Treatment of Hospital Wastewater by Electro-Coagulation Technique

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Abstract - *In addition to using a lot of water, hospitals also generate a lot of wastewaters that contains several dangerous substances. Not disposing of medical waste appropriately can have detrimental impacts on both neighborhood residents and those who work in clinical institutions. Therefore, this kind of contamination cannot be discharged into the sewer system as untreated effluent.*

Our project involves employing electrocoagulation to treat hospital wastewater. Hospital wastewater is treated with aluminum electrodes. After the completion of initial wastewater characteristics study COD and Iron content were 1220 mg/l and 3.32 mg/l. Electrode distance, pH and Electrolysis Time where taken as varying parameters and each parameter had three different values. The optimum value obtained is 4 cm distance, 7 pH and 45 min time. The COD and Iron content after the electrocoagulation was reduced to 230 mg/l and 0.04 mg/l.

Key Words: Hospital wastewater, Electrocoagulation, Aluminium electrodes, Contaminants, Optimization

1.INTRODUCTION

1.1 General

Hospital wastewater is one of the most dangerous sources of pollution. The prevalence of pathogens in hospital wastewater highlights the importance of the pollution causes. Electrical coagulation, an electrochemical waste-water treatment method, uses direct current electricity to draw contaminants out of the solution. In this process, a suitable anode is electrolytically oxidized to create a coagulant there instead. Then, it is possible to remove charged ionic species by either letting the waste produce metal hydroxides or by enabling a reaction to the opposite charge. Due to the need for straightforward and simple operation, good sludge settling ability, lower sludge production, larger produced flocks compared to chemical treatment, and reducing secondary pollution by not using chemical compounds, electrocoagulation technology has recently grown in popularity for waste-water treatment. Pollutants like heavy metals can be removed with this technique. To treat synthetic solutions containing refractory substances like antibiotics, heavy metals, and petroleum, electrocoagulation has drawn increasing attention because to its low cost, in-situ generation of coagulants, high adsorption capacity, requirement for less land, and ecologically benign characteristics.

1.2 Objectives

a) To investigate the characteristics of hospital wastewater.
b) To estimate the concentration of COD & other contaminants in the wastewater.
c) To optimise the different factors, including time, pH, and electrode distance.
d) To analyse to what extend the purity is achieved by the electro coagulation process using aluminium electrodes.

2. MATERIALS AND METHODS

2.1 Sample collection

HWW was collected from a hospital in Thodupuzha. 5 liters of water was taken for initial wastewater characteristics study and later 1 liter was taken for electrocoagulation process.

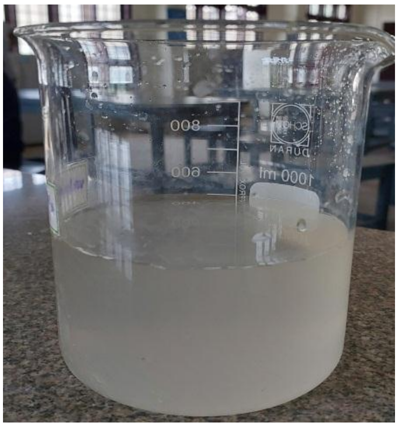

Fig -1: Effluent collected from Hospital

2.2 Initial wastewater characteristics study

The features of the water sample were investigated, and numerous metrics were analyzed. The findings are displayed in table 1

Table -1: Wastewater Characteristics

Parameter	Unit	Result	Standards
Alkalinity	mg/L	50	75 to150
Conductivity	µs	923.3	Less than 2500
TDS	ppm	710.7	Less than 500
pH	-	6.4	5.5 to 9
Turbidity	NTU	11	Less than 30
BOD	mg/L	120	Less than 30
COD	mg/L	1220	Less than250
Iron	mg/L	3.32	Less than 0.3

According to the Kerala Pollution Control Board, the maximum allowed concentrations of COD and iron in wastewater that is to be disposed of in a public sewer are 250 mg/L and 3 mg/L, respectively. The hospital effluent's COD and iron concentration were determined to be over the allowable limit based on the characteristics analysis. So, before being released, this hospital wastewater must be treated.

2.3 Electrocoagulation apparatus

Fig -2: Electro-coagulation apparatus

The device consists of two components: electrodes and a reactor. The reactor is made of a circular, 1 L capacity, 15 cm (about 5.91 in) high by 10 cm (about 3.94 in) wide glass beaker. We used rectangular aluminum plates with a 19 cm (about 7.48 in) length, a 6 cm (about 2.36 in) width, and a 1 mm (about 0.04 in) thickness as electrodes. It is bipolar and positioned parallel. We utilize direct current to operate the device because electrocoagulation only occurs when cations are deposited in the cathode and anions are deposited in the anode, and this is only feasible when the polarity of the electrodes remains constant.

2.4 Optimization of various operating parameters

1 gm of glucose and 20 ml of stock iron solution was used to prepare the synthetic solution. Both these were dissolved in 1000 ml distilled water to make a synthetic solution with the necessary amounts of COD and iron. Three different operating settings are chosen in order to achieve the best value. Electrode separation, pH, and electrolysis time are these parameters. Three distinct values are chosen for each parameter. This refers to the electrode distance, which might be 4 cm (about 1.57 in), 6 cm (about 2.36 in), and 8 cm (about 3.15 in). The pH is then changed between 6.5, 7 and 7.5. The electrolysis duration is then modified to be 15 minutes, 30 minutes, and 45 minutes.

3. RESULT

3.1 Effect of electrode distance

In this instance, all other parameters were held constant while the electrode distance was changed to 4 cm, 6 cm, and 8 cm. It was discovered from fig. 5.1 that the COD and iron removal efficiency decreases as the distance between the electrodes increases. At a distance of 4 cm between the electrodes was accomplished in 45 minutes. This is owing to the fact that, with constant cell voltage, current falls as interelectrode distance increases due to a reduction in electrode resistance. At the high current value, the anodic dissolution increases, leading to more collisions of the ions that promote coagulation, which raises the number of coagulants. Therefore, the lowest electrode spacing was necessary to obtain the best COD and iron removal efficiency.

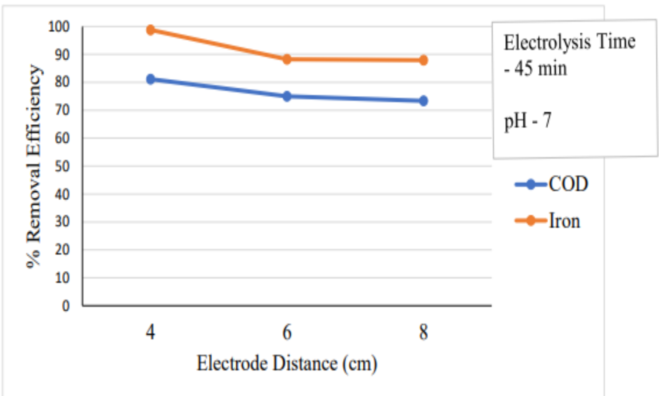

Chart -1: Percentage removal cod & iron – Inner electrode distance relationship

3.2 Effect of electrolysis time

One of the crucial factors in electrocoagulation is the electrolysis time (ET), also known as the treatment time. In this instance, the electrolysis duration was changed to 15, 30, and 45 minutes while all other variables remained the same. The elimination of fluoride becomes more pronounced over time, as seen in figure 5.2. Maximum COD and iron removal was discovered to occur at 45 minutes of contact time. By extending the EC procedure, the removal efficiency was increased until it reached the acceptable level. This is due to Faraday's law, which states that dissolved coagulants from the aluminum electrode increased with time. The COD and iron ions were trapped by a significant amount of coagulant that had been dissolved from the aluminum electrode, leading to better removal efficiency over a longer period of time.

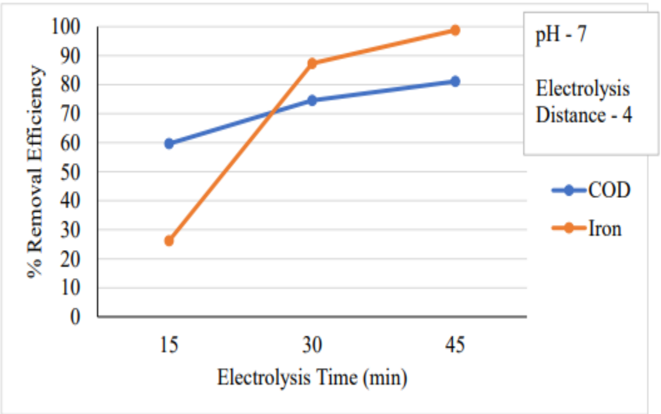

Chart -2: percentage removal – electrolysis time relation

3.3 Effect of pH

The pH of the solution is recognized to be crucial in the electrocoagulation process. The original pH was changed to 6.5, 7 and 7.5 to study its impact. Figure 5.3 revealed that the pH range of 7 was where COD and iron elimination was at its highest. Additionally, it was shown that when acidity or alkalinity increases, the effectiveness of removing COD and iron diminishes. This is because aluminum hydroxide (Al (OH)3) exhibits amphoteric properties. Al (OH)3 dissociates into Al3+ cations at acidic pH, whereas Al (OH)4 is formed as a monomeric anion at alkaline pH. All of the aluminum generated at the anode formed polymeric species (Al13O4(OH)247+) and precipitated Al (OH)3 when the initial pH was neutral. Al (OH)3 is known to contribute to the elimination of fluoride during electrocoagulation utilizing aluminum electrodes. Therefore, great removal efficiency is reached at neutral pH.

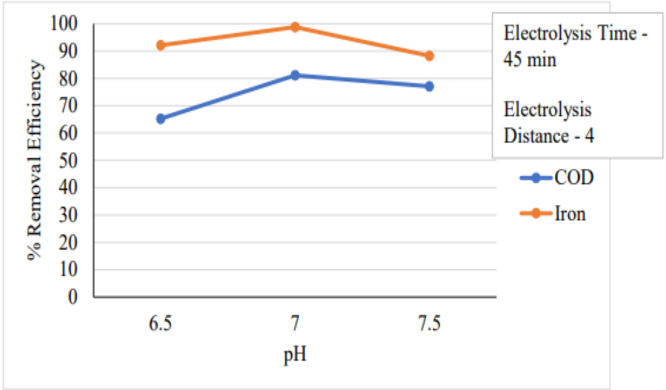

Chart -3: Percentage removal – pH relationship

3.4 Removal of COD and Iron from original wastewater sample

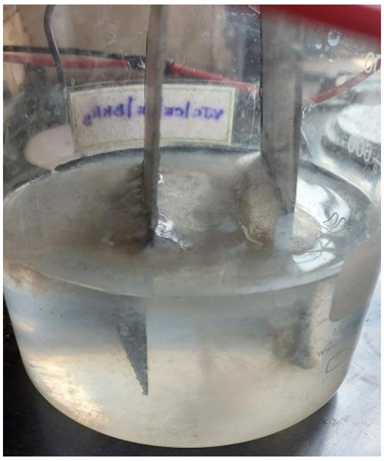

Fig -3: During Electrocoagulation process

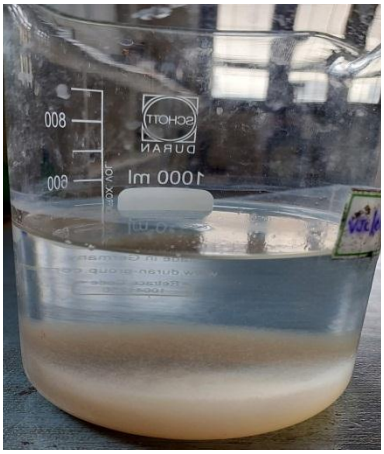

Fig -4: After Electrocoagulation process

An ideal of 7 pH, a 4 cm electrode distance, and a 45-minute electrolysis period were selected from the electrocoagulation experiment done on synthetic water. The final COD and iron electrocoagulation procedure of hospital wastewater was carried out using the optimized settings. The removal of COD and iron by electrocoagulation with electrodes made of aluminum was 81.14% and 98.79% respectively. Thus, hospital wastewater COD and iron removal using the electrocoagulation technique was shown to be quite successful.

Table -2: Optimization of Parameters for COD Removal

pH	electrode distance (cm)	Time (min)	Initial COD (mg/L)	Final COD (mg/L)	Percentage removal of COD (%)
7	4	45	1220	230	81.14

Table -3: Optimization of Parameters for Iron Removal

pH	electrode distance (cm)	Time (min)	Initial Iron (mg/L)	Final Iron (mg/L)	Percentage removal of Iron (%)
7	4	45	3.32	0.04	98.79

4. CONCLUSIONS

The outcomes of the experiment demonstrated the effectiveness of aluminum electrodes in removing iron and COD. It was discovered that the electrolysis time, pH, and electrode distance all affected the removal effectiveness.

The greatest COD and iron removal efficiency using electrocoagulation technique was determined to be 81.14% and 98.79% for an initial COD and iron content of 1220 mg/L and 3.32 mg/L, respectively. The procedure's ideal parameters were determined to be a pH of 7, a distance between the electrodes of 4 cm, and an electrolysis period of 45 minutes.

To sum up, EC appears to be a practical and cost-effective alternative in the purification of various types of water and wastewater, but more research is required, particularly using larger-scale and/or continuous systems and concentrating on the fundamentals of the EC process.

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