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MICROBIAL METHANE OXIDATION ASSESSMENT AND CHARACTERISATION IN BENCH-SCALE LANDFILL BIOREACTORS

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A dissertation submitted to the Faculty of Science, University of the Witwatersrand, Johannesburg, in fulfillment of the requirements for the degree of Master of Science

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DECLARATION

I declare that this is my own, unaided work. It is being submitted for the degree of Master of Science in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other University.

_____

NAMISHA K. MUTHRAPARSAD

___ day of _____, 2006.

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ABSTRACT

Anaerobic fermentative bacteria degrade waste components in landfills where methane (CH_4) and carbon dioxide (CO_2) are the primary biogases emitted and methanotrophic bacteria in the cover soil oxidise the emitted CH_4. Three bi-phasic bench-scale landfill bioreactors were commissioned to evaluate soil nutrient addition effects on CH_4 formation and oxidation and to isolate inherent soil methanotrophs using Nitrate Mineral Salts (NMS) medium. Set A soil contained no nutrient additions, Set B soil contained 50 µM nitrate and 150 µM phosphate and Set C soil contained dried sewage cake. Bioreactors were run for a 4 week period and pH, anaerobic gas emissions, volatile fatty acids (VFA), bacterial counts and scanning electron microscopy (SEM) analyses were performed. A pilot study revealed that pH dictated the stability of methanogenesis, where increased VFA levels inhibited methanogenesis. Furthermore, it was revealed that modifications of the NMS medium were needed to enrich for methanotrophs. An in depth study showed that the Set C anaerobic reactor produced the most methane with Set B the least. The hypothesis that methane oxidation in the soil could regulate methane formation in the waste could not be conclusively observed, as a lack of aeration in the soil reactors is believed to have prevented the proliferation of methanotrophs here. No methanotrophs were successfully isolated from soil, but rather major heterotrophic bacterial interference was observed. SEM revealed the presence of rod and cocci forms of bacteria in both leachate and soil, consistent with literature reports, which indicated that the bench-scale landfill bioreactors were capable of promoting bacterial growth.

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