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.

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NAMISHA K. MUTHRAPARSAD

___ day of __________, 2006.
<table>
<thead>
<tr>
<th>CHAPTER</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Literature review</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Design and Operation of Bench-Scale Landfill Bioreactors</td>
<td>37</td>
</tr>
<tr>
<td>2.1</td>
<td>Description of a Bench-Scale Landfill Bioreactor for Investigating the Production of Biogas from Solid Waste.</td>
<td>38</td>
</tr>
<tr>
<td>2.2</td>
<td>PH, bacterial populations and methane emission observations on three different soil nutrient types: a preliminary study</td>
<td>60</td>
</tr>
<tr>
<td>3</td>
<td>Effects of nitrate and phosphate on the methane oxidation capacity of methanotrophs in landfill cover soil</td>
<td>83</td>
</tr>
<tr>
<td>4</td>
<td>Scanning electron microscopy (SEM) studies of leachate and soil in laboratory-scale landfill bioreactors</td>
<td>116</td>
</tr>
<tr>
<td>5</td>
<td>Summarising discussion and conclusion</td>
<td>144</td>
</tr>
<tr>
<td>REFERENCES</td>
<td>.....................................................................................</td>
<td>151</td>
</tr>
</tbody>
</table>
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.
LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table 2.1.1.</td>
<td>Composition of refuse used as the MSW fraction in this study</td>
<td>55</td>
</tr>
<tr>
<td>Table 2.1.2.</td>
<td>Morphological characteristics of the anaerobic reactor leachate</td>
<td>57</td>
</tr>
<tr>
<td>Table 3.1.</td>
<td>Bacterial PCR primers used in this study</td>
<td>108</td>
</tr>
<tr>
<td>Table 3.2.</td>
<td>Phylogenetic Sequence Identification using the methanotroph-specific Meth T1dF and Meth T1bR primer set</td>
<td>115</td>
</tr>
</tbody>
</table>
### LIST OF FIGURES

| Figure 1.1. | A typical soil cover layer (A) and (B) the waste compaction process | 32 |
| Figure 1.2. | Design of a landfill as set out by the Minimum Requirements for Waste Disposal by Landfill, South Africa, 1998. The landfill liner below the waste body separates wastes from the land surface below | 33 |
| Figure 1.3. | The 5 phases of gas generation and biodegradation in a landfill. The diagram shows the levels of the various gases at different degradation stages in a landfill (Farquhar and Rovers, 1973) | 34 |
| Figure 1.4. | The ribulose monophosphate (RuMP) pathway of formaldehyde assimilation during methane oxidation by methanotrophs | 35 |
| Figure 1.5 | The serine pathway for formaldehyde assimilation during methane oxidation by methanotrophs | 36 |
Figure 2.1.1. Schematic diagram of the setup of the landfill bioreactor. (1) Anaerobic phase, (2) Aerobic phase. a) leachate recycling pipe, b) peristaltic pump, c) leachate sampling and dilution port, d) leachate outlet, e) water jacket, f) leachate inlet, g) manometer outlet, h) additional gas measurement outlet, i) methane outlet, j) water trap, k) gas sampling port, l) air inlet, m) methane inlet port, n) gas volume measurement outlet, o) Tygon piping.

Figure 2.1.2. Anaerobic (1) and Aerobic (2) phases representing the MSW waste and landfill cover soil components, respectively.

Figure 2.1.3. Schematic diagram illustrating the pressure manometer (A) and corresponding photograph (B): a) Linseed oil inlet capillary b) Second capillary tube, c) manometer arm with linseed oil, d) Clamped Tygon piping to hold the oil reservoir, e) 3 – way tap, f) spring with clamps, g) ground glass, h) ground glass tube location in solid Perspex cap, i) solid Perspex cap (anaerobic reactor), j) clamps for manometer support.

Figure 2.1.4. pH profile of leachate from the anaerobic reactor showing pH changes over a 21 week period.

Figure 2.1.5. Gas emission profile of the anaerobic reactor showing methane (CH₄) and carbon dioxide (CO₂) levels over a 21 week period.

Figure 2.2.1. Reactor set-up for reactor sets A, B and C. Set A: no nutrient addition to the soil; Set B: 50 µM nitrate and 150 µM phosphate concentrations and Set C: dried sewage sludge cake added to soil.

Figure 2.2.2. Wastes from anaerobic reactors A, B and C after run completion. (I) Degraded organic matter (fruit, vegetables, meat, etc.). (II) Paper content. (III) Plastic content.
Figure 2.2.3. pH profile of leachate from anaerobic reactors Set A only (A) and Sets A, B and C, in comparison (B)  
Figure 2.2.4. Gas chromatography analysis of methane (CH\textsubscript{4}) and carbon dioxide (CO\textsubscript{2}) of gas samples from anaerobic reactor Set A (A) and Set B (B) and Set C (C) in comparison  
Figure 2.2.5. Bacterial counts (log cfu/ml) associated with leachate samples from anaerobic reactor Set A only (A) and Sets A, B and C, in comparison (B)  
Figure 2.2.6. Bacterial counts (log cfu/ml) associated with soil on TYG media from aerobic reactors A (A) and in comparison A, B and C  
Figure 2.2.7. Bacterial counts (log cfu/ml) associated with soil samples on NMS media from aerobic reactor Set A only (A) and Sets A, B and C, in comparison (B)  
Figure 2.2.8. Scanning electron micrographs of leachate from anaerobic reactor sets A (A-C), B (D-F) and C (G-I). 'Web-like' strands are shown associated with cells (A, B, G-I). Cocci and rod shaped cells are shown to be present in leachate from all 3 reactor sets  
Figure 2.2.9. Scanning electron micrographs of soil from aerobic reactor sets A (A-C), B (D-F) and C (G-I). Cocci and rod shaped cells are shown in all reactor sets. 'Web-like' strands are illustrated for Set B soil (D-E)  
Figure 3.1. pH profile of leachate from anaerobic reactors Sets A, B and C (A) and soil from aerobic reactors Sets A, B and C in comparison (B)  
Figure 3.2. Volatile fatty acid (VFA) analysis of leachate from anaerobic reactor Sets A (A), B (B) and C (C). Fatty acids analysed were: acetic acid, propionic acid and butyric acid
Figure 3.3.1  Gas chromatography analysis of methane (CH₄) of gas samples from anaerobic reactor Set A (A) and Set B (B) and Set C (C) in comparison. .................................................................

Figure 3.3.2  Gas chromatography analysis of carbon dioxide (CO₂) of gas samples from anaerobic reactor Set A (A) and Set B (B) and Set C (C) in comparison. .................................................................

Figure 3.4  Counts (log cfu/ml) of bacteria associated with leachate samples from anaerobic reactor Sets A, B and C in comparison (B). .................................................................

Figure 3.5  Counts (log cfu/ml) of bacteria associated with soil samples from aerobic reactor Sets A, B and C on tryptone yeast extract (TYG) medium (A), single strength Nitrate mineral salts (NMS) medium (B) and triple strength NMS medium (C)……...

Figure 4.1  Scanning electron micrographs of bacteria from a 5-year old field landfill leachate showing (A) overall view, (B) different bacterial forms in the leachate and (C-F) ‘web-like’ material associated with single bacterial cells. A curved rod cell is also present as shown in (B). Short, fat rods are shown in (A-D) with longer rods shown in (B)…………………………

Figure 4.2  Scanning electron micrographs of leachate from the Set A anaerobic reactor after 1 week. (A) illustrates an overall view, (B-E) highlights the presence of ‘web-like’ material associated with bacterial cells and (C-F) shows different bacterial forms. Cocci (C) and rod shaped bacteria can be distinguished (D-F) with a curved bacterial cell (F) also present………………

Figure 4.3  Scanning electron micrographs of leachate from the Set B anaerobic reactor after 1 week. 'Web-like' strands are shown in micrographs (A-D) with chains of rods shown in (E-F). Associations of rod and coccal bacterial forms are also shown with filamentous rods (C) and fat rods (E) also present………………
Figure 4.4. Scanning electron micrographs of leachate from the Set C anaerobic reactor after 1 week. Web-like’ material (A, B, E, F) associations with bacteria are illustrated. Different sized cocci and rods(A-D) are shown while a curved rod cell is highlighted in (E) ……………………………………………………………………………………………

Figure 4.5. Scanning electron micrographs of leachate from the Set A anaerobic reactor after 3 weeks showing 'web-like' material (A-B, E), filamentous rods (B-C), cocci (D, F) and shorter fat, rods (A, E, F). A curved rod bacterial cell is shown in (B)………………

Figure 4.6. Scanning electron micrographs of leachate from the Set B anaerobic reactor after 3 weeks showing 'web-like' strands (A-E), filamentous rods (A, C, E), shorter, fatter rods, (A, C-F) and cocci (A-C, E). A large, spherical coccal cell is shown in (C) associated with smaller coccal cells……………………………………

Figure 4.7. Scanning electron micrographs of leachate from the Set C anaerobic reactor after 3 weeks showing 'web-like' strands (A-C, E), cocci (A-C), shorter, fatter rods (A, B, D, F), filamentous rods (D-F) and spherical cocci (F). ………………………………………

Figure 4.8. Scanning electron micrographs of soil from aerobic reactor A after 1 week showing an overall view (A), cocci shaped bacteria (A, C, D, F) and rod shaped cells (C, E) with spherical shaped bacteria also shown (B and E)………………

Figure 4.9. Scanning electron micrographs of soil from aerobic reactor B after 1 week showing 'web-like' material presence (A-D), short rods (B-C, E-F) and cocci shaped bacteria (B-D, F). Different sized cocci cells are also shown (B-D)…………………………

Figure 4.10. Scanning electron micrographs of soil from aerobic reactor C after 1 week showing extensive 'web-like' strands (A, D-F), cocci shaped cells (A-C) and short fat rods (B-D). The presence of curved rods is also shown in (E)………………

Figure 4.11. Scanning electron micrographs of soil from aerobic reactor A after 3 weeks showing cocci shaped cells (A, C-E) larger, rod
shaped and cocci shaped cells (A-E) and possibly embedded cells (F) which appear to be rods and cocci.

**Figure 4.12.** Scanning electron micrographs of soil from aerobic reactor B after 3 weeks showing an overall view of cells and debris (A-C), cocci shaped cells (B, C, F) and rod shaped cells (C-E).

**Figure 4.13.** Scanning electron micrographs of soil from aerobic reactor C after 3 weeks showing an overall view (A), cocci shaped cells (B-D, F) and rod shaped cells (C, E, F). 'Web-like’ strands are shown associated with cocci shaped cells (E-F).
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