



Title

Remarkable Separation of Carbofuran Pesticide from Aqueous Solution Using Free Metal Ion Variation on Aluminum-Based Metal-Organic Framework

Abstract

The alarming increase in pesticide residues poses a major threat to aquatic and natural habitats. Therefore, it has become essential to design extremely operationally and economically advantageous systems for the removal of carbofuran pesticides from wastewater. Here, an aluminum based metal-organic framework (MOF), MIL-53-NH₂, and its modified forms, MIL-53-NH-ph, MIL-53-NH-ph-Fe, MIL-53-NH-ph-Zn, and MIL-53-NH-ph-Cu, have been successfully synthesized. Full characterization using IR, ¹HNMR, XRD, and SEM was carried out. The prepared MOFs have been utilized as effective adsorbents for carbofuran in aqueous solutions. The various factors affecting the adsorption process (pH, time, and adsorbate concentration) were also investigated. Spectroscopic approaches were used to investigate the adsorption mechanisms. A mixture of π - π stacking contact, coordination bonding, and hydrogen bond formation can be connected to the current process. The adsorption of carbofuran from aqueous solutions was best described by pseudo-second-order kinetics and Langmuir equilibrium isotherm models. MIL-53-NH₂, MIL-53-NH-Ph, MIL-53-NH-Ph-Fe, MIL-53-NH-Ph-Zn, and MIL-53-NH Ph-Cu demonstrated adsorption capacities of 367.8, 462.1, 662.94, 717.6 and 978.6 mg g⁻¹, respectively. The current study proposes an ideal approach for the removal of carbofuran from wastewater, on the basis that the framework has a free metal center that facilitates coordination bonding with carbofuran insecticide.