Technical Strategies in Water Systems
https://sanad.iau.ir/journal/tsws
ISSN (Online): 2981-1449
Autumn 2023: Vol 1, Issue 2
https://doi.org/10.30486/TSWS.2023.783193

Research Article

Modeling of copper removal from electroplating industry wastewaters using zinc oxide nano adsorbent supported on graphene oxide

Mahin Moradi[1], Soroor Sadeghi*[2], Sara Sharifi[3]

[1] Department of Chemical Engineering, College of Engineering, Kermanshah Branch, Islamic Azad University, Kermanshah, Iran.

[2] Department of Chemistry, College of Basic Sciences, Kermanshah Branch, Islamic Azad University, Kermanshah, Iran.

[3] Department of Biology, College of Basic Sciences, Kermanshah Branch, Islamic Azad University, Kermanshah, Iran.

**Corresponding Author email:* soroorsadeghi@iauksh.ac.ir

Received: 03 Sept 2023 Accepted: 08 Oct 2023 Published: 14 Oct 2023

Extended Abstract

Introduction

The discharge of industrial wastewater containing heavy metals, such as copper, poses significant environmental and health risks due to their toxicity, persistence, and bioaccumulation in ecosystems. Traditional methods for removing heavy metals from wastewater, including chemical precipitation, coagulation, and ion exchange, are often costly, inefficient, or generate secondary pollutants. Adsorption has emerged as a promising alternative due to its simplicity, cost-effectiveness, and high efficiency. In this study, a novel nanocomposite adsorbent, zinc oxide nanoparticles supported on graphene oxide (ZnO/GO), was developed for the removal of copper ions from electroplating wastewater. The adsorbent was characterized, and its performance was evaluated under various experimental conditions.

Materials and Method

Graphene oxide (GO) was synthesized using a modified Hummers' method, and its structure was confirmed by FTIR spectroscopy and SEM imaging. Zinc oxide nanoparticles were immobilized on GO to create the ZnO/GO nanocomposite. Batch adsorption experiments were conducted to optimize parameters such as pH, initial copper concentration, contact time, adsorbent dosage, and temperature. The adsorption capacity and efficiency of the nanocomposite were evaluated using simulated and real industrial wastewater samples. Isotherm, kinetic, and thermodynamic studies were performed to elucidate the adsorption mechanism.

Results and Discussion

The ZnO/GO nanocomposite exhibited a high adsorption capacity for copper ions, with a maximum removal efficiency of 89.77% achieved at pH 7, using 0.5 g of adsorbent, a contact time of 30 minutes, and an initial copper concentration of 200 mg/L at 20°C. The adsorption process followed pseudo-second-order kinetics, indicating chemisorption as the rate-limiting step. The Freundlich isotherm model best described the adsorption

behavior, suggesting heterogeneous surface adsorption. Thermodynamic analysis revealed that the adsorption process was spontaneous and exothermic, with an enthalpy change (ΔH) of -6361.21 J/mol. The nanocomposite demonstrated excellent performance in removing copper from both simulated and real industrial wastewater, achieving a removal efficiency of up to 99.95%.

Conclusion

The ZnO/GO nanocomposite proved to be an effective, low-cost, and environmentally friendly adsorbent for the removal of copper ions from electroplating wastewater. Its high adsorption capacity, rapid kinetics, and ease of synthesis make it a promising candidate for industrial wastewater treatment. The study highlights the potential of graphene-based nanocomposites for the efficient removal of heavy metals, contributing to sustainable water management practices.

Keywords: Graphene oxide, Nano zinc oxide, Copper, Nano-adsorbent, Electroplating wastewater