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Evaluation of the Discoloration of Methyl Orange Using Black Sand as Semiconductor through Photocatalytic Oxidation and Reduction

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Abstract : Organic compounds in wastewaters coming from textile and pharmaceutical industry generated multiple harmful effects on the environment and the human health. One of them is the methyl orange (MeO), an azoic dye considered to be a recalcitrant compound. The heterogeneous photocatalysis emerges as an alternative for treating this type of hazardous compounds, through the generation of OH radicals using radiation and a semiconductor oxide. According to the author’s knowledge, catalysts such as TiO₂ doped with metals show high efficiency in degrading MeO; however, this presents economic limitations on industrial scale. Black sand can be considered as a naturally doped catalyst because in its structure is common to find compounds such as titanium, iron and aluminum oxides, also elements such as zircon, cadmium, manganese, etc. This study reports the photocatalytic activity of the mineral black sand used as semiconductor in the discoloration of MeO by oxidation and reduction photocatalytic techniques. For this, magnetic composites from the mineral were prepared (RM, M1, M2 and NM) and their activity were tested through MeO discoloration while TiO₂ was used as reference. For the fractions, chemical, morphological and structural characterizations were performed using Scanning Electron Microscopy with Energy Dispersive X-Ray (SEM-EDX), X-Ray Diffraction (XRD) and X-Ray Fluorescence (XRF) analysis. M2 fraction showed higher MeO discoloration (93%) in oxidation conditions at pH 2 and it could be due to the presence of ferric oxides. However, the best result to reduction process was using M1 fraction (20%) at pH 2, which contains a higher titanium percentage. In the first process, hydrogen peroxide (H₂O₂) was used as electron donor agent. According to the results, black sand mineral can be used as natural semiconductor in photocatalytic process. It could be considered as a photocatalyst precursor in such processes, due to its low cost and easy access.

Keywords : black sand mineral, methyl orange, oxidation, photocatalysis, reduction
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