1,4-Dioxane Cometabolic Biological Treatment in a Fluidized Bed Bioreactor: Bench- and Full-Scale Results

Jim Hatton (james.hatton@jacobs.com) (Jacobs Engineering Group)
Todd Webster (TWebster@envirogen.com) (Envirogen Technologies, Inc.)
Paul Hatzinger (Paul.Hatzinger@aptim.com) (APTIM)
R. Hunter Anderson (richard.anderson.55@us.af.mil) (USAF)

Background/Objectives. 1,4-Dioxane (1,4-D) is a persistent contaminant in groundwater commonly encountered at contaminated sites with a history of solvent use, often impacting nearby supply wells. The USEPA classifies 1,4-D as a suspected carcinogen. 1,4-D is a low-level but pervasive contaminant at a USAF base in the southern Appalachians. Groundwater at this facility is managed using small pump and treat systems as source control measures. 1,4-D is present in all four of these systems, passes through the systems at concentrations from 2 to 55 µg/L, and is discharged to facility surface water. The action limit for 1,4-D treatment at this facility is the USEPA Tapwater Regional Screening Level of 0.46 µg/L. The USACE and USAF have commissioned Jacobs to study and recommend treatment technologies to treat 1,4-D from these systems.

Approach/Activities. Jacobs collaborated with Envirogen Technologies, the developer of this FBR process, to conduct a bench-scale test using facility treatment system effluents. Bench-scale testing, conducted in APTIM's treatability laboratory, included microcosm studies and the operation of a bench-scale reactor. Results of the microcosm testing indicated two microbial cultures reduced 1,4-D concentrations to non-detectable (<0.039 ug/L) levels from two system effluent sources in less than 24 hours, indicating site water was not inhibitory to the process. The bench-scale reactor test has been completed and results indicated effective treatment of 1,4-dioxane. Following the bench test, a pilot-scale reactor (30 gpm) has been constructed and is currently treating 1,4-D.

Aerobic cometabolic biological treatment (CBT) was identified as a potential treatment technology. CBT utilizes propane to grow a biomass with enzymes capable of cometabolically degrading the target compound (1,4-D). Based on previous DoD research for other contaminants, a fluidized bed bioreactor (FBR) CBT system was identified as a fixed-film bioreactor technology that could be applicable at this USAF site. The FBR process selected includes the required elements for 1,4-D treatment, including propane as a biomass growth substrate and a known 1,4-dioxane degrading microorganism (ENV425).

Results/Lessons Learned. The paper will discuss testing and operational experience, including operational effectiveness of the system. The paper will also present economic information on the biological treatment system and anticipated operations to meet treatment goals.

The bench-scale achieved removal rates as high as 96 percent on groundwater containing up to 50 µg/L 1,4-D. The pilot system, which is still in start-up has removed up to 80 percent of 1,4-D. The presentation will include a discussion of operational experience from both the bench and pilot systems and describe some of the challenges peculiar to cometabolic biological systems.