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Speciation of collector degradation by-products and electro-Fenton treatment of thiosalts in flotation effluents.

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Thiosalts are metastable, partially oxidized sulfur oxides that require treatment in mine water because they can oxidize to sulfuric acid, cause delayed downstream acidity, and may contribute to aquatic toxicity. Main thiosalts are thiosulfate ($S_2O_3^{2-}$) and tetrathionate ($S_4O_6^{2-}$). In sulfide-ore operations, thiosalts main source is pyrite/pyrrhotite, while flotation collectors, such as potassium amyl xanthate (KAX) and dithiophosphate collectors (AERO® 407 and AERO® 3477), are a secondary source. The collectors degrade into organosulfur by-products, yet the key formation pathways and dominant by-products remain partially documented. For thiosalts treatment, the electro-Fenton (EF) process emerges as a promising advanced oxidation process, achieving >99% thiosalts removal within 90 min [1]. This study aims to (i) quantify collector degradation and its contribution to thiosalts formation, and (ii) evaluate EF process effectiveness in thiosalts degradation in real flotation effluents. Degradation tests were conducted using synthetic effluents prepared at different collector concentrations. Experiments were performed under controlled conditions over time, both with and without hydrogen peroxide (H_2O_2), and at pH values of 2, 4, 7, and 10. Degradation was monitored using UV-Vis spectroscopy along with the measurement of dissolved organic carbon (DOC) concentrations and ion chromatography analysis. Seven mine flotation effluents with different thiosalt concentrations (54–396 mg/L) were treated using the EF process under the optimal operating conditions identified in a previous study [1]. The results of the degradation test revealed collector-specific behavior, with KAX mainly producing carbon sulfide (CS_2), AERO® 407 results in persistent organic residues (136 mg/L DOC with H_2O_2), and AERO® 3477 promotes the highest thiosalts concentration (74 mg/L). For real flotation effluents treatment, an efficient conversion (95% removal) of thiosalts to sulfate within 60 min was obtained following the EF process. These findings show that flotation collector degradation drives distinct byproduct formation pathways, and EF treatment of real flotation effluents showed high efficiency for effluents originating from a collector circuit (KAX), with a pronounced decrease in thiosalt concentrations.

References

[1] Dubuc, J., Coudert, L., Lefebvre, O., & Neculita, C. M., 2022. Electro-Fenton treatment of contaminated mine water to decrease thiosalts toxicity to *Daphnia magna. Science of the Total Environment*, *835*, 155323.