Treatment of saline acidic, metal-containing groundwater from the WA Wheatbelt

P.D. Franzmann1, J.J. Plumb1, J.T. Wylie1, W.J. Robertson1, G.B. Douglas1, T.P. Bastow1, A. H. Kaksonen2, J.A. Puhakka2

1CSIRO Land and Water, Underwood Avenue, Floreat, WA 6014, Australia
2Institute of Environmental Engineering and Biotechnology, Tampere University of Technology, Tampere, Finland

Introduction

The Wheatbelt of Western Australia has an excess of water of poor quality due to recent landscape clearing, its flat topography, high salt stores and rising water tables. As a result, secondary salinisation associated with the rising groundwater threatens road and town infrastructure, agricultural productivity in the valleys, and the biodiversity in remnant bushland and wetlands in the region. Groundwater drainage is often problematic. These groundwaters in many regions are also acidic, and contain elevated concentrations of metal contaminants such as aluminium, iron, zinc, lead, copper, chromium and uranium. We examined the potential of sulfate-reducing fluidised bed bioreactors for the treatment of acidic, metal-contaminated, saline groundwater for the recovery of metals, salt free of metals, and for reducing acidity.

Materials and Methods

This study examined sulfate-reducing, fluidised bed bioreactor treatment of Narembeen groundwater (pH 3.1, 59 g L\(^{-1}\) salt, with aluminium, lead and uranium concentrations of 156 mg L\(^{-1}\), 152 152 µg L\(^{-1}\) and 16 µg L\(^{-1}\), respectively). Ethanol was used as a source of carbon and energy for the bioreactor treatment.

Results

A summary of performance of the reactor treating Narembeen water over 320 days is shown in Figure 2. The experimental work was undertaken to test the limits of the process, so that the minimum hydraulic retention time (HRT) required for effective treatment of the water could be determined. In testing process limits, it was known that periodic upset of the process would result, and periods for recovery of the microbial biomass and its activity would be necessary. Sulfate-reducing bacteria do not function well in environments of pH < 4. The process was first established using pH-adjusted Narembeen water as influent water (phase A). During periods of stable operation (Phases G and L) the pH of the effluent from the reactor was stable at around pH 6.5. Provided the HRT was increased to target 24 hours to restore sulfate-reducing activity.

The reactor was effective at removing most problematic trace metals, including the metalloid silicon (91% removal), which was the major membrane foulant when desalination was tested for treating Wheatbelt waters for the local production of potable water (Barron and Zil, 2008). Increasing of pH from 3.1 to 6.5 and removal of trace metals in the sulfate-reducing fluidised bed process should enable the potential to interface this process with desalination to produce potable water in localised Wheatbelt communities, with salt production from the desalination reject water. Because of the nature of the metal precipitates, it is unlikely that economic recovery of metals will be possible, so they will have to be disposed of to a Class IV secure landfill unless they could be disposed of to mine site tailings dams.

Conclusions

Fluidised bed, sulfate-reducing bioreactors can be developed to treat saline, metal-contaminated groundwater for removal of metals and for ameliorating acidity. Although estimates of cost derived from laboratory studies should be viewed with great caution, we estimated that the process may cost ca. $3.72 kL\(^{-1}\) to implement at Narembeen. Sulfate-reducing technology is being taken up internationally by the mining industry. It has potential for use in WA for improving the water quality of mine drainage or acid drainage from urban or Wheatbelt environments.