Sonolysis, Photolysis, and Sequential Sonophotolysis for the Degradation of 2,4,6-Trichlorophenol: The Effect of Solution Concentration

Abstract

Ultrasonic sound waves, ultraviolet-A irradiation, and a combination of these two techniques were applied to a non-catalytic aqueous system containing 2,4,6-trichlorophenol (TCP) to study the effectiveness of sonolytic, photolytic, and sonophotolytic oxidation processes for the degradation of TCP. The operating parameters for the horn-type sonicator and the UV-A lamp were kept constant along with the solution temperature, but the TCP concentration was varied from 30 to 90 ppm. A first-order kinetic rate model was used to study the synergistic effect of the sonophotodegradation process. It was found that at a lower TCP concentration of 30 ppm, sonophotodegradation exhibited a synergistic effect, but at a TCP concentration of 70 ppm and higher, sonophotodegradation resulted in an antagonistic effect. The synergistic effect was explained in terms of an increase in the .OH radical formation by the combined process complemented by the photolysis of H2O2 formed by sonolysis. In contrast, the antagonistic effect was explained in terms of the combined effect of viscosity increase resulting in the reduction of the cavitation efficiency and degradation rate, and by considering the dynamics of bubble growth and implosion.