, fast kinetics and simple preparation. It offers remarkable efficiency for Cr(VI) removal from wastewater compared with many other natural and synthetic adsorbents.

Xitong Sun et.ai. (2016) was investigated that two novel strongly basic magnetic adsorbents, quaternary ammonium modified polystyrene and chitosan magnetic microspheres were prepared using the in situ co precipitation and emulsion cross-linking methods under mild conditions with features of strong magnetic responsiveness and high quaternary ammonium group contents. The Cr(VI) adsorption/desorption properties and mechanisms of strongly and weakly basic magnetic adsorbents were compared through simulated wastewater. The strongly basic adsorbent exhibited low pH dependence and the main adsorption mechanism was ion exchange. The weakly basic adsorbent exhibited high pH dependence and the major adsorption mechanism was electrostatic attraction. The strongly basic adsorbent required higher desorption conditions than the weakly basic adsorbent owing to the difference of the desorption mechanisms. The removal selectivity of the strongly and weakly basic magnetic adsorbents was estimated by the chromium plating wastewater. The results demonstrated that the strongly basic magnetic adsorbents exhibited higher selectivity than the weakly basic magnetic adsorbents. In addition the Pst–MIMCl was selected as the optimal magnetic adsorbent for

Cr(VI) recovery from wastewater with the advantages of strongly magnetic responsiveness wide pH applicable range, high removal efficiency, high adsorption selectivity and good reusability.

F. Ali (2015) was observed that adsorption is one of the effective techniques for heavy metals removal from wastewater. removal of cadmium ion from aqueous solutions was studied using mixture of low cost material silica gel and calcium carbonate at different mole ratio. Influence of contact time, pH, initial concentration of metal ion, dosage of solid, ratio of SiO:CaCO and particle size of adsorbent on removal percentage were investigated. Experiments were carried out at room temperature.The optimum parameters required for maximum adsorption determined Contact time=120 minutes, pH=9, initial concentration of Cd2+= 105 ppm, ratio of SiO:CaCO= 1:3 adsorbent dosage =10 gm/L.

Ali Akbar Babaei (2015) was found that spent tea-supported magnetite (ST/Mag) nanoparticles were synthesized as an adsorbent for the removal of hexavalent chromium [Cr(VI)] from saline wastewater. Prepared ST/Mag adsorbent was characterized using X-ray diffraction, scanning electron microscopy and fourier transform infrared spectroscopy. factors affecting the uptake behavior such as pH, contact time, initial concentration of metal ions, adsorbent dose, coexisting ions and desorption behavior were studied using batch tests. The results concluded that adsorption of Cr(VI) was highly pH dependent and the kinetics of the adsorption followed by the Avrami fractional order and pseudo-second-order kinetic models. The results showed that the adsorption isotherms were more accurately represented by Langmuir and Liu isotherm models with a sorption capacity of 30.0 mg g^{-1}. Adsorption experiments with co-ions indicated that the adsorptive removal of Cr(VI) ions was slightly decreased. Desorption studies using alkaline showed maximum recovery of ST/Mag and only 10% decrease occurring in maximum adsorption capacity after five cycles. The ST/Mag nanoparticles proved to be a very prospective adsorbent for Cr(VI) uptake from industrial high-TDS effluents.

Ai Phing Lim (2014) was investigated that heavy metals contamination in water has been an issue to the environment and human health. The persisting contamination level has been observed and concerned by the public due to continuous deterioration of water quality. conventional treatment system could not completely remove the toxic metals in the water thus alternative purification methods using inexpensive materials were endeavour to improve the current treatment process. Wide ranges of low cost adsorbents were used to remove heavy metal in aqueous solution and wastewater. The low cost adsorbents were usually collected from agricultural waste, seafood waste, food waste, industrial byproduct and soil. These adsorbents are readily available in a copious amount. the pretreatment are not complicated to be conducted on the raw products which is economically sound for an alternative treatment. The previous studies have provided much evidence of low cost adsorbents' efficiency in removing metal ions from aqueous solution or wastewater. In this review, several low cost adsorbents in the recent literature have been studied. The maximum adsorption capacity, affecting factors such as pH, contact times, temperature, initial concentration and modified materials were revised and summarized in this review for further reference.

Hexavalent chromium and COD removal from electroplating wastewater was investigated using a low cost Corncob based activated carbon (CAC). The particle size of CAC was in the range of 450-850 µm. Proximate and ultimate analysis of CAC showed the presence of high carbon content. BET surface area and pore volume were found 399.006 m^2 /g and 0.23 cm^3 /g respectively. The effect of various parameters such as temperature (T), adsorbent dose (w), pH and contact time (t) on adsorption of chromium ions by CAC were investigated. The optimum pH=3 was found for the removal of Cr (VI) and COD for optimum dose of CAC (15 Kg/m^3). Freundlich model well fitted to Cr (VI) adsorption while Redlich Peterson is found fit for COD removal. Pseudo-second order kinetic model was well fitted for both Cr (VI) and COD removal.

S. Kumar (2013) was investigated that industrial effluents containing heavy metals had become a major problem. For the removal of heavy metals several types of adsorbents have been developed economically from waste materials by different processes. green coconut shell which was waste material chosen for the development of adsorbent by treatment with orthophosphoric acid economically. This adsorbent was used for the removal of chromium(VI) in batch mode in concentration and temperature range of 10–100 mg/g and 10–80°C. The influence of contact time, temperature, concentration, adsorbent dose, particle size and pH was studied. Langmuir and Freundlich isotherm models were fitted for equilibrium data with maximum adsorption capacity of 22.96 mg/g. Pseudo-second-order model confirmed that the chromium(VI) uptake capacity of adsorbent was due to pore, film and particle diffusion. properties of adsorbent different analysis such as XRF, X-ray diffraction, scanning electron microscope, energy dispersive spectroscope, and particle size distribution using Malvern analyzer were studied. The adsorption capacity of green coconut shell based adsorbent achieved was greater than 90% for 10 mg/l solution.

III. CONCLUSION

1. Use of bio adsorbent prepared from coffee powder cost effective and efficient.
2. The kinetic studies found that Cr(VI) adsorption on coffee polyphenol-formaldehyde/acetaldehyde resins is very fast.
3. Percentage removal of Cr(VI) increases and adsorption capacity decreases with the increase in adsorbent amount because of the availability of more adsorption sites. coffee polyphenol-formaldehyde/acetaldehyde resins which provide a convenient and low-cost adsorbent for heavy metal removal.
4. Heavy metal ion Cr(VI) removal technique using such biomaterials would be an effective method for economic treatment of wastewater.
5. Lime is a good precipitating agent for removal and recovery of chromium from tanning wastewater.
6. Bioremoval of Cr(VI) using actinomycetes is a suitable mean for reducing the tannery wastewater toxicity. The combination between the chemical precipitation and the biological removal of chromium from tanning wastewater make it meet the environment safely.

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