## HotRot – a new generation composting technology

HotRot can be regarded as a new generation composting system. Developed in early 2000 by the then Wool Research Organisation of NZ; HotRot was developed to efficiently compost difficult odorous organic waste.

There are a number of technical and environmental issues that are associated with traditional composting that the developers of HotRot set out to address; these included:

- Uneven air flow leading to areas within the composting material that become too wet or too dry, too hot or too cold. This is especially a concern with any static composting system. Product that is produced by these traditional systems is variable and generally requires extended curing or maturation.
- Poor temperature control – there is a fallacy that hotter is better. Many systems also exhibit what are known as edge effects, the temperature in the core is vastly different from the edge and as a result compost quality and pathogen elimination is variable. Regulators then have a tendency to specify excessive temperature minimums, which are counter to the production of quality compost, rather than address the inherent short-comings of many composting systems.
- Odour – this is the biggest single reason for more composting plants to be shut down globally than any other. There are two principle contributors to odour – poor facilities design leading to poor odour containment; especially with respect to waste receivals, and poor composting performance. Poor composting performance leads to incomplete oxidation of volatile organic compounds and the release of these.
- Leachate is a major operational cost, management headache and potential source of odour and environmental contamination. Elimination of leachate or effective management is key to a successful composting operation.
- High maintenance costs. Many traditional composting systems employ large amounts of machinery, some working at high speed or under extreme load. Even relatively slow moving equipment such as rotating drum composters are exposed to high mechanical forces and drum failure is common in poorly designed units. The composting atmosphere is corrosive and often results in equipment or building failure.
- Agricultural or “backyard” engineering. Many systems are not designed for the mechanical stresses outlined previously or the corrosive environments that can be generated by the composting process. It can be relatively easy to build a cheap composting system much more difficult to build a system that will last.
- High labour requirements. Many composting systems rely on large amounts of labour and manual materials handling.
- Large land areas are traditionally required, not only for the process but also product storage and then additional buffer zones to neighbours. As land costs increase a seemingly cheap composting system can become expensive either due to the size of land needed or the distance the plant needs to be from neighbours or sensitive receptors.
- Composting plants are often seen as dirty and smelly establishments.

HotRot set out to address all of these issues; clearly there are compromises between capital and operational costs with control over environmental and visual impacts and labour requirements impacting on these.

Composting is a natural aerobic process, it requires a material moisture content of between 40-60%, a near neutral pH and sufficient porosity to maintain oxygen concentrations.

Temperature is a result of the composting process not a cause; much like humans produce heat when they exercise not when siting on a warm couch. Optimal temperatures for composting are 45-63$^{o}$C; temperatures outside this range significantly retard the overall composting rate without additional benefits.

The HotRot in-vessel composting system is a continuous agitated flow-through system. Waste enters one end of the unit and composted product is discharged out the other end. The HotRot unit comprises a longitudinal central shaft with tines or arms. This shaft rotates periodically and slowly.

*HotRot 3518 central tine bearing shaft – unit lids removed*

Waste is generally added to the inlet "feed" end of the HotRot unit via an enclosed feed hopper. This feed unit regulates waste additions to the composting vessel while containing the material to avoid odours.

Each HotRot composting unit operates via a repeating cycle. Each cycle consists of a period of forward (clockwise) shaft rotation, a static period, a reverse rotation period and a second static period. A typical cycle is:

Forward: 5-10 minutes
Static 1: 30-60 minutes
Reverse: 0 or 3-7 minutes
Static 2: 30-60 minutes.

Cycle times are established during commissioning and are generally set and forget. Waste transfer to the HotRot units is generally split in to an even number of short "feed" periods based on the overall cycle time; for instance, if the total cycle time was 60 minutes then there are 24 cycles in a day and feed would be split in to 24 even "batches". Periodic feeding in this way ensures that a small amount of waste is frequently added to an otherwise actively composting mass, eliminating any lag phase and speeding up the overall composting process. Periodic "feeding" of individual HotRot units also means that the feed hoppers and augers only run periodically, thus drive sizes and discharge rates can be minimised.

Material passes through the HotRot composting unit as a result of displacement by fresh material added at the feed end and assisted by the periodic rotation of the central tine-bearing shaft. The shaft provides mixing, helps release excess moisture, $CO_2$ and heat, and

prevents compaction of the waste enabling efficient aeration by the integrate air injection system. External air is injected in to the base of the HotRot unit's hull periodically during static periods and continuously during shaft rotation. Air is additionally continually drawn from the upper headspace within the composting unit. Air draw varies according to temperature and $CO_2$; both used as a measure of microbial respiration. The exhaust fan operates on a variable speed drive with a minimum low-speed setting slightly greater than the volume of air that can be injected to ensure constant negative airflow.

Extracted air passes through a condensate tank and a biofilter for odour control. Because the air drawn from the unit removes excess moisture, leachate is avoided; this can result in greater than 90% saving in leachate disposal costs (see *HotRot units do not produce leachate.pdf*). The periodic shaft rotation and air injection ensures optimal aerobic conditions and removal of excess $CO_2$, and prevents the build-up of carboxylates and a reduced pH that would otherwise retard the composting process.

Material takes approximately 10-12 days to pass down the length of the HotRot unit. During this period the waste is converted from unstable putrescible organics to stable relatively mature compost ($CO_2$ evolution generally less than 10mg $CO_2$/g OM/d – comparable to windrowed product after 9-12 months). The HotRot is a continuous flow-through system; as such waste is continually added at the feed end and compost is automatically discharged out the opposite end of the unit.

Compost is generally discharged during periods of shaft rotation. Compost drops out of the outlet chute (the chute has weir plates that can be used to control material levels inside the unit) and is collected by an auger, which in turn drops the compost in a temporary storage bunker. Automatic discharge and temporary storage minimises labour requirements and allows the plant to operate for extended periods unattended.

HotRot units have been designed with robustness in mind and have a nominal design life of 12-15 years but with routine maintenance and periodic replacement of wear parts can be expected to operate well past this period.

The smaller HotRot units (1206 and 1811) utilise stainless steel inner hull linings. The central shaft is coated with a corrosion protective coating or manufactured in stainless steel. Mild steel tines are expected to last 5 years in normal operation but stainless steel tines can be supplied with extended life. All main drive gearboxes have a minimum design life of in excess of 15 years provided routine oil changes are undertaken. The larger HotRot 3518 composting unit's hull is manufactured from special high-density wear resistant concrete or steel/stainless steel sections. All internal steel components are protected by zinc-aluminium arc spray coatings; with steel hull sections lined in stainless. External steel is either zinc-arc sprayed, galvanised or coated with a marine-grade paint system.

HotRot ancillary equipment is often manufactured from stainless steel but mild steel, blasted, primed and finished with epoxy paint is also used.

The robustness of the equipment significantly reduces maintenance. Routine maintenance is generally restricted to periodic greasing and annual gearbox oil changes; all capable of being performed by any operator. HotRot offers on-going technical and maintenance support post-installation.

The fully enclosed HotRot unit protects the composting process from the influence of ambient temperature and moisture, virtually eliminating all climatic and seasonal influence on the composting process. The enclosed system prevents the release of odours and HotRot staff have the skills and experience to design appropriate waste reception and handling facilities to ensure that a contractual OdourFree Guarantee can be provided to our clients.

The enclosed nature of the HotRot system also ensures the unit is the composting system you want when you don't want a composting system. We have eliminated the need for buffer zones with HotRot units being sited in public areas associated with zoos, universities, breweries and even waste transfer stations. The production of stable, relatively mature, compost significantly reduces the need for on-site storage or maturation greatly reducing the plant's overall footprint.

**The HotRot Advantage**

- HotRot Organic Solutions is the only technology supplier to offer a contractual odour-free guarantee.
- HotRot units do not produce any leachate.
- HotRot systems require 50-75% less labour than similar sized in-vessel and tunnel composting systems.
- Because the HotRot system produces a highly stable and mature compost requiring minimal storage, the HotRot system requires 50-75% less space than similar sized in-vessel and tunnel composting systems.
- The HotRot system has low maintenance and operating costs – in an independent study, annual operating costs for a HotRot plant were 25% less than for a comparable tunnel composting facility. These annual savings were shown to more than offset the slightly higher capital cost of the HotRot system.

**Additional Reading**
The following documents are available from HotRot and provide additional details on some of the topics discussed here:

- HotRot units do not produce leachate.pdf
- OdourFree guarantee contract version.pdf
- Why is HotRot different.pdf
- A three part series
    - Part 1 composting context report.pdf
    - Part 2 HotRot system summery.pdf
    - Part 3 Understanding HotRot.pdf
- HotRot reference sites.pdf