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Application of mechanically alloyed Mn-Al metallic particles to wastewater treatment: a comparative investigation of chemical and bacterial approaches to dye degradation in residual textile waters

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Residual dye compounds in textile wastewater are one of the most critical sources of environmental pollution because of their visibility and potential carcinogenic properties. The use of Mn-Al nano-crystalline particles has been shown to provide a rapid and convenient degradation of these dye compounds [1]. It is also expected to be a low-cost method for the degradation of many types of contaminating compounds and not just residual textile dyes. This work analyzes the efficiency of Mn-Al metallic powders for degrading azo dyes and compares the results with the ones obtained in a pilot scale trickling filter. Several batches of Mn-Al metallic powders were produced using a ball-milling process, applying different durations of the milling operation. This resulted in a set of batched powders that differed from each other in terms of their internal particle structure as characterized by X-ray diffraction and electron microscopy. The ability of these powders to act as decolorization materials was assessed by degradation experiments of Orange G and Orange II azo dyes in aqueous solutions, obtaining fast kinetics with reaction times among the shortest when com-pared to the results reported using other decolorizing materials. The effect of various parameters such as initial pH, dye concentration, and temperature were studied. The electrochemical and corrosion properties of the Mn-Al metallic powder seemed to be the key factors explaining the high decolorization efficiency of these materials.
The ability of biological agents to treat textile wastewater streams was also examined. The bacterial microorganisms selected in the trickling filter presented the ability to remove dye under aerobic conditions at pH values between 6 and 7.5 but with low efficiency. The bacteria microorganisms were able to remove mono-azo dyes but no other chemically different dyes. Both bacterial and metallic powder approaches appear to be viable options for the treatment of textile wastewaters, though lower rates of dye removal where observed with the bacterial approach as compared to the Mn-Al powder method. A discussion on possible combinations of these two processes to increase efficiency on a wide range of temperature and pH conditions will be also discussed in this work.

[1] M. AboliGhasemabadi et al. J. Alloys Compd. 741 240-245 (2018)