

## Evaluation of In Situ Thermal Hydrolysis of Haloalkanes

**Jason Cole** (jason.cole@jacobs.com) (Jacobs, Boston, MA)  
Joel Krueger (joel.krueger@jacobs.com) (Jacobs, Chicago IL)  
Gary Dyke (gary.dyke@jacobs.com) (Jacobs, Detroit, MI)  
Jim Strunk (jstrunkjr@dow.com) (Dow Chemical Company, Bristol, PA)

**Background/Objectives.** Halogenated alkanes are an important class of chemical compounds with a broad and diverse range of uses in manufacturing, agriculture, pharmaceuticals, refrigeration and fire protection. When substituted with one or more halogens including fluorine, chlorine, bromine or iodine haloalkanes are typically present as volatile liquids with specific gravity measurements greater than water. Although the chemical properties of haloalkanes differ greatly depending on degree and nature of halogen substitution, professional experience has shown that nearly every compound within this functional class are persistent and recalcitrant contaminants. In situ thermal treatment (ISTT) has emerged as a formidable tool in the restoration of soil and groundwater contaminated with haloalkanes namely in DNAPL source zones. Vaporization of haloalkanes readily occurs during ISTT, as many compounds in this class exhibit significant vapor pressure. Haloalkane removal by chemical mechanisms including hydrolysis is also known to occur. The rate and extent of hydrolysis is proportional to temperature; many common haloalkanes exhibit significant half-life reduction (years to days) with only modest increases in ambient temperature. Relatively few studies have attempted to evaluate and quantify the benefit of field-scale heating on in situ hydrolysis reactions for haloalkane destruction.

**Approach/Activities.** A thermally enhanced hydrolysis study was performed in parallel with thermal remediation of a 1,2-dibromo-3-chloropropane (DBCP), ethylene dibromide (EDB) and ethylene dichloride (EDC) contaminant source zone. A novel approach using specially constructed reaction chambers that emulate in situ environmental conditions was employed to evaluate the effects of temperature on contaminant transformation in soil and groundwater. The reaction chambers were installed in specially constructed wells within the thermal treatment zone and incubated in situ to match actual field temperature conditions. Individual chambers were selectively removed at set times and temperatures during the ISTT heating process and submitted for sacrificial analyses. Laboratory data were used to document contaminant removal as a function of time and in situ temperature. Detected products of haloalkane decomposition also provide for direct comparison of field observed degradation to published literature.

**Results/Lessons Learned.** This paper will present the findings of the thermally enhanced hydrolysis study. Study results inform and document the feasibility for removal of DBCP, EDB and EDC by thermal treatment and help to identify conditions where in situ decomposition reactions are promoted.