IMSEC 2017
2nd International Mediterranean Science and Engineering Congress (IMSEC 2017)
Çukurova University, Congress Center, October 25-27, 2017, Adana / TURKEY
Pages:

The Synthesis and Characterization of Zero Valent Iron Nanoparticles and Using for the Degradation of Imidacloprid

Utku Bulut Simsek[1*], Cihan Gecgel[1], Meral Turabik[1,2]

[1]Mersin University Department of Nanotechnology and Advanced Materials, Turkey ;
U.B.Simsek (utkubulutsimsek@msn.com), C. Gecgel (cihangecgel@hotmail.com),
[2]Mersin University Technical and Vocational School Chemical Program, M.Turabik (mturabik@mersin.edu.tr)

Abstract

In recent years, many research have focused on certain materials for the removal of pesticides, such as nanoparticles. Pesticides, a class of synthetic compounds with high toxicity, have been extensively used due to their low price and effective ability to protect crops from pests and diseases. Imidacloprid (IMC) is also one of the most important chlorinated insecticide because of extensive use and its toxicity. In this study, degradation of imidacloprid (IMC) from aqueous solution, by zero valent iron nanoparticles (Fe^0, nZVI) has been investigated in a batch reactor as a function of nitrogen/air reaction medium, nZVI dosage, temperature and pH. The synthesis of nZVI were carried out by the reduction of ferric iron ions with borohydride method and characterized by SEM, EDX, FTIR, DLS and XRD measurements before and after treatment with IMC. The XRD and FT-IR measurements indicates that the typical characterization peak of nZVI was not changed in anoxic (Fe^0/N_2) medium but an additional peak of magnetite was observed in oxic (Fe^0/air) medium showing the oxidation of nZVI particles. SEM results showed decomposed structures in air medium, but spherical and homogeneous shape have protected in nitrogen medium. The more increased particles sizes for treated with imidacloprid in air medium might be because of formed magnetite layer on the Fe^0 core that effects the degradation efficiency. The effects of nZVI dosage, pH and temperature were also investigated in the nitrogen medium and degradation rate constants (k_1) were determined by using first-order kinetics model. The increased nZVI amount enhance the active sites and reactive surface areas of zero valent iron and also the degradation efficiency of IMC. Lower IMC removal efficiencies were obtained at higher pH and especially at the lower pH values than original pH of IMC because of the by accelerating the corrosion of iron at low pH, and passivating it by the formation of iron hydroxides at high pH. Temperature effect was investigated for different temperature values and IMC removal percents increased as 92.28% to 100.00% with increasing solution temperature proved to be an endothermic reaction. Also, the activation energy(E_a) value was calculated as 54.68 kJ/mol indicating that the dominating degradation reactions of imidacloprid was take place on the surface of nZVI. The level of the imidacloprid mineralization was also investigated by COD and released inorganic ions measurements. The results showed low mineralization efficiency as 12.5% COD removal. Degradation products of IMC were identified by LC-ESI-MS/MS analysis that three main compounds were determined as imidacloprid nitrosamine, imidacloprid urea keton, imidacloprid keto urea. Accordding to the these results a plausible degradation mechanism was proposed for IMC degradation by using nZVI.

Keywords: Degradation, imidacloprid, zero valent iron nanoparticles, pesticides.

(*) Corresponding author