Photocatalytic degradation of cobalt cyanocomplexes in a novel LED photoreactor using TiO2 supported on borosilicate sheets: A new perspective for mining wastewater treatment

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Abstract

The photocatalytic degradation of hexacyanocobaltate ion ([Co(CN)6]3−) by TiO_2 supported on borosilicate sheets was studied in a novel photoreactor operated under UVA-LEDs irradiation. The presence and absence of O_2 during the process, and the reuse of the TiO_2-impregnated sheets were evaluated. The semiconductor was supported by the dip-coating method, and the influence of g TiO_2/g Methanol (MetOH) ratio in the suspension and substrate roughness modification were evaluated in the detachment percentage and adherence of TiO_2. The highest semiconductor detachment percentage was obtained at 0.36 g TiO_2/g MetOH ratio. Besides, it was determined that for the ten layers supported, the substrate roughness modification does not influence the detachment of TiO_2. In the first photocatalytic tests, the results show that a better degradation performance was achieved by direct photolysis than photocatalysis according to the higher concentration of CN− released from the cyanocomplex. However, a decrease in the concentration of cobalt in solution was not observed. When the sheets were reused, a decrease of 10% in the concentration of cobalt was achieved, and 14% of CN− was released from the cyanocomplex. This was attributed to the formation of microchannels, hollows amongst other imperfections that increase the surface area and active sites of the coating when TiO_2 peels off. The simplified kinetics analysis shows that for UV + O_2 (oxic environment) UV + N_2 (anoxic environment) similar kinetic parameters were obtained, indicating that both processes follow the same homogeneous pathway in the degradation of [Co(CN)6]3−. However, for the UV + TiO_2+O_2 and UV + TiO_2+N_2, their different kinetic parameters suggest a non-homogeneous degradation mechanism with different pathways induced by the presence or absence of O_2.

Keywords

Dissolved oxygen, UVA-LEDs, Detachment percentage, Roughness modification, Photocatalyst reuse, Heavy metals