Report:

ISSUES RELATING TO ORGANIC WASTE DISPOSAL – PART 2 – AN INTRODUCTION TO THE HOTROT COMPOSTING SYSTEM

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1 Executive Summary

HotRot is a continuous in-vessel composting unit capable of processing most types of organic waste. The HotRot unit is a u-shaped vessel with a central tine-bearing shaft running down its length. The shaft rotates periodically and slowly to mix, aerate and facilitate transportation of the material through the composting unit. The operation of the shaft is under microprocessor control based on readings from a number of sensors installed within the unit. The shaft manipulates the physical structure of the material within the vessel thus providing optimal and sustainable conditions for effective composting.

This is the second report in a three part series. The first report looked the issues of organic waste recycling and reuse. This report provides an overview of the HotRot composting system and a third report looks at the science behind the operation of the HotRot system. Each report is complete in itself but combined provided a detailed reference tool for those wishing to understand organic waste composting and the HotRot system.

2 Summary of the HotRot Composting System

The HotRot technology is the foundation of a highly efficient and cost-effective composting system. The system utilises a modular horizontal composting chamber. Each chamber is individually controlled and monitored ensuring consistent and predictable product.

Material to be composted enters one end of the HotRot unit where a central shaft ensures that the mix is uniform and moisture is evenly distributed. The central tine-bearing shaft is turned intermittently, in both forward and reverse directions, and is under programmable logic controller (PLC) control. This facilitates process control, and permits agitation (aeration) and residence time of material in the units to be independently manipulated; aeration being a function of total shaft rotation and air injection and residence time a function of net forward rotation and waste volume additions (displacement).

The central shaft, by way of the tines arranged around it folds air into the mix from the overhead airspace, eliminates compaction and redistributes heat and moisture. Regular but periodic movement prevents compaction of wastes ensuring efficient air injection. Supplementary low-volume air injection ensures that the material is maintained in an aerobic state and the composting process proceeds at an optimum rate, without the evolution of nuisance odour.

The HotRot composting system is fully modular allowing plant capacity to be easily extended as collection services or demand increases. Modularity also allows the plant to be configured to produce niche products from defined feed materials.

All HotRot units are fully enclosed and do not need to be housed in a building[1]. This minimises capital and maintenance costs. The significant problems of moisture and by-product gas build-up causing corrosion of structures and electronic components observed in within-building composting systems are completely avoided with the HotRot system.

Each unit incorporates a relatively low volume headspace. This ensures that the amount of air that is passed through the process is minimised, reducing the size of the biofilter and the cost of moving air. There are no fugitive emissions from the HotRot Composting System as the entire system is under slight negative pressure; indeed HotRot is offered with an Odour-Free guarantee[2]. Importantly, plant operators are not exposed to the composting atmosphere, reducing the risk of respiratory illness or disease and providing a more comfortable work environment.

Each HotRot unit is equipped with monitoring equipment that provides on-line diagnostic facilities and an auditable record demonstrating compliance with international regulatory guidelines and standards. Each unit is fully insulated protecting the process from the influence of fluctuating ambient environmental conditions, including solar heat gain and moisture loss.

[1] A unit is installed in Nova Scotia, Canada, in ambient conditions down to -25°C
[2] When installed and operated according to instruction

3 Advantages of the HotRot Process

The HotRot process overcomes a number of inherent composting problems, and offers a number of technological benefits.

The major concerns with all composting processes are the provision of a consistent product that meets quality criteria and control of impacts such as aerosols, odour, dust and noise. Other important issues include process monitoring, capital and operating costs, reliability, and ease of use, land area and scalability/modularity. The following notes summarise the HotRot approach.

3.1 Product consistency:

- The rotation of the central shaft ensures that all material is evenly mixed and composted.
- There are no edge effects in the HotRot system that might lead to material that has not been efficiently aerated and/or pasteurised.
- All material must pass through the thermophilic zone of the composter and there is no opportunity for short-circuiting (by pass).
- The rotation of the shaft prevents compaction and channelling and therefore permits fine particles to be composted with confidence. Compaction and channelling are problems associated with static piles or unmixed systems. Compaction can lead to areas of anaerobic activity and channelling can result in preferential air movement with subsequent odour problems. This can be overcome by other systems but requires far greater operator experience, diligence and attention to feed characteristics.
- Composted material cannot be contaminated by leachate that can be released by some putrescibles. The air draw and therefore moisture removal from the HotRot unit is manipulated to ensure moisture removal is sufficient to prevent moisture build-up within the unit, which could in turn lead to the formation of leachate; no leachate is produced by the HotRot system. Additionally, the regular mixing that occurs through shaft rotation ensures that moisture is evenly distributed within the material in the unit.

3.2 Compliance with standards and Auditability:

- The sophisticated monitoring and feedback systems of the HotRot system ensure that accurate and timely data reports can be generated. These reports can significantly reduce the amount of testing required, especially with respect to vector attraction reduction (VAR) and pathogen control.
- Temperatures, processing conditions and equipment status data are automatically recorded by the control system and can be relayed by a computer network or Internet connection.
- Data can be stored within a Server database that can be accessed remotely via a secure web-address. Custom software is also able to automatically interrogate the database and produce processing reports, including time/temperature profiles. These processing reports can be automatically sent via fax or email to the plant operator or interested regulatory authority.

- Process faults can also be sent as text messages or emails to operational or maintenance personnel.

3.3 Minimisation of Capital Cost:

- In-vessel composting systems are capitally intensive but tend to compensate through lower operating costs. Significant efforts have been made to ensure that HotRot is as cost effective as possible.
- Each individual unit is rated for outdoor operation, thus obviating the need for a building.
- Plinth foundations are all that is normally required, as opposed to full slab foundations and most of the site can be sealed with asphalt or compacted aggregate.
- The amount of air requiring treatment via a biofilter is kept to a minimum. This reduces both the capital cost of this item and its operating costs.
- The HotRot PLC controls ancillary equipment, reducing the need for additional control systems.

3.4 Minimisation of Operating Costs:

- A HotRot composting system (including biofilter)[3] uses approximately 30-40kW of electricity per tonne of waste processed. This is one of the lowest figures of any in-vessel system.
- The HotRot PLC integrates the operation of the feed system (and other ancillary equipment) minimising operator involvement.
- Shredders, screens and conveyors can all be integrated with the composting units themselves.
- One of the largest direct costs of a composting plant can be control and treatment of possible odour. A variable speed exhaust fan controls the amount of air needing to be processed from each composting unit. Fan speed is regulated in relation to processing conditions and shaft rotation and for much of the time minimal air draw will occur.
- Routine maintenance is low. There are two or three grease nipples on each HotRot unit and a gearbox that requires occasional oil change. Similarly conveyors, augers and feed units will require periodic greasing and cleaning.
- The HotRot is a mechanically simple machine. Averagely competent operators can accomplish most maintenance tasks. The control software detects mechanical problems such as jams and the machine automatically attempts to clear itself, and if unsuccessful, shuts down and notifies the operator. Many potential problems can be resolved on-line from HotRot's base in telephone/web-based dialogue with the site operator or by remote operation of the unit. This means that problem resolution is both rapid and inexpensive.

3.5 Reliability:

- The HotRot composting unit has proven extremely robust in service. The first HotRot 1509 (installed at Palmerston North sewage treatment works) has operated continually since February 2001 with no noteworthy maintenance other than

[3] Note the figure for energy consumption varies depending on the throughput/residence time of the material being composted, as well as the ancillary equipment installed.

routine lubrication. Annual inspections have revealed no significant wear on the bearings, motor or shaft.

- Each HotRot composting unit can be equipped with a data link and data connection permitting remote operation and troubleshooting. Remote monitoring ensures that HotRot Exports can report and action any operational deviations (such as low temperatures or high motor currents) that suggest sub-optimal performance.
- The HotRot design ensures that significant and vulnerable parts are protected from the composting atmosphere thus avoiding problems of corrosion. Shaft rotation speed is very low, and the potential for wear and damage is consequently reduced. The motor/gearbox is a stock item with a service life in excess of 10 years in this application.
- Removable lids permit access to the material being composted. This also makes it possible to alter the blend during the process if problems occur with excess moisture or product drying out. This has not been, and should not be, an issue in practice but the ability to rescue a "bad mix" is a useful advantage.
- The removable lids also facility maintenance such as the replacement of bent or damaged tines, or servicing of the central bearing (where fitted).

3.6 Land use:

- In-vessel composting utilises significantly less land area than windrow composting, vermi-composting or anaerobic digestion.
- Individual HotRot composting units can be sited close to one another utilising common walkways and feed systems. This ensures that the land area required for a HotRot plant is one of the most compact of any system currently available. However, it should be noted that when reviewing site requirements it is important to include provision for vehicle access and movement as well as curing or storage of product.
- The land area required is more a feature of total plant design that the HotRot in-vessel component.

3.7 Modularity:

- Individual HotRot units are available with nominal capacities of:
  a. HotRot 1206: 0.3-0.4 tonnes per day
  b. HotRot 1509: 1.1-1.3 tonnes per day
  c. HotRot 1811: 2.1-2.3 tonnes per day, and
  d. HotRot 3818: 9.5-10.5 tonnes per day[4].
- Plant capacity is increased through the addition of units. We advocate consistency in unit size throughout the plant, and the initial module size should be chosen accordingly.
- The modularity of the HotRot system allows a plant's capacity to be expanded as demand for its products or services increase.

[4] The daily throughput is dependent on residence time, bulk density and volatile solids content of the material in the unit, figures quoted here are based on a 16-18 day residence time producing stable compost, applications which utilise a much shorter residence will therefore have a greater daily throughput capacity.

3.8 Flexibility:

- It is recognised that waste volumes may vary on a daily and seasonal basis. The HotRot composting system deals with waste volume fluctuations in a variety of ways.
- The capacity of the HotRot system is dictated by the residence time of the material to be composted in the HotRot unit. With the HotRot unit's ability to manipulate residence time via shaft rotation and increasing input quantities (an ability not shared by other systems), plant capacity can be manipulated to compensate for short-term or systematic fluctuations, as for instance caused by 5 or 6-day working weeks or the receipt of specific wastes at specific times.
- Where more than one unit is installed it is possible to operate units under different modes, again greatly adding to plant flexibility. Some units can be operated with short-residence times for producing lower-grade product or material for extended windrow or vermiculture processing. Other units may operate on extended cycles or may process certain types of wastes, allowing specific niche products with added value to be produced.

3.9 Aerosol control:

- Aerosols are corrosive due to their temperature, moisture content and the presence of gases such as ammonia. All vital equipment, electronics and motors, etc, are external to the HotRot unit isolating them from this damaging environment. Internal steel work is stainless or hot-wire zinc-sprayed and unit covers are corrosion resistant concrete, fibreglass or plastic.
- Aerosols may also contain pathogenic microorganisms that may cause respiratory illness. The HotRot system contains aerosols within the unit, eliminating operator exposure.

3.10 Odour control:

- Each HotRot is maintained under slight negative pressure thus preventing the emission of fugitive odours.
- Electronic slide gates are often fitted to feed inlet chutes and these are only open for short periods of time to allow waste entry.
- All exhaust gases are treated via a biofilter that can also draw air from feed units and adjacent waste storage facilities.
- Excessive odours are normally associated with inefficient aeration and anaerobic conditions. The frequent rotation of the shaft ensures aerobic conditions are maintained thus odour concentrations are modest.
- Odours are more concentrated and greater volumes of moisture are released during shaft rotation, during this period the speed of the biofilter fan is increased to draw more air through the system. Operating the biofilter fan on a variable speed drive further minimises power consumption and operating costs.

3.11 Dust:

- The shredding process, transportation of materials and storage of compost may generate dust.
- Some shredders can be supplied with a cover to minimise dust and odour release during processing.
- All feed units and feed and discharge conveyors or augers are covered.

- The moisture content of the compost can be monitored and controlled to minimise dust formation.
- Wind protection on the site may be needed to minimise waste and product movement however.

3.12 Noise:

- Most noise will be associated with vehicle and loader movements and the operation of certain shredders.
- Some shredders are slow speed units that generate considerably less noise than conventional high-speed shredders, hammer mills or tub grinders.
- The use of electric drives and large reduction gearboxes (and thus slow speeds) ensures that each individual HotRot unit is virtually silent in operation.
- Biofilter fans can be housed in soundproof enclosures.
- Feed conveyors and the screen will generate minimal noise as they are covered and only operate periodically.

4 Appropriate installations for HotRot

A HotRot composting system should be installed where odour control and the elimination of environmental impacts is important. The technology is most to sites with space constraints or those dealing with potentially odorous wastes. HotRot is the only technology to offer an Odour-Free Guarantee and we encourage you to contact us for more information.

www.hotrotsystems.com