EFFECT OF ELECTRODE GEOMETRY ON THE PERFORMANCE OF ELECTROCOAGULATION

V. Khandegar[1], Anil K. Saroha[2]

[1]*University Shcool of Chemical Technology,*
Guru Gobind Singh Indraprastha University, Delhi, (India)
[2]*Department of Chemical Engineering, Indian Institute of Technology, Delhi, (India)*

ABSTRACT

Electrocoagulation is a versatile technique for treating various types of industrial effluent. The heart of the electrocoagulation process is the material of construction of the electrodes and the geometry of the electrodes. Presently plane electrodes have been used in the electrocoagulation. Therefore, in the present study, efforts have been made to investigate the effect of the shape of the electrodes on the contaminant removal efficiency by performing experiments using punched- hole electrodes. The effect of number of the holes on the dye removal efficiency was investigated. An increase in the dye removal efficiency was obtained with the punched-hole electrodes as compared to the plane electrodes.

Keywords: Electrocoagulation, acid red 131, punched electrode, aluminum, efficiency

I. INTRODUCTION

Electrocoagulation (EC) assembly consists of electrode plate and a power supply which is electrically connect to the electrodes and the coagulant is in-situ generate due to the dissolution of sacrificial metal anode by the application of given amount of current. The hydrogen at the cathode also helps in removing the oil and grease from wastewater by floatation. The coagulated species have the ability to adsorb suspended, dissolved and colloidal solids. EC has been applied for the treatment of paper mill, textile, distillery, electroplating and hospital wastewater etc. The significant operating parameters in the conventional electrocoagulation technique are current density, pH of the solution, inter-electrode distance, electrolysis time, and conductivity of the solution [1, 2]. The material of the construction of the sacrificial electrodes is crucial as the electrode material should be cheap, readily available and non-toxic [3]. Various metals such as aluminum, iron, steel, graphite, magnesium, titanium have been used in the electrocoagulation [4-7]. The shape of the electrodes may affect the performance of the electrocoagulation. But to the best of our knowledge, all the electrocoagulation studies reported in the literature had been performed with plane electrodes and no study has been reported using punched-hole electrodes. Therefore in the present study, the shape of the electrode was changed from plane to punched-hole electrodes. The effect of number of holes in the electrodes and the geometry of the punched holes on the performance of the electrocoagulation has been investigated. The electrocoagulation technique has been employed for the treatment of synthetic textile solution containing acid red 131 dye by batch mode of electrocoagulation using aluminum electrode.

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II. RESULTS AND DISCUSSION

Electrocoagulation of a synthetic dye solution containing acid red 131 dye was carried out at 0.4A current and the solution pH of 7. The inter-electrode distance was kept constant 3 cm for an electrolysis time of 120 min, retention time of 120 min, dye concentration 10 mg L^{-1} and solution conductivity of 0.304 mS cm^{-1}. The following results were obtained with different shapes of the electrodes:

2.1 Effect of plane electrode

Experiments were performed with plane electrodes and the results were evaluated in terms of color removal efficiency (CRE). It can be noticed that 50 % CRE obtained by plane electrode for an electrolysis time 30 min. The results are shown in Fig. 1.

2.2 Effect of single hole

Experiments were performed with single hole punched electrodes to see the effect of holes on the performance of electrocoagulation. The electrode single hole has been taken in the electrode with 2 to 5 mm diameter. The effect of single hole with different diameter on CRE is shown in Fig. 1. It can be noticed that 50 % CRE obtained by plane electrode for an electrolysis time 30 min. The CRE obtained by single hole (2, 3, 4 and 5 mm hole diameter) were 52 %, 54 %, 60 % and 62 % respectively. It is clear that CRE obtained by punched electrode is higher as compared to plane electrode. The expected explanation of such results is that, higher current discharge from the electrode with punched holes than plane electrode resulting in higher CRE with punched electrode compared with plane electrode. Also the electric field intensity at the edge of punched holes type electrodes is higher than at plane type electrode resulting in an increase in the discharge current at punched type electrode having large hole diameter [8]. The results agreement with the Kuroda et al. (2003), they have reported that the electric field intensity at the edge of punched holes type electrodes is higher (1.2 times) than at plane type electrode resulting in an increase in the discharge current at punched type electrode.

2.3 Effect of two holes

Experiments were performed by taking two holes in the electrode with different diameters (2 to 5 mm). The results are shown in Fig. 2. It can be noticed from Fig. 2 that increasing the number of holes in the electrode results in higher CRE obtained as compared to plane (no hole) and single hole electrode. The CRE obtained by two holes electrode from 65 % to 99 % for an electrolysis time of 30 to 120 min. But in comparison to single hole and plane electrode the CRE increased from 62 % to 99 % and 50 % to 95 % for an electrolysis time of 30 to 120 min respectively. It is clear that the CRE obtained by two holes electrodes is higher as compared to CRE obtained by single hole and plane electrode because the more number of holes discharge higher current as compared to plane and single hole type electrode [8].

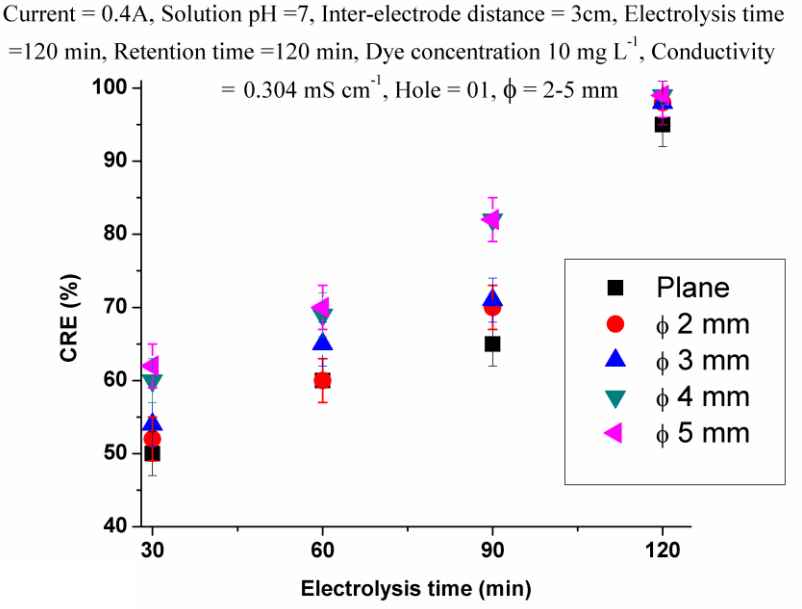

Fig. 1 Effect of palne and single hole punched electrode on CRE

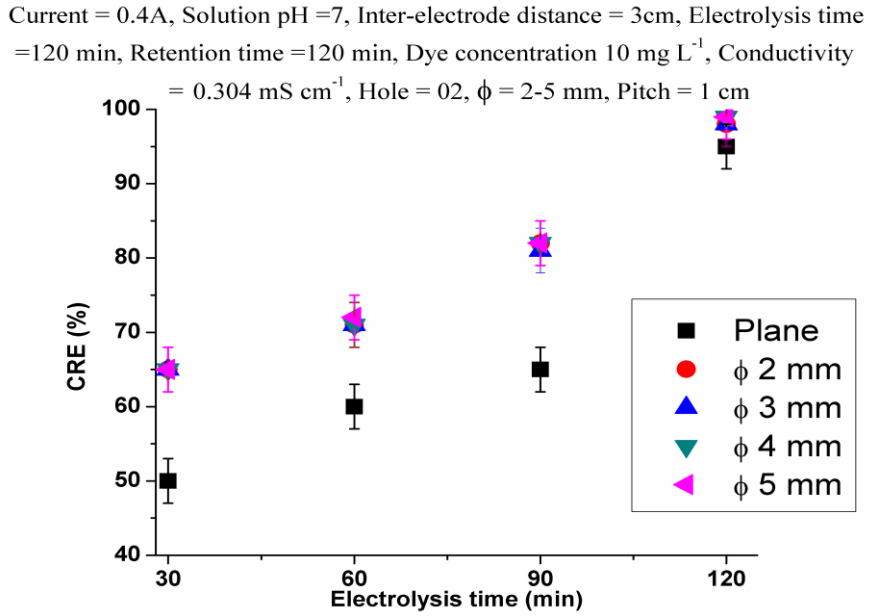

Fig. 2 Effect of palne and punched (two hole) electrode on CRE

III. CONCLUSIONS

Electrocoagulation in a batch mode of operation using plane and punched aluminum electrode was studied. The experiments were performed with plane, single hole, two holes in electrode. The effect of number of holes, diameter of holes on the CRE was investigated. It was found that number of holes increasing leads to increase in CRE with increasing hole diameter. A 95 % and 99% CRE was obtained by plane and punched electrode for an electrolysis time of 120 min and 90 min respectively at the operating conditions of current 0.4 A and solution pH of 7. From the observation, it was found that, discharge current was higher for the electrode with punched holes than for plane electrode and there is no effect pitch on CRE. It can be concluded that the shape of the

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electrodes can improve the performance of electrocoagulation process and reduces the energy consumption as well as operating cost.

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