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SCHOOL OF CHEMICAL AND METALLURGICAL ENGINEERING.

Research Topic: An Investigation into the Use of Fischer Tropsch Wastewater as an Organic Source in the Treatment of Acid Mine Drainage (AMD) Using Dissimilatory Sulfate Reduction.

By

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Abstract

Acid mine drainage (AMD) and Fischer Tropsch wastewater (FTWW) are two major pollutants associated with coal mining and usage, as such these pollutants are likely to be found in proximity to each other in coal mining regions. AMD is characterized by high sulfate and dissolved ion concentrations with little to negligible organic content, while FTWW has a very high organic content made mainly from alcohols and short chain fatty acids (SCFA). FTWW has very high COD of up to 30 000 mg/L. Sulfate reducing bacteria (SRB) can use organic substrates to reduce sulfate to sulfide in the process generating alkalinity. The hydrogen sulfide reacts with dissolved metals to form metal sulfide precipitates, while the alkalinity attenuates pH. This means SRB can be used to remove organic pollutants from FTWW and dissolved metals and sulfates from AMD. This study sought to use FTWW as the carbon source and electron donor for biological sulfate reduction in a fixed bed bench scale bioreactor treating AMD. Batch and continuous flow reactors including single stage and two stage continuous sulfate-reducing bioreactors were evaluated in this investigation. The reactors were assessed on their ability to remove COD from the FTWW, sulfate and dissolved iron from AMD. Considerable success was observed in batch reactors, with up to 99 % of iron removed from AMD, sulfate removals was at 95 %, while more than 99 % COD was removed from the effluent. Fed batch and continuous reactors were not as successful as the treatment efficiency dropped with time due possibly to the accumulation of inhibitory substances such as hydrogen sulfide and metal sulfide precipitates. The two-stage continuous bioreactor performed better compared to the single stage continuous reactor. All the reactors however maintained the pH above 7.0 against an influent pH of 2.0. Lower temperatures during winter reduced the performance of the bioreactors as the pH of the effluent dropped to below 6.0. There was a a large amount of residual sulfate, iron and COD in the reactors operated in winter than in those operated in summer. Another 2-stage bioreactor system consisting of a sulfate reducing bioreactor connected in series to a sulfate oxidising bioreactor was operated for converting the hydrogen sulfide produced in the sulfidogenic bioreactor to sulfur. Micro aerobic conditions were applied by pumping limiting amounts of oxygen into the sulfur oxidising reactor to allow for the oxidation of sulfide to elemental sulfur. Up to 92 % of sulfate was removed in the silfidogenic reactor with the subsequent production of an average 116mg/L/d of hydrogen sulfide during the operational period. The hydrogen sulfide was converted to sulfur in the oxidising reactor with 97 % sulfur recovery. An average102 mg/L/d sulfur was produced in the sulfur oxidising reactor. The results indicate the potential in using FTWW as a cost-effective electron and carbon source for biological sulfate reduction allowing for the co-treatment of AMD and FTWW.