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Cobalt and Lead Ions Removal from Simulated Wastewater by Electro Coagulation Techniques: Using Iron-Aluminium Electrode

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Abstract:

In this study ,the effectiveness of the electro coagulation technique in removing Cobalt and lead from a simulated wastewater was investigated using Iron –Aluminum electrode pair at four operation variables :PH (1,3,8 and 10) :current density (15,25,30 and 50mA/cm²):inter electrode distance (3,4,6 and 8cm) and charging time of(4,10,12 and 18 minutes).The experimental results revealed that after 10 minutes charging time, the highest removal of cobalt and Manganese of 99% and 97.615 respectively were achieved at 25mA/cm²,PH of 10,inter electrode distance of 3cm.The experimental results showed that Cobalt and Lead can be removed from simulated water using the electro coagulation technique.

Keywords: Electro coagulation, Cobalt, Lead, Iron Aluminum electrode

1. Introduction

Heavy metals defined as the metallic elements that have a relatively high density compared to water (Banfalvi et al., 2001). The presence of heavy metals in the environment has led to a number of environmental and health issues, in order to meet water quality standard for most countries the concentration of heavy metals in wastewater must be controlled. (Kim et al., 2008).

Over the years many water treatment techniques have been developed to treat water contaminates. This treatment technologies developed includes, biological treatment which uses microorganism to remove effluents from discharge. The microorganism present in wastewater called the heterotrophs uses the organic content in water to grow thereby converting one third of the colloidal and dissolved organic matter into stable products and converts the remaining two third into microbial cells that can be removed through gravity separation (Waw et al.,2011).

Chemical treatment generally uses any of air stripper, ion exchange, chemical oxidation, carbon adsorption, ultra-filtration, reverse osmosis and chemical coagulation. Coagulation a widespread method of removing colloidal solids from wastewater enhances the destabilization of colloids and aggregation of sediments.

Electrocoagulation is an electrolytic process that uses electricity to remove metals from wastewater (Mullah et al., 2004). Electrocoagulation techniques have been applied in removing pollutants from water in that it is easy to operate, inexpensive and ecofriendly. The process is based on in-situ production of coagulating ions, involving three stages. First, the formation of coagulants by electrolytic oxidation of the sacrificial electrode, then the destabilization of contaminate, particulate suspension and finally aggregation of the destabilized phase to form flocs.

2. Materials and Method

A Perspex vessel of 25cm by 12cm by 18cm dimension working at 1litre volume fixed with a lid with an incorporated adjustable support for the introduction of iron-aluminum electrode with dimensions 15cm by 0.5 cm respectively whose terminal are connected to a dc supply. The stock solution was prepared from Pb (NO₃)₂ and CoCl₂.6H₂O

The optimum PH was determined by first adding few drops of 0.5M MgCl₂ to the solution to increase electrical conductivity and the PH was varied for 1,3,8,1 and 10 using 0.1 M HCL or NaOH at 15mA/cm² current density,3cm inter electrode distance with 10 minutes charging time.

The optimum current density was determined for varying current density of 15, 25, 30 and 50mA/cm² at optimum PH, 10 minutes charging time and 3cm inter electrode distance. The same procedure was used in obtaining the optimum charging

time by varying time at 4,10,12 and 18 minutes using optimum PH at 15mA/cm² and 3cm inter electrode distance. Inter electrode distance was varied at 3, 4, 6 and 8cm at optimum PH at 15mA/cm² at charging time of 10 minutes.

3. Results and Discussion

3.1. Effects of Operating PH

PH is a very important factor that impacts the electro coagulation process. The effect of PH was investigated at initial PH of 1, 3, 8, and 10. The solution of the metal was obtained by adjusting the solution of NaOH as illustrated in figure 2.1. The removal efficiency of lead and Manganese reached their highest level of 94.51% and 94% respectively for a PH of 10. It was discovered that when the PH was reduced below 10 the removal efficiency was found to also decrease. From previous work by (Chen et al., 2004), it was seen that their results were consistent with the results obtained in this research for a PH of 10.

Figure 1: Effects of pH on Removal Efficiency

3.2. Effects of Current Density

Current density has a significant effect on the removal of Manganese and lead. The effect of current density on the removal of Manganese and lead was investigated at current density of 15, 25, 30 and 50mA/cm² at optimum PH, 10 minutes charging time and 3cm inter electrode distance. It was discovered that highest removal efficiency of 99.13% and 95.10% were respectively obtained for Manganese and Lead at a current density of 30mA/cm², from figure 2.2 it can be seen that after the 30mA/cm² current density the removal efficiency was found to be constant at this point the process should be discontinued. These results obtained were similar to results by (Holf,2006) who demonstrated and increase in metallic ion in solution by increasing the current density

Figure 2: Effect of Current Density on Removal Efficiency

3.3. Effect of Inter Electrode Distance

The effects of inter electrode distance on the removal of cobalt and lead was investigated at 30mA/cm² current density at PH 10 with varying inter electrode distance of 3,4,6 and 8cm. The results obtained showed that as we increase the inter electrode distance the removal efficiency decreases. From figure 2.3 it can be seen that an inter electrode distance of 3cm gave the highest removal efficiency of 99% for cobalt and 93% for lead. (Brazrafhshen et al.,2009) obtained similar results were showed that an increase in inter electrode distance impacts the removal efficiency

Figure 3: Effect of Inter Electrode Distance on Removal Efficiency

4. Conclusion

From results obtained from this research the removal of cobalt and lead from simulated wastewater by electrocoagulation technique using iron aluminum electrode. It can be seen that current density, charging time and initial PH were directly proportional to heavy metal removal while inter electrode distance was inversely proportional to the heavy metal removal efficiency. The results have demonstrated that the electrocoagulation using iron aluminum electrode is an effective method.

4.1. Effect of Charging Time on Removal Efficiency

The effect of charging time was studied by varying time at 4, 10, 12 and 18 minutes. The results show an efficient process for the first few minutes and the subsequent time is neither economical nor optimal treatment. This follows that at higher time more coagulating dosing increases the removal rate but excess coagulated dose causes re stabilization of particle which eventually hampers heavy metal removal rate. From figure 2.5 it can be seen that removal rate is highest at optimum charging time of 10 minutes removal efficiency for cobalt and lead were 94% and 95% but as time increases beyond 10 minutes the removal rate is negligible and percentage removal appears constant. (Chen et al., 2006) e removal efficiency obtained similar results showing an increase in removal efficiency at moderate time but at higher time the removal efficiency decreases.

Figure 4: Effect of Charging Time on Removal Efficiency

5. Conclusion

From results obtained from this research the removal of cobalt and lead from simulated wastewater by electrocoagulation technique using iron aluminum electrode. It can be seen that current density, charging time and initial PH were directly proportional to heavy metal removal while inter electrode distance was inversely proportional to the heavy metal removal efficiency. The results have demonstrated that the electrocoagulation using iron aluminum electrode is an effective method in the removing cobalt and lead from simulated wastewater.

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