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Promoting sustainable waste management worldwide

Composting may be one of the oldest waste management strategies in the world, but it continues to evolve, with new technologies focusing on reducing emissions and making a valuable end product

by Martin Meyer and Guy Robinson

Cutting edges

Trends in composting technologies

Composting is the natural biological decomposition of all kinds of organic materials by micro-organisms. The process can be controlled under specified conditions to produce a relatively stable, humus-like material known as compost.

Composting techniques have been employed in different parts of the world for perhaps longer than any other waste treatment strategy. Consequently, a variety of technologies has evolved that can be integrated into the modern composting process. These include equipment for preparing the organic waste material for composting, i.e. choppers, shredders and sorting machines, as well as equipment that offers an effective environment in which composting can occur.

Typically there are five stages in the composting process:

1. Input
2. Shredding
3. Composting
4. Screening
5. Output.

Conventionally the main process of composting occurs in an aerobic environment, whereby air supports the activity of the micro-organisms vital to the decomposition process. To achieve this, mobile turning machines are often used to maintain optimal aerobic conditions within the material stored in open windrows or heaps. In general terms, the design of modern composting facilities reflects the multi-stage, aerobic nature of this process (see Figure 1).

Digging beneath the surface

The activity of millions of micro-organisms causes the temperature of composting material to rise to up to 70°C, which

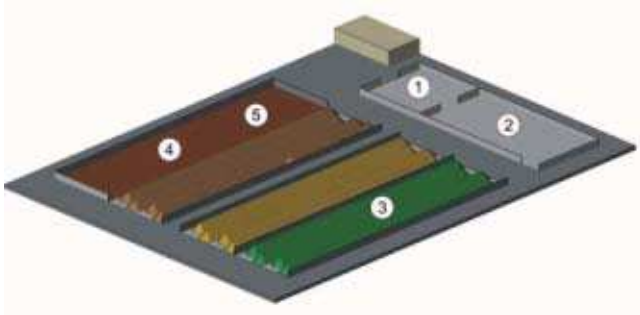

FIGURE 1. A typical composting facility. 1. Input area. 2. Shredding of material. 3. Composting. 4. Screening. 5. Output of matured compost.

is important if the operator wishes for an optimal turnaround time. Also temperatures of up to 70°C are necessary to ensure the material is sterilized, i.e. making the compost hygienic for use. In fact, the thermophilic bacteria (bacteria that thrive at relatively high temperatures) active in compost perform best at a temperature of around 65°C.

The decomposition process of 'hot' composting is outlined in Table 1. And this also includes indicators of the likely odour emissions during each stage. The main odour emissions occur in stage 2, namely the self-heating stage. Composting around the world often occurs in an open, uncovered manner, and there have been cases where resulting emissions have caused concern for nearby residents. It is therefore important to consider the impact of likely odours and take action as appropriate.

The situation is made more complex because human action can enhance or lessen the extent of any problem resulting from odour or germ emissions from this form of waste management.

Recognizing the importance of this issue and prior to examining some of the latest trends in composting, it is worth dwelling on some potential failure areas in planning and management that may result in odour problems at a composting site. Regularly occurring pitfalls have emerged throughout the past few years. These can be divided into three areas:[1]

Design errors: These may start with a basic failure in simply underestimating the likely emissions from a chosen waste management technique and therefore not taking necessary precautions. Also designers may propose inappropriate dimensions for the compost heaps, leading to insufficient stabilization or humification in the final product and intensified odour emissions when packing and storing the compost. Poor air management can cause problems, particularly as a result of installing unsatisfactory or poorly-sized air-cleaning equipment. A lack of suitable planning for unscheduled occurrences, such as failure of an engine, can also lead to unwanted emissions

Work management: Again, careless management can be an issue, whereby operators do not acknowledge the importance of emissions, for example by not considering the impact of weather conditions upon open plants. Furthermore, managers may underestimate the impact of 'small' odour sources, such as open waste material containers, process water storage or the open loading of fresh compost. Air cleaning equipment naturally needs regular maintenance following professional installation

Exogenous influences: Belittling the complaints of neighbours by a plant operator can lead to an unwanted escalation of discussion about bearable conditions surrounding a plant. Hesitant progress in problem solving is to be avoided, whether due to reasons of cost or image. Regrettably, some neighbours may exploit the situation, counting on a materialistic profit by making a problem from bearable emissions. New residential or industrial developments occurring nearby may also impact on a composting site.

Fleece covering the heaps reducing odour emission

The above pitfalls can usually be avoided through effective techniques, design and management. Emissions emerge as a concern largely in open composting sites, which require extra attention to detail in locating the site appropriately and managing local concerns.

A changing legislative framework

Turning to the regulatory framework, the development of clear standards for compost is emerging as a focal point for stakeholders. For example, last autumn the European Compost Network announced that it had won a tender of the European Commission's Joint Research Centre (JRC) to study 'Compost production and use in EU', evaluating the organic material flows, their quantities and qualities including standards and quality assurance in the EU 27. The results will be used by JRC to develop the End-of-Waste methodology for compost reducing waste and emissions. And, in parallel, the Integrated Pollution

TABLE 1. The stages of odour intensive substances developing during rotting process

Rotting stages and range of temperature	Characteristically odour odour intensive substances[1]	Determining odour impression	Concentration of odour substances [ou/m³]	Duration of stages[2]	pH value
Mesophile initial stage (15–45°C)	Low carbon acid, aldehydes, alcohols, carbon acid ester, ketones, terpenes, sulphides	From alcoholic-fruity to cheesy-sweaty	6000–25,000 [3]	few days to maximum of one week	4-6
Self-heating stage (45–65°C)	Low carbon acid, aldehydes, alcohols, carbon acid ester, ketones, terpenes, sulphides	From alcoholic-fruity to cheesy-sweaty	Peak values up to 30,000[4]	Few days to maximum of one week	4-6
Hot rotting stage stage (> 65°C, partly up to > 70°C)	Ketones, sulphur organic compounds, terpenes, pyrazine, pyridines, hydroxy furanones, ammonia	Sweet-smelly, hot rotting smell, unpleasantly musty	1000–9000[3], to more more than 10,000[4]	Few days to couple weeks	6- more than 7
Cooling down stage (65–45°C)	Sulfides, ammonia, terpenes	Musty, ammoniacal	150–3000[3]	Up to 12 weeks	Up to more than 8
Maturing stage (< 45°C)	Humic matter	Smelly, earthy	Less than 500[4]	A couple of weeks	>7

Notes:
1 This is not intended to be comprehensive, but should be a useful guide
2 The duration of states is dependent on rotting procedure
3 See Pöhle, 1994 (contact the first-named author for full reference)
4 Data from Bundesgütegemeinschaft Kompost e.V.
(collated from Pöhle, 1994; Mayer, 1990; Jager, J. et al., 1995 and other studies in: Bundesgütegemeinschaft Kompost e.V. (German Composting Association): Wie ist die Geruchsbelästigung in der Umgebung von Kompostierungsanlagen? (Expert opinion on odour issues around composting facilities), http://www.bgkev.de/download/antwortfrage3.pdf (accessed on 2007-11-25)[1]

Prevention and Control (IPPC) Directive looks set to include a new Best Available Technique Reference Document (BREF) on 'Composting and digestion of separately collected organic waste'.

From the UK to California

Also exemplifying an interest in developing standards is the UK composting industry, which experienced a busy year in 2007. March saw the launch of the UK's Quality Protocol for compost. This was developed to help the market to distinguish between certified compost and waste and thereby provide more certainty for business development. More recently, in December, the UK Composting Association published a manifesto for achieving sustainable biodegradable waste management. This was principally a tool for discussion with the UK government, integrating recommendations for action along the following themes:

- supporting the development of new infrastructure
- managing residual waste: compost-like outputs
- supporting sustainable agriculture: the sector's role as carbon managers.

Within the manifesto, the Composting Association reports that in 2005/6 over three million tonnes of waste was composted in the UK, with over two million tonnes undergoing certification to the BSI Publicly Available Specification 100.

Of course, the UK market is not the only one in which the regulatory framework is developing. Developments are occurring across the globe. In February last year, the California Integrated Waste Management Board adopted a set of directives which included a goal to reduce the amount of organics in the waste stream by 50% by 2020. To achieve this, like the UK, the industry will need to expand its infrastructure: the CIWMB website states that 50–100 new facilities (or equivalent expansion of existing facilities) would be needed that produce compost, biofuels, and/or bioenergy; this would be coupled with increased development of product standards and increased procurement by private and public entities.

Growing momentum

Another point worthy of note is the greater degree of public participation that is required and, in fact, appears to be taking place. For example, in the USA, recent data were collated within a survey conducted by the BioCycle magazine. Its nationwide survey identified 42 communities and/or counties with source-separated residential organics collection programmes in the USA, which is an increase of 12 from its 2006 data.

LEFT TO RIGHT BACKHUS 6-series employed by Den Ouden, the Netherlands. ■ The Backhus LT lane turner, operating in a dynamic, in-vessel setting.

Reflecting this dynamic perspective is the Winter 07 newsletter from the US Composting Council, where the President's Greeting predicted general trends along the following lines:

- tougher regulations on the disposal of organic materials
- a better understanding of the connection between managing organics and greenhouse gases/climate change
- big steps in commercial organics collection and processing
- decreased amount of food waste going to landfill
- using more truly compostable material
- increased mortality composting
- more on-campus composting.

Technology trends

The growth of professional composting worldwide has led to innovation, particularly in improving the ability to process putrescible waste using treatment facilities located near to populated areas.

Acting as a 'greenhouse of Europe', the Netherlands offers a particularly interesting insight into effective waste management within populated areas. Taking a specific example, the Den Ouden DELTA Milieu Groencompost B.V. (http://www.denoudengroep.com), the Netherlands, handles 250,000 tonnes per year of green waste, and aims to lower odour emissions by additional encasing and irrigation of the turning machine. Fleece windings covering the heaps with fleece and thereby reducing odour emission, are also employed by Tarnowska Gospodarka Komunalna, Poland, as effective tools for advanced management of organic waste. These fleece materials act like an ultraviolet light shield and can be differentiated into two types: permeable geotextiles (e.g. by fibertex) and in semi permeable fleece (e.g. by Goretex).

The notion of greater encasing is playing a part elsewhere in Europe too, with a general trend toward in-vessel systems, not least due to the need for effective odour management. These can be divided into two types: namely 'static' and 'dynamic'. A static rotting container allows for effective waste flow management while avoiding cross-contamination and emissions while processing. The compost remains static while it heats up and decomposes, to be turned once out of the tunnel during a maturation phase. Advances in this field include greater use of computer equipment to control various parameters during the rotting process and the use of new materials, for example COMPObox Membrane Technology from Compost Systems in Austria. Completely closed 'dynamic' systems integrate the input, shredding, composting, screening and output stages under one roof and thus allow, due to air and waste water filters, the entire control of all emissions occurring during the waste treatment processes. Technology suppliers in this context include, amongst others, Gicom b.v. in the Netherlands and Backhus GmbH in Germany. The Backhus LT lane turner, operating in a dynamic, in-vessel setting; it is employed on lanes or in tunnels shortening the rotting time, facilitating process control and avoiding odour emissions.

Other companies are also active in the field of odour control, indeed specializing in this important subject by developing odour neutralizing sprays, new filters or scrubbers, or indeed by burning off the gases emitted.

Odour control is, of course, only part of the story. Another crucial aspect worthy of comment is the emergence of modern technologies to suit a customer base that has hitherto relied on only a basic compost heap at the bottom of the garden or has discarded organic waste with general household waste. Recent years have seen a growth in diversity of composting technologies suited for residential applications, including flats and other community dwellings i.e. not only detached houses with large gardens. A case in point is Joraform, a Swedish company specializing in composting technology at a household level and for community dwellings. Exemplifying its technology, the company has completed a significant installation in Oslo, Norway providing services for 1100 households, using twelve machines.

> "One of the clear trends in Europe is toward in-vessel systems"

Joraform also demonstrates the fact that the field of composting technology is becoming increasingly international, whereby once a technology has proved itself in its country of origin, it is often promoted in other countries too. The company's business partner in Italy, I&X Solutions Ltd, was present at the Ecomondo show for the first time last November as Joraform looks to expand its distribution pathways beyond already established markets.

Conclusions

The over-arching conclusion that can be drawn from a broad review such as this is that composting remains an active market. The tradition of open windrow composting is developing, with new technologies and methodologies being employed to minimize emissions. It may be one of the oldest waste management solutions, but composting continues to evolve and is starting to be seen as integrated part of an overall solution as in completely closed waste management plants.

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