Abstract

The present study focuses on the preparation of titania (anatase and rutile) and titania-zirconia nano composite catalyst with various Zr/Ti ratios (3.83, 6.3, 11.8 and 24.4 wt% and those were designated as ZT-1, ZT-2, ZT-3 and ZT-4 respectively) by sol-gel method and application to photocatalytic degradation of non biodegradable organic compounds (malachite green, reactive red 120, diclofenac and carbamazepine). The synthesized catalysts were characterized by different techniques like Scanning Electron Microscopy (SEM) coupled with Energy Dispersive Spectroscopy (EDS), X-Ray Diffraction (XRD), Transmission Electron Microscopy (TEM), and Brunauer Emmett Teller analysis. In the SEM images of all synthesized catalysts, it is clear that the catalyst particles are spherical in shape. The average particle size of ZT-3 catalyst is found to be 5-10 nm. The chemical compositions of the catalysts are determined from EDX analysis. The surface area and pore volume of all synthesized catalysts are obtained from BET analysis. The photocatalytic reaction was carried out for degradation of three organic compounds like malachite green, reactive red 120, diclofenac and carbamazepine in a batch reactor using synthesized catalysts under UV irradiation. The catalyst was selected by comparing the degradation efficiency of different organic compounds in photocatalytic reaction. Two different industrial effluents were also used in the photocatalytic process for the application of same catalyst.

The effects of different process parameters on the photo degradation were studied and kinetic data were obtained. It was observed that the degradation were influenced by the zirconia content in catalyst, initial concentration of reactant, catalyst concentration, initial pH of the solution, irradiation time, reaction temperature, air flow rate and hydrogen peroxide concentration. The Langmuir-Hinshelwood kinetic rate model was fitted well to the rate data for all cases.

The artificial neural network with three layered feedforward model was applied to predict the degradation of carbamazepine. The model output showed good correlation with the experimental data. The reusability study of ZT-3 was performed for textile effluent treatment and it is observed that the catalyst is very stable after five reaction cycles. So, the development of photocatalytic reactors is essential for the successful exploitation of heterogeneous photocatalysis on semiconductor particles, which has been shown to be an effective means of removing organic pollutants.