Degradation of Toxic, Carcinogenic, and Bioaccumulative Environmental Pollutants

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Hundreds of millions of persistent chlorocarbons are produced annually, many of which are toxic and bioaccumulative. In addition to problematic chlorocarbons, fluorocarbons are emerging pollutants, due to their increasing use in pharmaceuticals and materials and their persistent nature. These pollutants are found in both soil and water systems. Exposure to chlorocarbons has been linked to liver and kidney problems and cancer. Toxicity is related to the chlorine and/or fluorine atoms (halogens), so complete dehalogenation of these pollutants effectively removes this concern.

The proposed research focuses on further development of a catalyst (Rh/Al_2O_3-H_2) for implementation in pump-and-treat systems. Preliminary studies show our system has many favorable traits: degrades both chlorinated ethylenes and fluorobenzenes, remains active with repeated use, and has rapid dehalogenation rates. Even given these strong results, numerous other factors must be considered before this type of system is ready for use in the field. Foremost among these is the sensitivity of the catalyst to water constituents. Sites contaminated with chlorocarbons and fluorocarbons are a complex matrix, containing nitrates, nitrites, sulfides, phosphates, etc. We have looked into the catalysts ability to function in the field by running the reaction in natural water taken from different seasons. We have also shown that sulfite slows the reaction rate down, the pH of the water also affects the rate of degradation, and natural water sometimes affects the rate of degradation depending on the time of year the sample was taken.

We are currently working on seeing if the binding of sulfite is reversible, looking at other compounds that can disrupt the effectiveness of the catalyst, and working on making the natural water results more reproducible. We are also exploring the defluorination reactions more as we have just began to show that our system catalytically breaks carbon-fluorine bonds.