UNIVERSITI TEKNOLOGI MARA

EVALUATION OF METHANE OXIDATION EFFICIENCY IN SELECTED LANDFILL SOIL COVER

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Thesis submitted in fulfillment
of the requirements for the degree of
Master of Science
(Environmental Science and Technology)

Faculty of Applied Sciences

March 2018

ABSTRACT

Landfill is a source of anthropogenic CH_4 and landfill soil cover has been considered as a potential medium to mitigate the gas emissions. This study investigated CH_4 oxidation efficiency (MOE) in Jeram Sanitary Landfill soil cover at different moisture contents, organic matter contents and texture using column with 80cm soil thickness. MOE of MC15 (15% moisture content) was the highest (82%). Drier MC5 and wetter MC30 (5% and 30% moisture content, respectively) showed lower MOE (54% and 50%, respectively) due to the reduction of microbial activity and limited gas diffusion. The mixture of soil to coir pith at 30:70 (%v/v) (CP70) had enhanced the MOE up to 92%. At 50:50 (CP50) and 70:30 (CP30) of soil to coir pith, the mixtures scored 88 and 86% of MOE, respectively. The incorporation of coir pith to soil cover also enhanced MOE by increasing C:N and permeability of the soil. Meanwhile, sandy clay loam scored the highest MOE with 94% of MOE compared to clay loam (84%) and sandy loam (85%). It was proven that coarser texture of soil cover increased the soil breathability properties to enhance gas transportation along the soil thickness. Via Michaelis-Menten kinetics study, the value of maximum oxidation rate (V_{max}) achieved by CP70 was higher (1.50μg g^{-1} h^{-1}) compared to sandy clay loam and MC15 (1.20 and 1.01μg g^{-1} h^{-1}, respectively). In conclusion, the data indicated modified soil cover with coir pith and sand achieved higher MOE compared to control soil.

ACKNOWLEDGEMENT

I would like to express profound gratitude to my supervisor Dr. Faeiza Buyong, for her invaluable advice, supervision and immense patience which enabled me to develop an understanding on the project carried out. I am also heartily thankful to the Science Officer, En. Zubir Othman and lab assistant, En. Rosmi Abdullah for their cooperation and kindness to assist me in the technical aspects from the beginning to the end of the project period.

I offer my regards and blessings to the whole family members for the continuous support throughout the journey of the programme. I also would like to express my appreciation to the rest of undergraduate and postgraduate friends under of the same supervisor for their non-stop cooperation and ideas shared since the proposal stage of the project.

Lastly, I am indebted to all of those who supported me in any respect during the completion of this thesis.

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CHAPTER ONE

INTRODUCTION

1.1 Research Background

Landfill gas (LFG) stems from the degradation of organic fraction of municipal solid waste in landfills and known to be flammable and potentially harmful mixture. It is primarily constituted by 30-40% by volume of CO_2 and 50-60% by volume of CH_4 and trace elements (Abushammala, Ahmad Basri, Basri, Kadhum & El-Shafie, 2012). The gases seep into the surface and cause the accumulation of Greenhouse Gases (GHG) in the environment and hence promote climates change (Tien & Agamuthu, 2011). CH_4 is the second largest GHG constituents with approximately 1.8ppm of atmospheric concentration after CO_2 (402ppm) (IPCC, 2013). In 100-year horizon, a global warming potential (GWP_{100}) of CH_4 is 34 times higher than that of an equal mass of CO_2. Its radiation force is the second-largest of the long-lived GHG (IPCC, 2013). At landfills, LFG can be manipulated to produce energy for daily use (Yuan, 2006) or directly vented into the atmosphere or burned by flaring to mitigate the potential greenhouse gas impact of CH_4. According to Albanna, Fernandes, & Warith (2007), gas extraction systems and reactive biological soil cover for CH_4 oxidation are the effective methods to reduce fugitive CH_4 emissions from landfills.

In developing countries, landfill is one of the most common disposal methods for municipal solid wastes. At landfills, municipal solid waste is spread out before compacted and layered with fresh cover soil. Within the compacted waste, a biochemical reaction takes place whereby the organic portion is decomposed to produce landfill gases like CH_4 and CO_2, and water (leachate).

During microbial CH_4 oxidation, methanotrophic bacteria or methanotrophs consume CH_4 as carbon and energy source. The process is carried out using methanemonooxygenase (MMO) enzyme to completely degrade CH_4 to CO_2 through their metabolism under aerobic condition (Albanna et al., 2007). Application of CH_4 oxidation by methanotrophs in landfill soil cover is preferable to control CH_4 emission from landfill for its low cost of operation (Tanthachoon, Chiemchaisri, & Chiemchaisri, 2007).