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Investigation of Electrocoagulation Effect on the Removal of COD, TOC from Industrial Waste Water

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Abstract**—** *Electrocoagulation process can provide effective solutions to overcome water pollution problems. This research aims to evaluate the performance of electrocoagulation for removing total organic carbon, chemical oxygen demand from polluted industrial waste water. Organic matter is the main contributor in industrial waste water pollution and must be treated. Organic matter contains a high amount of chemical oxygen demand (COD), total organic carbon (TOC) which can cause serious human health problems. Experiment (Aluminum and stainless steel) were used as anode and cathode electrodes respectively. Efficiency of electrocoagulation evaluation was studied by the effect of various parameters including pH (4, 5, 6, 7, 8 PH) and voltages (4, 7, 10, 12, 15V) and time (10, 20, 30, 40, 50 min). This treatment method led chemical oxygen demand (COD) removal of 90 % and total organic carbon (TOC) removal of 79 % at PH 7, 40 min, 12 V. Electrocoagulation results show that it is a possible method for treat of heavily polluted industrial wastewater.*

Keywords**—** *Electrocoagulation; organic matter; industrial wastewater; treatment.*

I. INTRODUCTION

The removal of organic matter from industrial waste water has become one of the most essential applications in industrial wastewater treatment in terms of protection of health as well as the environment, these organic matter are known to poses health risks. Wastewater is the largest contaminated and contains high organic matter, (COD), (BOD) and (TSS). The characteristics of industrial wastewater depend on the type of raw material, treatment method [1,2]. Electrocoagulation is one methods of industrial wastewater treatment [3]. Industrial wastewater treatment is an important problems in many countries difficult problem [4,5]. Industrial wastewater may contain organic contaminants in large amounts and can be measured as (BOD5), (COD), NH3, and high concentration of heavy metals. And this concentration of pollutants can have adverse effects on the environment [6,7]. COD is the organic matter in water [8]. Organic matter may lead to the formation of by-products; they are considered carcinogenic compounds such as trihalomethane compounds [9-11]. In the last years, ecosystems have called to new techniques for efficient treatment of different industrial wastewaters with low cost. Electrocoagulation process has a significant role in the industrial waste water treatment resulting from different uses and its suitability to the environment. Electrocoagulation is method simple, easy operation and more economic and has high treatment efficiency [12-15]. This method is characterized by a short reactive retention period, the absence of equipment for adding chemicals, decreased the amount of sediment or sludge. Various methods were used including physical, chemical, and biological treatments for treat the industrial wastewater [16-21]. Most treatment method has its drawbacks. For example, cellulose and organic compounds with large molecular weight cannot be decomposed by biological method [22]. Electrocoagulation has received a great interest in the literature on the use of electrocoagulation technology [23,24]. The Electrocoagulation method showed successful results for wastewater [25–32]. Electrocoagulation has several advantages, no chemicals are needed, and the main reagent is the electron, ability to remove the tiniest colloidal particles and shorter treatment time comparing to other methods [33–36]. In this research, industrial wastewater treatment was investigated in electrocoagulation process using Aluminum (cathode) and stainless steel (anode) electrodes. Electrolysis time, pH, and voltage were chosen as variable parameters to reach the maximum removal of COD, and TOC.

II. MATERIALS AND METHODS

2.1. Experimental Procedure

The electrocoagulation cell consists of 1 liter cylindrical glass beaker. Aluminum and stainless steel have been used as anode and cathode electrodes. The electrodes (anode and cathode) were clamped at electrode stand. All connections in the circuit were completed by connection the wire positive and negative end to supply DC power, electrodes (anode and cathode), voltmeter and ammeter. The electrodes have been immersed in the electrolyte solution. The color of the solution of electrolyte solution was observed before and after the process occurred. Difference of electrolyte solution with varying initial pH values were pH (4, 5, 6, 7, 8) and also difference applied voltage used were (4, 7, 10, 12, 15) V and also electrolysis time (10, 20, 30, 40, 50) min. The characterization of industrial wastewater was conducted by determining the physical and chemical parameters, such as total organic carbon (TOC), chemical oxygen demand (COD). COD, TOC are used as a representation of organic matter. The laboratory analysis was carried out according to the standard methods of APHA [37].

2.2. Analytical Techniques

Industrial wastewater characteristics including COD, TOC were analyzed before and after each treatment and all the experiments were conducted at room temperature. The experiment was performed in 50 minutes and the reading is taken every 10 minutes intervals. After 50 minutes, the power supplies were switched off and both electrodes were taken out carefully and filtered before being analyzed to determine COD, TOC. COD, TOC, pH were determined according to the standard methods of APHA [37]. COD was measured using COD reactor and direct reading spectrophotometer. The pH was measured using a pH meter. The TOC was measured using a Shimadzu TOC Analyzer.

III. Results and Discussion

In this present study, electrocoagulation process was investigated to treat industrial wastewater under different operating conditions such as initial pH (4–8), electrolysis time (10–50 min), and voltage (4, 7, 10, 12, 15V). Three factors were used to study the effect of process variables on chemical oxygen demand (COD) and total organic carbon (TOC) removal.

3.1. Effect Time on Removal of Organic Matter

The experiment was conducted to evaluate the effect of electrolysis time on the removal efficiency of organic pollutants. The effect of electrolysis time as an estimate of the percentage of COD, TOC removal is shown in Figure 1. Electrolysis times were evaluated (10, 20, 30, 40, 50 min). Samples were taken and tested for each electrolysis time. The electrolysis time is of importance to perform the electrocoagulation process. Generally, the organic concentration in industrial wastewater decreases with the increasing in electrolysis time. It can also be understood from the Figure. Increasing electrolysis time had a positive effect on COD, TOC removal at the electrolysis time of 10 to 50 minute. Electrocoagulation reduced the organic matter content between 40 and 50 minutes. Therefore, 40 minutes of runtime was chosen, which gave 90% removal of COD, 79% removal of TOC. This is consistent with the findings of [38- 39] when he said that the rate of pollutant removal is also a function of the electrolysis time. The efficiency of pollutant removal increases with increasing electrolysis time. So, after the optimal electrolysis time, the removal rate becomes constant. This is consistent with the findings of [40] that when operation time is increased, the removal efficiency is increased as well.

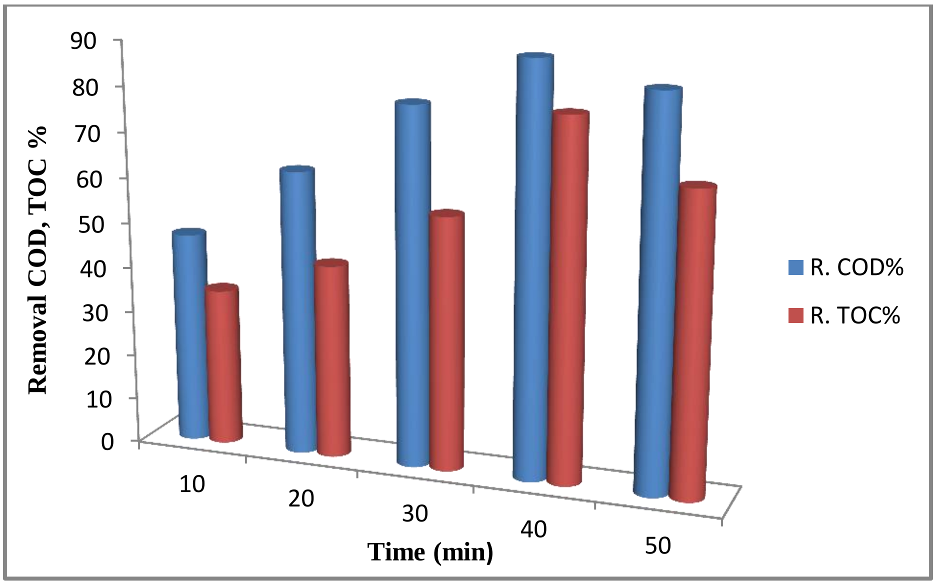

Fig. 1. Effect of time on the removal of COD, TOC

3.2. Effect Voltage on Removal of Organic Matter

The experiment was conducted to evaluate the effect of voltage on the removal efficiency of organic pollutants. Voltage is an important factor in the electrocoagulation process for decontamination, according to a number of researchers [41-44]. Figure 2 illustrates the percentage of COD and TOC removal at a different voltage. The effect of different voltages (4, 7, 10, 12, 15 V) has been studied on the removal of COD, TOC. Samples were taken and tested for each voltage. Higher voltages increase the amount of ferric ions that leads to removal of organic matter. Electrical coagulation reduced the organic matter content between 12 - 15 V. Therefore, the optimal voltage for the process was 12 V which results in 90% removal of COD, 79% removal of TOC. This is consistent with the findings of [45-46] when he said increasing the voltage, which is beneficial to removing pollutants.

3.3 Effect pH on Removal of Organic Matter

PH is an important factor for reactions that can occur in the electrocoagulation process. The study used the ranges were pH (4, 5, 6, 7, 8). The pH has a significant impact on the COD and TOC removal efficiency. The efficiency for COD, TOC removal was investigated in different pH values. These ranges give the results of the pH effect for electrocoagulation process in the removal of organic matter that contain in wastewater sample. As shown in Figure 3, the maximum efficiency of removal COD and TOC have been achieved at pH 7 the highest removal efficiencies for COD (90%), and TOC (79%) have been achieved. For adjust the pH, the H_2SO_4 and NaOH solutions were used. Current results demonstrate that electrocoagulation acts as a buffer for the pH. This is

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consistent with findings of [36]. The highest removal efficiency can be achieved in an acid condition, leads to formation of iron hydroxides that have higher adsorption capacity at this pH. From this experiment, maximum removal efficiency is found at the pH of 7 and which is optimal pH for the electrocoagulation process. The effect of the pH on removal is similar to the work of [47-61].

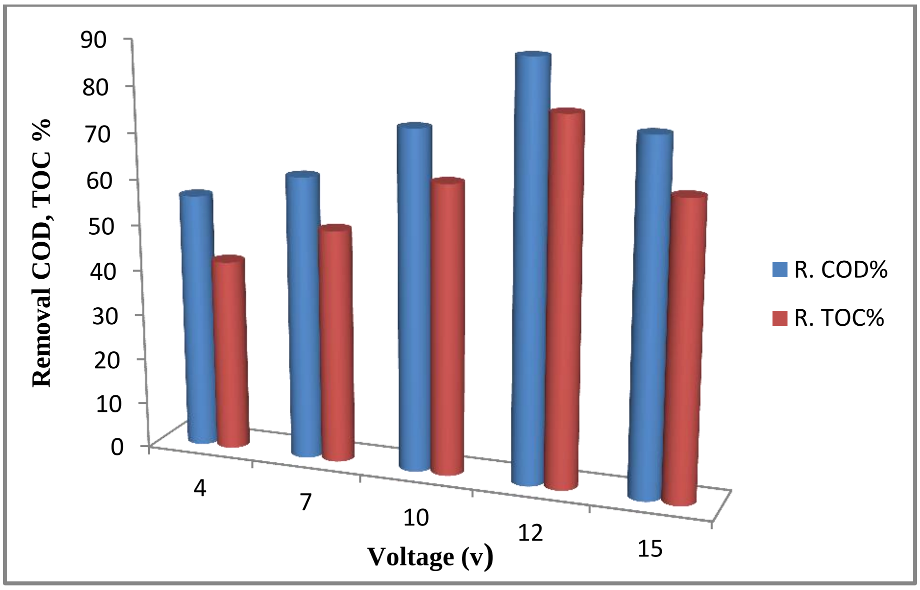

Fig. 2. Effect of voltage on the removal of COD, TOC

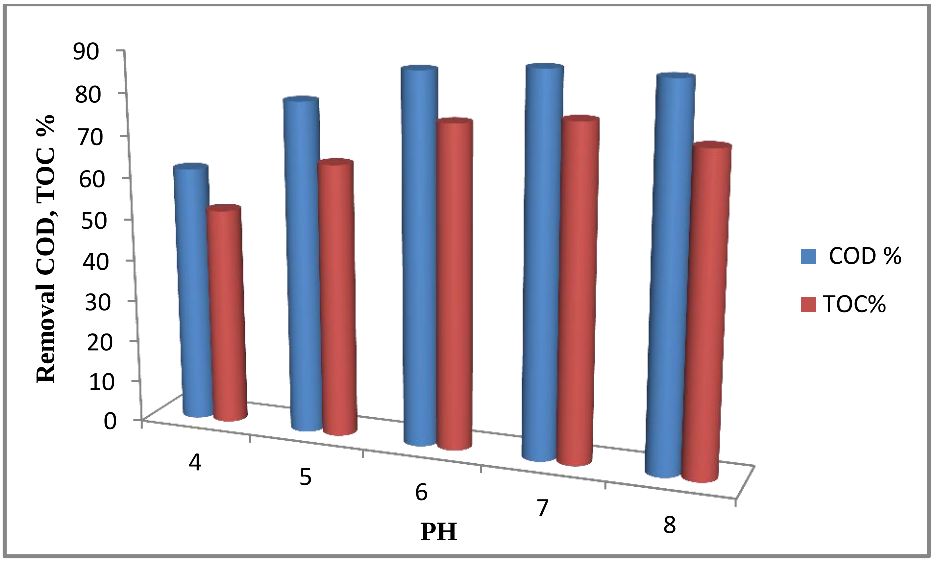

Fig. 3. Effect of PH on the removal of COD, TOC

IV. Conclusion

Electrocoagulation is an efficient on industrial wastewater treatment, special for organic matter. This study showed the successful application of electrocoagulation in the treatment of industrial wastewater. It can be concluded that the electrocoagulation process can be considered as a reliable method, flexible, efficient and rapid, economical to Industrial wastewater treatment. The effect of electrocoagulation pH, time and voltage was investigated for the removal of COD, TOC. Under optimum condition (12 V, pH 7, 40 min), the removal efficiency of COD, TOC was 90%, 79% respectively. The results of this study demonstrated that electrocoagulation can be used successfully to remove the COD and TOC from industrial wastewater contaminated by organic matter.

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