Photocatalytic degradation of cationic dye simulated wastewater using four radiation sources, UVA, UVB, UVC and solar lamp of identical power output

Abstract

This study uses photocatalysis, classified under advanced oxidation processes, for the treatment of simulated cationic dye (methylene blue)-contaminated wastewater using TiO_2as the photocatalyst. Three parameters were manipulated throughout this study including the effects of ultraviolet irradiation wavelength (using UV-A, UV-B, UV-C and solar light), the initial dye concentration (2–10 ppm) and the initial pH (4–10), with a total reaction time of 1 h. The shortest wavelength irradiation (UV-C) proved to be the most effective yielding 100% degradation of MB was achieved within 14 min. Increasing the initial dye concentration proved reduced the degradation rate due to the inner photon filtering effect by the dye molecules and as a result of the reduced generation rate of hydroxyl radicals. Since MB is a cationic dye, by increasing the pH of the system, the degradation rate was enhanced requiring just 12 min to achieve complete degradation in the experimental photoreactor. This is due to the electrostatic attraction between the dye molecules and the negatively charged TiO_2 particles. Kinetic studies showed that all experiments fulfilled an apparent first-order kinetics at MB concentrations less than 6 pp mmeaning the photocatalytic degradation of MB depended only on its concentration in the solution. Saturation kinetics (zero-order) was observed at MB concentration higher than 6 ppm and a reduction of the initial rate was observed at concentration higher than 10 ppm due the absorption of photon from the dye in solution. From the findings, photocatalysis using $TiO_2$is able to fully degrade organic compounds like dyes into degradable substance such as carbon dioxide, water and inorganics.