



## **OPTIMAL CHEMICAL DOSING RATES FOR HEAVY METALS REMOVAL FROM LEATHER WASTE WATER EFFLUENT**

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### **ABSTRACT**

Increasing cost of chemicals used in wastewater treatment has necessitated this study with a view to seek ways to increase efficiency and reduce cost of leather waste water treatment operation. Sampling of leather raw waste water was taken twice a week for laboratory test. The result of the Jar test experiment revealed that optimizing pH coagulant and flocculants doses metal removal from leather waste water can be accomplished. The test showed that pH value of 10 is the best optimum value for metals removal in the leather waste water. Further the results revealed that the metal removal in the waste water treatment plant requires applying the correct chemical dosage, adequate mixing, maintaining suitable pH value and controlling suspended solids in the effluent.

**Keywords:** metal removal, leather waste water, optimizing pH

### **INTRODUCTION**

Leather waste water containing heavy metals is of great concern due to its content of toxic metals such as copper (Cu), cadmium (Cd), nickel (Ni) and lead (Pb). These metals degrade the water quality and endanger aquatic life, human health (Armah et al. 2010; Kansal et al.2012) and cause treatment plant to malfunction and make sludge disposal more difficult (Ntengwe 2006). Leather waste water contains poisonous chemicals which may become dangerous to the waste water treatment process. Heavy metals are among the most toxic pollutants present in leather waste water (Zorer et al 2008). These heavy metals are of particular concern in surface water quality as a result of their environmental persistent, biogeochemical recycling and biological risks (Armah et al 2010). Elevated levels of heavy metal concentrations in surface water are ubiquitous as a result of a wide range of human activities as well as natural geochemical processes which contaminate the surface environment (Lu et al. 2010). Disposal of sewage to the surface water become a necessity as soon as industries are established, the outcome is a deterioration of standard of many rivers and their water become useless for either domestic consumption or industrial uses (Satheeshkumar and Khan 2011). Depending on the type and amount of effluent being generated from different type of industries, it could be concluded that, areas that find its location close to industries are heavily polluted with industrial effluents and produce greater negative effects on the environment.

The cost of complying with pollution control legislation and the increasing cost of chemicals used in waste water treatment have driven electroplaters to seek ways to reduce cost of their operation. One of the factors of electroplating waste water is the volume of chemicals used in the treatment of leather waste water. This study was carried out with the view to optimize the chemical dosing rates for metals precipitation in leather wastewater.

## RESEARCH METHODOLOGY

Sampling of leather raw waste water was taken twice a week for laboratory test from August 2013 to November 2013, preservation of samples and chemical analyses of waste water were carried out following the standard methods for physical and chemical analysis (APHA, 1998). In order to provide greater data confidence from the analytical procedure regarding bias and variability appropriate quality-assurance and quality-control (QA/QC) on raw water samples were ensured. The QA/QC were followed to ensure that data products are of documented high quality and reproducible. The overall data quality was assessed through precision, accuracy and comparability

The determination of optimal pH for precipitation of copper ( $\text{Cu}^{2+}$ ) and silver ( $\text{Ag}^+$ ) were determined as follows: Sodium hydroxide (NaOH) used for this experiment was approximately 250 ml of waste water effluent, while the copper holding tank was placed into each of 6 beakers. The pH of each beaker was adjusted to 6, 7, 8, 9, 10 and 11 using sodium hydroxide (NaOH). After 20 minutes of settling, the copper ( $\text{Cu}^{2+}$ ) and silver ( $\text{Ag}^+$ ) content in the beakers were determined and the graph of  $\text{Cu}^{2+}$  and  $\text{Ag}^+$  were obtained.

For the determination of ferric chloride ( $\text{FeCl}_3$ ) dosage for the coagulation, a standard ferric chloride solution of pre-treated effluent was placed into each of 6 beakers. The first beaker was dose with 0.5 ml of the  $\text{FeCl}_3$  stocked solution and 0.5 ml increments of  $\text{FeCl}_3$  doses were placed into each of the other beakers. The mixture was stirred rapidly at 100 rpm for 3 minutes of moderate mixing at 30 rpm and 7 minutes of slow mixing at 2 rpm. The flocs were allowed to settle followed by chemical oxygen demand (COD) determination in each of the beakers.

For the determination of flocculants dosing, a standard polyelectrolyte solution of 1 ml was prepared for this experiment, and approximately 200 ml of pre-treated effluent was placed in each of the 6 beakers, and each was dose with optimal  $\text{FeCl}_3$  dosage for coagulation and rapidly mixed at 100 rpm for 3 minutes. The 1<sup>st</sup> beaker was dose with 0.5 ml of polyelectrolyte followed by 1.0, 1.5, 2.0, 2.5 and 3.0 ml in each of the remaining 5 beakers respectively and the mixture was stirred moderately at 30 rpm for 10 minutes followed by slow mixing at 2 rpm for 7 minutes. The flocs were allowed to settle for 45 minutes followed by turbidity measurement in each of the beakers.

## RESULTS AND DISCUSSION

Tables 1a, b and c and Figures 1a, b and c showed  $\text{Cu}^{2+}$  and  $\text{Ag}^+$  total metal removal efficiency at various pH levels. The results revealed that, the minimum concentration for  $\text{Cu}^{2+}$  and  $\text{Ag}^+$  were less than 0.01mg/L and 0.07 mg/L at pH 9 in trial 1 and 0.05 and 0.01 for  $\text{Cu}^{2+}$  and  $\text{Ag}^+$  at pH10 and 6 for trial 2 respectively. Trial 3 showed that the minimum concentration for metal removal using  $\text{Cu}^{2+}$  and  $\text{Ag}^+$  occurred at pH level 10 and pH 8, 10 and 11.

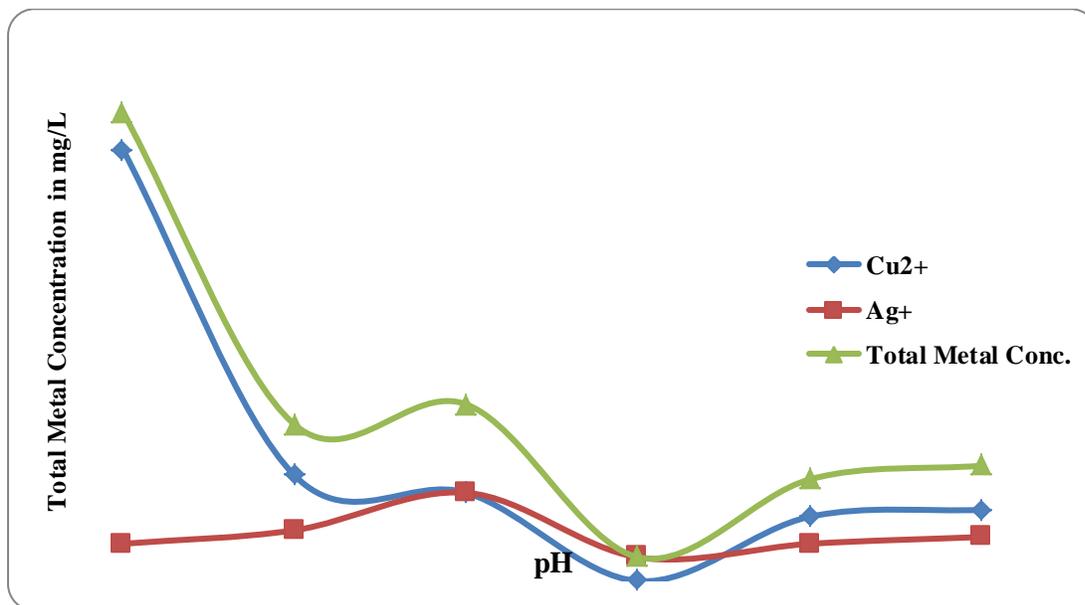


Fig.1a Determination of the optimal pH for precipitation of Cu<sup>2+</sup> and Ag<sup>+</sup> in leather raw wastewater (1<sup>st</sup> trial)

**Table 1. Determination of optimal pH for precipitation of Cu<sup>2+</sup> and Ag<sup>+</sup> in trial 1**

No	pH	Cu <sup>2+</sup>	Ag <sup>+</sup>	Total Metal Conc.
1	6.103	1.27	0.11	1.38
2	7.201	0.31	0.15	0.46
3	8.184	0.26	0.26	0.52
4	9.074	0.00	0.07	0.07
5	10.002	0.19	0.11	0.30
6	10.995	0.21	0.13	0.34

**Table 1b Determination of optimal pH for precipitation of Cu<sup>2+</sup> and Ag<sup>+</sup> in trial 2**

No	pH	Cu <sup>2+</sup>	Ag <sup>+</sup>	Total Metal Conc.
1	6.206	1.37	0.01	1.38
2	7.026	0.49	0.02	0.51
3	7.981	0.38	0.03	0.41
4	9.067	0.17	0.16	0.33
5	9.789	0.12	0.21	0.33
6	10.016	0.05	0.25	0.30
7	11.266	0.11	0.20	0.31
8	11.770	0.13	0.20	0.33

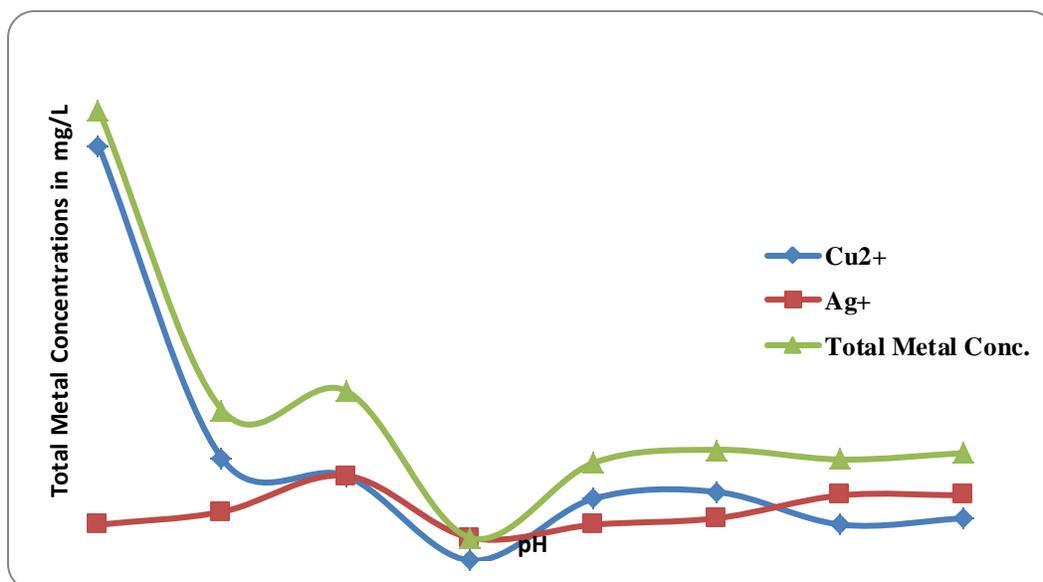


Fig.1b Determination of the optimal pH for precipitation of Cu<sup>2+</sup> and Ag<sup>+</sup> in leather raw wastewater (2<sup>st</sup> trial)

Table 1c Determination of optimal pH for precipitation of Cu<sup>2+</sup> and Ag<sup>+</sup> in trial 3

	pH	Cu <sup>2+</sup>	Ag <sup>+</sup>	Total Metal Conc.
1	6.124	2.27	0.11	2.38
2	6.969	0.74	0.11	0.85
3	8.219	0.38	0.08	0.46
4	9.017	0.36	0.13	0.49
5	10.002	0.29	0.08	0.37
6	11.04	0.52	0.08	0.60

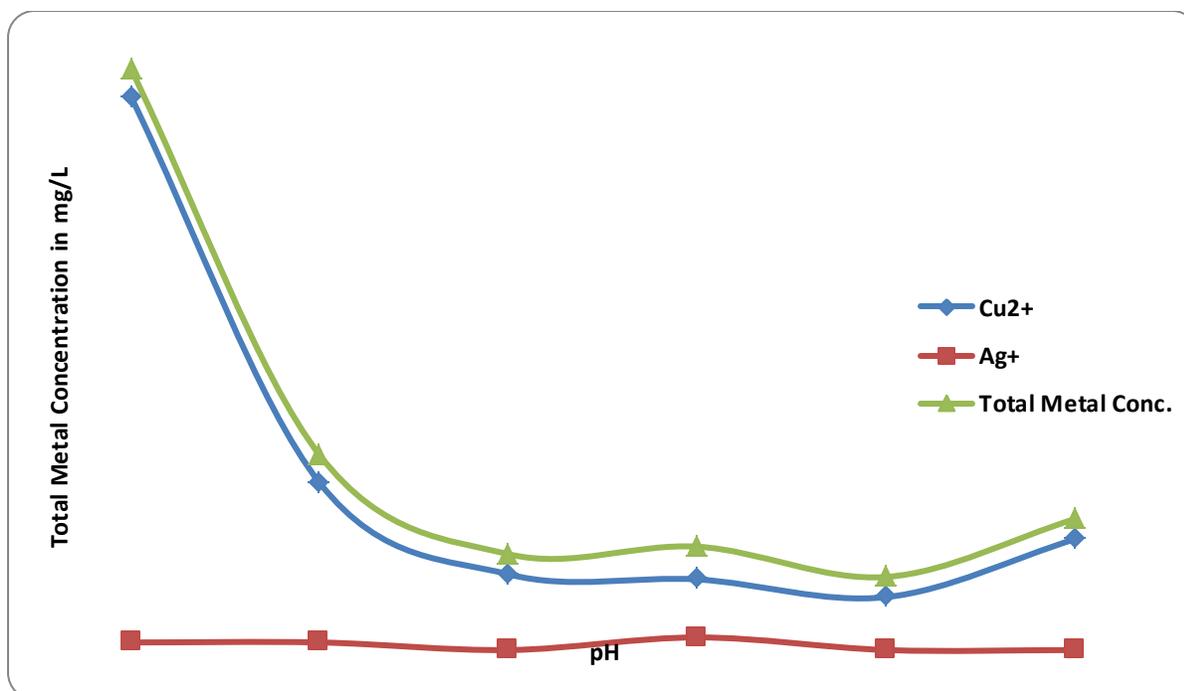


Fig.1c Determination of the optimal pH for precipitation of Cu<sup>2+</sup> and Ag<sup>+</sup> in leather raw wastewater (3<sup>st</sup> trial)

The increase in pH to 10 caused increases in Cu<sup>2+</sup> concentration but less significant for Ag<sup>+</sup> concentrations. The removal efficiency decreased significantly at pH less than 10. Ag<sup>+</sup> concentration decreased at pH 6.2 and increase as the pH increases to 11. Furthermore, Ag<sup>+</sup> concentration between pH 6.0 and 11 was less significant and Ag<sup>+</sup> removal efficiency reached a maximum between pH 6.0 to 7.0 as shown in Figure 1a, b and c.

The result revealed that the optimum pH for metal removal is pH 10 which yielded 98% and 86% removal for Cu<sup>2+</sup> and Ag<sup>+</sup>. pH affects the rate and degree of coagulation treated with iron salts due to formation of intermediate metal hydrate species in aqueous systems. The soluble metal hydrates become predominantly anionic due to excess of hydroxyl ions in the formation of complex metal ion species. Shifting pH to a minimum removal of metal concentration, metals coagulants can be made more effective in destabilizing the hydrophobic colloids at optimum pH value.

## CONCLUSION

Optimizing chemical dosing rate is of great concern in reducing the cost of waste water treatment. Conducting a cost-benefit analysis in selecting the most appropriate process for metal removal was conducted. The results revealed that the metal removal in the waste water treatment plant requires applying the correct chemical dosage, adequate mixing, maintaining suitable pH value and controlling suspended solids in the effluent.

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