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Sulfidation of As_2O_3 Roaster Waste from Giant Mine, NWT: Experimental Approach and Results

SÉBASTIEN SIMARD, JENNA MILLER AND TOM AL
University of Ottawa

Giant Mine, located outside of Yellowknife NWT, is host to 237,000 tonnes of soluble As_2O_3-rich roaster waste that is stored in the underground workings, posing a risk to the surrounding environment. Remediation efforts at Giant Mine focus on preventing interaction with groundwater by pumping to maintain an artificially low water table and freezing the surrounding ground.

Our objective is to transform the As_2O_3 into an insoluble As_2S_3, first dissolving As_2O_3 prior to sulfidation with $H_2S_{(g)}$ to form an amorphous nano-scale precipitate. Transformation to As_2S_3 decreases the risk of As transport, with no long-term maintenance required when isolated in anaerobic deep mine water.

Experiments were conducted to determine final As concentrations in water in contact with As_2S_3 and to maximize particle size to allow solid-liquid separation. Sulfidation was conducted at 20 to 80 °C and pH 4, with 700 mg/L initial As concentration and a S:As molar ratio of 7.5 or higher. Surface-charge was manipulated to overcome the nanoparticle dispersion due to the low pH isoelectric point ($pH_{IEP} \approx 1.0$) using a range of Alum ($Al_2(SO4)_2 \times nH_2O$) concentrations. Effective coagulation and filtration (0.22 µm) was achieved at Alum-As mass ratios as low as 0.05. Following the sulfidation reaction, As concentrations in filtered solutions ranged between 0.015 and 0.165 mg/L. Reflectance spectroscopy was used to monitor particle settling following Alum addition, and Stoke's law for settling velocity was used to estimate aggregate size (range from 8-11 µm). A second approach to surface charge manipulation - reaction under UV irradiation - is currently being tested. Catalysis with UV radiation is reported to improve reaction rates at relatively low S:As ratios, while promoting the formation of larger particle aggregates [1]. Experiments to test the sulfidation reaction at elevated temperatures (40, 60 and 80 °C) indicate a maximum 20% reduction in reaction time with a negligible effect on the residual As concentration and aggregate size. Powder XRD measurements indicate the As_2S_3 product is amorphous, but there may be a slight increase in crystallinity with increasing temperature.

[1] Kong, L. et al. (2018) *Environ. Sci. Technol* **52**, 10719−10727.