Hydrogen sulfide (H2S), a major odorous component emitted from construction and demolition debris landfills, has received increasing attention. Although cover materials such as soil and compost are recommended to be used routinely to control an odor problem from the landfills, the problem still remains. Autotrophic denitrification may have environmental applications including treatment of water, groundwater, wastewater or gaseous streams contaminated with sulfur and/or nitrogen compounds. However, there have been no studies reported in the literature on H2S removal using autotrophic denitrification from landfills. This study, therefore, investigated the application of autotrophic denitrification incorporated into landfill covers in order to evaluate the feasibility of controlling H2S emissions generated from landfills.

Research was investigated by two techniques, microcosm and laboratory-scale column studies. The microcosm experiments were conducted to evaluate the kinetics of autotrophic denitrification in biocovers with H2S-nitrate as electron donor-acceptor couple. Cover materials including soil, compost and sand were tested and nitrate was added. Based on the microcosm study results, the addition of nitrate into soil and compost can stimulate indigenous autotrophic denitrifying bacteria which are capable of H2S oxidation biologically under anoxic conditions. There was no H2S removal observed in sand microcosms. Rapid H2S oxidation to sulfate was achieved, especially in soil. Zero-order kinetics described the H2S oxidation rate. The rates of sulfide oxidation under autotrophic denitrification in soil and compost were 2.57 mg H2S/d-g dry soil and 0.17 mg H2S/d-g dry compost, respectively.

To further explore H2S removal in a landfill biocover, two sets of column experiments have been run. The first set of columns contained seven cm of soil. The autotrophic column was prepared with 1.94 mg KNO3/g dry soil; an identical control column was prepared without nitrate. A gas stream was introduced to the columns with a H2S concentration of 930 ppm. The second set contained seven cm of soil, with both an autotrophic (0.499 mg KNO3/g dry soil) and control column. Influent H2S concentration was 140 ppm for the second set. Column studies supported the results of microcosm studies; removal of H2S was observed in all columns due to the capacity for soil to absorb H2S, however autotrophic columns removed significantly more. The higher concentration of H2S resulted in partial oxidation to elemental sulfur, while sulfate was found at the lower concentration. H2S oxidation in the column with higher loading was found to follow zero-order kinetics. The rate of H2S oxidation was 0.46 mg H2S removed/d-g dry soil.

The economic comparison of cover systems including autotrophic denitrification, soil amended with lime, fine concrete, and compost covers were also compared. Based on the case-study landfill area of 0.04 km2, the estimated H2S emissions of 80,900 kg over the 15-year period and costs of active cover system components, autotrophic denitrification cover system is a cost effective method for controlling H2S emissions from landfills.

Based on theses studies, the autotrophic denitrification landfill biocover would offer an attractive alternative to control emission of H2S generated from landfills. However, validation of the laboratory results with a field-scale study is needed.
Dr. Hala Sfeir, Brown and Caldwell

Approved for distribution by Dr. Debra Reinhart, Committee Chair, on May 13, 2010.

The public is welcome to attend.