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Treatment of Automobile Wastewater by Electrocoagulation

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***Abstract*—**Present study is aimed to explore the pollution potential of automobile service station wastewater and to treat the same. The wastewater samples were collected from nearby automobile garage and the sample was characterized for various parameters like pH, Total solids, Total Suspended Solids, total dissolved solid as well as chemical oxygen demand (COD) etc. The characterization results revealed that COD were major pollution parameters of concern. This research presents a bench scale electrocoagulation methods applied for the treatment of automobile service station wastewater. Experiments were performed in batch mode in 2 L capacity cubical shape reactor. Four stainless steel plates were used as electrode for current study which was immersed in wastewater. Continuous stirring was performed for consistent of sample concentration throughout the experimental run by a magnetic stirrer. Direct current was applied to the electrodes by an external power supply. Different process parameters like pH and current were varied to evaluate the maximum efficiency conditions. Maximum COD removal of 80 percent was found at an optimal condition, current density of 19.74 A/m^2 and pH 5.

***Keywords*—** *Automobile service station, treatment, electrocoagulation, Chemical Oxygen Demand (COD)*

I. INTRODUCTION

Automobile (mechanized) auto-wash is one of the services generally gave by service stations. The wastewater from an auto-wash section regularly make-up a noteworthy extent of the services station wastewaters [1]. Wastewater from services station contains chemical, surfactant and dirt. Chemicals utilized for washing operations may show a peril to environment if they are discharged wildly [2]. In high concentrations, they may hinder the working of the general sewage and the waste water treatment processes.

The chemicals utilized as a part of self-serve auto washing compare with those utilized as a part of mechanized auto washes. The noteworthy distinction between these two auto wash modes is that the solvents are fittingly recouped and sent for treatment in the controlled auto wash frameworks, while at the self-serve auto wash destinations, the oleiferous squander waters for the most part wind up in the dirt or in the general sewage arrange.

Electrocoagulation (EC) has been successfully used for treatment of a variety of wastewaters from olive manufacturing plant, semiconductor, surfactant, lodgings wastewater, sustenance handling, metal plating, poultry, sanitizing and mechanical cleaning industry, tannery, potato chips manufacturing, dairy, slaughterhouse, pulp and paper plant, and arsenic contaminated drinking water [3,4]. EC incorporates into situ generation of coagulants by electrolytic oxidation of a fitting propitiatory anode (for example, iron) supply of an electric current [5]. The metal ions produce during EC process, generation of metal hydroxide and unbiased metal hydroxides. The low solubility of these hydroxides mainly at pH values in the range of 6.0–7.0, promotes the generation of sweep flocs inside the treated waste and the removal of pollutants by their enmeshment into these flocs [6]. EC process remove contaminations basically by coagulation, adsorption, precipitation and flotation [7,4]. Various factors influence EC process and among them main considerations like electrolysis time, current density (CD) and wastewater characteristics [8,4,9,10]. Optimization of these factors is important to diminish power utilization and general treatment cost.

Objective of the present study was to survey the relevance of electrocoagulation as a conceivable method for treatment of automobile service station wastewater. Study on three essential process parameters like CD, pH and initial COD concentration, had been done and COD removal has taken as responses.

II. MATERIALS AND METHODS

A. Sample Collection and Characterization

The study was conducted in the Raipur city and sample was collected from nearby authorized vehicle service stations where, washing, servicing, and maintenance of vehicles are done. Though all maintenance and repair works were done in the service stations, the primary contribution for the automobile effluent was vehicle washing. Service station was indulged in both 2-wheeler and 4-wheeler servicing. No separate sump systems were provided in the service stations; instead they were directly linked to drainage systems. Hence, for the study, to get random samples of service station effluent, a 25 L can was placed in the outlet of the service station.

Characterization tests was performed on the automobile effluent and the different parameters determined are pH, total and dissolved solids, turbidity, conductivity, chlorides, sulphates, total hardness, COD and BOD as per IS codes. The different test results are compared with General Standards for Discharge of Environmental Pollutants specified by Central Pollution Control Board (CPCB) 2006. Characterization parameters are summarized in Table 1. From the characterization results it is observed that though sample was alkaline. Among all the characteristics COD was very high when compared to the standards as specified by CPCB.

TABLE 1. CHARACTERITION RESULT FOR SAMPLE

Sr. No	Parameters	Values
1	pH	7.67
2	Total suspended solid(TSS) (mg/L)	178
3	Total dissolved solid(TDS) (mg/L)	1269
4	Turbidity (NTU)	76.50

5	Chlorides, (mg/L)	196.87
6	Sulphates, (mg/L)	60.54
7	Chemical Oxygen Demand (COD) (mg/L)	470
8	Biological Oxygen Demand (BOD) (mg/L)	78
9	Hardness (mg/L)	317

III. ELECTROCOAGULATION EXPERIMENT

The electrocoagulation (EC) tests were performed in a batch mode operation EC unit with capacity of 2L reactor was manufactured from acrylic sheet. Four electrodes were utilized in monopolar parallel plate connection, as shown in Fig.1. For mixing magnetic stirrer was used and each pair of sacrificial electrodes was connected with each other internally. Rectangular stainless steel electrodes (0.2m×0.19m× 0.04m) effective surface area of 0.076 m^2 were used as anodes and cathodes with an electrode. The gap between the electrodes was kept as 1.5 cm based on previous work and the values reported in the literature [4]. Electrodes were washed with 1M HCl after each EC run to evade passivation [11]. Current and voltage were controlled by a digitally controlled DC power supply (0–30V, 0–5A).

Various EC tests were done to research the impact of different EC process factors, for example, current density (CD), pH and initial COD focus on the process efficiency. The intial pH of the sample was changed in accordance with a desired value using 1N H_2SO_4 or 1N NaOH.

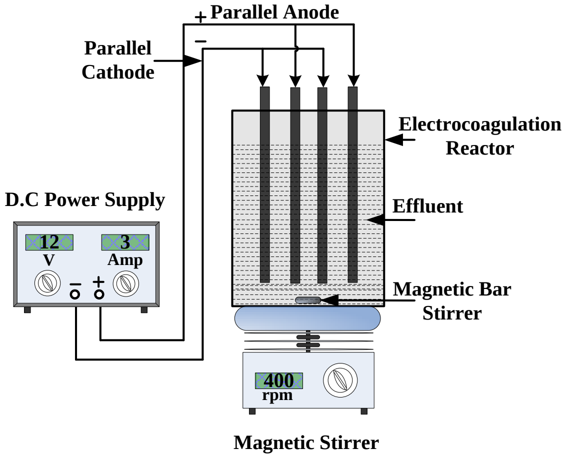

Fig. I. Experimental setup of Electrocoagulation *(EC)*

IV. RESULT AND DISCUSSTION

A. Effect of pH

The effect of pH on treatment of automobile servicing station wastewater was investigated at a constant current density (CD) 19.74 A/m^2. Fig. 2 shows the effect of pH onto COD removal. The COD reduction of automobile servicing station wastewater solution was increased with increase in pH from 5 to 7. The effect was decreased when the pH was increased further up to 9. It was also observed that COD reduction of automobile servicing station wastewater solution increases with increase in electrolysis time (t). The COD reduction of 35%, 39% and 33% is obtained in 20 min at pH values of 5, 7 and 9 respectively, which increased to 74%, 79% and 72% in 120 min. Similar effects were also observed by different investigators [4,12,13]. It is observed that automobile servicing station wastewater provided best COD reduction at pH 7 and less reduction at pH > 7 and pH < 9. The different values of COD reduction at different pH were probably due to the quality and quantity of metal hydroxide ions generated at particular pH. It was also reported that, at pH > 7 and pH < 9, part of the solution get reduced to H_2 and the proportion of the hydroxide ion produced is less; consequently, less COD removal efficiency [14]. However, pH 5 was considered as optimum pH due to less power consumption and electrode loss.

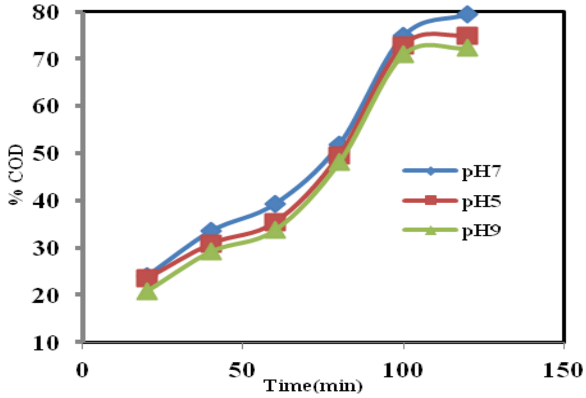

Fig. II. Effect of pH on %COD Reduction *(CD= 19.74 A/m2, Electrode distance= 1.5 cm and CODi= 470 mg/L).*

B. Effect of Current Density

The current density (CD) has been found to have strong effect on the productivity of the EC procedure, as reported by several authors [4,12,13]. To observe its effect, experiments were conducted at various CDs (13.16–32.89 A/m^2) at constant pH 7 and the observations are shown in Fig. 3. At CDs 13.16, 19.74, 26.32 and 32.89A/m^2; COD reduction of 48%, 62%, 75%, and 80%; respectively were obtained in a time period of 120 min. The removal of COD increases with increase in CD. Significant COD removal is obtained after 100 min of treatment at all current densities. By increasing the EC time to 120 min, it is observed that only 3% more COD reduction were achieved. The data reflects that 12% increase in COD reduction was found when CD was increased to 13.16A/m^2 from 19.74A/m^2. By further increasing CD from 26.32 A/m^2 to 32.89 A/m^2 only 10% increase in COD reduction was obtained. Increase in CD increases the cost of processing. The removal of COD increases with increase in current density. This is in accordance with Faraday's law (Eq. (1)) which provides a relationship between current density and the amount of anode material that dissolves in the sample [15].

$$w = \frac{M \times CD \times t}{nF} \qquad (1)$$

Where, w is the mass of electrode material dissolved (gm of the metal per m^2), CD the current density (A/m^2), t the time in min. The number of electrons participating in the oxidation/reduction reaction are expressed by (n); for Fe, n = 2. M is the relative molar mass of the electrode concerned material, for Fe, M =62.5 g/mol; and F is the Faraday's constant (96,487 C/mol). In EC process, when current density increases, number of Fe^{2+} ions also increases because m is directly proportional to CD. At higher CD, higher rate of formation of iron hydroxides results into the higher COD removal efficiency, because of occurrence of precipitation and sweep coagulation.

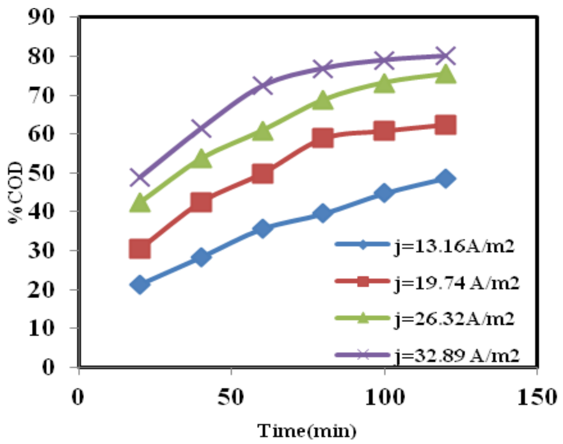

Fig. III. Effect of Current Density on % COD Reduction *(pH=7, Electrode distance= 1.5 cm and CODi= 470 mg/L).*

CONCLUSTION

EC process for treatment of automobile station wastewater was found effective treatment method to reduce COD. COD reduction of 72, 74 and 79 percent were obtained at pH 5, 9 and 7 respectively at constant CD of 19.74 A/m^2.The COD reduction was found to increase with increase in current density. At pH 7, COD reduction of 48%, 62%, 75%, and 80% was obtained at CD 13.16, 19.74, 26.32 and 32.89A/m^2, respectively.

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