Treatment of the fuel oxygenate, MTBE, contaminated ground water using Sequence Batch Bioreactor

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ABSTRACT

A mixed bacterial culture capable of mineralizing methyl *tert*-butyl ether (MTBE), other fuel oxygenates ethers, tertiary carbon alcohols, benzene and toluene was used to inoculate batch reactor and sequence batch reactor (SBR) to treat gasoline contaminated ground water containing about 60 mg/L MTBE, 5 mg/L benzene, 5 mg/L toluene, and low concentrations of several other aromatic and aliphatic hydrocarbons.

Respirometery studies showed that MTBE degrading mixed culture could treat MTBE contaminated ground water with addition of nitrogen and phosphate.

SBR was operated to demonstrate the feasibility of using suspended growth activated system for the treatment of ground water and to confirm that the respirometry derived kinetics and stoichiometric coefficients were useful for predicting reactor performance. Theoretical performance of the reactor was predicted using mathematical models calibrated with biokinetic parameters derived from respirometry studies.

key word: Fuel oxygenate, MTBE, Ground water, Biodegradation

I. Introduction

MTBE is one of the fuel oxygenates designed to increase the oxygen and octane content of gasoline as an effort to reduce the environmental consequences

associated with fuel combustion in the U.S. MTBE was added to 30 percent of the gasoline in 1996.[1] It was found in ground water and in some drinking-water supplies of various urban locations.[2] The treatment of MTBE contaminated ground water was reported to be complex and expensive.[3] In addition to this, ethers and tertiary carbon compounds are generally considered to be resistant to biodegradation.[4]

This presentation describes the treatment of MTBE contaminated ground water using sequence batch reactor inoculated with MTBE degrading mixed culture.

II. Materials and Methods

1. Gasoline contaminated ground water

Gasoline contaminated ground water were sampled from two different places, one from Syracuse of New York and another from Metuchen of New Jersey. Both ground water were contaminated by gasoline through the leakage of gasoline underground storage tanks and contained up to 60 mg/L MTBE, 5 mg/L benzene, and 5 mg/L toluene.

2. Batch treatment of ground water using respirometer

Gasoline contaminated ground water was applied to the respirometer to investigate the capability of MTBE degrading mixed culture to treat gasoline contaminated ground water at four different temperatures (15, 20, 25, and 30°C).

3. Sequencing Batch Reactor

The reactor was constructed using a 5 liter vessel with pH and temperature controller. The solid retention time (SRT) of SBR was maintained at about 25 to 30 days using the Garret method. The gasoline contaminated ground water with nitrogen and phosphate was used as a feed.

III. Results and Discussion

1. Batch treatment of ground water using respirometer.

The results of batch treatment of gasoline contaminated ground water at

different temperatures are shown Table 1. The oxygen uptake curves at each temperature indicated that the gasoline components in ground water were biodegraded by MTBE degrading mixed culture (not shown in this paper). More than 60 % COD of applied gasoline contaminated ground water was occupied by MTBE, benzene and toluene (Table 1). The batch biodegradation experiment at 15°C indicated that only a small portion of MTBE was biodegraded at this low temperature. The specific chemical analysis after 120 hours reaction showed that only 40 % of initial MTBE was degraded at 15°C during 120 hours while benzene and toluene was completely degraded. These experiments showed that MTBE degrading mixed culture can be used to treat gasoline contaminated ground water with the addition of nitrogen and phosphate. Nitrogen and phosphate were critical inorganic compounds for biodegradation of gasoline compounds in ground water.

Table 1. Batch treatment of gasoline contaminated ground water at different temperatures.

	Compounds	Temperature				
	(mg/L)	15℃[1]	20℃[1]	25℃[1]	30℃[1]	30℃[2]
Initial	COD	116.2	110.5	106.9	100.9	104.7
	MTBE	12.6	11.5	11.2	12.3	-
	Benzene	2.4	2.2	2.4	2.1	-
	Toluene	6.9	7.1	7.5	7.4	-
Final	COD	45.3	17.5	14.0	11.8	95.4
	MTBE	7.7	ND	ND	ND	-
	Benzene	ND	ND	ND	ND	-
	Toluene	ND	ND	ND	ND	-

[1] temperature effects experiement with nitrogen and phosphate. [2] without nitrogen and phosphate where each compound was not analyzed. ND means not detected.

2. Operation of SBR reactor to treat gasoline contaminated ground water

Figure 1. illustrates the performance of the SBR reactor. The SBR reactor performed satisfactorily for the 350 days of continuous operation with less than 20 μg/L MTBE effluent, except during pH and DO shock periods.

The effluent MTBE concentration was predicted based on the Monod kinetic

parameter at 25 °C using IAWQ activated sludge model No. 1. The effluent MTBE concentration was predicted as 22 μg/L, which was shown at Figure 1. The results of this study demonstrated that SBR reactor with isolated MTBE degrading mixture culture can be used as an *ex-situ* treatment system for treatment of the gasoline contaminated ground water.

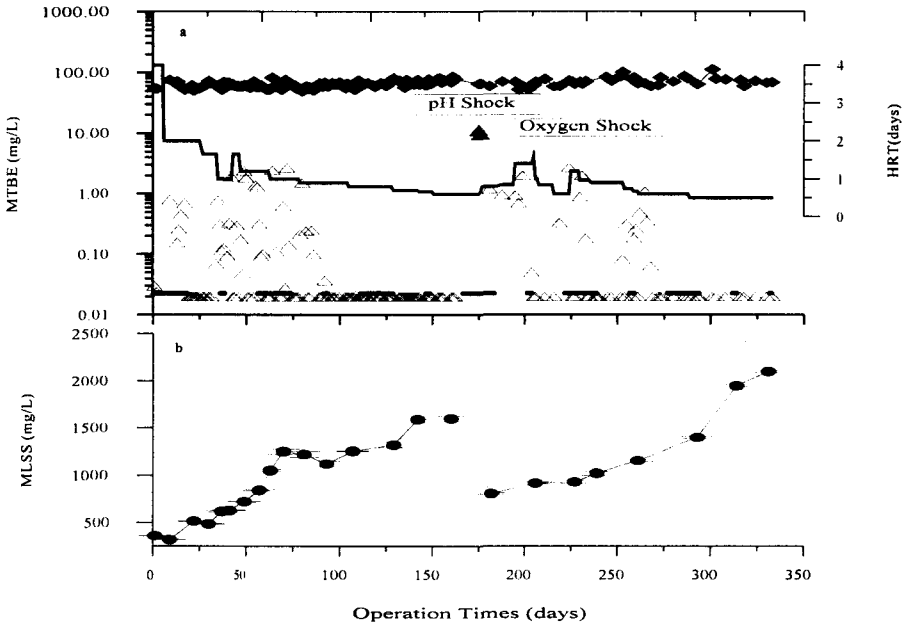

Figure 1. Performance of SBR reactor. After pH shock, re-inoculation was done at 180 days. Legend: ◆ influent MTBE concentration, △ effluent MTBE concentration, ▲ effluent MTBE concentration due to pH control problem, — hydraulic retention time (days), and - · - calculated effluent MTBE concentration (0.023 mg/L).

IV. References

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