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## Data Article

# Modeling and optimization data analysis on photocatalytic decolourization of amido black 10B using ZnO catalyst



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## ABSTRACT

This article contains the experimental and statistical data related to decolourization of Amido Black 10B using photocatalytic process. Box-Behnken experimental design (BBD) has been used to study the influence of operational parameters on photocatalytic oxidation of Amido Black 10B by using zinc oxide (ZnO) as a catalyst. This data set presents a concise description of experimental conditions for variable factors such as initial dye concentration of 100 ppm, oxidant dosage 20 mMol/L and catalyst dose 1g/L at natural pH for 4 hr of reaction time in presence of 12W intensity ultra-violet radiation were optimized for over a response parameter, decolorization efficiency of Amido Black 10B. The effects of decolorization on process variables were investigated by developing a mathematical model, results indicated that ZnO can be used as an efficient catalyst for the decolorization of Amido Black 10B. Analysis of variance (ANOVA) showed a high coefficient of statistical measure value ( $R^2 = 0.9915$ ) and prediction of the driven regression model was found to be satisfactory.

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## Specifications table

Subject area	Environmental Engineering
More specific subject area	Advanced Oxidation Process
Type of data	Table and Figures
How data was acquired	The ZnO catalyst was blended with the dye aqueous solution, stirrer was utilized for uniform blending at that point, known amount of oxidant was added and observed for their photo-degradation efficiency. Three variables were evaluated over a response using BOX-Behnken design for optimization of experimental condition. The dye concentration of solution was determined by using UV–vis spectrophotometer at 618 nm wavelength.
Data format	Raw and Analyzed
Experimental Factor	Variable parameters, dye concentration, oxidant dosages (H <sub>2</sub> O <sub>2</sub> ) and catalyst dosages (ZnO) was analyzed over a response parameter, decolorization efficiency of Amido Black 10B.
Experimental features	Statistical analysis of Photocatalytic decolorization of Amido Black 10B with Zinc oxide as a catalyst by using Box-Behnken experimental design (BBD). Box-Cox plot data generated by Design Expert software used for power transformation study.
Data source location	National Institute of Technology Raipur, Raipur Chhattisgarh, India
Data accessibility	Data information are available in this article only
Related research articles	M. Shanthi and V. Kuzhalsoi, Photocatalytic degradation of an azo dye, Acid Red 27, in aqueous solution using nano ZnO, Indian J. Chem. 51A (2012) 428–434. <a href="http://nopr.niscair.res.in/handle/123456789/13656">http://nopr.niscair.res.in/handle/123456789/13656</a> .

**Value of data**

- ZnO catalyst has a promising application for photocatalytic decolorization of amido black 10B from aqueous solution.
- The statistical data will be useful for optimization of amido black 10B removal from dye industry wastewater by photocatalytic oxidation.
- The utilization of Box-Behnken experimental design (BBD) for optimization can support researchers to utilize outline in other color removal from dye industry wastewater.
- The Box-Cox plot data will be helpful to determine the most appropriate power transformation to apply in response data. Most data transformations can be described by the power function.

**1. Data**

The dataset represent the application of Box-Behnken design (BBD) for optimization of photocatalytic decolorization of Amido Black 10B by using ZnO catalyst [1,2]. Properties of Amido Black 10B is shown in Table 1. Table 2 shows low and high values of factors and limit of experiment run in Box-Behnken design. Experimental design model and outcomes of Amido Black 10B color decolorization have been exhibited in Table 3. The ANOVA obtained is shown in Table 4 and *P*-value less 0.05 and lack of fit values demonstrate that the model is significant [3,4]. A summary of information for the proposed model as diagnostic case statistics actual and predict values for testing the significance of the regression coefficients is presented in Fig. 1. Fig. 2 represent the box-cox power transformation for normal distribution of dataset and Fig. 3(a–c) represents the 3D contour lines plots for the effects of three independent variables dye concentration, oxidant dosages (H<sub>2</sub>O<sub>2</sub>) and catalyst dosages (ZnO) on

**Table 1**  
Properties of Amido Black 10B dye.

Dye	Amido Black 10B
Nature	Acidic dye
Other names	Naphthol Blue Black, Acid Black 1, Acidal Black 10B
Empirical formula	C <sub>22</sub> H <sub>14</sub> N <sub>6</sub> Na <sub>2</sub> O <sub>9</sub> S <sub>2</sub>
Formula Weight	616.49 g/mol
Appearance	Blue-Black
Control Parameters	Threshold Limit Value (TLV) - 10 mg/m <sup>3</sup>

**Table 2**

Coded levels of variable factors and experimental range.

Factor Coded	Factor	Unit	Levels of Box-Behnken		
			Low (-1)	Middle (0)	High (+1)
A	Initial Concentration of Dye	ppm	50.00	100.00	150.00
B	Catalyst Dosage	gm/L	1.00	2.00	3.00
C	Oxidant Dose	mMol/L	10.00	20.00	30.00

**Table 3**

Box-Behnken Design experimental model and response results.

Run	Initial Dye Concentration (ppm)	Catalyst Dosage (gm/L)	Oxidant dose (mMol/L)	Observed Response Decolorization (%)	Predicted Response Decolorization (%)
1	150	3	20	55	55.13
2	100	2	20	65	65.00
3	100	2	20	65	65.00
4	50	3	30	70	69.88
5	50	3	20	68	68.38
6	100	2	30	60	59.26
7	100	1	10	56	56.37
8	100	1	30	62	62.10
9	150	3	10	52	51.63
10	150	2	10	55	55.00
11	100	2	30	60	59.26
12	50	2	20	65	65.00
13	150	2	10	55	55.00
14	100	1	20	70	69.26
15	100	2	20	65	65.00
16	50	2	20	65	65.00
17	100	1	20	70	69.26

**Table 4**

Quadratic model test Analysis of variance (ANOVA).

Source	Sum of squares	D <sub>f</sub>	Mean square	F value	p-value, Prob>F
Model	558.28	9	62.03	90.78	<0.0001
A	16.62	1	16.62	24.33	0.0017
B	14.07	1	14.07	20.62	0.0027
C	35.02	1	35.02	51.25	0.0002
A <sup>2</sup>	14.04	1	14.04	20.55	0.0027
B <sup>2</sup>	11.91	1	11.91	17.43	0.0042
C <sup>2</sup>	165.92	1	165.92	242.83	<0.0001
AB	10.93	1	10.93	15.99	0.0052
AC	52.68	1	52.68	77.10	<0.0001
BC	32.12	1	32.12	328.12	0.0016
Residual	4.78	7	0.68		
Lack of fit	4.78	1	14.78		Insignificant
Pure Error	0.00	6	0.000		
Core Total	595.16	16			

Amido Black 10B decolorization efficiency. A quadratic equation between response and independent variables was obtained according to Equation (1).

$$\text{Decolorization} = 65.49 - 3.10 * A - 2.0913 * B + 3.30 * C - 3.59 * A^2 + 1.69 * B^2 - 9.53 * C^2 - 3.03 * A * B - 9.03 * A * C - 0.066 * B * C \quad (1)$$

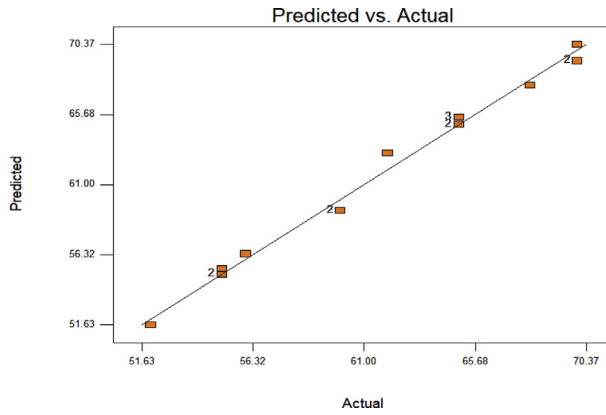


Fig. 1. Actual and predicted response data for decolorization of Amido Black 10B.

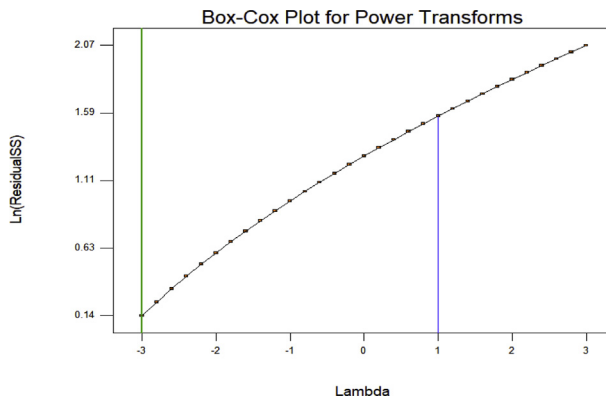


Fig. 2. Box-Cox plot for decolorization of Amido Black 10B.

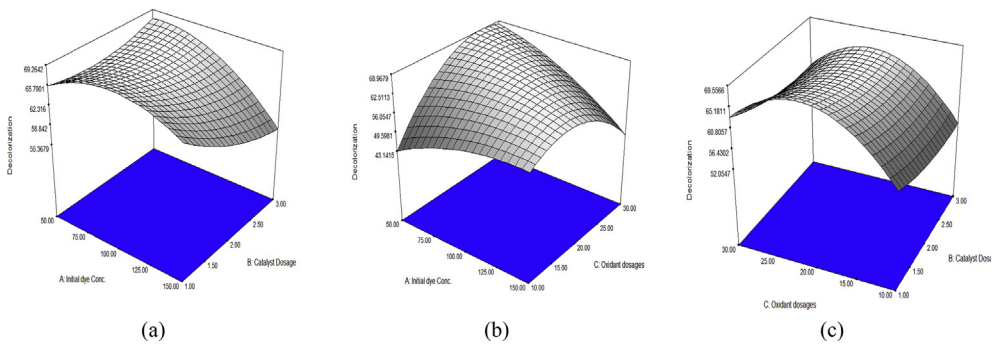


Fig. 3. 3D contour plot for interaction effect of decolorization on (a) initial concentration of dye, oxidant (b) catalyst dosage, initial concentration of dye (c) oxidant dose, catalyst dosage.

## 2. Experimental design, materials and methods

### 2.1. Materials

All chemical used in this data article is of analytical grade. Commercial Zinc Oxide (ZnO) and Hydrogen peroxide ( $\text{H}_2\text{O}_2$ , 30%) were purchased from Merck Chemicals, India. Amido Black 10B ( $\text{C}_{22}\text{H}_{14}\text{N}_6\text{Na}_2\text{O}_9\text{S}_2$ ) dye was purchased from LOBA Chemie, India. The pH of the solution was adjusted by 1 N  $\text{H}_2\text{SO}_4$  and 1 N NaOH solution. Distilled water was used for preparation of various solutions.

### 2.2. Design of experiment

For the statistical design of the experiments and data analysis, Design Expert programming (Version 6.0.8) was utilized. In this investigation, BBD model with 3 variable factors, which is response surface technique, was utilized and a total of 17 trial sets were employed. As experimental parameters such as initial dye concentration (A), catalyst dosages (B), oxidant dosages (C) and as response variables, Decolorization efficiency was determined as system responses. Graphical perspective of the mathematical model has resulted in the creation of response surface method term. The relationship between response and variables is illustrated in Eq. (1). Main goal of this study is to optimize the process for maximum efficiency and the influential factors evaluation of interactions between these factors, and modeling mathematical result.

Photocatalytic reactions were carried out in a Batch process. The arrangement consists of two 6 Watts tungsten-halogen lamps (Philips, India) to facilitate continuous emission of UV light. Solution was kept in a borosilicate glass vessel (1000 ml). A magnetic stirrer was provided for proper circulation of catalyst throughout the vessel. The arrangement was kept inside a Chamber and reactions were carried out at room temperature. Initial concentration of the dye solution was taken as  $C_0$ . For measuring the decolorization rate the decomposed dye was taken out after every 30 min, and filtered to separate out the catalyst. The UV–visible spectrophotometer was used to measure the absorption spectrum of the decomposed dye. The concentration of solution at any time interval  $t$  is  $C_f$ . The decolorization rate of Amido Black 10B dye was estimated by the following equation [5,6]:

$$\text{Decolorization Rate} = \frac{(C_0 - C_f)}{C_0} \times 100 \quad (2)$$

where,  $C_0$  denotes the initial concentration.

$C_f$  denotes concentration at time  $t$ .

### 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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