# LARGE SCALE COMPOSTING SEWAGE SLUDGE USING A NATURAL MICROBIAL TECHNOLOGY CALLED EM®

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## Introduction

Effective Microorganisms (EM) is a global technology currently being used in more than 120 countries worldwide (EM America, 2009). EM was originally developed as a microbial enhancer for soil applications and crop production in farming systems (Higa & Parr, 1994), but later discovered to have very successful applications in the waste sector (Okuda & Higa, 1995).

The technology originally developed in Japan, but produced here in New Zealand using all local and natural microorganisms, has proved very effective at odour reduction (da Silva, *et al* 1997), improving composting (Daly & Pontin, 2001, Daly & Arnst, 2005), and also bioremediation of contaminated waste (Miyajima, et al., 1995).

## What is EM and how does it work?

A microbial culture named "Effective Microorganisms" (EM) was developed by Professor Teruo Higa of the University of Ryukyus, Japan after he began his microbial technology research in 1984, with the purpose of improving soil quality, soil health, and the growth, yield and quality of plants (Higa and Parr, 1994). EM consists of approximately 80 species of selected beneficial microorganisms including lactic acid bacteria, yeasts, photosynthetic bacteria, and actinomycetes, among other types of microorganisms such as fungi (Xu, 2000).

The basis for using EM in waste processing is that some of the species contained in EM produce various organic acids due mainly to the presence of lactic acid bacteria, which secrete organic acids, enzymes, antioxidants, and metallic chelates. These organic acids, enzymes and metallic chelates are also important in the suppression of odour substances, and odour producing microbes (Higa & Chinen, 1998). A key microbe in EM is phototrophic bacteria, particularly in environmental fields; this microbe is effective at decomposing organic materials and working efficiently in anaerobic conditions (Anon, 2009).

A study carried out in 1997 at Lincoln University, New Zealand, demonstrated increased respiration when EM was added to organic matter in a laboratory experiment. Further this paper (Daly & Stewart, 1999) described the species present in EM and some positive effects on crop production.

EM has been widely used for suppressing odours in intensively farmed animals such as poultry, and significant reductions in odour mainly associated with ammonia levels have been recorded (Weijiong & Yongzhen, 1995).

The technology has a longstanding application record with the Christchurch City Council for odour control in green waste composting and sewage sludge composting. The technology was

also a significant component in a bioremediation project of contaminated wool scour sludge presented to this conference two years ago (Kroening, et al., 2007).

***What benefits do we expect from the use of EM technology in this process of sewage sludge composting?***

This project has been initiated to demonstrate firstly, a working model of this composting process using EM technology, and secondly, to allow more detailed monitoring and focussed research on the process.

Based on published data and case studies from within New Zealand and International, we can expect to see the following benefits coming out of the addition of EM to the composting process:

1. Odour control
2. Faster composting and more complete composting
3. Compost with a higher growth index
4. Reductions in pathogens during and at the end of the composting process
5. Bioremediation of the sludge during the process
6. Improvements in the quality of water and leachate coming from the process.

This paper will present the initial findings of a case study of large scale trial composting using EM on municipal sewage sludge from Palmerston North Sewage Treatment Station (WWTP).

**Approach**

Since the closure of the Awapuni Landfill in February 2007, the Awapuni site has been transformed into an Eco-Industrial site, which includes a Commercial Green Waste composting operation. The WWTP is situated adjacent to the site and produces up to 20 cubic metres of sludge waste daily. This sludge previously was land filled at Bonnie Glen, but with increasing landfill costs an alternative solution has been sought. A 13-month trial is being conducted on composting the sludge using EM technology.

This project is to test the potential of EM technology in a range of applications in an around the Awapuni site, first applications being;

1. Sludge handling and composting,
2. General composting (green waste and food waste),

In addition after successful implementation of the above, these further application areas will be developed:

3. Bio solids screened from sewage and destined for “Hot Rot” composter.
4. Wastewater treatment plant, primary screening station

Our focus in this paper and the conference presentation is, specifically on the handling of dewatered sludge and composting with green waste, using EM.

Partners in the project were as follows:

- Palmerston North City Council (PNCC), Sludge operation of composting process at the Awapuni Site.

- New Zealand Nature Farming Society, supply of Effective Microorganisms (EM®) and associated technical assistance.

**The Composting Process**

There are two types of sludge that come out of the WWTP; Alum Sludge, and Bio-digester sludge, the former having the most offensive odour. With both of these by-products the main aim for the use of EM is to reduce the associated odour. Both of these sludge types come through the de-watering plant, so the method we have put in place provides an opportunity to dose the sludge as near to the dewatering phase as possible. This helps in two ways, firstly it allows the odour reducing characteristic to work as earlier as possible in the process, thereby minimising odour release, and secondly the early introduction of microbial inoculants means that there is a more rapid inoculation with less competition from opportunistic microbes that can develop rapidly once the sludge has been exposed to the atmosphere.

The method of application was to install a 1000 litre Shultz container as a reservoir for the EM (Figure 1). The reservoir is plumbed to the dewatering auger using a pump which is wired to auger drive so that when the auger is running EM is dosed into the sludge at 3 litres/m³ (Figure 2).

**Figure 1: Reservoir containing EM plumbed to top of auger**

**Figure 2: Sludge auger showing EM line plumbed into dewatered sludge auger**

Once the sludge comes out of the auger it is loaded onto a truck (Figure 3) and taken up to the Awapuni closed landfill site, and mixed at a ratio of 1:2 with woodchips and shredded green waste (feedstocks)(Table 1). It is then windrowed. A digger is used to form the windrows, which also has a dosing system set up attached, for application of EM (Figure 5& 6). This provides thorough inoculation of the feedstock's with EM, ensuring that odour is further controlled, and the composting process is further enhanced.

**Figure 3: Sludge Auger out-feed to truck**

**Figure 4: Sludge compost windrows**

The sludge is then put into windrows for decomposition to take place (Figure 4).

Once the sludge has decomposed, it will be used for landfill cover over the completed clay capping. The sludge compost is expected to provide a suitable growing media for native plantings which will be established on the site.

**Table 1: Awapuni Sludge Composting Project: Components, Volumes, Additives**

| Component | Amount | Comments |
|---|---|---|
| Dewatered Sludge | 18 – 20 Cubic metres per day (Less over winter period) | Both Alum and Bio-digester sludge |
| EM | 3 litres per cubic metre of sludge | Cost is $1.50 per litre for EM-A (activated EM) |
| Wood chips | 18 - 20 cubic metres per day | Combined with sludge, greenwaste and woodchips 1:1:1 |
| Greenwaste | 18 - 20 cubic metres per day | Combined with sludge, greenwaste and woodchips 1:1:1 |

**Figure 5: EM reservoir mounted on Digger**

**Figure 6: EM dosing ring on Digger boom**

***Further areas of EM application at the Awapuni site:***

1. ***Food waste***

EM is also used for odour control and to enhance the breakdown of the commercial collection of organic waste. The PNCC has a compactor truck that picks organic waste (food waste) from over 65 businesses within its region. On average this is 25m³/week. This is mixed with stable waste to a ratio of 1:3 and EM is added at 3 litres/m³ as it is mixed and windrowed. When these windrows are turned every three months (EM applied again at the 2nd turning at 6th months) all the workers on site, especially the contractors who operate the Green Waste Composting Site (Roy Harding Engineers Ltd), have noticed a greatly reduced presence of odour (Roy Harding, pers com.).

2. ***Leachate ponding areas around the composting site***

Over the winter period, EM has been used to dose any areas where leachate has ponded around the site. This leacheate is a source of intense odour. At present, this leachate runs off the site into a drainage system that takes the liquid back to the WWTP. In the future if suitable, the leachate will be utilised by the bio-digesters to generate more methane for energy use, as part of the PNCC goal of diverting as much organic waste to energy as possible (Slack & Pepper, 2009). Should the leachate be unsuitable for energy generation, then it will be applied back onto the windrows, to increase moisture levels and enhance the composting process.

**Results and Discussion**

The project began in December 2008 and initial observations and feedback has been excellent for odour control since the commencement of the project.

To abide by the Horizons Resource Consent for running this trial, three months of odour monitoring was required at the boundaries of the existing PNCC closed landfill site. Using the FIDOL Assessment Factors (frequency, intensity, duration, offensiveness and location) there were no odour effects evident. Under the RMA, 1991 there is different sensitivity classifications for different land uses. A closed landfill comes under heavy industrial and has a sensitivity rating of low. This meaning that a mix of odour is generally tolerated in these types of zones as long as it is not severe and people who work in these areas are more likely to work in these zones without finding the odour to be objectionable. However upon talking with a range of people who have visited the WWTP and the sludge composting site, both daily workers and visitors to the site who had previously experienced the odour in both areas, were surprised at the lack of smell.

At the WWTP, the PNCC Resource Consent Engineer would not enter the premises of the auger room and the bay where the truck is loaded due to the offensiveness of the odour. However after the application of EM, was able to stand within a metre of the truck and not be able to detect an offensive odour (Natasha Simmons, pers com.).

Prior to the application of the EM to the Alum-sludge, the smell was highly offensive and could be strongly detected from up 50 metres away from the dewatering plant and inside the

building, and during transport (less than 1 km) to the Green Waste Site where it is deposited for composting. People, who were not accustomed to the odour, would either not enter the premises or make complaints to the Senior Weigh Bridge Operator of the site. With the introduction of the EM, there was a huge reduction in the odour that was noted by all people who dealt with the sludge daily as well as Engineers and Project Managers who infrequently visit the site. Complaints to the weigh bridge were also greatly reduced.

When we proposed this paper, we were expecting to have significantly more data to present, however due to an illness with a key person in the project, and in addition, core data was lost due to the integrity of our trial compost rows being compromised. This was due to an error in a contractor combining rows, and has put the data collection part of the project behind. Therefore we are largely reporting anecdotal evidence, but we take the opportunity to introduce the project and anticipate more comprehensive data will be available for future reporting.

The additional areas of application with EM, that is the food waste and leachate ponds have also been seen as effective for odour control by the observers of the project. Further EM applications around the recycling centre sort line and associated machinery, floors and bins applied using a "Solo" Mister/blower resulted in a noticed reduction in odour within 8 hours, by both the workers and visitors at the centre. As mentioned above the primary purpose of using EM was odour control, this has been achieved.

**Summary and future work**

The reduction of odour in the sludge handling process has been apparent from the initiation of the project and is obvious to the staff working in the handling process. Other potential benefits, such as, improved composting, reduction of pathogens and toxic substances, has yet to be determined. These parameters will be investigated in the next phase of the project in which greater monitoring will be undertaken and independent research opportunities in conjunction with Massey University will be sought.

The performance of EM in this sludge composting project, has given confidence to staff of PNCC, sub contractors at Awapuni Green Waste Compost site, and the WWTP, to begin using EM in other areas of their operations that are a source of odour. These will be further documented and data collected for presentation in more detail in future reports.

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