Degradation of Diphenhydramine by the Photocatalysts of ZnO/Fe_2O_3 and TiO_2/Fe_2O_3 Based on Clinoptilolite: Structural and Operational Comparison

https://www.sciencedirect.com/science/article/abs/pii/S2213343717305535?via%3Dihub

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Abstract

The photocatalysts of TiO_2/Fe_2O_3 and ZnO/Fe_2O_3 based on clinoptilolite natural zeolite were synthesized by impregnation route and sol-gel methods. The synthesized photocatalysts were characterized by XRD, XRF, EDX, FE-SEM, FT-IR, and BET analyses. The results of XRD, FT-IR, and EDX confirmed the presence of Fe_2O_3, TiO_2, and ZnO nanoparticles on the surface of clinoptilolite. The FE-SEM results confirmed deposition of TiO_2/Fe_2O_3 and ZnO/Fe_2O_3 on the surface of zeolite. The approximate particle size of TiO_2/Fe_2O_3 and ZnO/Fe_2O_3 ~~were~~ was 47 and 34 nm, respectively. According to the XRF results, the synthesized nanoparticles had Fe^{3+}/TiO_2 and Fe^{3+}/ZnO molar ratios of 0.06 in TiO_2/Fe_2O_3/Zeolite and ZnO/Fe_2O_3/Zeolite, respectively. Based on BET analysis, the surface area of TiO_2/Fe_2O_3/Zeolite and ZnO/Fe_2O_3/Zeolite was about 112 and 289 m^2/g, respectively. The performance of these two photocatalysts in degradation of diphenhydramine (DPH) from contaminated water was evaluated by investigating the effects of operational factors such as ~~the~~ concentration of the contaminant (1-100 mg/l), photocatalysts (0.5-2 g/l), irradiation time (45-180 min), and pH (4-10). The results of the photocatalytic experiments revealed that the ZnO/Fe_2O_3/Zeolite had a more effective performance in degrading DPH, compared to TiO_2/Fe_2O_3/Zeolite. Under the optimal conditions, the efficiency of DPH degradation with TiO_2/Fe_2O_3/Zeolite (DPH: 50 mg/l, hydrogen peroxide: 50 mg/l, irradiation time: 120 min, photocatalyst: 0.5 g/l, pH=5) and ZnO/Fe_2O_3/Zeolite (DPH: 50 mg/l, hydrogen peroxide: 50 mg/l, irradiation time: 100 min, photocatalyst: 0.5 g/l, pH=10) ~~were~~ was 80 and 95%, respectively.

Keywords: Diphenhydramine, photocatalyst, TiO_2/Fe_2O_3, ZnO/Fe_2O_3, Clinoptilolite

1. Introduction

According to Iranian food and drug organization, DPH is the seventh frequently used medication in Iran [1]. DPH the water cycle through pharmaceutical and urban wastewaters and due to high sorption in surface and ground waters, it becomes permanent

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