ACID MINE DRAINAGE PASSIVE TREATMENT: EVALUATION OF FULL SCALE SYSTEM EFFICIENCY AT MINA ESPERANZA (IBERIAN PYRITE BELT)

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Abstract

On the basis of the experience gained in the design and operation of passive treatment system in previous pilot scale experiments dealing with the remediation of acid mine drainage (AMD) at the Iberian Pyrite Belt (IPB), a full scale passive treatment system was constructed at Mina Esperanza. This full scale treatment has achieved a great efficiency in metal decontamination and an optimal hydraulic performance during its operation time. The encouraging results observed show the use of this technology as a real tool to address this type of environmental pollution.

Keywords: acid mine drainage, dispersed alkaline substrate, full scale, Iberian Pyrite Belt.

Introduction

Along the last years various pilot scale experiments have been implemented and monitored at the Iberian Pyrite Belt (IPB) in order to develop an efficient treatment technology to deal with the remediation of waters affected by acid mine drainage (AMD) (Caraballo et al., 2008; Rötting et al., 2008). The results obtained in these previous pilot scale treatments at the field offered the necessary experience to design the full scale passive system treating the high metal polluted AMD from Mina Esperanza. The system has been working for twenty months. During this time hydraulic conductivity, hydrochemistry, mineralogy of the precipitates and metal removal efficiency were studied. The present summary synthesizes the general hydrochemistry behavior and the metal removal efficiency of this passive treatment system.

Methods

The full scale passive treatment system constructed at Mina Esperanza comprises a 480m^3 reactive tank (15m*8m*4m) filled with limestone-DAS as reactive material (20% v/v limestone sand mixed with 80% v/v pine wood shavings), and followed by a 60m^3 decantation pool (10m*3m*2m).

Mine adit, reactive tank and decantation pool are connected in series by an open channel (Fig.1). AMD at the exit of the adit has pH of 2.66-2.95, net acidity of 2200-2800 mg/L as CaCO3, 750-950 mg/L Fe (95% Fe2+), 3500-4200 mg/l SO42- , 125-160 mg/L Al, 15-20 mg/L Zn, Cu and 0.1-1 mg/L As, Pb, Co, Cd and V. During the twenty months of operation water samples were taken in six representative points along the whole passive treatment system. Metal content in these samples was determined by ICP-OES at the University of Huelva Central Research Services. Some physic-chemical parameters like pH, redox potential, electrical conductivity and dissolved oxygen were measurement in situ during the samplings.

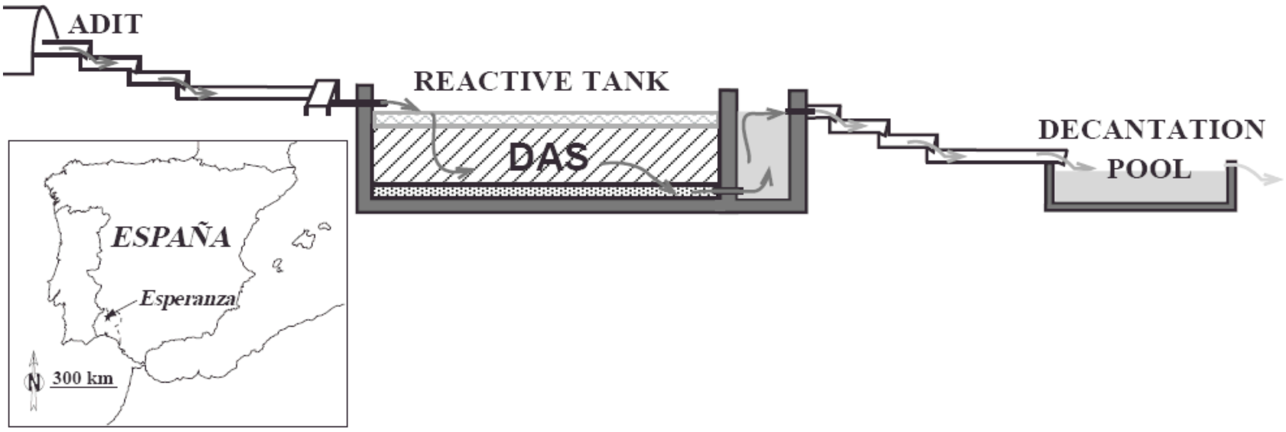

Figure 1 Field site location and schematic cross-section of the full scale DAS passive treatment system.

Results and discussion

As can be observed in figure 1 the high metal polluted AMD merging from the adit flows through the reactive material (producing limestone dissolution) and is conducted by the open channels to the decantation pool. Water pH increases from 2.5 to 6 at the output of reactive tank and to 6.5 at the output of decantation pool (Fig. 2). pH changes induce a total and massive precipitation of Al within the reactive tank (Fig.2) and also the coupled removal by sorption/coprecipitation process of others elements such as Cu or Cd. Although Fe removal takes place throughout the entire system, higher removal efficiency is observed for the reactive tank. In close relation to this Fe removal it can be observed a complete removal of other toxic elements like As (Fig.2). Relative removal over time was quite steady showing values of 100% Al, Cu, As, Pb, Cd and V; 90-100% Ti and Cr; 60% Si, as well as 30% Fe at the output of reactive tank and 40% Fe at the output of decantation pool. Although this treatment system is not designed to remove sulfate, a 15% SO_4 removal was achieved. This removal implies the accumulation within the reactive tank of 2700 kg Al, 7100 kg Fe, 6900 kg SO_4, 600 kg Si, 300 kg Cu and 100 kg Zn. To obtain a better idea of the great efficiency accomplished by the passive treatment system at Mina Esperanza, data provided by Ziemkiewicz et al., 2003 from 82 passive treatment systems constructed in the USA were compared with our results.

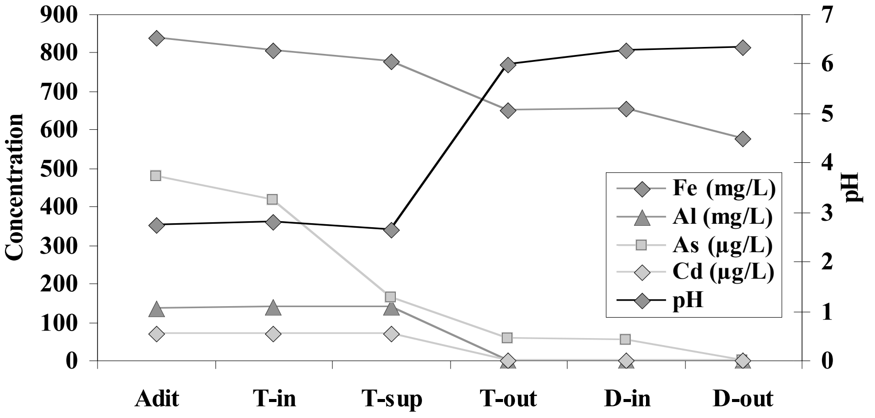

Figure 2 Selected mayors and minors elements and pH distribution across the passive system treatment. T-in = reactive tank input, T-sup = reactive tank supernatant, T-out = reactive tank output, D-in = decantation pool input and D-out = decantation pool output.

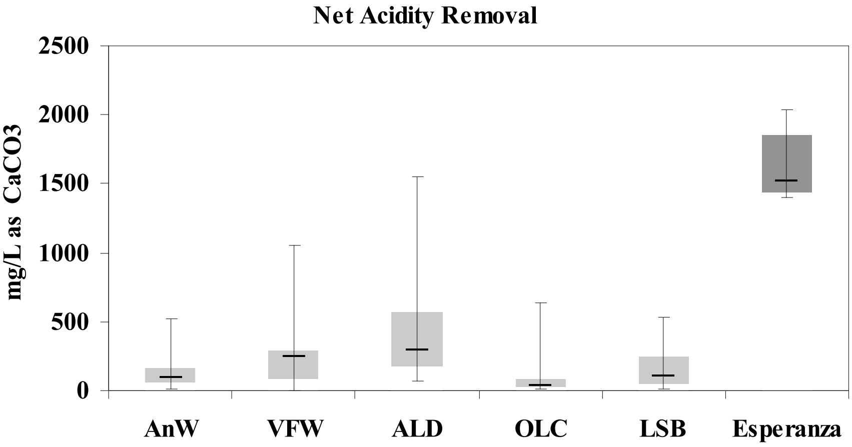

Figure 3 Net acidity removal at different passive treatment systems

To synthesize the study perform, the results obtained for the net acidity, $net\ acidity: 50045 \cdot (3 \cdot cAl + 2 \cdot cFe + 2 \cdot cMn + 2 \cdot cZn + 10\text{-}pH) - alk$, are shown on this manuscript. As can be observed in Figure 3, net acidity removal at the Mina Esperanza system is one or two orders of magnitude higher than the values shown by the other typical passive treatment.

Conclusions

The passive treatment system implemented in Mina Esperanza has achieved a great metal removal efficiency and an optimal hydraulic performance during the 20 months of proper operation. The results obtained place this design as a real tool to address the full scale remediation of many polluted places at the IPB.

References

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