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Editorial

This special issue of *Biodegradation* provides timely reviews on mechanisms, kinetics and modeling of the aerobic cometabolism of chlorinated solvents. Aerobic cometabolism is a promising technology for the *in-situ* treatment of subsurface contamination with chlorinated solvents, such as Trichloroethylene (TCE). Since the initial observations of cometabolism of TCE by microorganisms grown on methane, over 16 years ago, basic and applied research has been conducted to gain a more fundamental understanding of the process. However, despite this research, both *in situ* and *ex situ* aerobic cometabolic treatment has not been widely implemented. Practitioners often view it as complex to apply, requiring the addition of both oxygen and the cometabolic substrate to the subsurface in order to grow the desired microorganisms. The microorganisms also do not gain any benefit from these fortuitous transformations and the transformations themselves can be detrimental requiring energy and imparting toxicity to the cells. Inhibition of the transformations can be the result, since the growth substrate and the contaminants vie for the same oxygenase enzymes, thus complicating the process. Thus the complexity of the process, that has been so interesting to study at the whole cell and the enzyme level, has resulted in avoidance of the use of this innovative process in practice as a treatment technology. Field demonstrations, however, have clearly shown the ability of aerobic cometabolism to remediate low solvent concentrations (TCE of 1 mg/L), which represents the most of the groundwater contamination. The process has also potential of being used to treat contamination in the unsaturated zone since gaseous cometabolic substrates (e.g., methane or propane) can easily be delivered along with air as an oxygen supply.

Currently, practitioners are focusing on the bioremediation of chlorinated solvents using anaerobic dehalogenation processes. An advantage of this process over aerobic cometabolism is that microorganisms can grow on the chlorinated solvents as electron acceptors, and there is potential for complete dehalogenation of chlorinated ethenes to ethene, a non-toxic end product. For enhanced remediation only an electron donor needs to be added, thus making it simpler to apply than an aerobic cometabolic process, where both substrate and oxygen must be added. However, aerobic cometabolism maintains better water quality being an aerobic process. Thus when drinking water quality issues are addressed, and potential impacts of groundwater recharge to surface water considered, aerobic cometabolism is likely the better choice, especially for the treatment of dilute contaminant plumes. The aerobic process can also be selected for contaminants of interest. For example chloroform, which can be an inhibitor of anaerobic processes, can be transformed cometabolically by microorganisms grown on substrates such as propane or butane. We will likely see an evolution in the use of these bioremediation technologies to treat subsurface contamination. Anaerobic dehalogenation has great potential for the bioremediation for high CAH concentrations near contamination sources zones, while aerobic cometabolism has potential to treat the more dilute portions of plumes.

Three papers are presented in this special issue that review our current knowledge of aerobic cometabolism related to biochemistry and mechanisms of cometabolism, the kinetics, and modeling of the processes. The first paper in the series "Molecular and cellular fundamentals of aerobic cometabolism" by Daniel Arp et al., reviews cometabolism from a biochemical perspective. The physiological role of monooxygenases in initiating the oxidation of the growth substrates is presented, and the metabolic and structural diversity of the enzymes that catalyze the oxidation of chlorinated solvents is presented. Physiological aspects of cometabolism are reviewed with an emphasis on the pathways for TCE oxidation, the reversible and inhibitory effects of TCE oxidation, and the irreversible and toxic cellular consequences associated with chlorinated solvent cometabolism. The second paper "Kinetics of aerobic cometabolism of chlorinated solvents", by Lisa Alvarez-Cohen and Gerald Speitel, reviews the wide range of kinetic models that have been introduced for modeling the cometabolic degradation of chlorinated solvents. A detailed compilation is made of selected kinetic coefficients for TCE cometabolism by Methanotrophs, and Aromatic Degraders, and other bacteria, such as propane and ammonia oxidizers. Selected kinetic coefficients are also presented for other chlorinated solvents. The development of models that include chlorinated solvent induced product toxicity and recovery of cells, and methods to incorporate energy requirements are also reviewed. The third paper in the series "Transport issues and bioremediation modeling for the *in situ* aerobic co-metabolism of chlorinated solvents", by Mark Goltz et al. reviews models that have been developed to aid in the understanding of the complex interactions between the physical, chemical, and microbiological processes affecting *in situ* cometabolic treatment. Processes at the macroscale (e.g., transport and dispersion), the mesoscale (e.g., sorption, dissolution, microbial transport), and microscale (e.g., reaction kinetics) are reviewed. The potential for models to aid in the understanding of transformation and transport processes, the design, and the prediction of performance of *in situ* treatment systems are discussed.

This special issue provides the integration of information that will be of use to both researchers and practitioners. Although the reviews have focused on the cometabolism of chlorinated solvents, the information presented is of value for other environmental contaminants of concern that can be cometabolized, such as Methy-tert-butyl-ether (MTBE). The special issue will provide for a better understanding of aerobic cometabolism and its potential as a means of remediating subsurface contamination. Hopefully these reviews will be of value to those considering applying aerobic cometabolism as an innovative treatment technology. The development of these review articles was funded in part by the Air Force Office of Scientific Research, USAF and the Air Force Research Laboratory Airbase and Environmental Division, Tyndall AFB, FL as a means of providing technology transfer on this topic.

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