



Brazilian Archives of Biology and Technology

Print ISSN 1516-8913

Braz. arch. biol.
technol. vol.44 no.2 Curitiba June 2001

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Effects of Trace Volatile Organic Compounds on Methane Oxidation

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ABSTRACT

The effects of volatile organic compounds (VOCs) on methane oxidation in landfill cover soils were examined. The batch experiments were conducted using single and mixed VOCs, such as, dichloromethane (DCM), trichloroethylene (TCE), tetrachloroethylene (PCE), and benzene. The results from all combinations showed a decrease in

methane oxidation rate with increase in VOC concentrations. Moreover, inhibition effects of TCE and DCM were found higher than benzene and PCE. The reduction of methane oxidation by benzene and PCE could be attributed to the toxicity effect, whereas TCE and DCM were found to exhibit the competitive-inhibition effect. When the soil was mixed with DCM, no methane oxidation was found. Damage to the cell's internal membrane was found in a methanotrophic culture exposed to VOC gases which is the attachment site of a key enzyme needed for methane oxidation

Key words: Landfill cover soils, methane, methanotrophs, methane oxidation, volatile organic compounds (VOCs)

INTRODUCTION

Landfills are important sources of greenhouse gases. Landfill gas consists mainly of methane and carbon dioxide. Currently, methane has received more attention due to its higher global warming potential compared to carbon dioxide. The annual rate of methane emission from landfills has been estimated to be 20 to 70 millions tons (IPCC, 1992) and is expected to rise as development continue towards the construction of sanitary landfills, in many countries.

Microbial activities in a landfill are complex and interrelated, particularly within the cover soil layer where the oxidation of methane takes place in the presence of naturally occurring methanotrophs. Many researchers have reported the phenomenon of methane oxidation in landfill cover soil by methanotrophic bacteria and identified the various factors which control methane oxidation (Whalen et al., 1990; Boeckx and Cleemput, 1996; Bojesson and Svensson, 1997). These researchers have identified soil texture, moisture content, temperature, nutrients, methane and oxygen concentrations as main factors. If favorable conditions are maintained, the landfill cover soil can serve as an effective sink for methane (Visvanathan et al. 1999, Humer and Lechhner, 1999). This natural microbial activity could be an alternative