Biological Activities of Methane Oxidation in Landfill Cover Soils

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ABSTRACT

Microbial oxidation of methane in the aerobic portion of a landfill cap serves as an available alternative to reduce its emissions to the atmosphere. In the landfill cover soils, a large number of methanotrophic bacteria can be found. These methanotrophs utilize methane for cell reproduction and as an energy source, while oxygen serves as an 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 are typical factors influencing soil microbial activities. An understanding of microbial activities and pertinent controlling mechanisms would help to manage landfill soil covers to reduce methane emission.

In this study, soil lysimeter was employed to examine the specific methanotrophs present in simulated landfill cover soils under tropical climatic conditions. The dominant type growing in the methane oxidation zone of the soil lysimeter was *Methylomonas methanica.* There was a gradual reduction of methane oxidation capacity after ten months. It was found that the extracellular polysaccharide (EPS) content in the methane oxidation zone was higher than that in the non-methane oxidation zone. This led to the assumption that methanotrophs might be the EPS producer. The microbial EPS normally is a binding agent of soil particles that could cause soil aggregation, thus blocking oxygen transfer from the atmosphere. In addition, high ammonium and low nitrate contents were found in the methane oxidation zone. Imbalance of N nutrients might affect the methane oxidation rate. Batch experiments were conducted to observe the release of EPS and the effect of different N nutrients on methane oxidation rate. The EPS was found to be related to soil biomass, which was higher in soil with a methane oxidation than in normal soil after 125 days of incubation. Nitrate was the N-form that methanotrophs utilized in the methane oxidation process. The additions of supplemental ammonium and nitrate ions exceeding 30 $\mu g.g^{-1}$ dry soil had negative effects on the methane oxidation rate. Ammonium in soil with methane oxidation was oxidized faster than in soil without methane oxidation, which may be due to the process of co-metabolism of ammonium by methane monooxygenase (MMO) enzyme from methanotrophs.

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