Biological Activities of Methane Oxidation in Tropical Landfill Cover Soils

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Abstract

Microbial oxidation of methane in the aerobic portion of a landfill cap was found to play an important role of reducing methane emission to the atmosphere. Methanotrphic bacteria present in the landfill cover soils could utilize methane for cell reproduction and as energy source, while utilizing oxygen as electron acceptor. The atmospheric oxygen can only penetrate to a certain depth of the cover soils and, thus, oxygen is often the limiting factor for methane oxidation. Available nutrients also influence soil microbial activities. In this study, soil lysimeters were employed to examine the specific methanotrophs present in simulated landfill cover soils under tropical climatic conditions. The effects of extracellular polysaccharide, N-nutrients utilization and amendments, and pertinent biological processes were investigated, in batch experiments, using soil samples taken from the experimental lysimeter. The study provides an understanding of microbial activities and pertinent controlling mechanisms to help manage landfill soil covers for reducing methane emission.
Keywords: methane oxidation, municipal solid waste, landfill gas, extracellular polysaccharide.

INTRODUCTION

Microbial activities within landfills are complex and interrelated, particularly within the cover soil layer where the oxidation of methane, a major landfill gas constituent, takes place in the presence of naturally occurring methanotrophs. Promoting the utilization of methane gas within the cover soil can be a best management practice for designing and managing landfill cover. It is essential to understand the biological processes and environmental factors influencing methane oxidation in landfill cover. Kightley et al. (1995) observed that the methane oxidation efficiency of soil columns purged with methane gradually declined over an extended period of time. The causes of declining oxidation efficiency with time have not been fully investigated. It has been suggested that accumulation of extracellular polysaccharides (EPS) combined with imbalance of soil nutrients could be one of these causes. EPS are common metabolic products of many cellular organisms including methanotrophs and serve as a binding agent for soil particles. An increase in soil aggregation may result in reduction of soil oxygen transfer and methane oxidation efficiency.
Studies of methanotrophic activities and the associated oxidation capacities in landfill cover soils have been conducted mostly under temperate and cold climate. The authors have examined the effects of temperature, soil moisture content and methane concentration on methane oxidation under tropical climate (Visvanathan et al., 1999). This paper presents additional findings of the

methanotrophic activities and related soil microorganisms, i.e. nitrifying bacteria, occurring within the experimental lysimeters and from batch experiments using test bottles. Types of methanotrophs, accumulation of extracellular polysaccharides, and conversion of nitrogen species were observed in both lysimeter and batch experiments. Cultivation of microorganisms and the effects of nitrogen amendments were carried out in batch experiments.