Effect of the presence of inorganic ions and operational parameters on free cyanide degradation by ultraviolet C activation of persulfate in synthetic mining wastewater

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Abstract

This work studied the influence of several parameters on free cyanide (CN−) degradation (50 mg L−1) by the UVC-activated persulfate (PS) at alkaline conditions (UVC/PS). Firstly, photolysis and alkaline activation of PS were evaluated. Then, the effect of initial PS concentration (0.2, 0.4, and 0.6 g L−1) and dissolved oxygen in solution (absence/presence) were studied. Lastly, the influence of phosphate, carbonate, and nitrate presence at different concentrations (50, 150, 350, and 500 mg L−1) on CN− elimination was tested. Additionally, the electric energy per order (EEO), a measure of the energy consumption in the process was determined, and a mechanistic view of CN− degradation was proposed. The results show that photolysis and alkaline activation of PS degraded 8 and 11% of CN−, respectively, whereas their combination presented a synergistic effect on CN− pollutant elimination. While oxygen had a vital role in photolysis due to the formation of 1O2 to oxidize CN− to CNO−, HO• and SO4•− were primarily responsible for CN− degradation by UVC/PS. It was also found that cyanide removal followed a pseudo-first-order kinetics whose apparent reaction rate constant (k) increased from 0.0104 to 0.0297 min−1 as the initial concentration of PS increased from 0.2 to 0.6 g L−1, indicating a strong dependency of the removal efficiency on the PS amount. Remarkably, cyanide degradation by the combined UVC/PS showed a high CN− conversion and selectivity even in the presence of high concentrations of phosphate, carbonate, and nitrate ions (500 mg L−1), which resulted in CN− removals higher than 80% after 60 min of degradation treatment. Furthermore, the EEO values were similar in the presence and absence of phosphate or carbonate; however, they decreased slightly with nitrate presence. All these results suggest the feasibility of the combined UVC/PS process for the elimination of cyanide such as that found in mining wastewater.

Keywords

Mining wastewater, Persulfate, Advanced oxidation process, Free cyanide degradation, Dissolved oxygen, Inorganic ions