Adsorption of Copper Ions in Aqueous Media using Tea Waste and Sawdust as an Adsorbent

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Abstract

The Tea Waste and sawdust is a widely useful adsorbent for heavy metals. The aim of this work was optimization of usage of Tea Waste and sawdust as heavy metal adsorbent. It was exanimated influence of Tea Waste and sawdust quantity on adsorption capacity and efficiency adsorption processes. Activated carbon are used as a good adsorbent but its cost is very high so we used Tea waste and sawdust as a low cost adsorbent. For better adsorption efficiency it was recommended to apply larger amounts of sawdust, if it is not cause problems with delaying of used adsorbents. Smaller amounts of adsorbent were better utilized in two or three stage adsorption processes. Tea Waste collected in tea stall and restaurants its Insoluble cell wall of tea leaves are made up of cellulose and hemicelluloses, lignin, condensed tannins and structural protein. The result shows maximum removal efficiency of copper ion by tea waste is higher than sawdust adsorbent. Thus experiment result showed that maximum removal of Cu2+ ion by tea waste and sawdust is 90% and 88%.

Keywords: Tea Waste, Sawdust, Heavy Metals, Adsorption, Copper Ions, Activated Carrbon

I. INTRODUCTION

The term "heavy metals" used in 1817, when Gmelin divided the elements into nonmetals, light metals and heavy metals. Lighter metals had densities of 0.860 to 5.0 gm/cm^3; heavy metals 5.308 to 22.000. In 1868, Wanklyn and Chapman speculated on the adverse effects of the heavy metals "Ar, Pb, Cu, Zn, Fe and Mg" in drinking water. They noted an "absence of investigation" and were reduced to "the necessity of pleading for the collection of data"[1]. Many Heavy metal Feed from industries such as metal purification, metal finishing, chemical manufacturing, mining operations, smelting, battery manufacturing, and electroplating. As a result of industrial activities and technological development, the amount of heavy metal ions discharged into streams and rivers by industrial and municipal wastewater have been increasing incessantly (Serencam et al., 2007). Heavy metals are member of a loosely-defined subset of elements that exhibit metallic properties, which mainly includes the transition metals, some metalloids, lanthanides, and actinides[2].

Serval heavy metals such as copper Cu, Pb, Cr and Mg are inhale by humans for normal biological functioning. However, heavy metals such as Pb, Cr are toxic to organisms. Most of the health disorders are linked with specific tendency of heavy metals to bioaccumulation in living tissues and their disruptive integration into normal biochemical processes[3]. Increased use of metals and chemicals in process industries has resulted in generation of large quantities of effluent that contains high level of toxic heavy metals and their presence poses environmental-disposal problems due to their non-degradable and persistence nature[4].

Adsorption techniques for wastewater treatment have become popular in recent years due to their efficiency in the removal of pollutants that are too stable to be removed by biological methods. Adsorption is a process that occurs when a gas or liquid solute adheres to a surface (adsorbent), forming a molecular or atomic film (adsorbate)[5]. This process differs from absorption, in which a substance diffuses into a liquid or solid to form a solution. Adsorption occurs naturally, but industrialists have perfected adsorption methods to clean up hazardous waste in wastewater or purify drinking water.

Adsorption has been found to be superior to other techniques for water re-use in terms of initial cost, flexibility and simplicity of design, ease of operation and insensitivity to toxic pollutants.Just like surface tension, adsorption is resulted from surface energy. Atoms on the surface of adsorbent are not wholly surrounded by other adsorbent atoms. Hence, they can attract adsorbates[6].

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II. MATERIAL AND METHODS

A. Preparation of the Tea Waste Adsorbent

Tea waste collected from Gwalior railway station and washed with boiled water until the water was colourless.This process is repeated 15 washing cycle however washing cycle can be reduced by washing with NaOH solution and then it is dried in tray dryer at 108^0c for 12h.This dried material converted into powder and screened to size 100µm.Again this powder dried at 108^0c for 5 hours and Then dried tea waste was chemically activated with 1.0M sulphuric acid and stored in sealed polythene bags. Now adsorbent is ready to use[7].

Fig. 2.1: Tea Waste Collected From Tea Stalls

B. Preparation of the Sawdust adsorbent

Raw saw dust of locally known as Neem Tree was obtained from nearby M.I.T.S Gwalior Campus. It was then screened to get particles of five different sizes i.e. (+ 70), (- 70 + 50), (- 50+30), (- 30 + 10) & (- 10) ISS mesh. The above fractions of saw dust were washed with sufficient quantity of RO distilled water until it gave a clear transparent solution. Only then the prepared solutions were passed through them[8].

Fig. 2.2: Pictorial View of Sieve Shaker Experiment

C. Preparation of synthetic wastewater

Synthetic Waste Water was made by dissolving analytical grade $CuSo_4.5H_2o$ in distilled water so that copper concentration of this solution was 1000mg/l.

1) Instrument and Apparatus used

In the whole experiment some glassware (Conical flasks, Pipette, Measuring cylinders, Beakers, burette and Test tubes etc.) are used of borosil. The instrument and apparatus are used in the experiment is listed below:

Table – 2.1

List of instrument and apparatus used in the experiment works:

S.No.	*Instrument*	*Make*
1.	*pH meter*	*Systronics(pH system 361)*
2.	*Magnetic Stirrer*	*Jyoti Scientific Industries Gwalior*
3.	*Digital Weight Balance*	*K.Roy Instruments Pvt. Ltd.*
4.	*What man filter paper no.1*	-
5.	*UV-Visible Spectrophotometer*	*Shimadzu (Model UV-1700)*

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D. Analysis of Adsorbate

Ultraviolet–visible spectroscopy or ultraviolet-visible spectrophotometry (UV-Vis or UV/Vis) refers to absorption spectroscopy or reflectance spectroscopy in the ultraviolet-visible spectral region. This means it uses light in the visible and adjacent (near-UV and near-infrared [NIR]) ranges. The absorption or reflectance in the visible range directly affects the perceived color of the chemicals involved. In this region of the electromagnetic spectrum, molecules undergo electronic transitions. This technique is complementary to fluorescence spectroscopy, in that fluorescence deals with transitions from the excited state to the ground state, while absorption measures transitions from the ground state to the excited state[8].

A beam of light from a visible and/or UV light source (colored red) is separated into its component wavelengths by a prism or diffraction grating. Each monochromatic (single wavelength) beam in turn is split into two equal intensity beams by a half-mirrored device. One beam, the sample beam (colored magenta), passes through a small transparent container (cuvette) containing a solution of the compound being studied in a transparent solvent. The other beam, the reference (colored blue), passes through an identical cuvette containing only the solvent. The intensities of these light beams are then measured by electronic detectors and compared. The intensity of the reference beam, which should have suffered little or no light absorption, is defined as I_0. The intensity of the sample beam is defined as I. Over a short period of time, the spectrometer automatically scans all the component wavelengths in the manner described. The ultraviolet (UV) region scanned is normally from 200 to 400 nm, and the visible portion is from 400 to 800 nm[9].

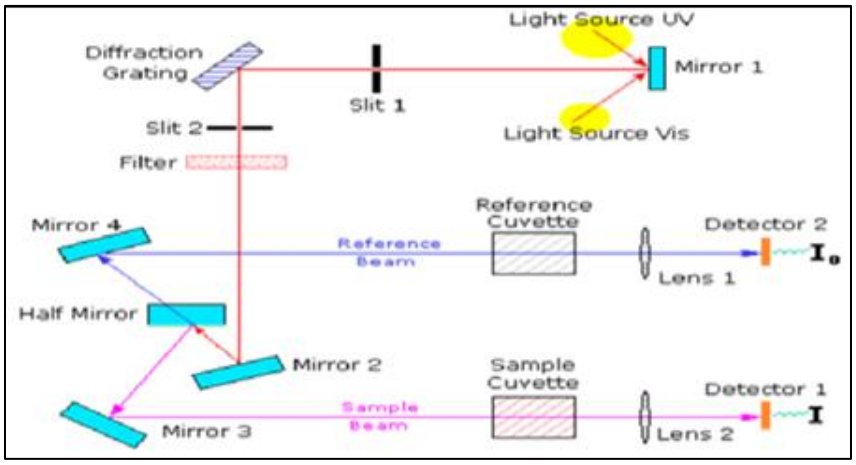

Fig. 2.3: Schematic diagram of Spectrophotometer

Thus residual concentration of copper ions was determined spectrophotometrically at 312nm.

Fig. 2.4: UV-Visible Spectrophotometerically

III. RESULT AND DISCUSSION

The percentage of removal efficiency of copper ions can be determined

Metal ion removal (%) = $[(C_0 – C_e)/C_0] *100$

Where C_0 is the initial metal ion concentration of test solution, mg/l and C_e is the final equilibrium concentration of test solution, mg/l.

In this experiment following factor effecting adsorbent is

- Effect of contact time
- Effect of pH
- Effect of adsorbent dose

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A. Effect of Contact Time

The pictorial figure 3.1 shows the variation in the percentage removal of heavy metal with contact time using 0.5g of tea waste adsorbent at 5 pH for varying concentration 10ppm to 30ppm. The percentage removal of copper is increases from 30 to 120 min and sharply decreases from 120 to 180 min. It is observed that for Cu^{2+} the percentage removal is nearly 90% throughout the 120 min. contact times. while as The pictorial figure 3.2 shows the variation in the percentage removal of heavy metal with contact time using 0.6g of Sawdust adsorbent at 6 pH for varying concentration 10ppm to 30ppm. The percentage removal of copper is increases from 30 to 50 min and sharply decreases from 50 to 160 min. It is observed that for Cu^{2+} the percentage removal by sawdust adsorbent is nearly 88% throughout the 40 min. contact times

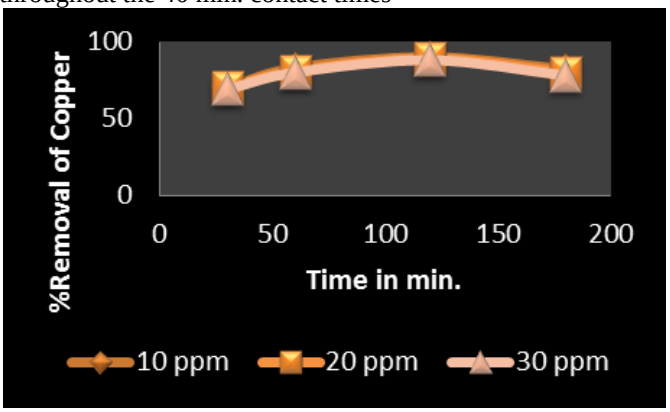

Fig. 3.1: Effect of contact time of %removal of copper ion by tea waste adsorbent.

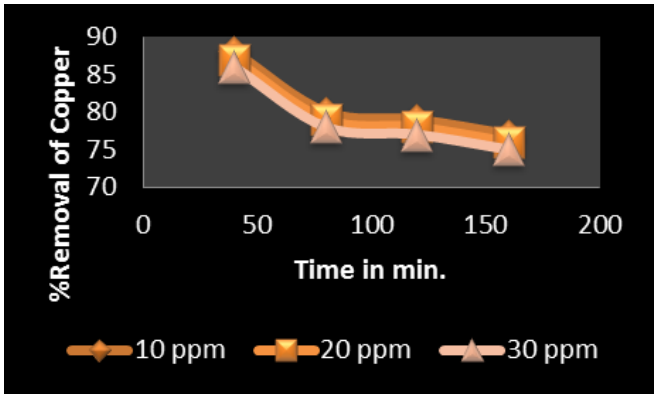

Fig. 3.2: Effect of contact time of %removal of copper ion by sawdust adsorbent.

B. Effect of pH

The pictorial figure 3.3 shows the variation in the percentage removal of heavy metal with 5pH using 0.5g of tea waste adsorbent at 120min for varying concentration 10ppm to 30ppm.The % removal of copper is increases 2 to 6 pH and sharply decreases from 6 to 7 pH.It is observed that for Cu^{2+} the percentage removal is nearly 90% at 5.0 pH.While as The pictorial figure 3.4 shows the variation in the percentage removal of heavy metal with 6pH using 0.6g of Sawdust adsorbent at 40min for varying concentration 10ppm to 30ppm.The % removal of copper is increases 2 to 6 pH and sharply decreases from 6 to 7 pH.It is observed that for Cu^{2+} the percentage removal by Sawdust adsorbent is nearly 88% at 6.0 pH.

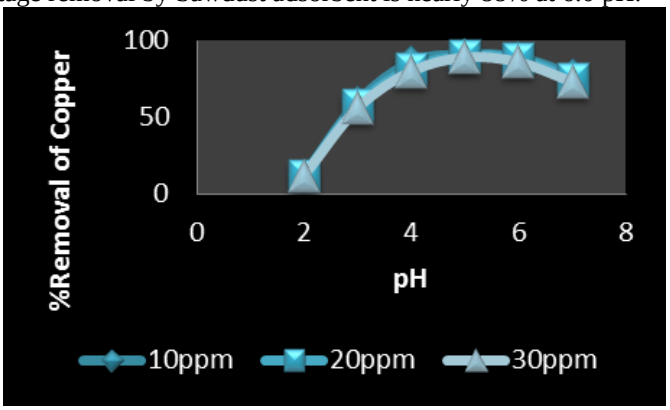

Fig. 3.3: Effect of pH on %removal of copper ion by tea waste adsorbent.

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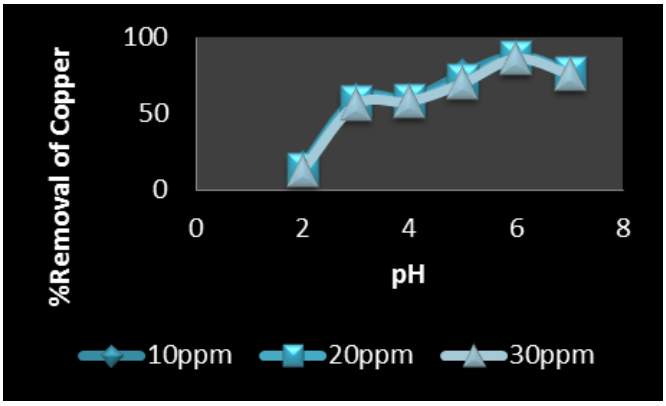

Fig. 3.4: Effect of pH on %removal of copper ion by Sawdust adsorbent.

C. Effect of Dose:

The pictorial figure 3.5 shows the variation in the percentage removal of heavy metal with adsorbent dosage using 120min contact time at 5 pH for varying concentration 10ppm to 30ppm.the % removal of copper ions is increases from (0.2 to 0.8) gram and decreases from (0.8 to 1.0) gram. It is observed that for Cu^{2+} the percentage removal by tea waste is nearly 89% at 0.6 gram adsorbent dose. While as The pictorial figure 3.6 shows the variation in the percentage removal of heavy metal with adsorbent dosage using 40min contact time at 6 pH for varying concentration 10ppm to 30ppm.the % removal of copper ions is increases from (0.2 to 0.8) gram and decreases from (0.8 to 1.0) gram. It is observed that for Cu^{2+} the percentage removal by sawdust is nearly 87% at 0.6 gram adsorbent dose.

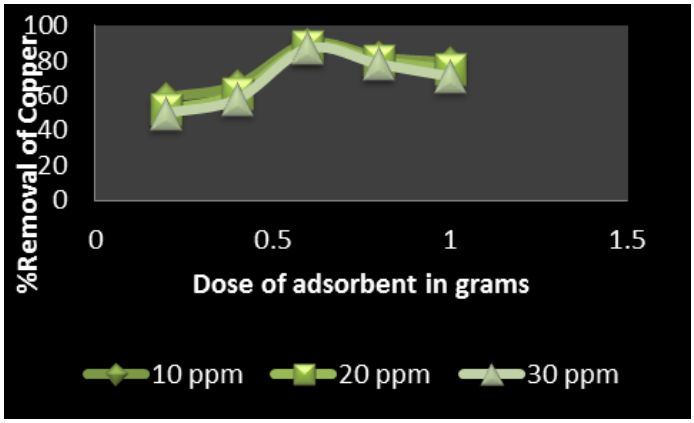

Fig. 3.5: Effect of Dose on %removal of copper ion by tea waste adsorbent.

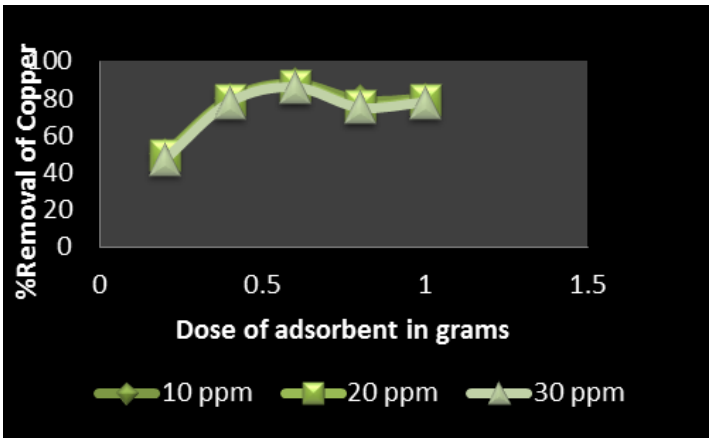

Fig. 3.6: Effect of Dose on %removal of copper ion by Sawdust adsorbent.

IV. CONCLUSION

Experiment results showed that maximum removal of copper ion by tea waste and Sawdust adsorbent is 90% and 88%.

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