

The Iron Based Metal Organic Frameworks MIL -101(Fe) Synthesis and Using for the Removal of the Imidacloprid from the Aqueous Solutions

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Abstract

Metal organic frameworks (MOFs), also called porous coordination polymers (PCPs), have been rapidly growing attention as a new type multifunctional materials in the last three decades. High surface area, large porosity, high thermal stability and modular inorganic/organic hybrid structure of the MOF materials have prompted researches of their potential applications in the areas of adsorption, separation, catalysis and gas storage. MOFs possess multiple functional sites that can be rationally designed their, regular and excellent pore structures. Iron based MIL-101 and iron based amino functionalization (NH₂-MIL-101) are one of the porous MOF materials owing to high surface area and high thermal stability which have been studied extensively. MIL-101 is made from the linkage of 1,4 benzene dicarboxylate (H₂bdc) and inorganic trimers that consist of three iron atoms in an octahedral geometry also NH₂-MIL-101 is made from the like MIL-101 but only difference amino functionalized MIL-101 is made from the 2-amino 1,4 benzene dicarboxylate (2-amino H₂bdc) organic linkers. Imidacloprid (IMC) is a systematic neonicotinoid pesticides effective for controlling sucking insects and used as seed-dressing, soil treatment in various crops. The half-life of imidacloprid in water is 33-45 days, depending on the amount of IMC. Within this scope, the growing use of imidacloprid has raised environments concern due to high solubility in water and low degradation by adsorption and photolysis process so removing imidacloprid from the aqueous solutions is an important.

In this study, MIL-101 and NH₂-MIL-101 (MIL, Material of Institute Lavoisier), were synthesized by solvothermal method and used for the investigation of IMC removal from aqueous solutions. The synthesized MIL-101 and NH₂-MIL-101(Fe) were characterized by XRD, SEM and FT-IR. The IMC removal from aqueous solutions with MIL-101 and amine functionalized MIL-101 were performed in a batch reactor. Also investigated two main parameters one of these effect of the initial imidacloprid concentration and the other one is effect of the initial MIL-101 and amine functionalized MIL-101 concentration. The amount of IMC was determined by high pressure liquid chromatography-diode array detector (HPLC-DAD). Furthermore the results obtained and compared each other. According to SEM results MIL-101 and amine functionalized MIL-101 have octahedral shape and also approximately particle size 1.5-3.0 µm. XRD results indicate that characteristic peak of amine functionalized MIL-101 and MIL 101 as shown by the higher relative intensity of the peaks in the 3-6° and 9-10° range, respectively. FT-IR results show that the typical asymmetric C-O and symmetric C-O stretches of terephthalate ligands in MIL 101 and amino-functionalized MIL-101 structures, assigned to the bands located at 1661, 1595, 1388 cm⁻¹ and 1653, 1559, 1382 cm⁻¹ for MIL-101 and amino-functionalized MIL-101, respectively. Also presence of amino groups in their free unassociated form is indicated by the bands located at 3470, 3373, 2979 cm⁻¹ corresponding to asymmetric N-H and symmetric N-H stretching modes, respectively. The highest removal percent of IMC was 82.8% with 20 mg/L NH₂-MIL-101 at 180 min on the initial concentration of 42.44 mg/L imidacloprid.

Keywords: NH₂-MIL-101(Fe), Metal Organic Framework (MOF), imidacloprid.

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