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Original Research Article

Synthesis and Carbonization of Core-Shell ZIF-67@ZIF-90 for Ciprofloxacin and Azithromycin Removal

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Abstract

The elimination of antibiotics such as Azithromycin (AZM) and Ciprofloxacin (CIP) from the contaminated water is crucial to safeguard both human health and environmental quality. This study investigates the synthesis of CoNC@NC core-shell composite by carbonizing ZIF-67@ZIF-90 composite, and the implementation of them in removing antibiotics from aqueous solutions. The composites were characterized using XRD, SEM, FTIR, Raman, TGA, and N_2 adsorption-desorption. In the batch adsorption tests, the carbonized composite showed enhanced adsorption capacities compared to the original composite, with maximum adsorption capacities for AZM and CIP being 256.49 mg/g and 514.26 mg/g, respectively. The adsorption process was found to fit the pseudo-first-order kinetics and Langmuir isotherm models. The solution pH showed a significant impact on the adsorption capacity, with maximum capacities recorded at pH of 7 and 6 for the AZM and CIP solutions, respectively. In addition, it was demonstrated that after five regeneration cycles, the carbonized composite maintained the adsorption capacity at over 90% of the first cycle value, suggesting good reusability. These results revealed the potential of using CoNC@NC composites in environmental decontamination and antibiotic removal for wastewater treatment.

Keywords: Core-Shell ZIF-67@ZIF-90; carbonization; removing Antibiotics; ciprofloxacin; azithromycin

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1. Introduction

The presence of pharmaceuticals in the water environment has become a serious concern for both the environment and human health [1-4]. Among them, antibiotics, such as azithromycin (AZM) and ciprofloxacin (CIP), have been frequently detected in drinking water, surface water, groundwater, and wastewater [5,6]. The extreme exposure to these antibiotics not only causes serious damage to the human body, but also can be harmful to the ecosystems and promote the dissemination of antibiotic resistance genes [7]. The incomplete removal of the antibiotics from the treated water using the traditional methods highlights an urgent need to develop efficient technologies to capture them from aqueous media. In this context, different physical and chemical methods, including membrane separation, adsorption, anaerobic reactors, chemical degradation, photocatalytic degradation, photo Fenton, electrocoagulation, and ozonation, were developed [8-10]. Among the other treatment technologies, adsorption has been considered as a promising method in the fight against water pollution owing to its high efficiency, simple operation, and cost-effectiveness [11]. Conventional adsorbents (e.g., metal oxides, zeolites, and porous carbons) often suffer from practical problems, including high cost, difficulties of regeneration, and low adsorption

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