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The effectiveness of electrochemical oxidation in removal of sulforhodamine B textile dye from wastewater

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The rapid expansion of industries has indirectly resulted in a substantial rise in environmental pollution due to the increased discharge of wastewater. Moreover, the lack of suitable and efficient methods for wastewater treatment has aggravated a crucial global issue concerning wastewater. In this context, the textile industry bears the primary responsibility for generating a significant volume of wastewater, primarily due to the processes of dyeing. Out of various wastewater treatment methods, the electrochemical oxidation method has emerged as an effective approach offering advantages of higher selectivity, minimal chemical utilization, energy efficiency, in-situ treatment capability, relatively faster treatment and reduced secondary waste generation. This method harnesses electrically charged electrodes to degrade and eliminate pollutants. In this study, the electrochemical oxidation of synthetic dye sulforhodamine B (Acid red 52), a xanthene dye, was employed to facilitate the removal of dye from wastewater. This dye is extensively used in the textile industry due to its enhanced colourfastness and superior stability across diverse processing conditions. However, its persistent nature poses significant environmental challenges. A series of experiments were conducted using graphite electrodes to optimize the electrochemical oxidation for the removal of dye from wastewater. The research investigated the effects of several parameters on the electrochemical oxidation process. These parameters encompass the applied potential (3 V, 5 V, 9 V), supporting electrolyte concentration (NaCl) (1 g L^{-1}, 2 g L^{-1}, 3 g L^{-1}, 4 g L^{-1}, 5 g L^{-1}), treatment time (0.5 hours, 1 hour, 1.5 hours, 2 hours), and pH level (3, 4, 5, 7, 9) of the sample. The efficacy of sulforhodamine B degradation was assessed by UV-visible spectroscopy and chemical oxygen demand (COD) values. Furthermore, changes in conductivity and pH post-treatment were subjected to analysis. The analysis resulted in the determination of optimal parameters, including an applied voltage of 5 V, treatment time of 1 hour, pH of 7, and NaCl concentration of 3 g L^{-1}. Under optimum conditions it was able to achieve 95.61% colour removal, 99.64% dye degradation, and 66.18% COD reduction. These results confirmed that electrochemical oxidation is an efficient method for removing sulforhodamine B from textile wastewater. To validate the effectiveness of the optimized conditions in practical situations, wastewater samples containing sulforhodamine B collected from a textile industry in Sri Lanka were also analysed under the optimal conditions found. The results obtained impart the use of the electrochemical oxidation method in degrading sulforhodamine B present in textile wastewater in a sustainable and cost-effective manner.

Keywords: Electrochemical oxidation, Graphite electrodes, Sulforhodamine B, Textile industry, Wastewater