Simultaneous removal of arsenic and zinc using an acidophilic sulfate reducing bioreactor

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Mining can release high concentrations of arsenic by the oxidation of sulfide minerals. The application of acidophilic sulfate reducing bacteria (SRB) for the treatment of mine-impacted waters containing arsenate can be an attractive alternative for removal arsenate in Chile, where high concentrations of this metalloid has been particularly found in the Azufre River. Precipitation of arsenic as sulfide mediated by acidophilic SRB has advantageous over chemical treatment including less waste production and lower lime and iron consumption. However, few successful applications using low-pH sulfidogenic reactors have been demonstrated for sulfate reduction and metal removal from mine-impacted water. The main reason for this challenge is that SRB preferentially grow between pH 6 and 8.

In this study, we have set up a low pH sulfidogenic bioreactor inoculated with a bacterial consortium obtained from an acidic, anaerobic sediment from the Azufre River. The sulfidogenic system was operated under continuous flow mode and maintained at pH 4.5. It was initially fed with an acidic (pH 2.1) synthetic mine water containing Zn^{+2} and As^{5+} (15 and 2 ppm respectively), based on the chemical composition of Azufre River. Since removal of Zn^{2+} and As^{5+} was achieved during the first 50 days of operation, the objective was to assess the performance of the bioreactor in the following 100 days by progressively increasing the arsenic concentration up to 15 ppm. The results showed that over 95% of As was removed from solution during this period, however the hydraulic retention times increased significantly from ~35 to 130 h. This phenomenon was closely coupled to the decreasing numbers (in about~75%) in the upper liquid phase of the bioreactor. The composition of the microbial consortia throughout the experiment showed the presence of a known sulfidogenic bacterium (*Desulfosporosinus acididurans* strain USS-CCA2). This study demonstrated the feasibility of arsenic removal from an extremely acidic water by using a continuous bioreactor system.