CIR20 - 128

REV: 02

Biostabilisation Plant Operation CIR20-128

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Originator …………………….

Signed of by ………………….

Date Released…………………

Purpose

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To outline the process for operation of the Biostabilisation Plant

Scope

Biostabilisation Process

Reason For Issue

First Release

Responsibility

Operational Director

Waste Quantities and European Waste Codes (EWC)

The proposed development is a combination of wet and dry AD designed to process the following

16,000 tonnes of MSW converted to 8,000 tpa of MBT fines (EWC 20 03 01)
4,000 tpa of domestic source separated food waste (EWC 20 01 08)
3,000 tpa of commercial source separated food waste (EWC 20 01 08)

Overview of Waste Flow

The facility is designed to treat both source separated and mixed waste feed stocks. As such, the incoming feedstock will be either directed to the biological building in the case of source separated material or to the mechanical pre-processing building in the case of MSW. Referring to Figure 3 and Figure 4 the following paragraphs will explain the process and waste flow. A more detailed explanation of each step within the process is given in the subsequent sections on dry AD and composting.

The brief mass balance for the MSW and bio-waste inputs to the facility is illustrated in Figures 1 & 2.

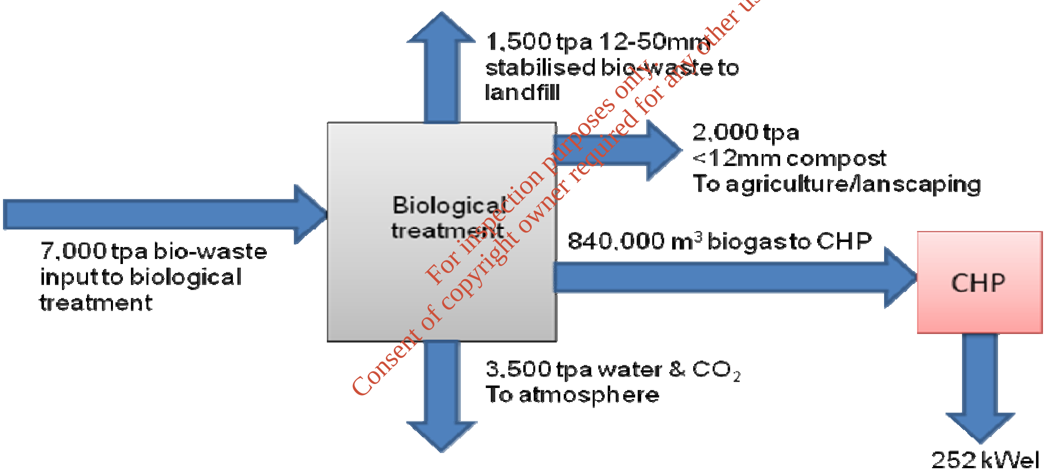

Fig. 1. Mass balance for the bio-waste inputs to the Clean Ireland facility.

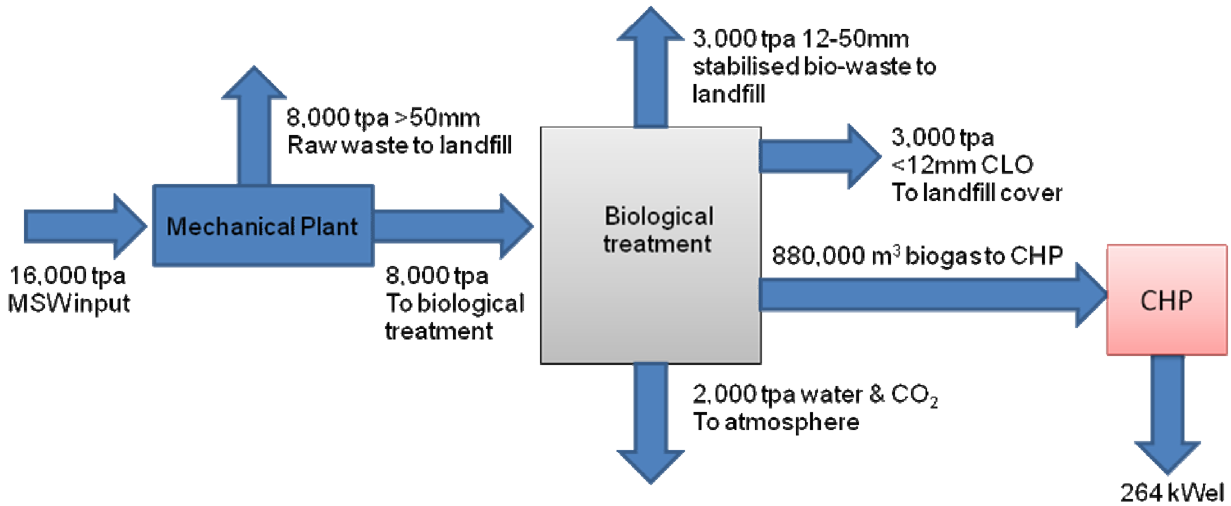

Fig. 2. Mass balance for the MSW inputs to the Clean Ireland facility.

Waste Reception and Pre-Treatment

The reception and pre-treatment of the bio-waste will occur within the waste reception building. The reception and pre-treatment method employed will vary depending on the incoming feedstock.

MBT Fines

The MBT fines consist of organic rich material that is mechanically extracted from mixed waste delivered to the facility. The mixed waste is shredded and screened at 50mm within the MRF section of the facility and the fines (Fig. 3) are conveyed to the biological building by conveyor. These fines are destined for the dry AD processing stream and will be delivered to the facility in a form that will not require any further pre-processing. The MBT fines will be stockpiled in a dedicated section of the reception building until such time as the volume of feedstock is sufficient to half fill a fermentation chamber (225-325 m^3).

Fig. 3. MBT fines currently being produced at the Clean Ireland MRF.

Domestic Co-mingled Food & Green Bio-Waste

The combined domestic food and green bio-waste feedstock will be delivered to the biological facility by refuse lorry in a form directly suitable for dry AD. Consequently, this material is directly tipped onto the reception building floor and then contained within a dedicated reception area (Fig. 4). As was the case with the MBT fines, this material will be stockpiled in the reception area until such time as there is an adequate supply to make a 50-50 mixture with the partially fermented contents of a recently unloaded fermentation chamber.

Fig. 4. Bio-waste being tipped at the Broadpath in-vessel composting facility in Devon (left) and material being held prior to processing (right).

Dry Anaerobic Digestion System

Introduction

Dry digestion is well suited to dealing with stackable bio-waste with lower moisture levels, i.e. >20% total solids (TS). These stackable materials can also have high levels of physical contamination and as a result dry anaerobic digestion is ideally suited to the processing of co-mingled brown bin material and MSW fines. In this system the incoming feedstock is loaded into "garage" like gas tight biocells using a loading shovel with little or no pre-processing required. These biocells are referred to as fermentation chambers. A summary schematic of the dry fermentation process is illustrated in Fig. 5. In brief, bio-waste or MBT fines are loaded into a sealed, gas tight concrete vessel and the anaerobic digestion (AD) process is initiated through the spraying of activated anaerobic percolate onto the biomass. This percolate is kept in circulation through an external percolate storage system. The biomass is heated to 37-40^{o}C and biogas production is facilitated. This biogas is drawn off the tunnels and stored prior to use as fuel in a CHP gas engine.

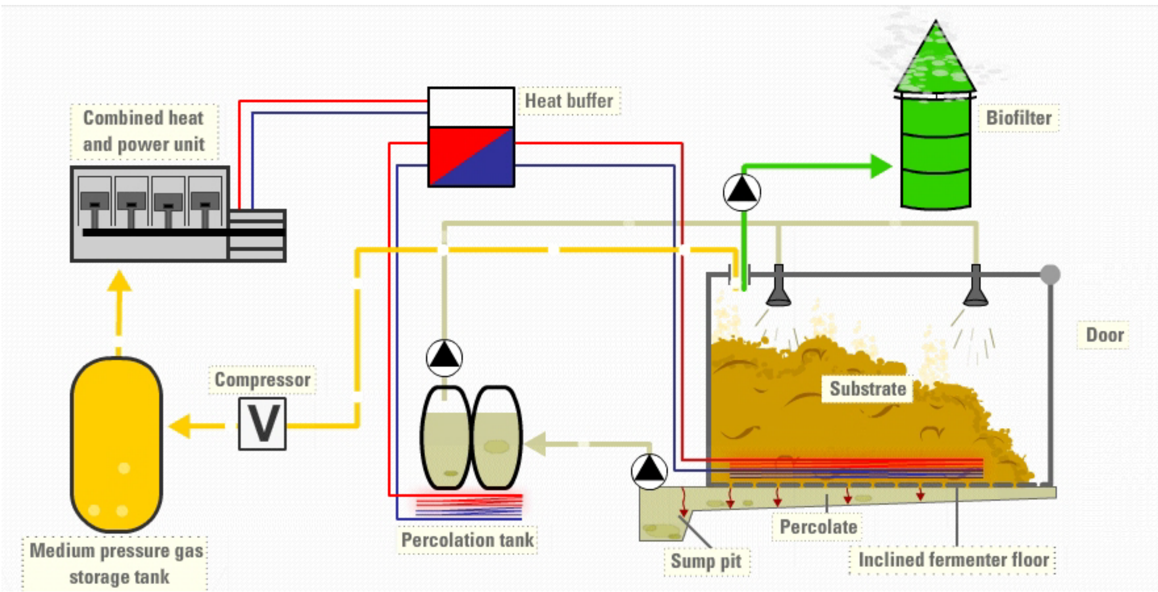

Fig. 5. Schematic of the BIOFERM dry fermentation process.

The system is modular with increasing tonnages of material being managed by additional fermenters. The fermenters are typically 30m long, 7m wide with an internal stacking height of 3.5m. Each fermenter can typically process 2,500 tonnes of bio-waste per year. Due to the cyclical nature of the biogas production process, the minimum number of fermenters is three. This ensures that there is always biogas available to feed the CHP (Fig. 6).

The process of dry fermentation is based on the following procedural steps:

1. Supply and storage of biomass
2. Fermentation
3. Extraction of digestate
4. Ventilation system
5. Gas utilisation

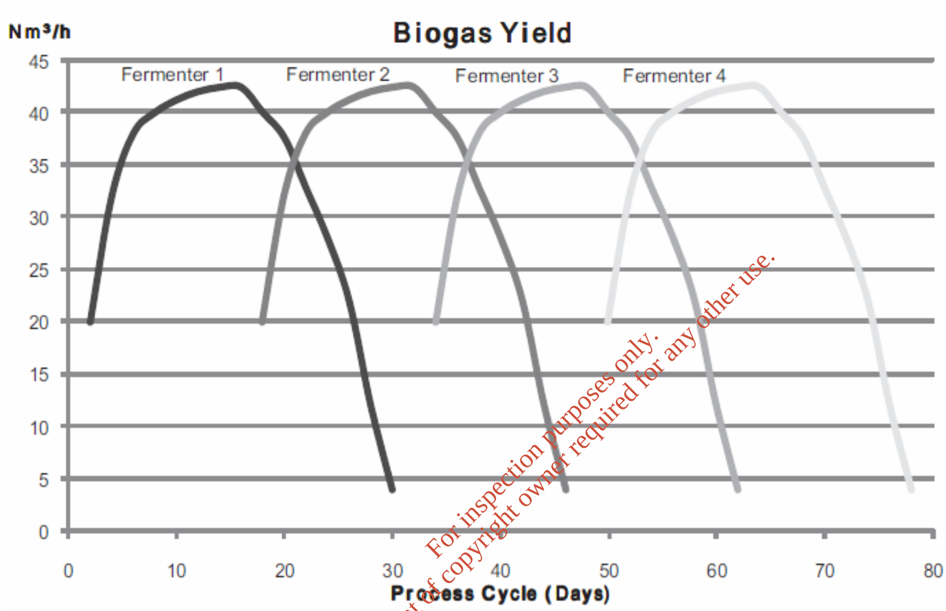

Fig. 6. Typical biogas production cycle from a four fermenter facility.

Supply and Storage of Biomass

When the plant is operational the supply of biomass to the fermentation chamber is based on a 28 day cycle. When a chamber is ready for fresh biomass the first step of the exchange requires the extraction of the partially fermented biomass within the chamber. One portion of the extracted biomass is kept on the building floor and then mixed in an approximate ratio with fresh biomass using a front loader. This ratio will be dictated by the tonnage of material being delivered to the facility and may fluctuate to accommodate seasonal peaks but is expected to be a 50-50 split. The loading and unloading of the solid state digestate is conducted using air-conditioned loading shovels (Fig. 7).

Fig. 7. Filling of a fermentation chamber with Bio-waste.

The Fermentation Chambers

Each of the individual fermentation chamber units has an inner floor area of 7m x 30m with an internal height of 5m (Fig. 8). The height of the stacked biomass however, must not exceed 4.0 meters and this is typically managed at 3.5m. The reinforced concrete fermentation chamber is gas tight to prevent the infiltration of oxygen (the presence of which would cause the methane producing bacteria to become inactive). This also prevents the leakage of biogas to the atmosphere. An in-floor heating system holds the biomass at a constant temperature range of between 37-40°C. The plant engineering components are located in a dedicated technology section housed above the fermenters. The capture and storage of biogas is managed through a stainless steel piped biogas ventilation system while short to medium term gas storage bags are also located above the fermentation chambers. The percolate from the fermenters is stored in two insulated and heated tanks.

Fig. 8. Interior of fermenter prior to filling (left) and with bio-waste prior to fermenter sealing.

To insure that the fermentation chamber is not opened before the methane gas is completely drawn from the chamber and safe atmospheric levels of O_2, CO_2 and H_2S are reached, the air inside the chamber is continuously measured and analysed. The values are communicated to the computerized security system controlling the chamber doors. With the exception of loading and unloading biomass from the fermentation chambers the entire plant is fully automated by PLC. Interruptions are immediately recognised and documented.

The Percolate Cycle

The dry fermentation process is facilitated by the "percolate cycle". This involves the spraying of the biomass with an activated anaerobic sludge that is developed in a separate heated tank. This percolate inoculates the biomass while keeping it moist (>70% moisture; <30% solids). While the process of hydrolysis is initiated during storage of the fresh biomass within the reception building, both acidogenisis and methanogenesis steps occur simultaneously within the fermenter. The bathing of the biomass in this activated percolate is key to the process.

In order to drain off excess percolate, a series of stainless steel gutters of 1 m length each with grating are built into the fermentation chamber floor. They absorb excess liquid from percolate sprinkling and route it in a controlled way to a gas tight pipe collection system. From the collection pipes the percolate is routed to the insulated covered transfer pump duct (10 m^3) utilising the following equipment:

- Fill level sensor to switch the lift pump
- Transfer pump (mix pump) with pressure pipe to the percolate storage unit
- Ventilated air pipe
- Temperature sensors
- Access door
- Limit Switch

From the transfer pump duct, which is already equipped with a 3-layer coating and a leakage detection system, the fermentation liquid is pressure pumped into an insulated percolate storage unit (Fig. 9). The entire piping system is routed in a frost-proof zone outside the fermentation chamber area. The percolate storage unit consists of the following parts:

- Inlet pipe end
- Filling level sensor to switch the pump
- Transfer pump (mix pump) with pipes to the chamber sprinkling system
- Water tank for excess pressure safety
- Heating (Wall heating)
- Temperature sensor
- Pressure sensor
- Access door
- Limit switch
- Fermentation chamber connection unit

This percolate storage unit is installed with capacity to hold enough percolate for the entire fermentation process (even in the case of dry or highly structured material) where excess water may need to be added. The percolate storage unit is heated via a heat exchanger attached to the CHP unit. A temperature meter is located in the storage unit and takes real time percolate temperature measurements. By doing this, the heat circulation pump can be controlled and when necessary turned on/off.

The percolate is pumped to the individual fermentation chambers via HDPE pressure pipes. The percolate pipes route to the sprinkling unit of the fermentation chambers through gas tight ceiling ducts. A time sensitive control system determines the maximum percolate sprinkling requirement of the biomass. The cycle comes to an end when the percolate has seeped through the biomass. The remaining bacterial fluid is collected, siphoned and then transported using the transfer pump duct. This is to ensure that the percolate cannot leave the system in an uncontrolled manner. Should the gauge in the percolator storage unit fall below the minimum level required for fermentation of exceptionally dry biomass, fresh water can be applied to the biomass. As a general rule the percolate level should be balanced as the percolate is recycled and stored in the final storage chamber.

Fig. 9. Percolate storage at a Bioferm facility in Japan.

Heating

Less than 5% of the heat generated from the CHP engine is utilised to maintain the working temperature within the fermenters; the rest can be used for external purposes. The thermal energy from the CHP engine is passed to a heat-exchanging device whose operating temperature averages around 85°C. By means of heat pumps, warm water is channeled though the heating system of the biogas plant. The fermentation system is conducted at mesophilic temperatures of around 37-40° C. Heat is transported through stainless steel pipes. The fermentation chamber floor is equipped with heat piping so that the temperature of the fermenting material is maintained at 37-40° C. The placement of the heat distributor alongside the heat in-feed of the percolate storage units ensures against excess heat exchanges.

Pneumatic Controls

The compressor produces the required compressed air to activate all pneumatic valves and it is regulated with an on/off switch. The air pressure lines are routed to a distribution manifold to facilitate individual valve requirements. In the case of pressure loss or a controlled emergency stop, all pneumatic valves are depressurised automatically through a closing mechanism, using the spring-break principle, thus securing the plant in a safe operating state and preventing uncontrolled gas leaks. Pneumatic valves are activated by the air pressure from the respective chambers: The chamber door is manually opened and closed. When the door is closed, it is pneumatically locked. Compression couplings generate the necessary surface pressure and use it to assure the chamber remains gas tight. In order to open the fermentation chamber door, clamping screws require loosening and a pneumatic release device needs to be operated by hand. Only when gas quantities of ≤ 3 % CH_4, < 0.5 % CO_2 and > 18 % O_2 are measured in the fermentation chamber is approval to open the door given via the PLC system (green indicator on control panel). The pneumatic lock on the chamber door can then only be opened with a key. There is a finite time limit within which the chamber door must be opened. If the door is not opened during the allowed time a new approval sequence must be given by the PLC control system based on the content of methane and oxygen in the fermentation chamber.

Gas Measurement and Storage

After loading the fermentation chambers, the biomass is kept undisturbed for a period of approximately four weeks, during which time the biomass is anaerobically fermented and biogas is produced. The gas quality (CH_4, CO_2, H_2S and O_2) is determined with a gas analysis device and communicated to the PLC system and the Siemens SCADA software interface (Figs. 10 & 11). The plant operating parameters such as temperature, pressure, gas quantity and quality are stored in a database. Percolate quantity, valve and plant conditions (fermentation chamber, gas storage, CHP) are monitored via the PLC.

The biogas is extracted from the chamber with an explosion and leak proof ventilation mechanism and it is routed into the gas storage unit located on top of the fermentation chambers (Fig. 12). The internal pressure of the gas storage unit under normal operating conditions is maintained at a maximum of 5 mbar. For safety reasons the internal pressure of the gas storage unit must never exceed 25 mbar. This is controlled by the PLC with a further mechanical pressure relief valve that routes the excess biogas to a flare. The gas storage bag is designed with enough capacity to buffer the biogas even during offline maintenance works on the degasification units of the plant or the CHP unit. When the degasification unit or the CHP unit comes back online the buffered gas can be reprocessed. Under normal operation the gas storage units are loaded to a maximal of 30 - 40 % of capacity via the level control sensor to guarantee enough buffer capacity for operational disturbances.

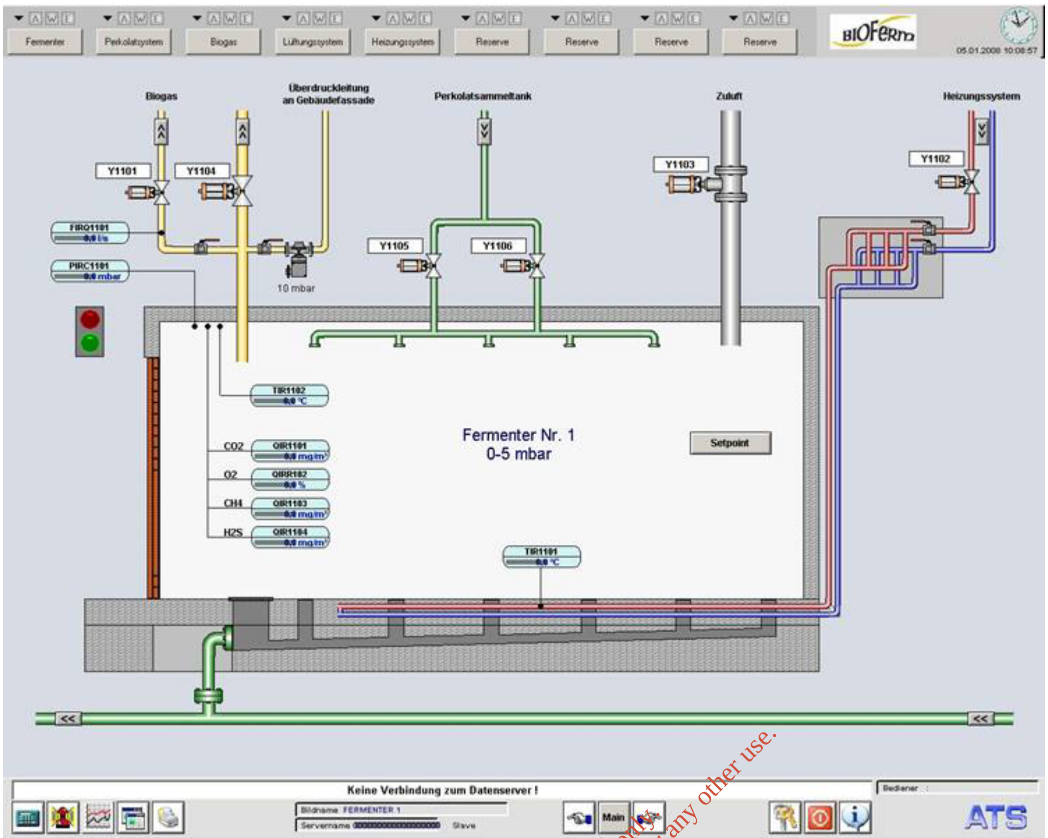

Fig. 10. Siemens SCADA control of fermenter No.1 at the Moosdorf facility in Bavaria.

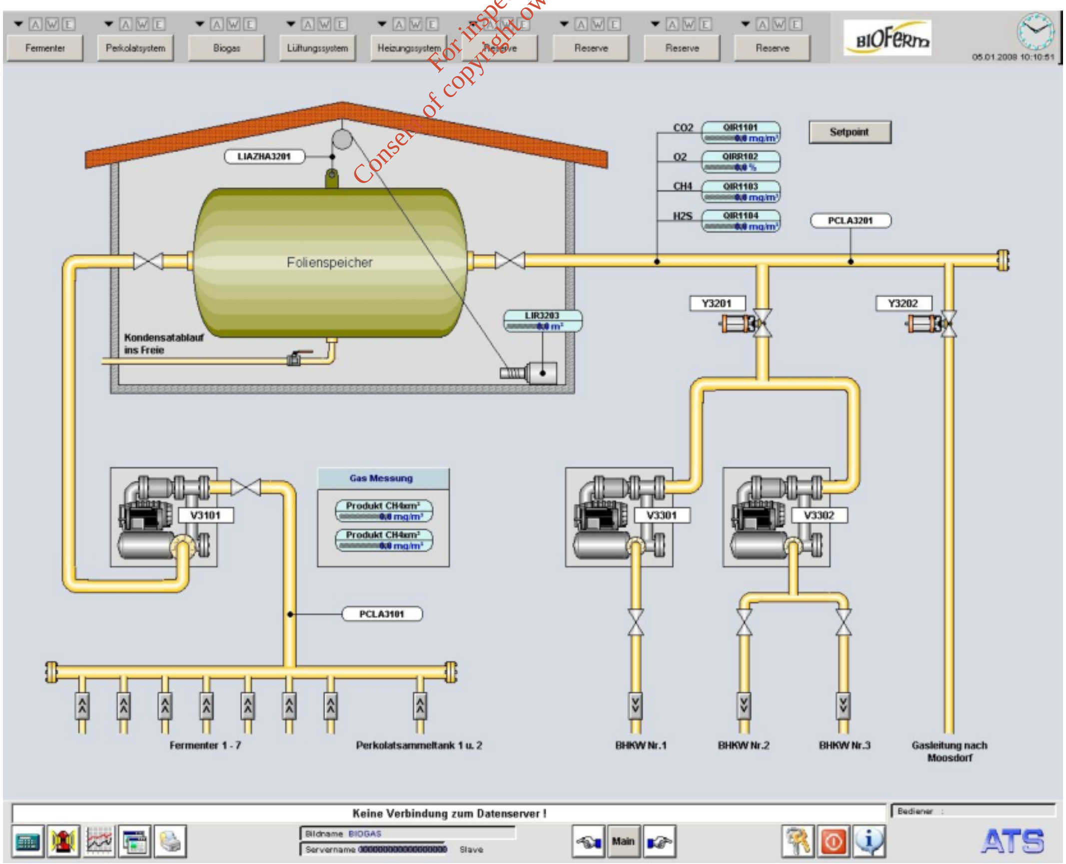

Fig. 11. Siemens SCADA control of gas storage at the Moosdorf facility in Bavaria.

By mixing the streams of gas from different fermentation chambers a gas with consistent methane content is produced. Due to this process the methane content of the mixed gas will be the average of the combined fermentation chambers thus achieving higher process stability. A minimum mixed gas methane content of 57% is aspired to. The desulphurisation of the gas is achieved automatically by the PLC control system. A hydrogen sulfide level of less than ≤ 100 ppm is desired. The moist biogas stays in the gas storage unit for a period of time while cooling to ambient temperature. During this process the water in the gas condenses and is transferred via a siphon water duct (150 mm) from the deepest point of the gas storage unit to the fermentation chamber below. This is process is referred to as passive condensation extraction. Further biogas production takes place in the percolate storage tank. A connection to a fermentation chamber is installed on the ceiling of the percolate storage tank and the biogas is exhausted via a gas compressor. The gas is condensed and routed to the gas storage unit.

Continuous measurement of CH_4, CO_2, H_2S and O_2 levels and gas volume for each individual fermentation chamber as well as the volume and composition of the mixed gas in the gas storage unit is carried out to monitor the line operation. This is essential for optimal control of all processes and any interruptions can be detected and prevented at an early stage.

Fig. 12. The pneumatic gas collection system on the roof of the fermenters (left) and the gas transfer blower to the gas bag located in the roof space above the fermenters (right).

A fermentation chamber gas extraction unit consisting of the following components is attached to each fermentation chamber on a gas tight ceiling conduit:

- Valve to the CHP
- Valve for the gas collection pipes with gas meter.
- Hydraulic safety valve for vacuum and pressure gauge

Fermenter Ventilation System

The ventilation system provides sufficient ventilation for the fermenter chamber opening process. Ventilation is accomplished with a controlled piping system (stainless steel, resistant to methane gas and electrical conductivity), backpressure valves and ventilation units. The exhaust air within the fermentation chamber is combined with compost exhaust and the building air which is ultimately discharged to the atmosphere via a bio-filter.

CHP

The CHP unit is supplied with biogas from the respective gas storage units via an individual gas control valve and gas compressor. The CHP units are installed in a separate, noise dampened containerised unit (Fig. 13). The electricity produced by the CHP units is fed into the public grid and/or used for internal consumption. The thermal energy generated by the CHP units is needed in small amounts as process heat (approx. 5 %) in the plant (in-floor heating of dry fermentation chambers, heating of buildings etc.); the surplus thermal energy can be provided for external thermal use. In cases where the thermal energy is not used, the CHPs are equipped with a standard emergency cooling mechanism.


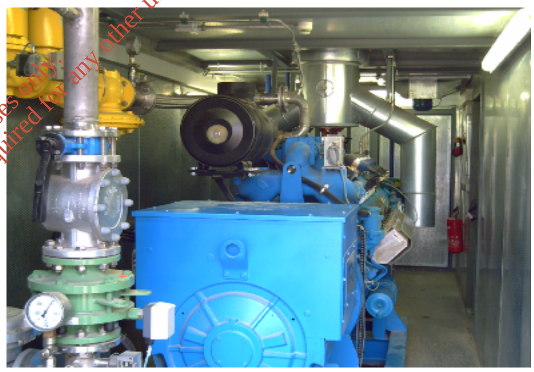

Fig. 13. Containerised CHP at the Decker biogas plant in Northern Germany

The accessories to the gas engines include the compressors, fire and smoke detectors within the room, a separate electrical control cabinet and remote control that enable the supplier to check the biogas engines on a daily basis or according to requirements. Exhaust gas emissions will be in accordance with European standards. Details can be adjusted for local requirements. Noise and exhaust gas quality are based on European regulations. All the safety design is according to German Safety Regulations for Agricultural Biogas Plants. In a situation where the gas engines are out of operation due to maintenance or repair, an emergency flare burns the surplus biogas. The emergency flare has a fully covered flame and is automatically turned on by the level control of the gas holder. It burns biogas at about 800 – 850 °C and follows international standards for this duty.

In-Vessel Composting System

The Compost Tunnels

Three aerobic tunnels are provided (30m x 7m x 5m) to post process the dry AD fermenter output for both the MBT and source separated outputs from dry fermentation. The tunnels are constructed from re-enforced concrete designed to withstand strong chemical attack and high abrasion (Fig. 14). They are sealed by insulated stainless steel lined sliding doors. The tunnels are equipped with a proprietary “C:N” aerated floor system with a computer controlled blower system that is mounted in a gallery on the roof of the tunnels overlooking the tunnel loading area. Approximately 50% of the output from the fermenters is transferred to the aerobic composting tunnels on each cycle and the material is mixed with screen overs to inoculate the material with aerobes.

This material is then stacked within the composting tunnels and aerated. The material readily de-waters and the aerobic microbial population rapidly increases. This is reflected by the auto-thermic increase in temperature of the biomass into the thermophilic range.


Fig. 14. Exterior of the composting biocells illustrating the sliding doors (left) and the proprietary C:N in-pavement aeration system (right).

Control of the Composting Process

The composting process for the tunnels is controlled by a PLC / PC interface, which dictates the airflow within the biomass. The flow of air responds to temperature, pressure and oxygen changes in the composting mass that are continuously recorded by the PLC.

At the beginning of the process, when the composting mass is heating up, the computer system is in “oxygenation” mode. Here the process control system is programmed to blow air into the vessels on a periodic basis to maintain adequate oxygen levels and stimulate the growth of aerobic bacteria. A diagram of the aeration system is illustrated below. The blower system is illustrated in Fig. 16.

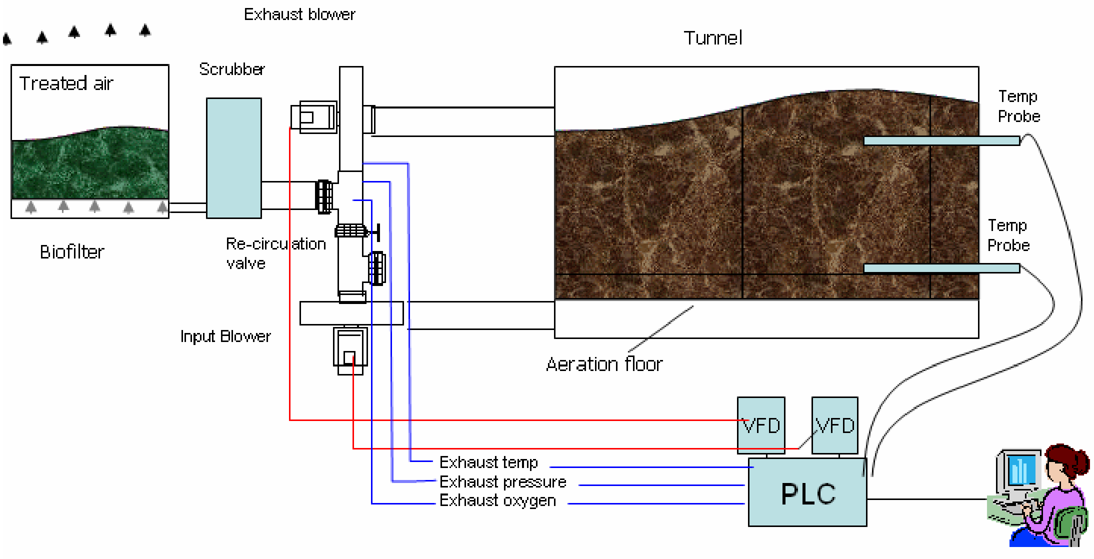

Fig. 15. Schematic of the CCS PLC controlled biocell aeration system.

The PLC coupled with a windows based PC computer allows the operator to configure a temperature profile for the 14-28 days of post fermentation composting and bio-drying. This allows the temperature within the biomass to be controlled within set limits while excess moisture is driven off. Typically the compost would be turned within 7-10 days to break up compaction during this aerobic stage. At the end of this period, a compost at Rottgrade IV will be produced with a moisture content of 35-40% that is then retrieved from the composting tunnels for screening.

Fig. 16. The blower modules in the gallery of the Deepmoor tunnel composting facility in Devon.

Compost Screening

The screening plant is housed within the building to ensure that there are no fugitive emissions of odorous air during the screening operation (Fig. 17). In order to achieve ABPR compliance, both MBT and source separated materials will be screened at 12mm. The overs from the MBT line will be landfilled as stabilised bio-waste, while a proportion of the source separated overs will be used to inoculate the digestate prior to tunnel composting. The unders from the 12mm screen will be segregated for pasteurisation.

Fig. 17. Housed trommel screen illustrating multiple sections that produce different grades of compost and overs.

Compost Pasteurisation and Storage

The trommel screen will produce a fine grain 12mm compost fraction from both MBT and source separated lines. This material will be loaded into a dedicated pasteurisation tunnel that is aerated under maximum re-circulation. Recently screened compost will generate a short period of increased microbial activity due to the physical abrasion resulting from screening. As a result, this compost will reach high temperatures (60-80^{o}C) in the following days if oxygen is supplied. This is facilitated within the controlled tunnel environment and while temperatures in excess of 70^{o}C can be expected in the following 48 hours, additional heat can be introduced from the CHP heat exchanger that is connected to the input blower as a fail safe feature.

After the pasteurisation set points have been achieved, the blowers automatically revert to heat exchange mode to bring the temperature down and thus facilitate further mesophillic maturation during the remaining 4-7 days. This also ensures that when the compost is retrieved from the back door of the pasteurisation tunnels odour is all but eliminated.

An area at the back of the facility has been designated for compost storage prior to release off site. The area will allow for approximately 2-3 weeks of compost storage to allow quarantine and seasonal demand issues (Fig. 18).

Fig. 18. Compost storage at the Waterford city Compost facility.

ABPR Compliance

The Animal By-Product Regulation (ABPR) was introduced into European legislation in 2002 on the back of concerns over exotic animal diseases such as foot and mouth and BSE. Regulation (EC) No. 1774/2002 of the European Parliament and of the Council of 3 October 2002 lays down health rules concerning animal by-products not intended for human consumption. This regulation defines animal by-products as *"entire bodies or parts of animals or products of animal origin… not intended for human consumption".* A distinction is drawn between the measures to be implemented in the use and disposal of the material concerned, depending on the nature of animal by- products involved.

Under the Regulation

- A composting plant is defined as *"a plant in which biological degradation of products of animal origin is undertaken under aerobic conditions"* and
- A biogas plant is defined as *"a plant in which biological degradation of products of animal origin is undertaken under anaerobic conditions for the production and collection of biogas".*

Article 15 of Regulation (EC) No. 1774/2002 requires that biogas plants and composting plants shall be subject to veterinary approval by the competent authority. Under Article 6 of S.I. 248 of 2003, the European Communities (Animal by-products) Regulations 2003 which implements the above Regulation, the Minister at the Department of Agriculture, Fisheries and Food (DAFF) may grant an approval, attach conditions to an approval, revoke or vary a condition, withdraw an approval or refuse an application.

As described in Section 1.8, the option of processing the compost at the back end in accordance with EU 1774 is being pursued. In this configuration, the incoming bio-waste is managed in the fermenters and biocells in accordance with best composting and fermentation practice. At the end of this process and as described, the material is screened @ 12mm and this fine grade material is placed in flow through tunnels that facilitate the attainment of the 70^{o}C protocol with the aid of external heat from the CHP as required. This latter heat re-use option is a distinct advantage of the fermentation/composting configuration. The other advantage of this approach is that former foodstuffs can also be processed thus maximizing the band width of bio-wastes that can be accepted by the facility.

Other aspects of the ABPR that the facility design has addressed include the full enclosure of the building and process with stock-proof fencing around the full waste management facility. In addition, all personnel access doors will be fitted with foot baths.

In accordance with the requirements of the latest guidance document published by DAFF, Clean Ireland will undertake the process of phase 1 and 2 ABPR application based on this facility configuration including the development of the facility HACCP plan in parallel with the facility operators manual and SOPs. Once material is available for pasteurisation, there will be a requirement for the facility to pasteurise six concurrent batches and to produce temperature and pathogen data as part of the final license confirmation process. Specifically, Clean Ireland will expect the facility to achieve validation when six batches have been demonstrated to have achieved the time/temperature requirements of the ABPR and to have passed the *E.coli* and Salmonella testing requirements. This is expected to take approximately six months from the date of reception of the first waste loads.

Celtic Composting Systems have been retained to achieve the ABPR license for the facility having successfully delivered on licenses for Galway City Council, Waddock Composting and Waterford City Council compost facilities in addition to a range of facilities in the UK.

COMPOST QUALITY

COMPOST QUALITY (SOURCE SEPARATED MATERIALS)

A good compost quality is clearly a key requirement of this facility. Compost quality parameters can be broken down in a number of key categories:

(a) Maturity / stability
(b) Microbial sanitization
(c) Trace metal concentrations
(d) Nutrient content
(e) Level of physical contamination

Maturity
In relation to maturity, it is expected that the proposed Irish compost stability standard of 13mmolO_2/gVS/h will be achieved (Prasad & Foster, 2009). Typically, the source separated bio-waste will be subjected to approximately eight weeks of dry fermentation followed by three weeks of post composting giving a total retention time of 11 weeks. This retention time within a managed biological treatment system will ensure that the requisite level of maturity is achieved (Fig. 20).

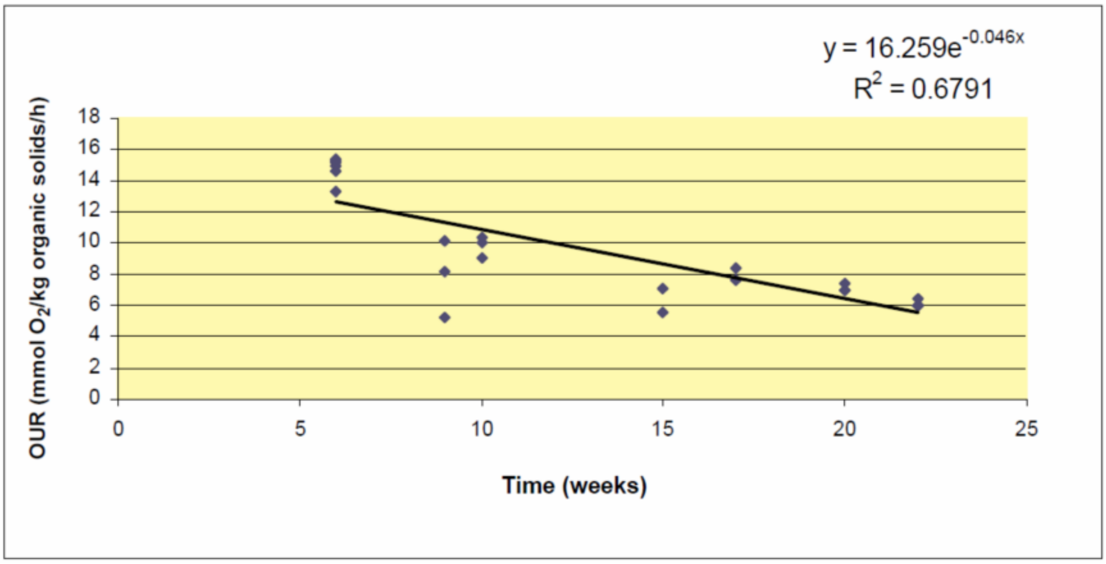

Fig. 19. Oxygen Uptake Rate (OUR) for compost against retention time (Prasad & Foster 2009).

Microbial Sanitation

This is specifically dealt with in accordance with DAFF Animal By-Products Legislation in relation to Salmonella and *E. coli* levels in the output compost product. The regulations state “Sampling must be carried out on digestive residue during or immediately after processing (i.e. immediately after processing parameters have been achieved) in the case of E.Coli, and during or on withdrawal from storage for Salmonella “.

Under the regulations the plant must comply with the following standards

Escherichia coli: n = 5, c = 1, m = 1000cfu, M = 5000cfu in 1 g;
or
Enterococaceae: n = 5, c = 1, m = 1000cfu, M = 5000cfu in 1 g;

and

Representative samples of the digestion residues taken during or on withdrawal from storage at the plant must comply with the following standards:

Salmonella: absence in 25 g: n = 5; c = 0; m = 0cfu M = 0cfu;

where:

n = number of samples to be tested;
m = threshold value for the number of bacteria; the result is considered satisfactory if the number of bacteria in all samples does not exceed m;
M = maximum value for the number of bacteria; the result is considered unsatisfactory if the number of bacteria in one or more samples is M or more; and
c = number of samples the bacterial count of which may be between m and M, the sample still being considered acceptable if the bacterial count of the other samples is m or less.

Trace metals

The concentration of trace metals in the final compost from facilities processing source separated bio-waste is directly linked with the concentration in the incoming material and a high correlation has been found between the level of physical contamination in the incoming bio-waste and the final compost. As a result, the control of this parameter is primarily the responsibility of the collector who is in a position to police the quality of the source separation schemes. In addition, it has been found that high levels of overs re-use containing plastics and metals has a detrimental effect on compost metal concentrations. As a result it is imperative that the >50mm fraction is removed from the process at every pass to avoid this material that contains much of the contamination from being re-processed. PVC has been identified as a particular problem in this regard. Facilities that have failed to do this tend to experience a noticeable increase in lead and zinc concentrations with subsequent issues as regards use of the final compost product.

Nutrient Content
While no standard has been set for these parameters, the data attached in Appendix 2 is for information. CCS uses the nitrate / ammonium ratio as a guide to maturity and process stability.

Physical Contamination
Similar to trace metals, physical contamination is a function of the quality of the incoming bio-waste. However, as the facility will not be using high speed shredders and will be screening the final product @ 12mm, this will preclude much of these contaminants, i.e. film and hard plastics, metals and textiles etc. The data attached illustrates that low levels of physical contaminants are possible as a result even from relatively contaminated bio-waste streams as has been experienced at the Waterford City and Galway City facilities.

COMPOST QUALITY (STABILISED BIO-WASTE)
The principal issue regarding the compost quality derived from mixed waste inputs is the stability of the output. Specifically, MBT is a process that is designed to biologically stabilise waste prior to landfill. Such stabilised wastes will have a substantially lower potential to generate landfill gas with resultant significant reductions in greenhouse gas emissions. In addition, the leachate strength from such material will be considerably lower than in the case of raw waste. In Ireland, the EPA has published a standard for stability:

'stabilisation' means the reduction of the decomposition properties of bio-waste to such an extent that offensive odours are minimised and that either the Respiration Activity after four days (AT4) is below 10mg O2/g dm or the Dynamic Respiration Index is below 1,000 mg O2/kg VS/h.

This standard must be met for qualifying waste in 2010 and is to be increased to **7mg O_2/g dm** by 2016 in accordance with the requirements of the EU Landfill Directive. The Clean Ireland facility is designed to achieve the 2016 standard given the design life expectancy of the facility (20 years). This increase in stabilisation as a result of the combined anaerobic and aerobic processing is illustrated in Fig. 21 below. The threshold illustrated is **5mg O_2/g dm** based on German standards. Given a design combined retention time of nine weeks, the Irish 2016 standard will be readily achieved.

The facility will produce two bio-stabilised products from the MSW stream. The first will be a 12-50mm material that will have been subjected to the full nine weeks of biological processing. This material will be destined for the landfill void as stabilised bio-waste in accordance with the EPA stability standards or will be thermally treated as a refuse derived fuel (RDF). The other product consisting of pasteurised <12mm compost will be used as a landfill cover. This material will not be used in agriculture, landscaping or horticulture due to the mixed waste nature of the origin material. The stability of this material will be the same as the coarse fraction. However, due to the fine grain nature of the material, the level of physical contamination is expected to be less than 3% by weight thus making it suitable for use as a cover material. Clean Ireland will also investigate alternative uses for this material for bio-remediation purposes in accordance with EPA guidance.

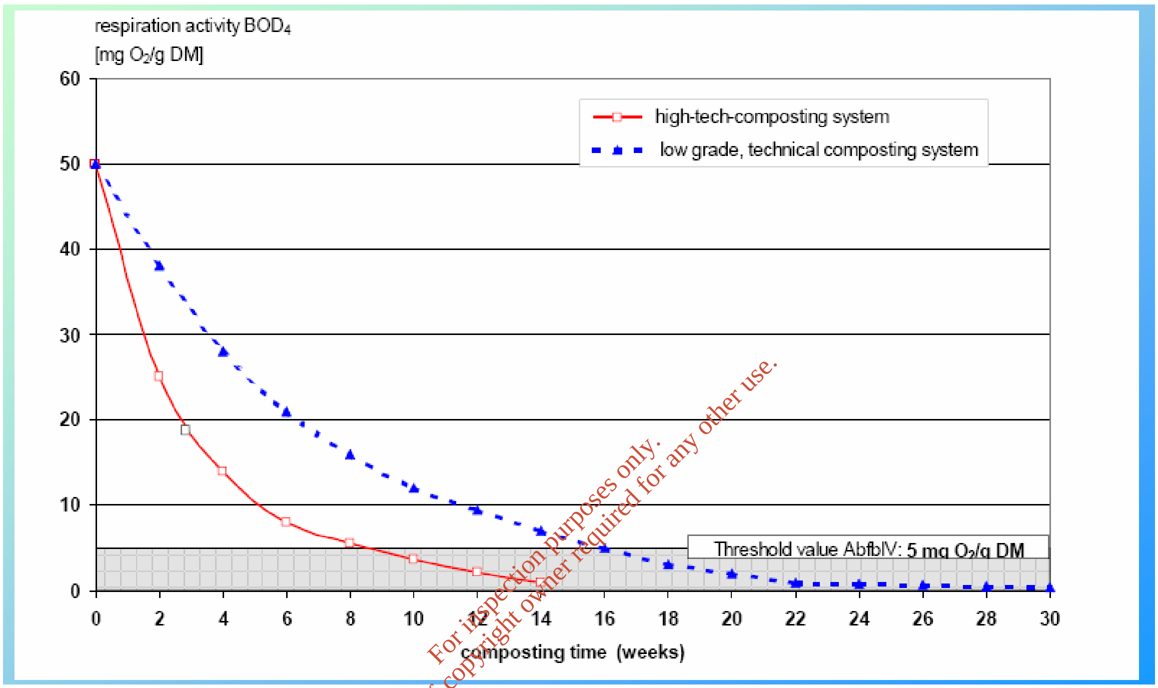

Fig. 20. Reduction in the AT_4 value of mixed waste comparing in-vessel composting and windrow composting techniques.