

Can microbial activity enhance chromium removal from industrial stormwater?

BRANDY D. STEWART¹, CODY SHEIK², PAUL EGER³,
BRANDY M. TONER¹

¹University of Minnesota-Twin Cities, St. Paul, MN, 55108
(correspondence: stewarb@umn.edu, toner@umn.edu)

²University of Minnesota-Duluth (cssheik@d.umn.edu)

³Global Minerals, (paul.eger@globalmineralseng.com)

Treatment processes for metals in industrial waste streams can be cost prohibitive; therefore, passive remediation strategies using natural materials and harnessing microbial processes have the potential to provide affordable solutions which is important from regulatory and environmental quality perspectives. Our research explores the key chemical, biological, and physical processes promoting removal of hexavalent chromium (Cr) from an industrial stormwater treatment system by association with granular organic peat media. In this installation chromium is primarily in the water soluble and carcinogenic hexavalent form, chromate. Prior to treatment, chromate is converted to Cr(III) via an oxidation-reduction reaction using iron sulfate. The resulting Cr(III) is less water soluble than chromate, making Cr precipitation as hydroxides possible. The removal capacity for Cr(III) is much higher than expected for adsorption and filtration by the peat media alone, suggesting other mechanisms, including microbially mediated attenuation may play a role. In addition to filtration of Cr(III) precipitates, the presence of iron (from the pre-treatment step) could yield Cr(III) co-precipitation with Fe minerals and/or serve as a terminal electron acceptor.

Samples were collected from the treatment site in Howell, MI USA, where Cr-laden stormwater is treated in large tank reactors filled with peat sorbent material. We sampled one reactor in four different locations at four depths for a total of 16 solid-phase peat material samples. DNA was extracted to collect metagenomic data and microbial coupons were installed in the tanks to harvest biofilm samples. Chemical digestions show total Cr concentrations ranging from 400-900 mg/kg. X-ray Fluorescence Microprobe (XFM) data reveal that Cr is heterogeneously distributed within the bioremediation media with diffuse and “hot spot” features on the micron to 10s of micron scale. Additionally, results show Cr(III)-bearing particles and metallic Cr bearing particles in the same sample. Lastly, incubations inoculated with microbial cultures, containing Cr(VI) and peat demonstrate efficient reduction to Cr(III).