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Data Article

Dataset on statistical reduction of COD by electrocoagulation process using RSM

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A B S T R A C T

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 (t_R) 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/m^2 and t_R = 20 min respectively.

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 t_R. 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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Specifications Table

Subject area	*Environmental engineering*
More specific subject area	*Wastewater treatment, electrocoagulation (EC) process*
Type of data	*Figures and Tables*
How data was acquired	*All experiments were performed in cubical reactor of 2 L as per standard run order obtained from central composite design (CCD) model. COD and pH were measured before and after each experiment and at certain time intervals of run. COD was carried out by closed reflux methods pH was measured by digital pH meter (EI-111, India)*
Data format	*Filtered Raw, Processed and analyzed*
Experimental factors	*pH, current density, operating time was considered to investigate the reduction of COD using batch EC process.*
Experimental features	*Optimization of batch EC process for the reduction of COD*
Data source location	*Institution: National Institute of Technology Raipur City/State: Raipur, Chhattisgarh, India*
Data accessibility	*Processed and analyzed data is with this article*

Value of Data

- The effect of pH, t_R and CD on COD removal from DS was optimized for EC process.
- Data would be beneficial for the researchers those are working on optimization of EC for the treatment of municipal wastewater
- The acquired optimized data will be advantageous for the research institutes and industries and municipal corporations wanting to scale up and design an effective sewage treatment plant (STP).
- The treated effluent can be discharged into the environment.

generated. Fig. 1 shows the graphs between predicated values and actual values. The correlation co-efficient obtained by the model is satisfactory, Fig. 2 shows 3D surface plot showing the effect of CD and t_R 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/m^2), A	13.89	27.78	41.67
pH, B	5	7	9
Time (min), C	10	20	30

Table 2
Central Composite Design (CCD) it's actual and predicted values.

Standard Order	CD (A/m^2), A	pH, B	Time (min), C	% COD (actual)	% COD (predicted)
1	13.89	5	10	37.91	38.27
2	41.67	5	10	36.76	34.38
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

2.2. Experimental procedure

The EC treatment was performed in 2 dm^3 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 dm^3 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 t_R 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

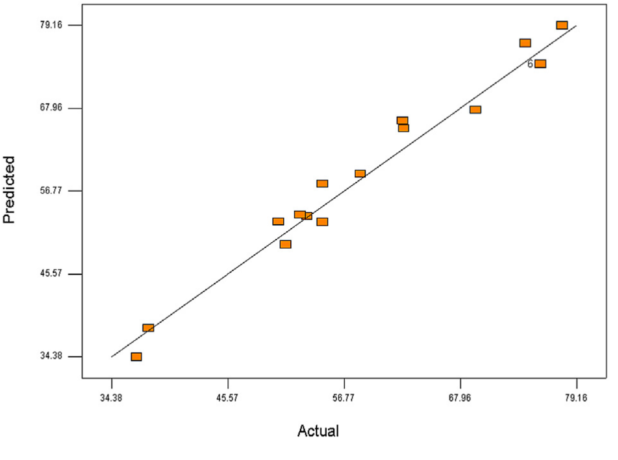

Fig. 1. Actual and predicted response for % COD removal of DS.

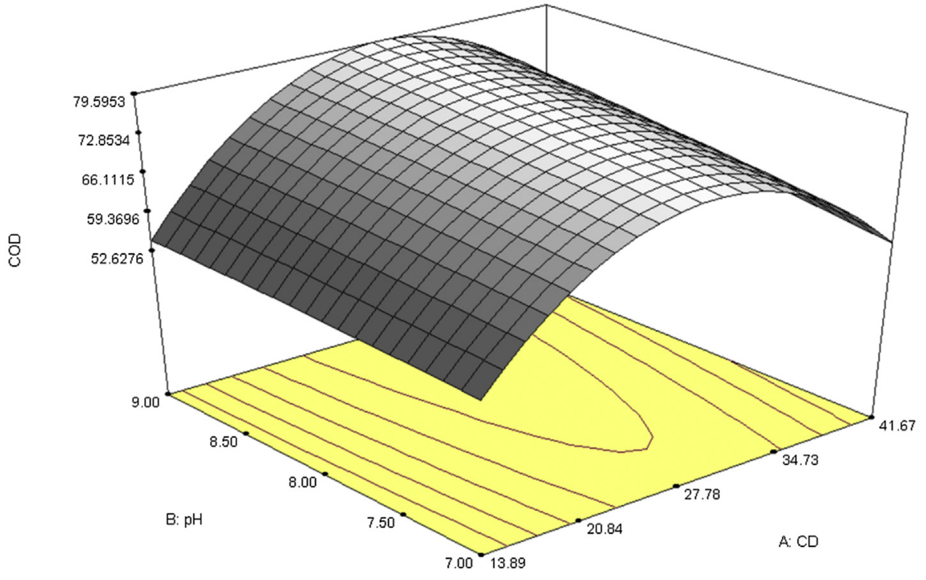

Fig. 2. 3D surface plot showing the effect of CD and time on percent COD removal of DS.

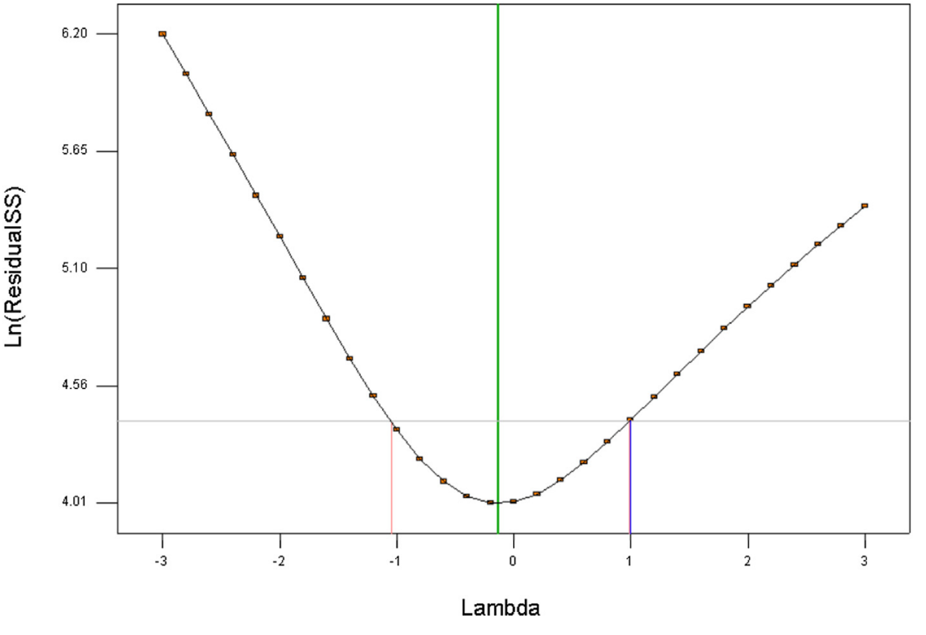

Fig. 3. Box-Cox plot for power transforms for percent COD removal of DS.

Table 3
ANOVA results from the data of Central Composite Design experiments.

Source	SS	DF	MS	FV	Prob > F
Model	3251.88	9	361.32	44.34	<0.0001
A	137.62	1	137.62	16.89	0.0021
B	58.878	1	58.88	7.23	0.0228
C	150.76	1	150.76	18.5	0.0016
A^2	964.97	1	964.97	118.41	<0.0001
B^2	3.94	1	3.94	0.48	0.5026
C^2	23.56	1	23.56	2.89	0.1199
AB	89.78	1	89.78	11.02	0.0078
AC	10.99	1	10.99	1.35	0.2723
BC	53.56	1	53.56	6.57	0.0282
Residual	81.49	10	8.15		
Lack of Fit	81.49	5	16.29		
Pure Error	0	5	0		
Cor Total	3333.37	19			

SS = Sum of Squares, DF = Degree of freedom, MS = Mean Square, FV = F-Value.

Table 4
ANOVA results for the treatment of domestic sewage.

Source	SD	R^2	Adj. R^2	Pred. R^2	PRESS	Remarks
Linear	12.56	0.2425	0.1005	−0.2848	4282.80	
2FI	13.50	0.2888	−0.0394	−3.2396	14132.25	
Quadratic	2.85	0.9756	0.9536	0.8201	599.60	Suggested
Cubic	3.27	0.9807	0.9390	−22.6861	78954.45	Aliased

SD = Standard Deviation, PRESS = Predicted Residual Error Sum of Squares, R^2 = Determination coefficient, Adj. R^2 = Adjusted R^2, Pred. R^2 = Predicted R^2.

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].

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

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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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