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Evaluation of the Photocatalytic Activity of Chitosan-G-C_3N_4 Composite for Methylene Blue Degradation

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Abstract

The growing concern over environmental pollution has driven research into effective, sustainable solutions, particularly in the field of water treatment. This study investigated the photocatalytic activity of a chitosan- g-C_3N_4 composite, aimed at degrading methylene blue (MB), a prevalent organic dye and pollutant in wastewater. Chitosan (CS) was synthesized from shrimp shells using a series of chemical processes, including demineralization, deproteination, and deacetylation, while graphitic carbon nitride (g-C_3N_4) was synthesized via thermal treatment of urea. The composite was prepared by mixing varying ratios of CS and g-C_3N_4, and its photocatalytic efficiency was tested against MB solutions of different concentrations under visible daylight including MB solution, chitosan and MB solution, g-C_3N_4 and MB solution as controls. Results showed that the chitosan-g-C_3N_4 composite effectively degraded methylene blue, and the degradation efficiency depends on the composite ratio and MB concentration. The highest rate constant of 10.6×10^{-3} min^{-1} was obtained with 2 ppm MB solution using 1:1 ratio of CS to g-C_3N_4, while a 1:2 ratio demonstrated optimal degradation rates for both 4 ppm and 5 ppm MB solutions, achieving a rate constant of 6.5×10^{-3} min^{-1}. The 1:2 ratio of chitosan to g-C_3N_4 consistently provided one of the most efficient degradation rates across concentrations, especially at 2 ppm. These findings underscore the potential of g-C_3N_4 and its composites with chitosan, particularly those with higher g-C_3N_4 content, to significantly improve photocatalytic degradation of MB compared to chitosan alone. The optimum performance was achieved at lower MB concentrations (2 ppm), with the 1:1 and 1:2 ratios being particularly effective. The enhanced photocatalytic activity is attributed to the synergistic interaction between chitosan and g-C_3N_4, where chitosan's adsorption properties complement the photocatalytic abilities of g-C_3N_4 by facilitating the separation of photogenerated electron-hole pairs and reducing recombination. This study highlighted the potential of using chitosan- g-C_3N_4 composites for wastewater treatment applications. By utilizing waste-derived chitosan, this approach not only enhances photocatalytic processes but also contributes to sustainable material development. The findings suggest that the composite can serve as an eco-friendly, cost effective, and efficient photocatalyst for degrading organic pollutants in wastewater, making it a promising and scalable solution for addressing water contamination challenges.

Keywords: *Photocatalysis, Chitosan, g-C_3N_4, Methylene blue, Wastewater treatment*