Treatment of Methyl *tert*-Butyl Ether (MTBE) Vapors In Biotrickling Filters Reactor Startup, Steady-State Performance, and Culture Characteristics

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Overview

A study was conducted at the university and funded by the U.S. EPA to find solutions to remove MTBE from ground water that was contaminated as a result of leaking of underground fuel tanks. **BAE** was introduced to the systems to improve the growth and activity of the bio-trickling filter microbial population.

Introduction

Methyl *tert*-butyl ether (MTBE) was first introduced in United States in the late 1970s as an octane enhancer in gasoline. The use of MTBE increased rapidly after the 1990s Clean Air Act Amendments to oxygenate gasoline to reduce tailpipe carbon monoxide and other smog forming emissions. As a result MTBE emerged as one of the best oxygenates because of its low cost and blending characteristics making MTBE the second ranked chemical in 1993. At the same time, increasing groundwater contaminations with MTBE have been reported from leaking fuel tanks. While MTBE is thought to be less harmful than gasoline constituents, the U.S. EPA wanted to find cost effective solutions to prevent MTBE contamination of drinking water supplies.

Materials and Methods

Two parallel laboratory scale bio-trickling filters were constructed and served both culture enrichment and to investigate the removal of MTBE from synthetic waste gas. Reactor-1 was filled with wet lava rock and Reactor-2 with polypropylene pall rings. MTBE was continuously pumped into the reactors and circulated through both of the media. At several times during the study **BAE** was added to the medium at a rate of 0.25 mg/l.

Performance Reporting

Performance was measured by removal efficiency as a function of the inlet and outlet gas concentrations, air flow rates and the packed bed volume. Elimination capacity represents the amount of MTBE degraded per unit of trickling filter bed volume and time being reported as a function of pollutant loading.

Inoculum

Groundwater samples and aquifer material from two long-term MTBE contaminated sites were mixed and introduced in both bio-trickling filters. The first sample was from the Borden Aquifer in Canada where chloride, BTEX, and MTBE were injected. The second sample was from a leaking storage tank site in Southern California.

Culture Enrichment and Culture Characteristics

After inoculation of both bio-trickling filters with the mixture of contaminated soil and groundwater, various attempts were made to shorten the startup phase. The MTBE degrading culture consisted of at least six Gram positive and negative bacteria, bacilli and cocci, fungi, protozoa, and rotifers.

PHS Added To The Systems

Starting on day 33, 0.25mg/L of **BAE** were added to both of the bio-trickling filters. The removal efficiency started to increase after 25 days for lava rocks and 35 days with polypropylene pall rings. Performance reached a relatively steady value at about 95% removal after 52 and 40 days for the lava rocks and pall ring reactors, respectively.

PHS MTBE Removal Efficiency
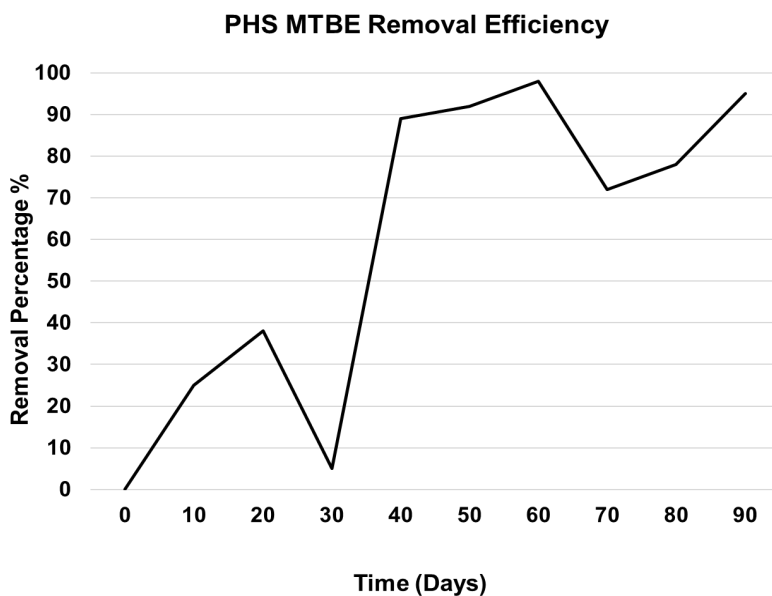
Conclusion

Further research to improve the startup of biosystems for the treatment of MTBE is warranted. In this context, it is interesting to note that **BAE** had a beneficial effect on the performance of the systems. **BAE** was developed as plant growth stimulant and has been used as a stimulant for bacterial activity in various aqueous systems. The mechanisms by which **BAE** stimulates biological activity are not well understood, but the concentration at which **BAE** had an effect, can rule out any co-metabolic process. A possible explanation is that **BAE** can form complexes with MTBE or any other growth limiting substrate and improve their assimilation.

This suggests that the main effect of **BAE** helps the initial colonization of the packing by competent cultures, and in addition experiments that were performed in shake flasks confirmed that **BAE** stimulated the growth of the consortium.