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CLAY - COMPOST PROJECT

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INTRODUCTION

Of all solid municipal domestic waste produced in Australia approximately 50-55% consists of food and garden waste. Other components are paper (20%), plastics (6%), glass (10%), metal (5-7%) and other inorganics (10-15%).

The organic fraction is by far the most environmentally polluting and can be hazardous. The reasons for this are 1) the enormous volume occupying 75% of landfill space, 2) its putrescible nature, causing it to be a source of pathogenic organisms, 3) the large volume of polluting gases released during the uncontrolled decomposition such as ammonia and methane, and 4) the decomposing organic matter is a major contributor to groundwater pollution through dissolution and its function as a carrier for inorganic pollutants (e.g. heavy metals). Furthermore it creates odour, attracts seagulls and is a breeding ground for rodents and insects.

The major challenge in any integrated waste management strategy is to solve the problem of how to deal with organic waste. The current practice of landfilling organic waste whether it includes compaction or other more advanced landfilling techniques is becoming an inappropriate waste treatment practice and unsustainable in the long term. Because of the previously mentioned reasons and also the fact that it consumes large amounts of land, it results in low land value and generally strongly objected by residents, landfilling is fast disappearing in major cities as a single waste treatment strategy. In low-density cities transport costs become prohibitive as suitable landfill space is only available well away from waste generation centres.

Main sources of organic waste beside domestic solid waste are, industry (breweries, abattoirs, food), agriculture, the wood and forestry sector and sewage treatment plants. In Western - Australia alone combined organic waste production is estimated to be approaching 1 million tonnes annually. Some of this is used on soils (wood, sewage sludge), reused as basis for other products (brewery waste) or used as stockfeed by piggeries. However, most of the waste is landfilled.

This organic waste has, however, considerable potential as a resource when treated properly. It is high in organic carbon (60-80%), nutrients, such as nitrogen (2%), phosphorus (0.5-0.7%) potassium (0.7-1.7%) and trace elements.

ORGANIC WASTE TREATMENT OPTION

There are three major alternative treatments for organic waste.

Incineration

Incineration has attracted considerable interest from city planners for its potential to destroy organic waste reducing the waste bulk and generating heat. A close examination of the process, however, shows high capital and operating costs; the process doesn't generally destroy pollutants such as heavy metals, but in fact concentrates them, requiring more advanced further treatment or disposal. Furthermore the risk of the synthesis of organic molecules such as dioxins, benzopyrene, polycyclic chlorinated hydrocarbons, etc., is of most concern and their destruction is very costly.

Anaerobic digestion

Anaerobic digestion of organic waste is costly as far as capital and operating costs are concerned. The main reasons being that the process requires full enclosure to avoid aeration and the fact that the process is relatively slow requiring a large treatment capacity. The residue may not be suitable for land application as it is odorous, has lower nutrient value than compost and may suffer from a combination of pollutants, eg metals, pathogens. The process does recover energy in the form of methane as a result of the bio-methanation process.

Composting

Direct composting of organic waste is considerably cheaper than the above processes, and there are a number of available composting systems with varying capital and operational running costs. For composting to be cost effective and sensible it is of paramount importance that the end product, compost, has commercial value with a market of sufficient size to absorb the quantity produced. Potential markets include local governments, market gardeners, nurseries, viticulture, agriculture and householders. The potential of the market is large and correlated to the quality of the compost. This is the crucial point for composting to be cost-effective, environmentally very sound and therefore the preferred waste treatment option.

PHILOSOPHY OF THE CLAY COMPOST PROJECT

Quality of compost relates in the first instance to the level of contamination by heavy metals in the compost. Heavy metals research in the United States and Europe has shown that composting of municipal waste is limited only because of contamination by heavy metals. Most soils demand protection from contamination in order to sustain land use. For this purpose soil protection guidelines are in place for the application of heavy metals to soils.
As stated before, the level of heavy metals in compost thus determines the size of the market and the appropriate application volume as a soil conditioner.
The main cause for heavy metals to occur in domestic organic waste is that domestic refuse is only separated after collections; allowing metal containing waste such as medicines, alkaline batteries, cosmetics, rubbers etc. to mix with the organic fraction. The resulting metal contamination is impossible to reverse. As during the composting process a reduction in solids of up to 50% occurs, any contamination will concentrate in the end product.

One way of avoiding the contamination is to separately collect the putrescible fraction. This practice has recently been adopted in the Netherlands. They currently collect and compost 70% of the domestic organic waste produced. Considering that 50% of total the waste stream is organic, it follows that effectively 35% of total waste produced is turned into a compost that conforms with the strict contamination guidelines. This requires, however, education programmes, co-operation of householders and increased waste collection costs.

Contamination is defined as either presence of xeno-biotic substances or an excess of biotic substances. In the case of metals, it is the concentration at a given time at a certain location, so-called flux, that causes contamination. In a practical sense it restricts application to prevent uptake by vegetables or groundwater contamination. From this follows that contamination only exists in case it adversely influences the ecology of the environment.

So the presence of metals itself is not a pollution until it is interactive with the environment at levels above background. This means that removal of the interactive flux of metals through reducing the interactive level over an extended period of time would remove the potentially adverse effects on the environment.

CLAY COMPOST RESEARCH

On this basis research is being carried out to develop a technology that reduces the mobility of heavy metals in various organic wastes. The principle of the process consists of the stabilisation of organic waste by a modified composting process whereby bauxite refining residue, a waste high in clay content and alkalinity is added to the process. Preliminary research where the effect of bauxite fining residue on the mobility of heavy metals in municipal compost and sewage sludge was studied showed encouraging results. (Hofstede et al., 1989 and 1990)

The idea of combining bauxite refining residue or clay is currently being further developed, with a combined research grant from Alcoa, Perth City Council and WA government. The development consists of instead of adding bauxite refining residue or clay with already composted organic waste, it is added before the stabilisation process enabling contaminants to be immobilised by the clay before being complexed in the organic fraction. The problem we faced in the initial stage was that red mud was only partially capable of binding the heavy metals since most metals had already been complexed to the organic faction during the composting process. Red mud seemed incapable of fully transferring these complexed metals from the organic fraction into the inorganic red mud.

The logical development was to mix the clay with the organic waste before composting. This has the following advantages.

- Heavy metals are immobilised through strong adsorption to the clay particles.
- The final compost has greater stability and density.
- The half-life of the organic fraction of the product is up to 5 times higher due to the formation of very stable clay-organic matter complexes.
- Increased product volume for sale.
- value - added process for clay and organic waste.
- Improved water and nutrient retention and buffer capacity.
- Presence of an inorganic fraction that remains in the soil after decomposition of the organic fraction.
- In case red mud is used, the large amounts of carbon dioxide released during composting will be partly absorbed by the alkalinity in red mud through formation of bicarbonate (HCO_3). This reaction turns red mud alkalinity in increased buffer capacity for the end product and reduces CO_2 emissions during the composting process.
- Clay amendment dilutes the metal concentration.

SCOPE OF THE PROJECT

This process has not been described anywhere in the literature and papers of preliminary research presented at international conferences in Geneva and Barcelona attracted considerable interest.

The research is innovative as it addresses the main problem in the stabilisation and reuse of organic waste and offers scope as a viable future waste treatment option.

Initial markets for this potential technology are within Australia, New Zealand and South East Asia, where organic waste is an urgent problem facing governments and health authorities. The problem of heavy metal contaminated organic waste is world wide and thus serves as a potential market. Red mud which is produced locally in abundance can elsewhere be substituted with clay or clayey waste.

REFERENCES

Hofstede H. et. al., The effect of the addition of bauxite refining residue (red mud) on the behaviour of heavy metals in compost, 1989, In "De Bertoldi et al. (ed.), Proceedings of the 7th International Conference on Heavy Metals in the Environment", Geneva, September 1989.

Hofstede H. et. al., The effect of the addition of bauxite refining residue (red mud) on the behaviour of heavy metals in sewage sludge 1990, In "Barcelo J. (Ed.) Proceedings of the 3rd International Conference on Environmental Contamination", Barcelona, October, 1990.