buyers' guide

The buyers' guide to in-vessel and anaerobic digestion technologies

Waste stream management - the range of systems available

Dr John L Burden discusses the various options open to compost producers when using IVC or AD technologies

The guides to In-vessel Composting and Anaerobic Digestion, published by The Association for Organics Recycling, ably present an introduction to the methods, the principals involved, the rudiments and requirements of the Animal By-Product Regulations, and the veterinary approval required to handle certain waste streams.

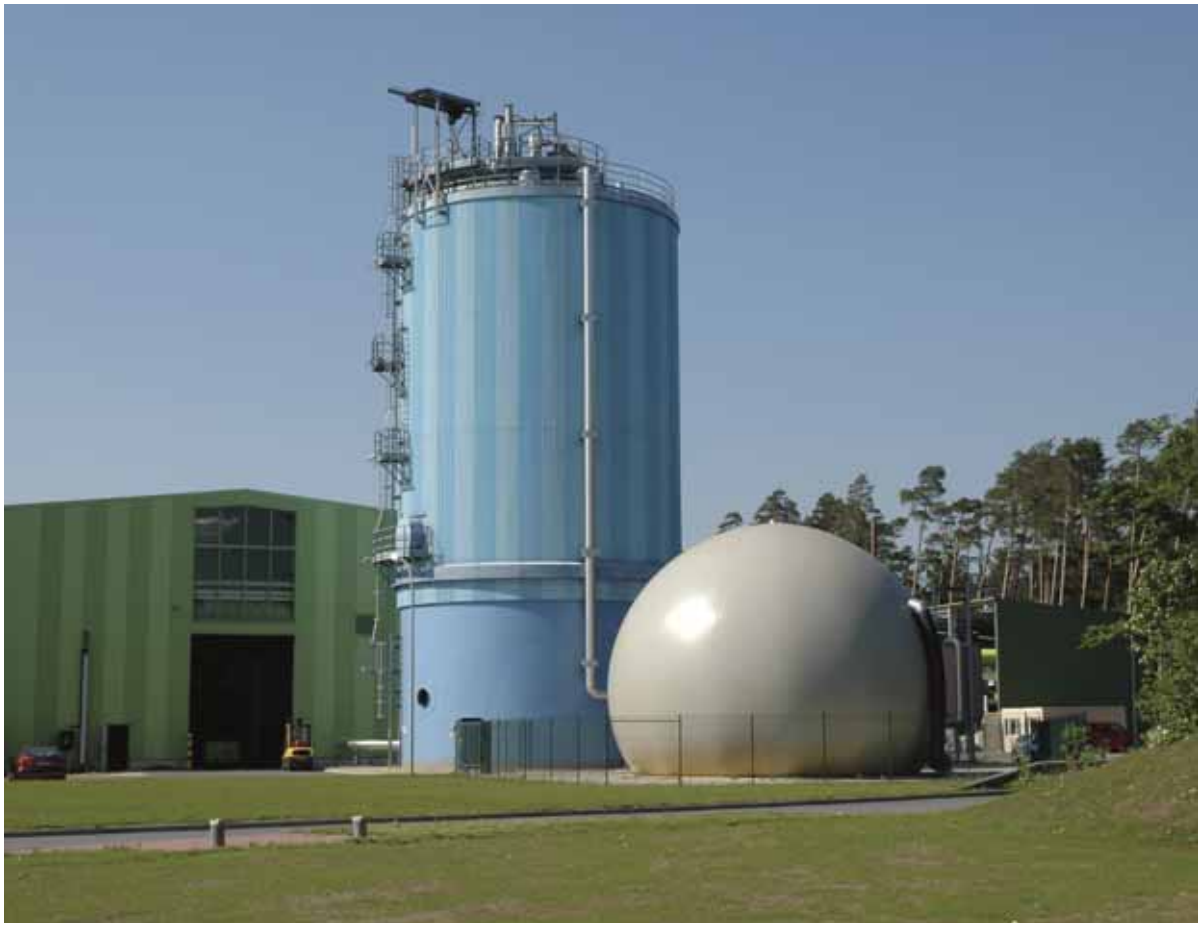
Deciding which system to employ in treating waste streams is often not clear-cut. Building a plant to handle waste materials - be it large or small - is an expensive project and one that needs detailed planning – from the outset - not just of the plant, and the economics of running it effectively, but of the impact upon the locality in which it is planned to build it. Society is fully aware of the need to recycle waste streams, but people tend to be very reticent about having the means to do so, built in their own locality.

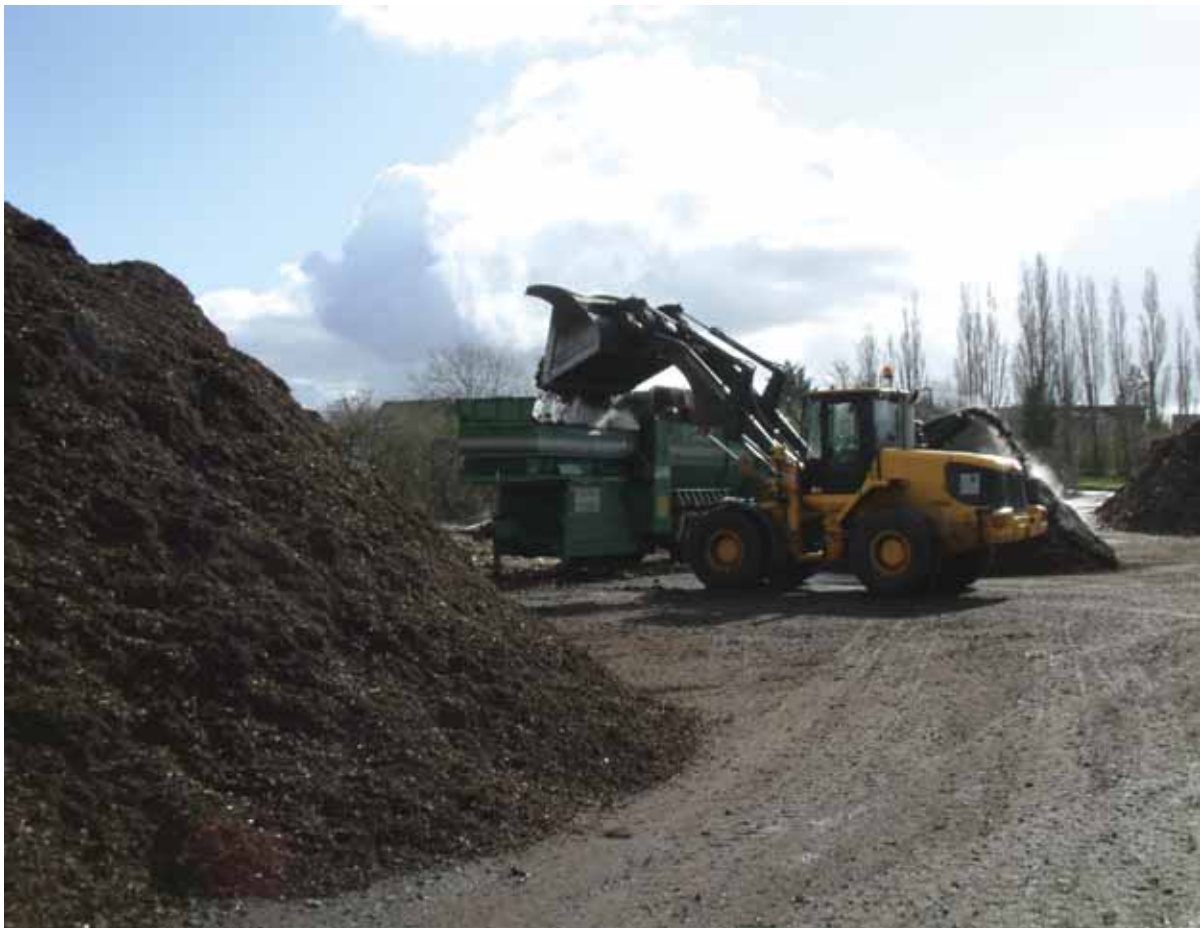
Composting is not a recent phenomenon borne out of the increasing pressure on our society to recycle, it has been occurring since organic matter was conceived. The organisms involved in the processes are naturally occurring species that can be found in most environmental niches throughout the world. The brilliance of the composting industry is in its ability to develop the plethora of systems that have been engineered to contain, control and enhance the microorganisms' activities to that end.

However, in this diversity there are potential pitfalls that those responsible in decision-making should seriously consider before committing to a specific system. Both anaerobic and aerobic systems have the basic requirements of an adequate feed stock and the optimum physical conditions for the organisms to work in.

Many of the aerobic systems available are arguably over-engineered in providing the basics for effective composting, and although they are not normally detrimental to the environment, some may present occupational health risks for those at the compost face.

Health related issues in handling organic waste streams start from the time that materials are placed in the waste container for collection. The number and complexity of such





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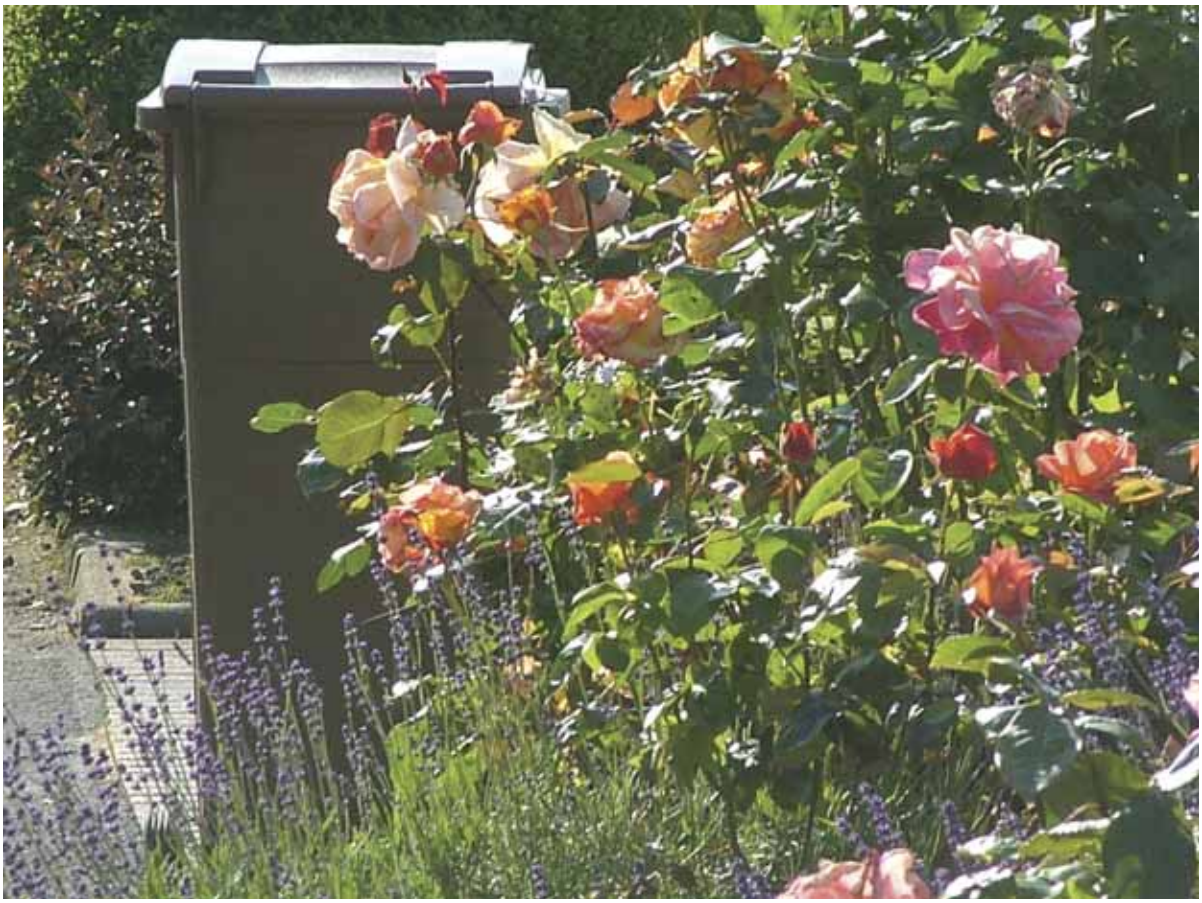
issues escalates from that point as the material is collected into larger quantities for bulk handling. With most well designed and managed projects that follow recommended procedures; the handling of the materials is not environmentally damaging, but the occupational exposure to those working within the plants does need careful consideration. All material within a composting plant will release dust and bio-aerosols when they are handled. Operators need to be trained to be alert to this and to react accordingly. Personnel Protective Equipment (PPE) should be considered in most working areas where compost is being moved.

All systems will work more effectively if the feedstock is consistent and correctly prepared for the process. For anaerobic systems, materials may need to be macerated and liquefied whereas aerobic systems need the physical matrix of the substrate to be open, so allowing air movement through it. This aspect of both systems needs consideration; having a uniform feed stock throughout the year may be a luxury that some plants will never attain, but having the space and ability to effectively blend diverse substrates will make most systems operate more effectively. Sometimes the physical nature of the substrate available for treatment will dictate the method employed; for example, it would be impractical to aerobically treat slurry unless you had an equivalent amount of dry material to form an open matrix. By such means waste streams can often be adapted to suit specific systems.

Protagonists of many waste recycling operations are latching onto the bio-aerosol issue as being a major cause for concern to those residents close to plants. There is ample evidence that confirms the Environment Agency (EA) guideline that by 250m bio-aerosol levels return to background levels, as being extremely robust. But still the term bio-aerosol often instils fear in the minds of many



residents. The fact that bio-aerosols are omnipresent virtually the world over does not seem to enter into their thinking. We are all exposed on a daily basis to all the organisms involved in the degradation process; it is the level of exposure that is important not the range of species. Those working with tumbling compost should be made aware of the implications of working with such materials.

Bio-aerosol issues appear to take a disproportionate amount of attention in relation to their impact in the industry as a whole. To partly pre-empt this, the location of any proposed recycling site to 'sensitive receptors' should be minutely reviewed, and maintaining the 250m zone could save a lot of hassle. However, re-specifying the 'site boundary' currently defined by the EA as the perimeter of the site by 'the area where composting operations occur, or in which compost is stored', would be more accurate in the context of their own 250m guideline, as that is the distance that bio-aerosols are considered to have returned to background levels. There is often land available within a site that could be landscaped with trees, hedges or bunds that would greatly enhance the dispersion of bio-aerosols before they left the site boundary. It would also be a more accurate assessment of the 250m zone than EA calculations for returning to background levels are based on. If this is accepted then operators should be careful not to abuse the decision once their permission had been granted.

Open windrow systems are probably the cheapest to employ but have the least control over the process, even systems that cover the windrows may find it hard to achieve the required temperature/duration profile required for treating ABP material, and to effectively separate treated material from raw material. To ensure that birds and vermin cannot move between the two is practically impossible to guarantee. Indeed, if rules were to be interpreted evenly throughout the country, then certain plants already possessing permission would have to modify their processes to conform to those rules. It is not only the system used that has to pass approval, but a state vet certificate is required for each site and that is where in the past some variation has crept in.

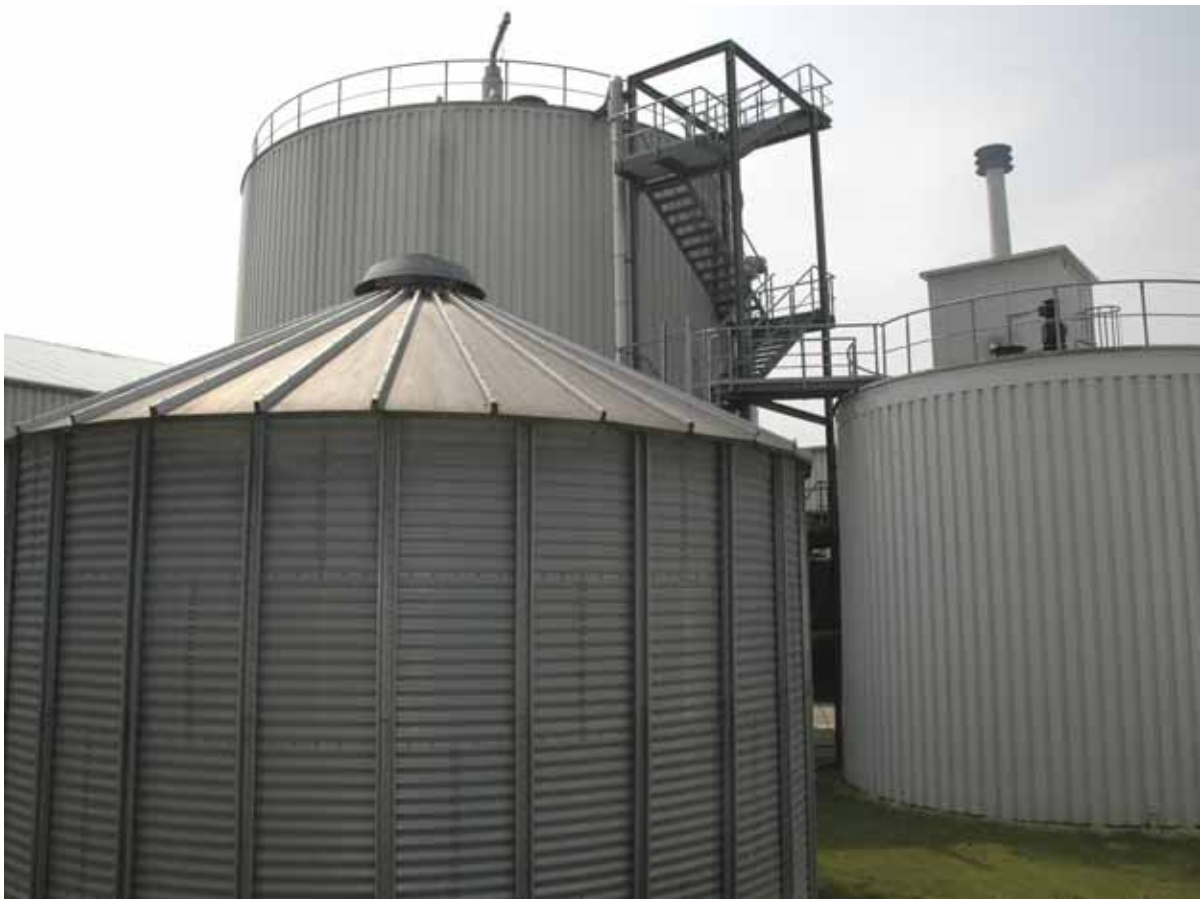
It cannot be disputed that with in-vessel Composting (IVC) and where windrows are set inside buildings, that the release of bio-aerosols to the environment can be more easily reduced. By passing all exhaust gasses through bio-filters, levels in the immediate vicinity of the site should be significantly lower. However, it should be noted that even bio-filters will have their own flora, albeit they will be magnitudes lower than in close proximity to tumbling compost.

> Bio-filter construction, design and positioning on a site, is important if it is to be effective

Bio-filter construction, design and positioning on a site, is important if it is to be effective. These filters should be easily managed with an efficient and easy facility to change a proportion of the bed matrix when necessary, so facilitating uninterrupted service.

Bio-filters can have an additional advantage in that they can moderate odours released in composting, though if the substrate being treated contains obnoxious breakdown products, then scrubbers may have to employed first. Water or acid scrubbers can very effectively reduce levels of odours and depending on the chemicals employed can yield a useable by-product in the terms of Nitrogen fertilisers.

When exhausting air from a composting plant, there is always the opportunity to capture heat in that air stream within heat exchangers; this can be very effective with IVCs. Some municipal systems heat entire sections of a locality through this means. The anaerobic systems also have the advantage that they can capture the gas produced within the



process, and use it to generate electricity. This power can be used within the plant and any excess sold to the National Grid.

Some may say that the current weighting towards energy from renewable sources offers the anaerobic systems unfair advantages in accruing recoverable funds, but these systems are costly to conceive and if the feedstocks are available in the vicinity then full advantage should be made of them. But both operators and legislators are acutely aware of the impact of transport costs on the economy: new sites should be near centres of production and although economies of scale are a major factor in the running of waste operations, shipping waste large distances should be discouraged.

Simplicity of design and operation should be sought where possible, with the minimum of moving parts: ammonia released during the process can be quite corrosive to equipment so longevity of the equipment should be investigated. Ease of access to essential parts, easy cleaning, 'down time' and maintenance requirements are also important factors to consider. With aerobic systems, all that compost needs to work effectively, is a supply of air through the compost mass; this alone will quickly activate a good feedstock. Systems that rotate or move the material during the process must be accessible, breakdowns within these systems can result in batches being aborted as target temperatures cannot be guaranteed and these can be difficult to empty. Rotating systems will also tend to favour bacterial decomposition, as movement of the substrate will be disruptive to developing mycelium of the fungal species. On the other hand, batch systems, and especially IVC tunnel or bunker systems, allow ample time between moves for the fungal flora to develop and contribute to the process.

Aerated floors are effective for all stages of the composting process, (composting and maturation) they are a simple, cost effective method of getting oxygen into the centre of the compost mass so maintaining microbial activity at its peak

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In-vessel composting technologies

This guide covers composting systems suitable for recovering animal by-products and other biodegradable input materials. Although it is called in-vessel composting technologies, it includes composting systems designed to be carried out inside buildings, under cover and any other enclosed processes that would comply with the Animal By-Products Regulations.

Company	Contact Name	Contact Number	Email	Website	Type of system
Bio Group Ltd	John Mullett	01353 649800	info@biogroup.co.uk	www.biogroup.co.uk	Chambers in enclosed hall
Bio Waste Solutions	Lewis Dodds	07785 783300	info@bio-waste.co.uk	www.bio-waste.co.uk	In-vessel aerobic digestion
Celtic Composting UK	Steve Bullock	0044(0)1884 259793 0044(0)7872119638	sbullock@celticcomposting.com	www.celticcomposting.com	Tunnel vessels
					Modular container vessels
					Clamp vessels
Envar Ltd	Andrew Urquhart	01487 849840	andrew.urquhart@envar.co.uk	www.envar.co.uk	Tunnels
Greenview Environmental Ltd	Steve Bailey	01284 747630	steve.bailey@greenviewgroup.co.uk	www.greenviewenvironmental.co.uk	In-vessel tunnel
HotRot Organic Solutions	James Lloyd	01842 816909 01234 354785	info@hotrot.co.uk	www.hotrot.co.uk/solutions/hotrot.php	Unique continuous flow, agitated in-vessel technology
					Fully enclosed concrete tunnel system with integrated aeration and drainage
					Enclosed hall with agitated bays
IPS Composting System by Siemens Water Technologies Corp	Graham Hordern	(0)780 882 2715	graham.hordern@siemens.com	www.siemens.com/ips-composting	(Closed reactor) enclosed hall with agitated bays
Kelag Umwelttechnik GmbH & Co KG	Helmut Schneider	0043 699 16030330	schneider.helmut@kelag-ut.at	www.kelag-ut.at	Enclosed hall with agitated bays
Komptech UK Ltd	Paul Carley	+44 01926 642972	p.carley@komptech.com	www.komptech.com	Modular tunnels with/without automatic filling/emptying
New Earth Solutions Ltd	Samantha Page	01202 583700	sam.page@newearthsolutions.co.uk	www.newearthsolutions.co.uk	Fully enclosed dynamic composting process
Scottish Water Waste Services	Brian Pirie Jennifer Agnew	07766 205766 07875 872481	brian.pirie@scottishwater.co.uk jennifer.agnew@scottishwater.co.uk	www.scottishwater.co.uk/compost	In-vessel composting system. Under floor computer controlled aeration system
TEG Environmental PLC	Deborah McSheen	01772 314100	deborah.mcsheen@theteggroup.plc.uk	www.theteggroup.plc.uk	Silo cage system
VCU Europa Ltd	Peter Hallam	+44 118 9298266	peterh@vcutechnology.com	www.vcutechnology.com	Vertical composting units thermophilc and mesophilic
Vital Earth Ltd	Malcolm Rich	07970 003801	mrich@vitalearth.tv	www.vitalearth.tv	Vital Earth bespoke bio-vessel
Wasteology Systems Limited	David McVeigh	01728 860 861	info@wasteology.com	www.wasteology.com	Two barrier bunker system with retractable roof, pairs of vessels required to create two barriers
Wormtech Limited	Jackie Powell	07960 51321	jackie@wormtech.co.uk	www.wormtech.co.uk	In-vessel system

System description	Fixed or mobile	Batch or continous flow	Processing capacity per unit (volume and/or tonnes)	Space required – footprint and capacity of the total system (volume and/or tonnes) Excludes maturation and storage areas	Suitable feedstocks	Ancillary equipment required
2 barrier covered chambers within an enclosed building for composting at 60°C for 48 hours twice. Maturation also within enclosed building	Fixed	Batch	125m³ per chamber	Greater than 10,000 t/yr	Co-mingled garden and food waste with or without paper and cardboard. Also mixed waste with appriopriate pre-treatment	Shredder, screening plant, 360 grab, loading shovel/telehandler
Aerobic digestion	Fixed	Batch	500 tonnes/week	18m x 30m	Any ABP or catering waste	Forklift and tanker
Totally enclosed concrete tunnel systems	Fixed	Batch	7,500-80,000 tonnes	1 acre per 10,000 tonnes	Green waste/food waste/municipal solid waste	Shredder telehandler(s) screener
Portable modular in-vessel composting container system	Mobile	Batch	500-5000 tonnes	1 acre per 5000 tonnes	Green waste/food waste	
In-vessel composting clamps with retractable roofs	Fixed	Batch	2,000-20,000 tonnes	1 acre per 7,500 tonnes		
Gicom batch tunnels	Fixed	Batch	200 tonnes	1,124 m² for processing up to 40,000 tpa of meat excluded co-collected kitchen and green waste	Co-collected kitchen and green waste (meat included or excluded), kitchen waste (meat included or excluded), MSW fines, other Category 3 feedstocks	Front loaders
Negatively aerated tunnel	Fixed	Batch	From 100-750 tonnes	Dependent on capacity	Category 3 Animal By-Products	None
HotRot 1206	Fixed and mobile	Continuous flow	Typically 400kgs per day (575-800 litres)	7.5m²	Restaurant and canteen wastes, ABP Cat 3 wastes, catering waste	None needed but a simple bin lifter is available as an option if required by the client
HotRot 1509			Typically 1500kgs per day (2150-3000 litres)	14m²	Catering waste, Cat 3 ABP waste, commercial food processing wastes, animal wastes, sewage sludge/ bio solids	Full turnkey solutions are provided which include all equipment needed for a complete working installation such as a feed hopper and discharge conveyor. Optional equipment for example bin lifters, picking lines, shredders and screens also available to meet clients specification
HotRot 1811			Typically 2.25 tonnes per day (3215-4500 litres)	20m²	Green waste, catering waste, Cat 3 ABP waste, commercial food processing wastes, animal wastes, sewage sludge/bio solids	
HotRot 3518	Fixed		Typically 10 tonnes per day (14,300-20,000 litres)	65m²		
HotRot modular tunnel composting solution using precast concrete wall elements and hollow core roof and floors		Batch	No upper limit - tunnel dimensions can be altered to suit the local situation. Typical installations 10,000 - 25,000 tpa but greater capacity possible	Dependent on processing capacity and final project design		Full Turnkey solutions or the supply of technology or parts thereof can be provided depending on client needs. Whatever the choice a full range of ancillary equipment can be provided which may include: Shredders, conveyors, screens , bagging plant, materials separation, picking and sorting lines etc
HotRot modular bays constructed from precast wall and floor panels with forced aeration option			No upper limit building and bay dimensions can be altered to suit client needs	Dependent on processing capacity and final project design	Predominantly green waste but will be dependent on final design	
IPS Composting System is an automated, agitated bay technology for catering waste, biosolids, SSO, MSW and MBT	Fixed	Continuous flow	10 to >500 tonnes per day	System is modular. Space is dependent upon volume	Catering wastes, source separated organics, biosolids, municipal solid wastes, green wastes, etc	Dependent upon feedstock
An automatic system for composting/MBT plants treating source-segregated or residual organic waste streams. The system automatically turns and moves a table windrow whilst simultaneously homogenising, loosening, aerating and irrigating the material within the composting building	Fixed	Continous flow	Starting from 50,000 t/year. At present (2008) installing a plant in Cambridgeshire for 200,000 t/year	The plant in Cambridgeshire will have a lengh of approx 200m and a width of 80m without the preparation building (50 x 60m)	Separately collected biowaste or green waste for production of compost. Or residual (household) waste for stabilising for landfill or for drying for further processing eg gasification	Kelag Umwelttechnik will deliver all machinery and technology needed for a composting responsible MBT plant
Please refer to website. Detailed technical proposal available upon specific project request	Fixed	Batch	Any (custom made)	Depending on capacity	Any organic material suitable for aerobic treatment	Air and water treatment systems
	Fixed	Batch	30,000-100,000tpa	4 acres	Food, green, card, paper and biodegradable packaging	None - facilities are delivered under the terms of a design, build, finance and operate contract
8 x purpose built IVC underfloor aerated tunnels	Fixed	Batch	In excess of 40,000 tonnes input pa combined	2,500m²	Green waste, Cat 3 ABP waste including catering waste	Mobile plant including front wheeled loaders, shredders, wind sifter and shredder
Insulated silo cages create a vertical, continuous-flow system, which requires no forced aeration or mechanical agitation. Material is pre-treated, mixed and fed directly onto an automated conveyor. This in turn feeds a traversing shuttle conveyor which fills each cage via ultrasonic level detectors. Material descends naturally through the cage, passing through a range of temperatures and maintaining 70°C for at least 1 hour. An automated unloader removes material from the base of each silo cage to side conveyors carrying the product to storage and maturation areas	Fixed	Continuous flow	Nominally 550-600 tonnes pa	System has modular design which enables customers to choose number of silos required. Therefore, footprint will vary however examples would be as follows: 30,000 tonne facility would require a total footprint for the intake area, silo cages and maturation area of approx 5700m²	Catering waste, meat including bones, general food waste, fruit and veg, green waste, cardboard, paper waste	Mixer and shredding equipment, Loading shovel for intake and maturation area, odour treatment system
Modular vertical composting units, 30m³ capacity each. Provides fully enclosed, low footprint, low operating cost, odour free solution	Fixed	Plug flow	2000-40000 tpa	From 25m² for 2000 tpa to 350m² for 40,000	Wide variety of organic feeds including Cat 3 ABP	Depending on feedstocks and end product usage, shredder and screening plant
Aerated batch in-vessel	Mobile	Batch	40m³	1,000 tpa/acre	Green and meat inclusive catering waste	Shredder/loaders/tractors/ process control
Vessels with solid concrete walls; retractable roofs constructed from stainless steel and Scandinavian PVC; air ducting system with electric fan units, steel quick fit door and steel walkways for easy access	Fixed	Batch	Vessel capacity 180 tonnes, depending on bulk density of material. Annual capacity of each pair of vessels approximately 6,250 tonnes	Vessel dimensions: length: 18m (15m inside vessel, 3m roof overhang) width 8m wall height 2.5m loading and unloading corridor between each pair of vessels 10m minimum	Green waste and kitchen waste, minimum amount of green waste required 60% to 40% food	Slow speed shredder, loading shovel and screener
In-vessel system enclosed in buildings	Fixed	Batch	15,000	0.5 acres for 45,000 tonnes	Green and food waste kerbside collected including meat or commercial food waste	Telehandler machines

Digestion technologies

This part of the guide includes aerobic and anaerobic digestion systems suitable for recovering animal by-products and other biodegradable input materials.

Company	Contact Name	Contact Number	Email	Website	System description	Solids and 'Wet' or 'Dry' Choose LSWP or HSDP (see key)	Temperature range - (see key)
Bio Group Ltd	John Mullett	01353 649800	info@biogroup.co.uk	www.biogroup.co.uk	Multi phase AD in horizontal concrete tanks with ABPR sanitisation at 70°C for 1 hour <12 mm	LSWP	Thermophillic
Bio Waste Solutions	Lewis Dodds	07785 783300	lewis@bio-waste.co.uk	www.bio-waste.co.uk	Aerobic digestion	LSWP	Thermophilic
Biowaste Recovery Ltd	Dr Laiqi Zhang	07795 214885	laiqi.zhang@ biowaste-recovery.com	www.biowaste-recovery.com	Aerobic digestion	Solids and 'Wet' or 'Dry'	70+°C
Celtic Composting UK	Steve Bullock	0044(0)1884 259793 0044(0)7872 119638	sbullock@ celticcomposting.com	www.celticcomposting.com	Complete mix reactor - wet fermentation	LSWP (Wet)	Mesophilic or thermophilic dependent on project
					Tunnel/bio cell - dry fermentation	HSDP (Dry)	Mesophilic
Enpure Limited	Robyn Haines	0121 2519000	rchaines@enpure.co.uk	www.enpure.co.uk	Please refer to Enpure leaflet - Focus on AD	LSWP	Mesophilic and/or thermophilic
HotRot Organic Solutions	James Lloyd	01842 816909 01234 354785	info@hotrot.co.uk	www.hotrot.co.uk/ solutions/bekon.php	Loaded and unloaded by front end loader, there are no internal moving parts to foul up or waste energy. No water is added to the process and percolate from the material is recycled through the mass via a central percolation storage unit. Gas is stored in and extracted from the digesters and percolation storage tank, while the material is resident between 4 and 6 weeks depending on the gas yield of the input material. For key benefits contact manufacturer	HSDP operating on up to 60% dry solids	Mesophilic or thermophilic
Komptech UK Ltd	Paul Carley	+44 101926 642972	p.carley@komptech.com	www.komptech.com	Digestion modular tunnels	HSDP	Mesophilic
Scottish Water Waste Services	Donald Macbrayne	07875 873020	donald.macbrayne@scottish water.co.uk	www.scottishwater. co.uk/compost	In development	LSWP	-
Vital Earth Ltd	Malcolm Rich	07970 003801	mrich@vitalearth.tv	www.vitalearth.tv	Vital Earth bespoke bio-vessel	-	Both

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Type of system							
Stages	Material flow	Number of digesters and capacity per digester	Biogas management system	Digestate separator (see key)	Space required footprint and capacity of the system (vol/tonnes). Excludes maturation and storage areas	Suitable feedstocks	Ancillary equipment required
3 stages	Continuous	Various	Designed in	Designed in	Varies	Food waste, mixed waste	-
3 stages	Batch	2 x 50 tonne 4 x 20 tonne	N/A	Oil separator can be added	18m x 30m	Any ABP/Cat 3	Forklift and tanker
Single or two stages	Batch	Case to case	N/A	Designed in	Case to case	ABP and biodegradable	Case to case
One or two dependent of site/customer requirements	Continuous	Dependent on project	Designed in	Can be added	0.6 hectares per 25,0000 tonnes	Pumpable organic substrates	None
One stage	Batch	10 digesters (30m x 7m x 5m each) per 25,000 tonnes			0.8 hectares per 25,000 tonnes	Dryer stackable organic substrates, co-mingled greenwaste and food waste, municiple solid waste	Mixer, loader(s) and screener
Single stage	Continuous	Bespoke to requirement	Designed in	Designed in	Bespoke to requirement but typically footprint per tonne of waste reduces with increasing scale	Any material with reasonable organic content	Yes
Single stage	Batch	On average and dependent upon gas yield - 2,500 tonnes per annum per digester	Plant able to be supplied with any number of configurations including: [1]CHP with thermal and electrical output [2]Gas clean up and compression for use as a transport fuel [3]Gas clean up and compression for putting into the natural gas network	Does not produce a liquor and so is not required. The process produces a high solids content, stackable material suitable for composting and aerobic maturation to produce a PAS100 product	Each digester is 5.9m wide by 28m long and 5m high	-	-
Single AD + composting of the digestate	Batch	Any (custom made)	Designed in	N/A	Depending on capacity	Any organic material suitable for anaerobic digestion	Air and water treatment systems and CHP unit
-	-	-	-	-	-	-	-
Two stages	Batch	1 bio-vessel/1k tpa	N/A	N/A	400m²/10k tpa	Green and meat inclusive catering waste	Shredders/loaders/tractors/ process control

Key

LSWP	Low solids 'wet' process
HSDP	High solids 'dry' process
Mesophilic	30 - 45°C
Thermophilic	45 - 80°C

Digestate separator produces 'separated liquor' and 'separated fibre'

Be included in the conference issue of *Composting News*

Earlier deadlines for the spring issue 2009

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Wednesday **17 December 2008**

Advertising close
Wednesday **7 January 2009**

When animal by-products are being considered this can be an important criteria as separation of phase I and II material has to be achieved. Positioning pipes and spigots prior to laying a new concrete floor and the associated fan and drainage manifolds are easy to lay and operate, and will last for decades.

All systems in the guides will process waste materials and produce compost but the cost effectiveness of them in relation to the feedstocks available and the quantities to be processed should be studied, (unit cost per tonne processed). The facility and design should where possible incorporate future expansion: where space is limited vertical systems may have an advantage.

Process control and record keeping is increasingly important in modern systems, records have to be kept to prove that kill temperature/duration periods have been achieved if compost is to be attributed any quality certification. It is imperative to ensure that all areas within the compost mass being treated reach the required temperature profile. A homogeneous feedstock both nutritionally and physically is important if uniform temperatures are to be achieved within the compost; if they are not, temperature differentials will establish within the compost matrix as different airflows develop, resulting in a variation in micro-floral activity. Poorly insulated areas of vessels can also contribute to cold spots where pathogens can survive the treatment. Positively ventilated systems tend to have more uniform temperature profiles than those that rely on natural convection.

The requirement for ancillary equipment with all systems is a point worth considering, as these extras can be costly items.

Nature has its own methods of breaking down most products. The composting industry, not without guile, has developed systems that are able to harness the abilities of microorganisms with quite elegant efficiency. In the final analysis it is a cost/benefit equation that should determine the system employed on the available waste stream. All-singing all-dancing systems may, on paper, provide utopia for officials attempting to solve an area's waste problems, and collecting ROCS and carbon credits may look good on the balance sheet. However, without government incentives, are they sustainable? The need to economise on energy will be ever present in the foreseeable future, but returning waste streams into useable forms to the benefit of the environment and the community may well be achieved by utilising more modest technologies.

Compost Advice and Analysis specifically services the waste industry; analysing and testing compost, performing bio-aerosol surveys and giving independent advice based on decades of experience in the composting arena.