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Tea Waste Adsorbent for the Removal of Chromium and Copper from Synthetic Wastewater

Hanit Kumar Thapak
Department of Chemical Engineering
Madhav Institute of Technology and Science, Gwalior

Sumint Singh Trivedia
Department of Chemical Engineering
Madhav Institute of Technology and Science, Gwalior

Laxmi Kant Pandey
Department of Chemical Engineering
Madhav Institute of Technology and Science, Gwalior

Abstract

There are numerous heavy metals present in Industrial waste water. These heavy metals like (Chromium and Copper) are toxic and harmful for human being especially chromium heavy metal spread pulmonary fibrosis diseases which is harmful for human being. There are many methods to remove and recover the metals from our environment and many physicochemical methods have been proposed for their removal from wastewater. Adsorption is one of the alternatives for such cases and is an effective purification and separation technique used in industry especially in water and wastewater treatments. Cost is an important parameter for comparing the adsorbent materials. Therefore, there is increasing research interest in using alternative low-cost adsorbents. To removing this heavy metal activated charcoal as a good adsorbent but it is very costly. The investigation has found the removal efficiency of tea waste as a low cost adsorbent is fruitful to neutralized heavy metal like (Copper and Chromium).The experiment result showed that maximum removal of Copper and Chromium ion by tea waste is 90% and 92%.
Keywords: Tea waste, Heavy Metal, Copper, Chromium, Adsorption, Synthetic Wastewaters

I. INTRODUCTION

A. Heavy Metal

A heavy metal is any metal or metalloid of environmental concern. The term originated with reference to the harmful effects of cadmium, mercury and lead, all of which are denser than iron. It has since been applied to any other similarly toxic metal, or metalloid such as arsenic, regardless of density. Commonly encountered heavy metals are chromium, copper, cobalt, nickel, copper, zinc, arsenic, selenium, silver, cadmium, antimony, mercury, thallium and lead. More specific definitions of a heavy metal have been proposed none have obtained widespread acceptance[1].

B. Chromium

Chromium (III) compounds and chromium metal are not considered a health hazard, while the toxicity and carcinogenic properties of chromium (VI) have been known since at least the late 19th century. In 1890, Newman described the elevated cancer risk of workers in a chromate dye company[2]. Chromate-induced dermatitis was reported in aircraft workers during World War II. In 1963, an outbreak of dermatitis, ranging from erythema to exudative eczema, occurred amongst 60 automobile factory workers in England. The workers had been wet-sanding chromate-based primer paint that had been applied to car bodies. In Australia, chromium was released from the NewcastleOrica explosives plant on August 8, 2011. Up to 20 workers at the plant were exposed as were 70 nearby homes in Stockton. The town was only notified three days after the release and the accident sparked a major public controversy, with Orica criticized for playing down the extent and possible risks of the leak, and the state Government attacked for their slow response to the incident[3].

Fig 1.1 Potassium chromate, a carcinogen, is used in the dyeing of fabrics, and as a tanning agent to produce leather.

C. Copper
Copper toxicity is a condition in which copper is retained and begins to build up in the body tissues. Dr. Carl Pfeiffer and other pioneering practitioners first warned of this problem in the 1970's[4]. The circulation and proper utilization of copper in the body requires good functioning of the liver, gall bladder and adrenal glands. If any of those organs are impaired, the body cannot properly excrete and utilize copper. Initially, the copper will build up in the liver, further impairing its ability to excrete copper. As copper retention increases, it will build up in the brain, the joints and the lungs, adversely affecting the structure and function of the tissues[5]. Copper is a powerful oxidant causing inflammation and free radical damage to the tissues. To avoid these toxic effects, it must be bound to the binding proteins, ceruloplasmin and metallothionine. These proteins can become deficient due to impaired adrenal and liver function which allows free copper to build up. It can have a toxic effect (similar to other heavy metals) on the body and mind and it is a contributor to many chronic illnesses and mental disturbances[6].

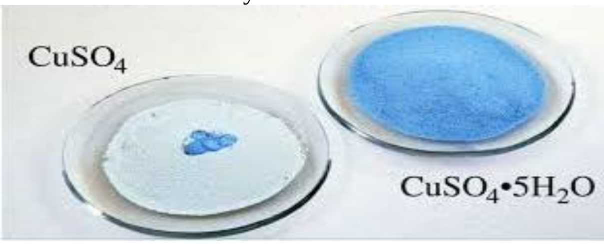

Fig 1.2: CuSo4.5H20 chemical for synthesis wastewater.

II. MATERIAL AND METHODS

A. Preparation of the 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 try 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. 1.3: Pictorial View of Non-activated tea waste

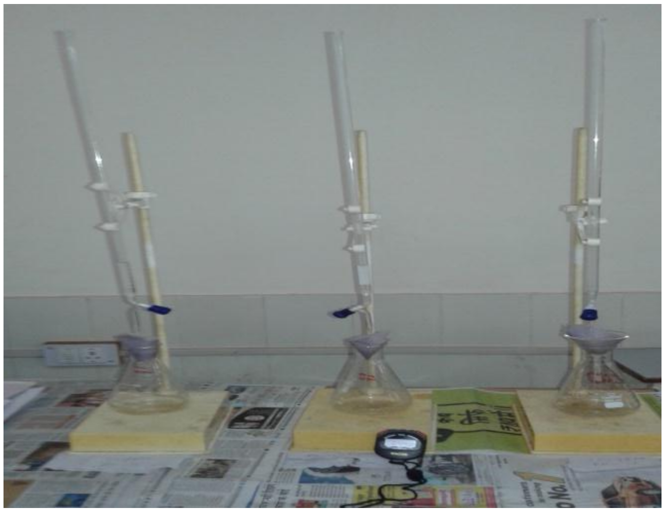

Fig. 1.4: Pictorial View of Eperimental work of project

B. 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[8].

III. *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 [9]. The instrument and apparatus are used in the experiment is listed below:

Table - 3
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)

C. Analysis of Adsorbate
The residual concentration of Copper and Chromium was determined spectrophotometrically at 312nm and 540nm.

IV. 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

A. Effect of Contact Time
The pictorial figure 1.5 shows the variation in the percentage removal of heavy metal with contact time using 0.6g of tea waste adsorbent at 7 pH for varying concentration 10ppm to 30ppm. The percentage removal of Chromium is decreases from 30 to 50 min and sharply decreases from 50 to 180 min. It is observed that for Chromium the percentage removal is nearly 94% throughout the 40 min. contact times. While as The pictorial figure 1.6 shows the variation in the percentage removal of heavy metal with contact time using 0.6g of tea waste adsorbent at 4.5 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 91% throughout the 120 min. contact times.

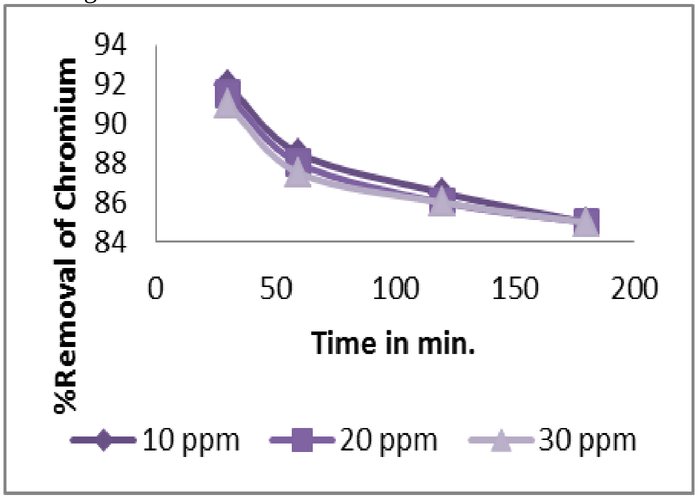

Fig. 1.5: Effect of contact time of %removal of chromium ion by tea waste adsorbent.

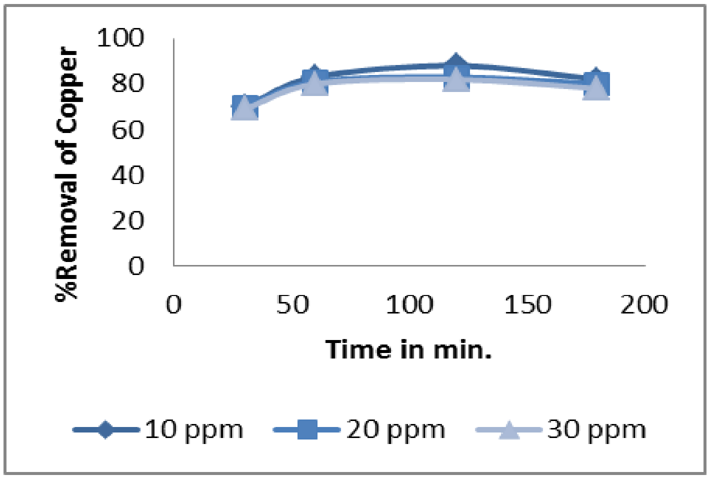

Fig. 1.6: Effect of contact time of %removal of copper ion by tea waste adsorbent.

B. Effect of pH

The pictorial figure 1.7 shows the variation in the percentage removal of heavy metal with pH using 0.6g of tea waste adsorbent at 40min for varying concentration 10ppm to 30ppm.The % removal of chromium is increases 2 to 3 pH apart from that decreases 3 to 4 pH and sharply increases from 4 to 7 pH.It is observed that for Cr (VI) the percentage removal is nearly 94% at 7 pH.While as The pictorial figure 1.8 shows the variation in the percentage removal of heavy metal with pH using 0.6g 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 91% at 4.5 pH.

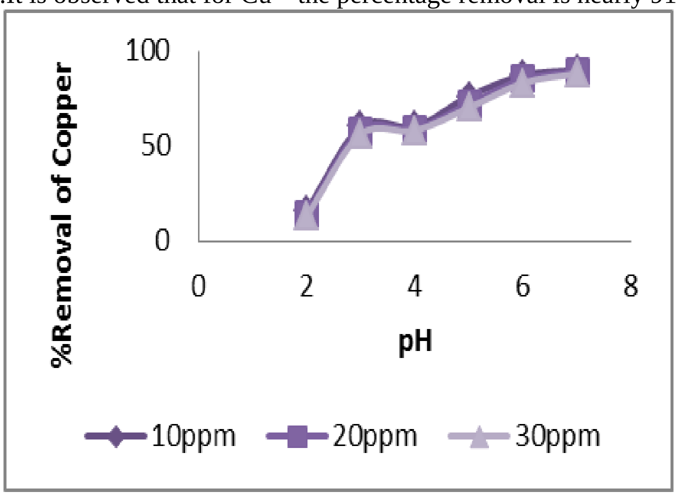

Fig. 1.7: Effect of pH on %removal of chromium ion by tea waste adsorbent.

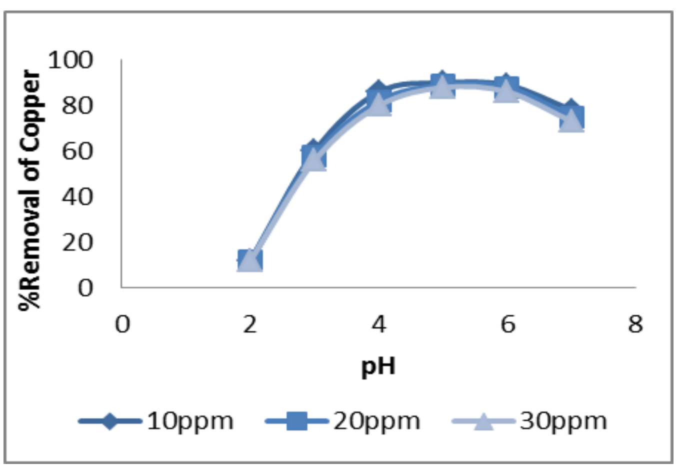

Fig. 1.8: Effect of pH on %removal of copper ion by tea waste adsorbent.

C. Effect of Adsorbent Dose

The pictorial figure 1.9 shows the variation in the percentage removal of heavy metal with adsorbent dosage using 40min contact time at 5 pH for varying concentration 10ppm to 30ppm.the % removal of chromium ions is increases from (0.2 to 0.6) gram and decreases from (0.6 to 1.0) gram. It is observed that for Cr (VI) the percentage removal is nearly 94% at 0.6 gram adsorbent dose. While as % removal efficiency of copper ions is 91% at 0.6 gram.

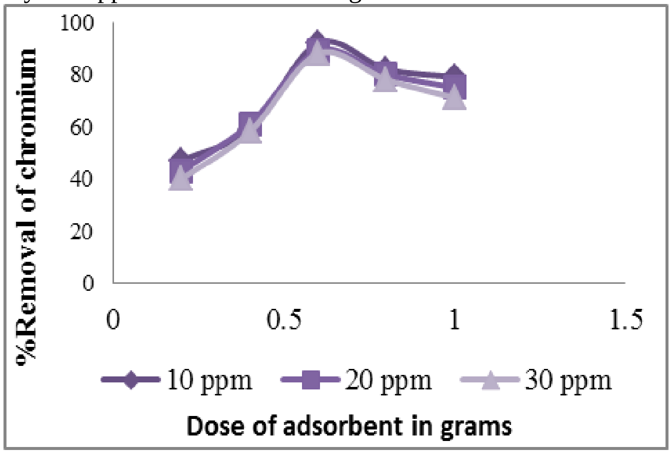

Fig. 1.9: Effect of pH on % removal of Chromium ion by tea waste adsorbent.

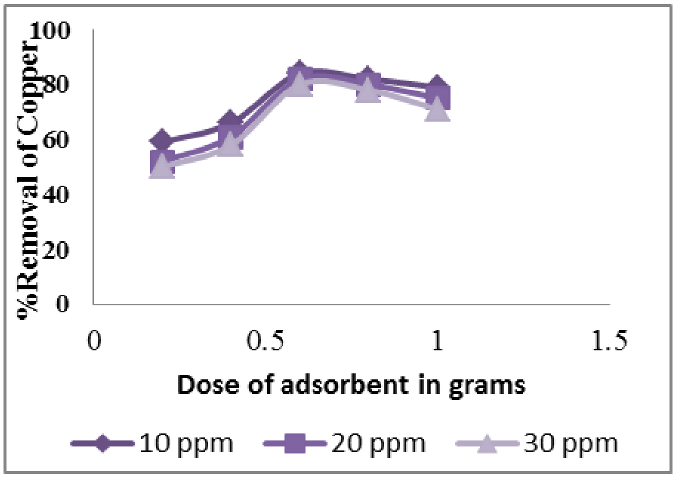

Fig. 2.0: Effect of pH on %removal of copper ion by tea waste adsorbent.

V. CONCLUSION

Experiment results 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%.

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