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Wastewater Treatment in the Abrasives Industry via Fenton and Photo-Fenton Oxidation Processes: A Case Study from Peru

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Abstract : Phenols are toxic for life and the environment and may come from many sources. Uncured phenolic monomers present in phenolic resins used as binders in grinding wheels and emery paper can contaminate industrial wastewaters in abrasives manufacture plants. Furthermore, vestiges of resol and novolacs resins generated by wear and tear of abrasives are also possible sources of water contamination by phenolics in these facilities. Fortunately, advanced oxidation by dark Fenton and photo-Fenton techniques are capable of oxidizing phenols and their degradation products up to their mineralization into H_2O and CO_2. The maximal allowable concentrations for phenols in Peruvian waterbodies is very low, such that insufficiently treated effluents from the abrasives industry are a potential environmental noncompliance. The current case study highlights findings obtained during the lab-scale application of Fenton's and photo-assisted Fenton's chemistries to real industrial wastewater samples from an abrasives manufacture plant in Peru. The goal was to reduce the phenolic content and sample toxicity. For this purpose, two independent variables-reaction time and effect of ultraviolet radiation–were studied as for their impacts on the concentration of total phenols, total organic carbon (TOC), biological oxygen demand (BOD) and chemical oxygen demand (COD). In this study, diluted samples (1 L) of the industrial effluent were treated with Fenton's reagent (H_2O_2 and Fe^{2+} from $FeSO_4.H_2O$) during 10 min in a photochemical batch reactor (Alphatec RFS-500, Brazil) at pH 2.92. In the case of photo-Fenton tests with ultraviolet lamps of 9 W, UV-A, UV-B and UV-C lamps were evaluated. All process conditions achieved 100% of phenols degraded within 5 minutes. TOC, BOD and COD decreased by 49%, 52% and 86% respectively (all processes together). However, Fenton treatment was not capable of reducing BOD, COD and TOC below a certain value even after 10 minutes, contrarily to photo-Fenton. It was also possible to conclude that the processes here studied degrade other compounds in addition to phenols, what is an advantage. In all cases, elevated effluent dilution factors and high amounts of oxidant agent impact negatively the overall economy of the processes here investigated.

Keywords : fenton oxidation, wastewater treatment, phenols, abrasives industry
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