Degradation of hexacyanoferrate (III) ion by the coupling of the ultraviolet light and the activation of persulfate at basic pH

Héctor Ibargüen-López, Brian López-Balanta, Luis Betancourt-Buitrago, Efraím A. Serna-Galvis, Ricardo A. Torres-Palma, Fiderman Machuca-Martínez, Samir Fernando Castilla-Acevedo

Abstract

The ultraviolet light activation of persulfate (PS) under alkaline conditions was evaluated for treating hexacyanoferrate (III) ion ([Fe(CN)6]3-). The effect of the wavelength type (i.e., UVA and UVC), initial PS concentration (0.3, 0.6, and 0.9 g L−1), and pH value (11 and 13) on the degradation of 50 mg L−1 of [Fe(CN)6]3- were studied. Finally, the role of the main degrading agents (SO4•-, O2•-, or HO•) involved in the degradation process was determined using scavengers and a degradation pathway for [Fe(CN)6]3- was proposed. Results show that [Fe(CN)6]3- can be decomposed by UVC light, while UVA is not effective neither in [Fe(CN)6]3- photolysis nor in the activation of PS. Alkaline activation alone at pH 13 can also not degrade the cyanocomplex. However, the combination of UVC with PS (0.3 g L−1) at pH 13 showed high efficiency in the elimination of [Fe(CN)6]3-, achieving 93.3% of removal after 125 min of treatment. The highest CN- release and Fe dissolved removal also occurs at pH 13 and 0.3 g L−1 PS. Further increases in initial PS concentrations may lead to an excess of radicals in solution, resulting in detrimental recombination reactions that affect the efficiency of the process. Quenching tests showed that the importance of radicals involved in the degradation of [Fe(CN)6]3- follows the order: HO• > O2•- >>> 1O2 or SO4•-, and allowed to demonstrate that singlet oxygen could participate in the UVC photolysis of [Fe(CN)6]3-. All these results suggest the feasibility of this technology to treat this type of industrial wastewater efficiently.

Keywords

Persulfate, Mining wastewater, Advanced oxidation processes, Ultraviolet light, Hexacyanoferrate (III) ion, Free cyanide