World Academy of Science, Engineering and Technology
International Journal of Chemical and Materials Engineering
Vol:18, No:07, 2024

Zeolite Supported Iron-Sensitized TIO_2 for Tetracycline Photocatalytic Degradation under Visible Light: A Comparison between Doping and Ion Exchange

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Abstract : In this study, we applied Fe-sensitized TiO_2 supported over embryonic Beta zeolite (BEA) zeolite for the photocatalytic degradation of Tetracycline (TC) antibiotic under visible light. Four different samples having 20, 40, 60, and 100% w/w as a ratio of TiO_2/BEA were prepared. The immobilization of solgel TiO_2 (33 m^2/g) over BEA (390 m^2/g) increased its surface area to (227 m^2/g) and enhanced its adsorption capacity from 8% to 19%. To expand the activity of TiO_2 photocatalyst towards the visible light region (λ>380 nm), we explored two different metal sensitization techniques with Iron ions (Fe^{3+}). In the ion-exchange method, the substitutional cations in the zeolite in TiO_2/BEA were exchanged with (Fe^{3+}) in an aqueous solution of $FeCl_3$. In the doping technique, solgel TiO_2 was doped with (Fe^{3+}) from $FeCl_3$ precursor during its synthesis and before its immobilization over BEA. (Fe-TiO_2/BEA) catalysts were characterized using SEM, XRD, BET, UV-VIS DRS, and FTIR. After testing the performance of the various ion-exchanged catalysts under blue and white lights, only (Fe-TiO_2/BEA 60%) showed better activity as compared to pure TiO_2 under white light with 100 ppm initial catalyst concentration and 20 ppm TC concentration. As compared to ion-exchanged (Fe-TiO_2/BEA), doped (Fe-TiO_2/BEA) resulted in higher photocatalytic efficiencies under blue and white lights. The 3%-Fe-doped TiO_2/BEA removed 92% of TC compared to 54% by TiO_2 under white light. The catalysts were also tested under real solar irradiations. This improvement in the photocatalytic performance of TiO_2 was due to its higher adsorption capacity due to BEA support combined with the presence of Iron ions that enhance the visible light absorption and minimize the recombination effect by the charge carriers.

Keywords : Tetracycline, photocatalytic degradation, immobilized TiO_2, zeolite, iron-doped TiO_2, ion-exchange
Conference Title : ICCEN 2024 : International Conference on Chemical Engineering and Nanomaterials
Conference Location : Prague, Czechia
Conference Dates : July 04-05, 2024