

COD and Color Removal by Electrocoagulation Method from Hospital Wastewater

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Abstract

In this study, Chemical Oxygen Demand (COD) and color removal were investigated and optimum conditions were determined by electrocoagulation method of hospital wastewater. Experimental studies were carried out with the wastewater sample taken from the hospital exit. For the COD and color removal, experimental studies were carried out to determine the optimum conditions for treatment by making changes such as initial pH value, current density, electrolysis time and mixing speed. In the study, the pH values of 2-9, the current density between 10-100 A/m², electrolysis time 5-40 minutes and the mixing speed 50, 150, 200, 250 rpm in the range of experiments performed by changing the optimum pH value, current density, electrolysis time and mixing speeds are determined. The results of the study suggest that hospital wastewater can be treated with electrochemical systems, but the establishment of a sustainable system with on-site treatment will make the treatment more efficient.

Keywords: Electrochemical treatment; COD; color; wastewater

1. Introduction

As water consumption and world population rates continue to increase rapidly, water scarcity is one of the challenges facing humanity in the future. A large number of chemicals are used in hospitals for treatment and sterilization purposes. These hospital wastewaters, which contain chemicals, significantly affect the environment. Wastewater from hospitals; It consists of waters of different character from a large number of treatment and/or diagnostic units such as laboratories, polyclinics, operating theaters, radiology units, drug preparation units, blood transfusion centers (Verlicchi et. al., 2012; Amouei et. al., 2015). Therefore, the hospital wastewater contains many pollutants of different character and causing environmental impact. (Gautam et. al., 2007). Hospital wastewater, like other wastewater, needs to be treated before being delivered to receiving waters. Targets in wastewater treatment are to control pollution, prevent infectious and chronic diseases, protect the environment and reuse water. Hospital wastewater can be reused if properly treated (Dehghani, 2013).

Electrocoagulation process (EC) has become a preferable process because of its advantages over chemical coagulation process. Therefore EC has been widely used to treat wide variety wastewaters (Ozyonar and Karagozoglu, 2012). Electrocoagulation has a significant impact on the wastewater treatment process (Suarez et. al., 2009). Wastewater treatment by electrocoagulation process has been mostly applied in the last century with limited success and popularity. However, its use has increased in recent years as electrical power consumption decreases and functionality increases. (Moreno-Casillas et. al., 2007). Electrocoagulation process seems to be effective in removing organic and inorganic pollutants, pathogens, hydrocarbons, oils, colloidal substances from water and wastewaters. Electrocoagulation (EC) is a process consisting of dissolving the anode by electrolysis to form metal hydroxide flocks in the wastewater to be cleaned (Ozyonar and Karagozoglu, 2012).

In this study, it is aimed to treat hospital wastewater by using electrocoagulation method. it was aimed to remove color and COD from hospital wastewater by electrocoagulation process. Studies were carried out to determine the optimum conditions for electrocoagulation process in COD and color removal in wastewater and all parameters were examined under these conditions.

2. Material and Methods

2.1. Studying Area

In this study, COD and color removal were aimed from the hospital wastewaters. Pollution capacity of hospital wastewater was determined by wastewater characterization. At the end of the electrocoagulation test in optimum conditions, characterization parameters of wastewater were

determined and the compatibility of treatment efficiency between COD and other parameters was determined.

The hospital wastewater examined in the study directly delivers to the sewage system. Experimental study was carried out with wastewater from the sewerage system of the hospital and the average flow rate was 0.296 m³/h. After determining the characteristics of the hospital wastewater, the treatability of the wastewater of Ondokuz Mayıs University Faculty of Medicine hospital by electrocoagulation method was examined. The parameters related to the characteristics of the wastewater used in the study are given in table 1.

Table 1: Characteristics of hospital wastewater used in the study

Text	Text
pH	7.48
Conductivity	746.00 µs/cm
COD (mg/l)	416.00 (mg/l)
BOD ₅ (mg/l)	218.00 (mg/l)
Color (Pt-Co)	347.80 (Pt-Co)
Suspended Solid (mg/l)	4.40 (mg/l)
Turbidity (NTU)	71.40 NTU
Temperature	18.00 °C
Redox	26.40 Mv
Dissolved Oxygen	3.42 (mg/l)

2.2. Electrocoagulation Study

Iron electrode was used as an anode material for COD removal by electrocoagulation method. The choice of the iron electrode is due to the fact that more COD removal efficiency is obtained at low current density, which requires less electricity and therefore less cost. Aluminum electrode was used as anode material for color removal by electrocoagulation method. Stainless steel was used as cathode material in both removal studies.

In this study, color removal efficiency, pH; the effects of current density and electrolysis time on COD removal efficiency were investigated and optimum conditions were determined. 145x80x75 mm electrocoagulation reactor made of Plexiglas material was used. 700 ml wastewater was put into the reactor in each run. In the treatment of hospital wastewater by electrocoagulation method, the electrodes are connected to the DC power source in parallel with the monopolar. The mixing of wastewater in the reactor was carried out with Jar Test device. Direct current power supply is used for current and voltage control. The current corresponding to the current density determined during the experimental studies was given to the electrocoagulation system and the volts were read from the power source at certain time intervals. Conductivity and pH measurements were carried out with pH meter.

2.3. Effect of Current Density on COD Removal

In order to determine the effect of current density on treatment efficiency in COD removal from hospital wastewater by electrocoagulation method, current density is between 10 and 100 A/m² at conditions where the electrolysis time is kept constant for 30 minutes and stirring speed is maintained at 200 rpm at pH 4, which is the optimum pH value, which was increased by 10 and experiments were performed and the change in COD removal efficiency was observed. When the current density varies between 50 and 100 A/m², there is not much change in the treatment efficiency and when the value falls below 50 A/m², significant decreases in the treatment are observed. The change in treatment efficiency due to current density in electrocoagulation is given in Table 2 and the graph is shown in Figure 1.

As a result, the increase in current intensity has resulted in an increase in COD removal efficiency as it dissolves more iron in the system and has led to an increase in energy consumption.

Table 2: Change of COD removal efficiency based on current density

Current Density (A/m ²)	Last pH	Voltage (V)	First COD (mg/l)	Last COD (mg/l)	Percentage of Treatment Efficiency (%)
10	6.93	1.2	390	257	34.10
20	7.36	1.5	390	253	35.12
30	7.74	2.6	390	250	35.88
40	6.22	2.6	390	230	41.02
50	6.41	2.7	390	207	46.92
60	8.19	2.8	407	213	47.66
70	6.73	2.9	407	210	48.40
80	8.21	3.6	407	207	49.14
90	9.22	4.0	407	207	49.14
100	8.30	4.9	407	197	51.59

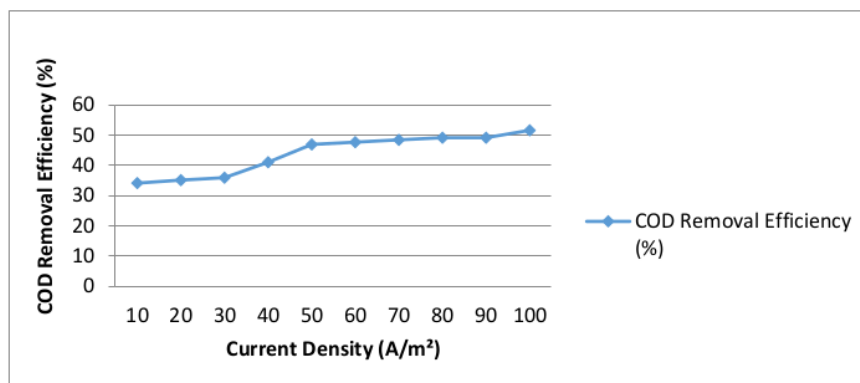


Figure 1: Change of COD removal efficiency based on current density

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2.4. Effect of Electrolysis Time on COD Removal

Experimental studies carried out in order to determine the effect of electrolysis time on the efficiency of electrocoagulation yielded the desired level of treatment efficiencies in the electrolysis time of 30 minutes. As the electrode consumption and energy consumption will increase as the time increases, it is determined that COD removal efficiencies obtained during the 30-minute electrolysis period are not sufficient for longer periods as both the treatment efficiency decreases at the 35th and 40th minutes and the electrical energy consumption increases.

In this study, it was observed that COD removal efficiency and electrical energy consumption increased with increasing electrocoagulation time. The change in treatment efficiency due to current density in electrocoagulation is given in Table 3 and graph is shown in Figure 2.

Table 2: Change of COD removal efficiency based on electrolysis time

Time (Minute)	Last pH	Voltage (V)	First COD (mg/l)	Last COD (mg/l)	Percentage of Treatment Efficiency (%)
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5	5.54	2.7	388	314	19.07
10	5.75	2.6	388	282	27.31
15	5.86	2.6	388	262	32.47
20	6.28	2.5	388	246	36.59
25	6.54	2.4	388	228	41.23
30	6.57	2.4	388	208	46.39
35	6.79	2.4	388	208	46.39
40	6.80	2.3	388	218	43.81

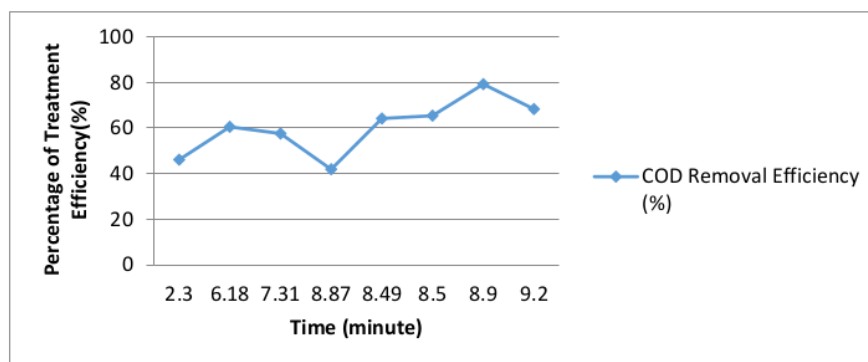


Figure 2: Change of COD removal efficiency based on electrolysis time

2.5. Effect of pH on Color Removal

In this study, the effect of pH on treatment efficiency by electrocoagulation method was investigated. Experiments were carried out at different pH values by keeping the mixing speed of 200 rpm, current density of 50 A / m², distance between electrodes of 5 mm, electrolysis time of 30 minutes. The pH of the wastewater was applied by changing the range of 2-9. Foam was observed as the pH increased during the experiment.

Table 3: Change of Color removal efficiency based on pH

First pH	pH	Voltage (V)	Color (A)		Color Removal (%)
			Input	Output	
2	2.30	4.1	0.371	0.200	46.09
3	6.18	5.7	0.400	0.158	60.50
4	7.31	5.6	0.403	0.171	57.56
5	8.87	5.6	0.382	0.222	41.88
6	8.49	2.9	0.324	0.116	64.19
7	8.50	3.6	0.347	0.120	65.41
8	8.90	3.6	0.409	0.085	79.21
9	9.20	3.7	0.385	0.122	68.31

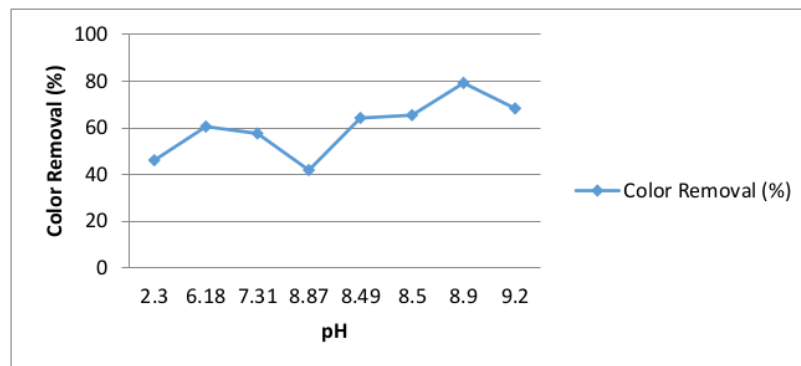


Figure 2: Change of Color removal efficiency based on pH

3. Conclusions

The results have demonstrated the efficacy of electrocoagulation in the treatment of hospital wastewater and also indicate that electrocoagulation is a suitable method for the removal of COD and color from hospital wastewater. Due to the advantages of the process such as high efficiency, simple equipment and low cost, it can be considered as a suitable, effective and economical method for hospital wastewater.

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