Eco-friendly synthesis and application of magnetite nanocomposites for the purification of dye-contaminated water

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Abstract

A large number of industries use dyes in their production processes, consuming substantial amounts of water and consequently generating large volumes of wastewater. Methylene blue is one of the most widely used dyes in various industrial applications, and its presence at elevated concentrations can cause serious health and environmental problems; therefore, its removal from wastewater is of extreme importance. Advanced oxidation processes, which decompose pollutants into biodegradable products, represent a promising approach for the efficient treatment of dye-contaminated water. However, one of the main challenges remains the development of photocatalysts that combine high photocatalytic efficiency, recyclability, and effective utilization of solar energy.

In this study, newly synthesized Fe_3O_4/PVC composites were investigated as photocatalysts for the removal of methylene blue ($c_o = 2.45 \times 10^{-2}$ mM) under simulated solar radiation and dark conditions. Magnetite (Fe_3O_4) was synthesized via an electrosynthesis method using a rotating cylindrical electrode. Fe_3O_4 and commercial PVC were used in the preparation of the composites. Fe_3O_4/PVC composites were prepared with different mass ratios of Fe_3O_4 to PVC (1%, 2.5%, and 5% w/w). The composites were shaped into tablets with a diameter of 5 mm and a thickness of 2 mm. The highest methylene blue removal efficiency (99.72%) under simulated solar radiation was achieved using the 2.5%Fe_3O_4/PVC photocatalyst. The degradation kinetics was monitored by UV/Vis spectrophotometry.

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