Passive Treatment of Highly Contaminated Iron-Rich Acid Mine Drainage[1]

C.M. Neculita*, T.V. Rakotonimaro, B. Bussière, T. Genty, and G.J. Zagury[2]

Abstract: Highly contaminated iron-rich (> 0.5 g L^{-1} Fe) acid mine drainage (AMD) is often generated on closed and abandoned mine sites. Efficient treatment of such quality AMD is sometimes achieved by using passive multi-unit systems. The reactivity and hydraulics of these units are challenging because they deteriorate over time. The DAS (dispersed alkalinity substrate) units, consisting of coarse organic matrix (wood chips) and neutralizing materials (calcite, magnesia) seem appropriate for the passive treatment of iron-rich AMD. Likewise, the use of a mixed treatment system comprised of passive biochemical reactors (PBRs - wood waste-based and constructed wetlands) appears to be suitable. The present paper comparatively evaluates the performance of laboratory and two field treatment systems. Firstly, laboratory batch and column testing was performed over a 2-year period, using DAS-calcite, DAS-dolomite or DAS-wood ash with the aim of iron pretreatment, prior to sulfate removal by PBR, followed by a final polishing unit. The performance of this laboratory treatment system was then compared to a field pilot tri-unit (two PBRs separated by a wood-ash unit) system, which was installed on Lorraine rehabilitated mine site and monitored over a 5-year period. Results showed better efficiency (up to 99% Fe removal) during laboratory testing, using two DAS-wood ash pretreatment units, relative to the field pilot (76% Fe removal). Moreover, laboratory testing showed that the hydraulic and clogging issues, often encountered in field passive treatment systems, were limited. On East-Sullivan, a second rehabilitated mine site, a 14-year monitoring data of a mixed treatment system showed the progressive improvement of water quality over time. Iron concentration decreased down to 98%, while regulation requirements (Fe <3mg/L) are respected in most of the discharge locations. Further studies are still required for the efficient design of performant multi-step systems for the passive treatment of iron-rich AMD.

Additional Key Words: multi-unit systems, passive biochemical reactors, dispersed alkalinity substrates.

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2. Carmen M. Neculita, Associate Professor - Holder of Canada Research Chair on Mine Water Treatment, RIME (Research Institute on Mines and Environment)-UQAT (University of Quebec in Abitibi-Temiscamingue), Rouyn-Noranda, QC, J9X 5E4; Tsiverihasina V. Rakotonimaro, RIME-UQAT (PhD Candidate); Bruno Bussière, Professor – Holder of NSERC-Industrial Chair on Mine Site Reclamation, RIME-UQAT; Thomas Genty, Project Leader – Environment and Sustainable Development, Agnico Eagle Mines Limited, Rouyn-Noranda, QC, J0Y 1C0; Gérald J. Zagury, Professor, RIME - Civil, Geological and Mining Engineering Department, Polytechnique Montreal, QC, H3C 3A7, Canada.