Data Article

Dataset on statistical reduction of COD by electrocoagulation process using RSM

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Viable and low treatment cost is a challenge for municipal wastewater, therefore, an efficient and cost effective electrocoagulation (EC) process was studied to treat domestic sewage (DS) in laboratory batch process using SS-304 as electrode material. Effects of various parameters like pH, current density (CD), electrode configuration in numbers and treatment time (tR) were tested to find optimum operating condition for COD and other pollutants removal. The experiments were also planned to optimize the operating parameters through response surface methodology (RSM) based central composite design (CCD) which gave 77.78% COD reduction at CD = 27.78 A/m² and tR = 20 min respectively.

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1. Data

Table 1 represents the coded value ranges of RSM based CCD model. Variables chosen are that which play vital role during the EC process. Table 2 presents the predicted values of COD removal of 20 experimental run, these values were obtained using RSM model by varying parameters pH, CD and tR. Experimental runs were performed as per the standard run order and response in term of percent COD removal was obtained in the experiments. Then using design expert software predicted values were

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Fig. 1 shows the graphs between predicted values and actual values. The correlation coefficient obtained by the model is satisfactory, Fig. 2 shows 3D surface plot showing the effect of CD and tR on percent COD removal of DS. Fig. 3 shows Box-Cox plot for power transformation for percent COD removal of DS. Table 3 shows the analyzed data which suggest the effect of parameters individually and in combinations in the adopted model. Table 4 represents the analysis of variance (ANOVA) results from the data of CCD experiments (Equation (1)).

2. Experimental design, materials and methods

2.1. Sample collection and its analysis

The DS samples were collected from sewage line located in campus of NIT Raipur, C.G, India and kept in deep freezer at about 4 °C for subsequent experiments. Physical and chemical parameters of DS were determined as per standard method given in American Public Health Association (APHA) 22nd edition, 2012 [1]. For COD estimation, the samples were digested for 2 h at 148 °C in a COD digester (CR-3200, WTW, Germany), then after digestion, it was allowed to cool, and then titrated with standard 0.1 N ferrous ammonium sulphate. Other parameters like hardness and chloride was determined by titrimetric method [1]. Sulphate and phosphate was determined by colorimetric method using visible spectrophotometer (Prove 300, MERK, Germany). pH was measured by digital pH meter (EI-111, India).

Table 1
Process parameters and their level for the EC treatment for RSM based CCD studies.

| Variables | -1   | 0    | 1    |
|-----------|------|------|------|
| CD (A/m²), A | 13.89 | 27.78 | 41.67 |
| pH, B      | 5    | 7    | 9    |
| Time (min), C | 10   | 20   | 30   |
2.2. Experimental procedure

The EC treatment was performed in 2 dm³ electrochemical reactor (ECR) in which electrodes were inserted inside the reactor for proper contact with DS. Current (1–5A) and voltage (1–30V) was supplied through D.C. power source. The reactor was placed on the digital magnetic stirrer platform for mixing. To perform the experiment the 1.7 dm³ DS at desired pH was taken in ECR. The electrodes were dipped in it and connected to a DC power supply. Wastewater suspensions were stirred using a magnetic stirrer adjusted to 200 rpm. The current and the voltage across the electrodes were displayed in DC power supply unit. Before each EC run, the electrodes were washed with 10% HCl to remove surface impurities.

2.3. Data analysis

In the EC process pH, CD and tR play important role due to this, these variables were taken for statistical analysis. The variables chosen and its level are presented in Table 1. For statistical analysis pH

| Standard Order | CD (A/m²), A | pH, B | Time (min), C | % COD (actual) | % COD (predicted) |
|---------------|-------------|-------|---------------|----------------|------------------|
| 1             | 13.89       | 5     | 10            | 37.91          | 35.27            |
| 2             | 41.67       | 5     | 10            | 36.76          | 36.38            |
| 3             | 13.89       | 9     | 10            | 51.11          | 49.59            |
| 4             | 41.67       | 9     | 10            | 58.33          | 59.10            |
| 5             | 13.89       | 5     | 30            | 54.68          | 52.59            |
| 6             | 41.67       | 5     | 30            | 53.19          | 53.38            |
| 7             | 13.89       | 9     | 30            | 52.50          | 53.56            |
| 8             | 41.67       | 9     | 30            | 69.44          | 67.75            |
| 9             | 13.89       | 7     | 20            | 50.44          | 52.63            |
| 10            | 41.67       | 7     | 20            | 54.67          | 57.78            |
| 11            | 27.78       | 5     | 20            | 62.40          | 66.32            |
| 12            | 27.78       | 9     | 20            | 77.78          | 79.16            |
| 13            | 27.78       | 7     | 10            | 62.50          | 65.27            |
| 14            | 27.78       | 7     | 30            | 74.22          | 76.75            |
| 15            | 27.78       | 7     | 20            | 75.70          | 73.93            |
| 16            | 27.78       | 7     | 20            | 75.70          | 73.93            |
| 17            | 27.78       | 7     | 20            | 75.70          | 73.93            |
| 18            | 27.78       | 7     | 20            | 75.70          | 73.93            |
| 19            | 27.78       | 7     | 20            | 75.70          | 73.93            |
| 20            | 27.78       | 7     | 20            | 75.70          | 73.93            |

Fig. 1. Actual and predicted response for % COD removal of DS.

Table 2
Central Composite Design (CCD) it’s actual and predicted values.
Fig. 2. 3D surface plot showing the effect of CD and time on percent COD removal of DS.

Fig. 3. Box-Cox plot for power transforms for percent COD removal of DS.
5, 7 and 9 were chosen because treatment at these pH gave good results as compared to other pH. The values of COD obtained by ANOVA and experimental values of COD for set of data is presented in Table 2. The set of data were taken as per earlier report [2,3]. The experimental data were fitted for second order polynomial by regression method using ANOVA and the relation obtained for percent COD removal was evaluated. The equation gave significant coefficient of determination ($R^2$) = 97.56% and adjusted $R^2$ = 95.56% shows validity of model up to mark. In EC studies of distillery wastewater, $R^2$ = 0.9144 has been reported by Thakur et al. [4]. Predicted values of COD removal determined by Equation (1) are very close to experimental values confirms validity of model (Table 2). The low value of SD shows closeness of predicted and experimental values. In present case SD = 2.85 is fair good. The maximum 3.8% deviation has been noted for experimental and predicted values of COD (from Equation (1)). The value of 3.97 was noted by a investigator [5].

$$\text{Percent COD removal} = -56.45 + 4.57 \times \text{CD} + 6.64 \times \text{pH} + 2.42 \times \text{time} - 0.097 \times \text{CD}^2 - 0.299 \times \text{pH}^2 - 0.02 \times \text{time}^2 + 0.121 \times \text{CD} \times \text{pH} + 10^{-3} \times \text{CD} \times \text{time} - 0.13 \times \text{pH} \times \text{time} \quad (1)$$

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### Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.
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