

Área: **ANA**

## Photodegradation of Brilliant Blue dye using zinc oxide (ZnO) photocatalysts

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Palavras Chave: *Photocatalysis, Zinc Oxide, Industrial Dyes, Brilliant Blue.*

### Highlights

- Influence of physicochemical parameters on the degradation kinetics of Brilliant Blue assisted by the ZnO semiconductor.
- Higher dosage values and lower dye concentration values tend to maximize the kinetic constant values.

### Resumo/Abstract

Micropollutants, including dyes, heavy metals, and pharmaceuticals, pose significant threats to ecosystems and human health, with industrial effluents as a major contributor. While conventional wastewater treatment methods can remove some of these compounds, they often fail to fully degrade persistent pollutants under conditions that are scalable to industrial levels. This study investigates the photocatalytic degradation of brilliant blue (BB), an industrial dye, using a photoreactor equipped with a UV-LED source ( $\lambda_{\text{max}} = 368 \text{ nm}$ , irradiance  $15.68 \text{ mW cm}^{-2}$ ). The effects of pH (5.0, 7.0, and 9.0), ZnO photocatalyst dosage (0.05, 0.15, and  $0.20 \text{ g L}^{-1}$ ), and dye concentration ( $10.0$ ,  $20.0$ , and  $30.0 \text{ mg L}^{-1}$ ) on the pseudo-first-order kinetic degradation constant of BB were evaluated. In the pH and catalyst dosage studies, a fixed dye concentration of  $10.0 \text{ mg L}^{-1}$  was maintained. The results indicate that the ZnO dosage is the most critical variable influencing the photodegradation of BB. At a dosage of  $0.20 \text{ g L}^{-1}$ , the kinetic constant reached approximately  $19.0 \times 10^{-2} \text{ min}^{-1}$  ( $t_{1/2} = 3.7 \text{ min}$ ), which is about 2 times higher than at  $0.10 \text{ g L}^{-1}$ . The increase in photocatalytic efficiency with higher dosages is attributed to enhanced light absorption and increased surface area, providing more active sites for the reaction. However, excessive dosages may reduce light penetration and increase turbidity, potentially hindering the process. At pH 7.0, the kinetic constant was  $7.26 \times 10^{-1} \text{ min}^{-1}$  ( $t_{1/2} = 9.53 \text{ min}$ ). This pH yielded the highest kinetic constant value, indicating that under neutral conditions, the adsorption process occurs more rapidly. Regarding dye concentration, increasing the initial concentration from  $10.0$  to  $30.0 \text{ mg L}^{-1}$  reduced the kinetic constant by a factor of four at a fixed ZnO dosage of  $0.15 \text{ g L}^{-1}$ . This reduction is likely due to increased competition among dye molecules for active sites on the catalyst surface, thereby limiting their availability and decreasing degradation efficiency. In conclusion, the optimal conditions for BB degradation were found to be at pH 7.0, a ZnO dosage of  $0.20 \text{ g L}^{-1}$ , and a dye concentration of  $10.0 \text{ mg L}^{-1}$  under the experimental conditions tested. These findings highlight the importance of optimizing operational parameters to achieve efficient photocatalytic degradation of micropollutants in industrial wastewater.

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