Hygienisation requirements for composting

Authors: Elke Vandaele, Vlaco
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The intensive decomposition phase includes thermal hygienisation in order to provide the necessary reduction of human, animal and plant pathogens. In this document the different hygienisation requirements from different regions/legislations are given.

ECN QAS

During the intensive decomposition phase, optimal conditions shall be ensured to support the decomposition processes. Intensive decomposition may take place in closed or open systems and with or without forced aeration.
The minimum water content should be ≥ 40 to 50 % and the pH-value should be approximately 6 to 8.
Further recommendations for time-temperature profiles in closed and open composting systems are given in the table:

Time-temperature profiles for sanitisation typically applied in national regulations and composting standards			
Composting system	**Temperature**	**Time**	In all open composting systems, physical agitation (turning and mixing) of the material is necessary in order to guarantee that all the material is exposed to the minimum temperature required.
Open windrow system	> 55 °C > 65 °C	10 days 3 days	
Closed system	> 60 °C	3 days	

The proposed time-temperature profiles are recommendations. NQAO[1] have to adopt minimum requirements for the time-temperature regime and its documentation.
Particularly regarding the composting facilities treating animal-by-products (ABP) such as catering waste, often national requirements are in place. Besides these, treatment plants also have the possibility to apply the standard parameters (1h 70°C with a maximum particle size of 12mm) or to prove equal effect by running a validation test in accordance with the ABP Regulation.

During the intensive decomposition phase, operational measures (dates of turning, watering, control of forced aeration, subjective assessment of odour) shall ensure optimal decomposition conditions with attention to minimised odour emissions.

[1] National Quality Assurance Organisations

The following measures and data of process control shall be recorded in the operational diary (together with the date):

- Temperature measurements during sanitisation,
- Determination of the water content (e.g. measurement, fist test),
- Watering,
- Turning,
- Aeration,
- Any other measures, such as covering with fleece, screening.

EPPO (European and Mediterranean Plant Protection Organization)

EPPO published a Phytosanitary Procedure in 2008, which proposes standardised procedures for the management of plant health risks associated with the use of biowaste of plant origin.

The treatment process will differ depending upon whether the waste is high or low risk. High risk waste is waste containing or suspected to contain quarantine pests or heat-tolerant pests. Other waste is considered to be low risk. When there is any doubt about the phytosanitary risk posed by the waste the NPPO should be consulted.

General requirements for the treatment process

General requirements aiming at eliminating most of the plant pests are defined below. Specific requirements related to biowaste known or suspected to contain quarantine pests or heat-tolerant pests are presented in the next section.

Composting

The processes at composting facilities should be managed in such a way to guarantee a thermophilic temperature range and a high level of biological activity over a period of several weeks. This can be achieved when conditions are favourable with regard to humidity and nutrients, as well as an optimum structure and optimum air conduction. In general, water content should be at least 40%. In the course of the composting process, the entire quantity of materials being treated should be exposed either to

- a temperature of at least 55°C for a continuous period of two weeks,
- or, alternatively, to a temperature of at least 65°C (or, in the case of enclosed composting facilities, at least 60°C) over a continuous period of one week.

A minimum number of turnings may be required to ensure that the whole mass will be exposed to this temperature.

These time-temperature combinations will eliminate most plant pests. It should be noted that there are scientific reports based on varying methodologies showing that some heat tolerant organisms (fungi with hardy resting spores e.g. Plasmodiophora brassicae and heat resistant viruses, e.g. Tobacco mosaic virus and viroids e.g. Potato spindle tuber pospiviroid) have survived these time temperature combinations and further studies are needed to determine the necessary time-temperature combinations to eliminate these and other similarly hardy pests. For further verification of the

sanitation effect of a composting process it may be useful to apply a direct process validation.

Quarantine pest and heat-tolerant pest

Special requirements for biowaste containing quarantine pests. Biowaste of plant origin known or suspected to contain any quarantine pest or heat-tolerant pest should not enter into the biowaste treatment process, unless it can be pre- or post- heat-treated to 74° C for 4 hours, preferably wet heat. However, exceptions could be made, at the discretion of the National Plant Protection Organization (NPPO), when the organism is well known to be inactivated by the biowaste treatment process. In all cases of waste known or suspected to contain quarantine pests, the treatment should be authorized and supervised by the NPPO (including confinement conditions to prevent escape of the quarantine pest, testing of the resulting treated biowaste which should be found free from the quarantine pest and specification of a 'non-risk' outlet for the final use of the treated biowaste). Standard tests for Plasmodiophora brassicae and Tobacco mosaic virus (TMV) are proposed by EPPO for validation of production plants and for testing of the end product.

Compliance

Treated biowaste should not be released for end-use unless all requirements are satisfied. Products failed to meet any of the requirements should be treated again or should not be used for the end use specified in this standard. Direct process validation may be required if the untreated biowaste is known or suspected to be infested with a quarantine pest or a heat-tolerant pest (see above). Heat treatment facilities should be verified before the first treatment and at regular intervals (preferably yearly) thereafter by a technical expert.

Indirect process supervision

'Temperatures should be recorded at regular intervals throughout the processing of the biowaste. If possible, these measurements should be continuous. They should be recorded in at least three representative zones of the biowaste unless the technical equipment of the process prevents access to these zones. During the thermal inactivation stage, the temperature should be recorded at least once every working day.' If the biowaste is subjected to a specific heat treatment, the temperature should be monitored and recorded continuously and automatically for each treatment period.

Product analysis

The analysis of the product after treating biowastes (final product controls) should include tests to ensure that the final product meets specified phytosanitary standards. These tests mainly concern the detection of viable seeds or reproductive parts of plants. If other validated test methods for the detection of specified plant pests in treated biowaste exist, the product may also be tested for these pests. Product analyses should

be carried out on appropriate samples at least every six months (for facilities with a capacity of up to 3000 tons a year), or every three months (for facilities with a capacity over 3000 tons a year), at every composting facility. If the product is stored before sale or distribution, product analysis should be done at the end of the storage period. The number of samples to be tested per year varies according to the capacity of the facility according as follows:

1. for facilities with a capacity of up to 3000 tons a year, six samples;
2. for facilities with a capacity of 3000–6500 tons a year, six samples, plus an additional sample for every 1000 tons or part thereof over 3000;
3. for facilities with a capacity of more than 6500 tons per year, 12 samples, plus an additional sample for every 3000 tons or part thereof over 6500.

The number of samples can be reduced (by up to 50%) if an adequate level of indirect process supervision is maintained. If viable weed seeds or reproductive parts of plants are detected during product analysis, the number of analyses should be returned to the recommended level for at least one year before it can be reduced again. No viable weed seeds or reproductive parts of plants should be detected during this period. Samples of approximately 3 kg should be taken, each composed of at least five different sub-samples per batch of finished compost or anaerobic digestion residue. The test result is considered satisfactory if none of the samples contain viable seeds or reproductive parts of plants. The presence of any viable seeds or reproductive parts of plants is considered to be evidence of failure in the treatment process. See Appendix 1 for details of the test.

Fertilising Products Regulation

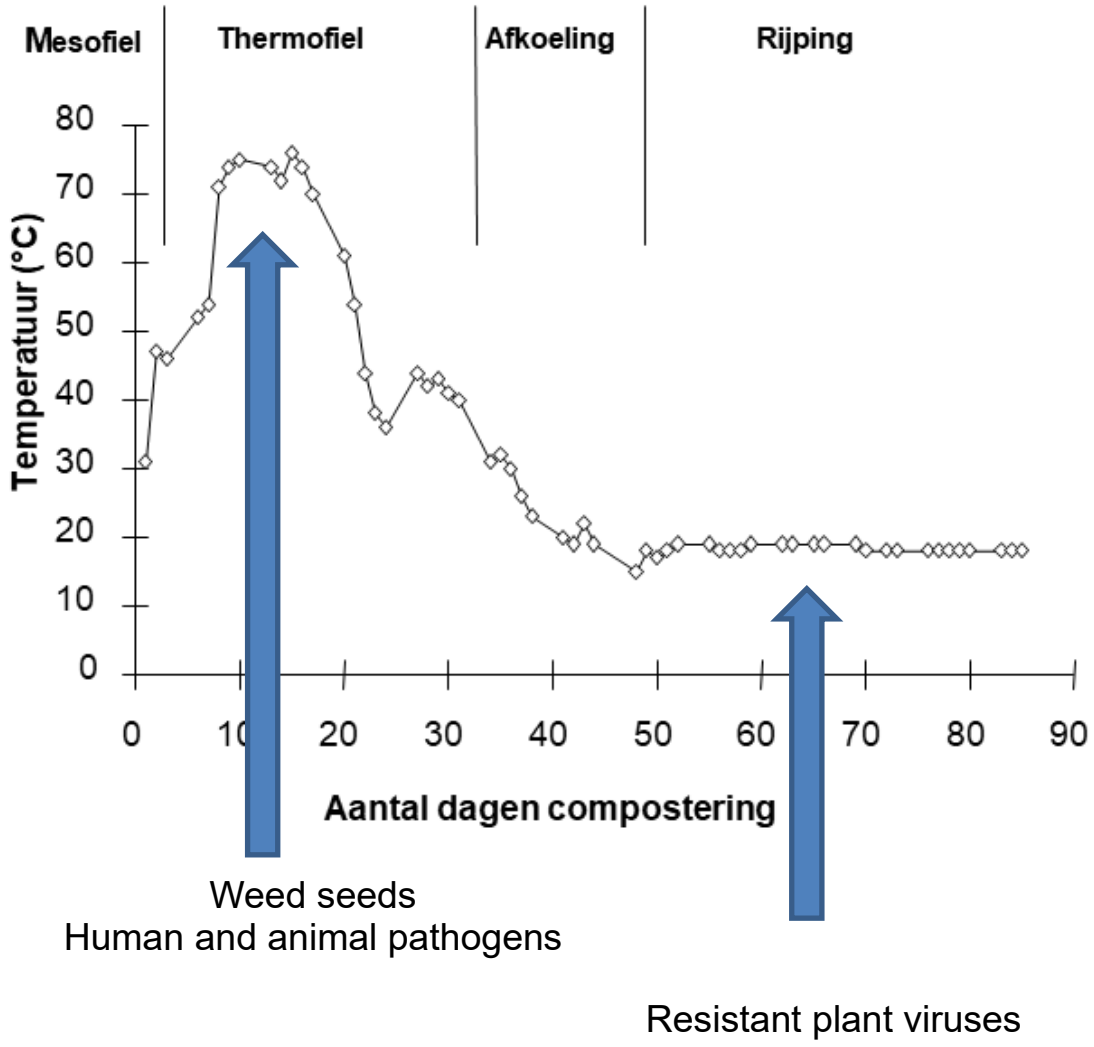
The EU is adopting new rules for bringing fertilising products on the EU market. The Council adopted a regulation which harmonises the requirements for fertilisers produced from phosphate minerals and from organic or secondary raw materials in the EU. These new rules will ensure that only fertilisers that meet high quality and safety EU-wide requirements and standards, can be sold freely across the EU. Manufacturers of fertilisers that can't be identified by the CE marking will still have the possibility of bringing them on their national market. The new regulation, which replaces the previous 2003 fertilisers regulation, covers all types of fertilisers (mineral, organic, soil improvers, growing media, etc.).

The aerobic composting will take place by controlled decomposition of biodegradable materials, which is predominantly aerobic and which allows temperatures suitable for thermophilic bacteria as a result of biologically produced heat. All parts of each batch shall be regularly and thoroughly moved in order to ensure the correct sanitation and homogeneity of the material. During the composting process, all parts of each batch shall have one of the following temperature-time profiles:

- 70°C or more for at least 3 days,
- 65°C or more for at least 5 days,
- 60°C or more for at least 7 days, or
- 55°C or more for at least 14 days.

Flanders: Vlaco QAS

General Regulation of the Certification of compost and digestate products, quality assured by Vlaco gives requirements for hygienisation. Those requirements for hygienisation of compost is based on direct process validation for elimination of many types of pathogens, including Tabacco mosaic virus. The research work was done by Dr. Ir. J. Ryckeboer: "Biowaste and yard waste composts: microbiological and hygienic aspects – suppressiveness to plant diseases".



The requirements for the different types of composting plants/materials are given below.

Green (waste) compost

The temperature during the composting phase is controlled and registered. For this purpose, all production batches are identified and followed during at least the mentioned minimum period for the treatment process.

For intensive green composting with short process time (< 4 months), the temperatures are measured and registered at least every week. For green composting with an average duration of > 4 months, the temperatures are measured and registered at least every 2 weeks.

At least the following process conditions are maintained:

- Minimum 10-week residence time at a minimum of 45°C, of which at least 4 consecutive days at a minimum of 60°C or 12 days at a minimum of 55°C (the temperature is measured at least daily in this thermophilic phase).
- At least 4 turning or other operations that mix the material and achieve homogenisation.
- Moisture control during composting.
- Moisture content should not be too low (depending on the organic matter content, the target is a minimum of 30-40% moisture during the first 10 weeks of the composting process, preferably even higher in the initial phase (45-55%).

All necessary steps are taken to avoid cross-contamination of composted material. In particular attention should be given to the use of different machines and instruments for handling non-hygienised material and marketable compost. In case of double use, thorough cleaning of the machines is essential.
The necessary registrations are carried out. The necessary documents are in place to demonstrate compliance with the above requirements.

Vfg-compost (fruit and garden waste)
The following requirements apply without prejudice to the process requirements as required in the delivered recognition for the treatment of certain animal by-products.

The temperature during the composting phase is controlled and registered. For this purpose, all production batches are identified and followed during at least the mentioned minimum period for the treatment process.

The temperatures are measured and registered at least every week.
At least the following process conditions are maintained:

- Minimum 6-week residence time at a minimum of 45°C, of which at least 4 consecutive days at a minimum of 60°C or 12 days at a minimum of 55°C (the temperature is measured at least daily in these thermophilic phase).
- At least 4 times of turning or other operations that mix the material and achieve homogenization.
- Moisture control during composting.
- Moisture content should not be too low (depending on the organic matter content the target is a minimum of 30-40% moisture during the first 10 weeks of the composting process, preferably even higher in the initial phase (45-55%).

All necessary steps are taken to avoid cross-contamination of composted material. In particular attention should be given to the use of different machines and instruments for handling non-hygienised material and marketable compost. In case of double use, thorough cleaning of the machines is essential.
The necessary registrations are carried out. The necessary documents are in place to demonstrate compliance with the above requirements.

Vfg-compost (fruit and garden waste) from digestion with post composting

The following requirements apply without prejudice to the process requirements as required in the delivered recognition for the treatment of certain animal by-products.

The temperature during the composting phase is controlled and registered. For this purpose, all production batches are identified and followed during at least the mentioned minimum period for the treatment process.

The temperatures are measured and registered at least every week.
At least the following process conditions are maintained:

- In case of thermophilic anaerobic digestion (>50°C): minimum 2 weeks thermophilic anaerobic digestion (>50°C) and minimum 2 weeks post composting at a minimum of 45°C, of which at least 4 consecutive days at a minimum of 60°C or 12 days at a minimum of 55°C (the temperature is measured at least daily in these thermophilic phase). In case of mesophilic anaerobic digestion: minimum 4-week post composting at a minimum of 45°C, of which at least 4 consecutive days at a minimum of 60°C or 12 days at a minimum of 55°C (the temperature is measured at least daily in these thermophilic phase). At least 4 turning or other operations that mix the material and achieve homogenization.
- Moisture control during composting. Moisture content should not be too low (depending on the organic matter content the target is a minimum of 30-40% moisture during the first 10 weeks of the composting process, preferably even higher in the initial phase (45-55%)).

All necessary steps are taken to avoid cross-contamination of composted material. In particular attention should be given to the use of different machines and instruments for handling non-hygienised material and marketable compost. In case of double use, thorough cleaning of the machines is essential.
The necessary registrations are carried out. The necessary documents are in place to demonstrate compliance with the above requirements.

Germany

Since 1989 the German Compost Quality Assurance Organisation (Bundesgütegemeinschaft Kompost BGK) is responsible for Quality Assurance of compost and digestate in Germany. This BGK organisation is the carrier of the RAL quality labels for compost, digestate, sewage sludge and sewage sludge compost. It is recognised by the RAL, the German Institute for Quality Assurance and Certification, as being the organisation to handle monitoring and controlling of the quality of compost, digestate, sewage sludge and humus products of sewage sludge in Germany.
In Germany considerable attention is directed towards the hygiene and sanitisation of compost. Harmful influences on human beings, animals and plants which may arise when compost is applied, should be eliminated during the biological treatment process. Three test methods are required by the Biowaste Ordinance for composting plants:

- The hygienic effectiveness of the individual composting procedure is determined by a process test.
- Indirect test criteria on hygiene effectiveness for a plant in practical operation is the daily measurement of the temperature during the hygienisation phase (>55 °C for more than 2 weeks, > 60°C for more than 6 days or >65°C for more than 3 days).
- The compost products are tested for absence of salmonellae and content of seeds.

UK

The Compost Certification Scheme (CCS) provides assurance to consumers, farmers, food producers and retailers that *quality compost* produced from composting processes is safe for human, animal and plant health. PAS 100, Publically Available Specification for Composted Materials, is a widely recognised standard within the organics recycling sector. BSI PAS 100:2018 is the current version of PAS 100.

Recommendations for the sanitization step

The sanitization step in a composting process serves as the CCP for minimization of risks associated with human, animal and plant pathogens [see 5.1.1 a) and b)]. Table B.1 provides recommendations for the parameters and Critical Limits that should be set, monitored and recorded. It is the responsibility of the composter to set Critical Limits for each sanitization parameter, as appropriate to characteristics and proportions of input material types, how the composting process is managed (including the composting conditions) and intended uses of the compost grade(s).
Processes that make compost entirely or partially from plant tissue biowaste/material should be assessed in terms of risks to plant health. Risk assessment should take account of plant pests and pathogens that could be present in the input materials.
Guidance is provided in the Food and Environment Research Agency's 'Code of practice for the management of agricultural and horticultural waste' [k], and the European and Mediterranean Plant Protection Organization's (EPPO) 'Guidelines for the management

of plant health risks of biowaste of plant origin' [l] (their recommendations might change following publication of the current review of management of plant health risks associated with processing of plant-based wastes, project PH0402 supported by the Department for Environment, Food and Rural Affairs, one of the outputs from which is the paper referenced [r] in the Bibliography).
The EPPO guidance recommends that where biowaste/material of plant origin is known or suspected to contain any "notifiable" (also referred to as "quarantine") plant pests or pathogens, the sanitization step and whole composting process should be authorized and supervised by the National Plant Protection Organization.

Temperature	Time [b)]	Moisture	Mixing/turning
65 °C	7 days	51 % mass / mass	Applicable if necessary in order to expose the whole batch to the recommended minimum conditions [9]. Number of mixes/turns as applicable to the composting system (incl. machinery)

Table B.1 – Recommended parameters and minimum crucial limit values for eradication of most pathogens during sanitization a)

a) Applicable to all composting systems, for all of the human- and animal-pathogens and most of the 60 plant-pathogens and nematode species reviewed [s] and subjected to bench- and commercial-scale trials [see reference [t], p 20, recommendation i)]. The plant pathogens the Table B.1 regime should eradicate include "club root" of brassicas (Plasmodiaphora brassicae), Fusarium oxysporum f.sp Lycopersici and Fusarium oxysporum f.sp Radicis-lycopersici. Conditions found effective for eradication of Plasmodiophora brassicae were 65°C with 51% m/m moisture for 1 day, and under other test conditions 60°C with 59% m/m moisture for 1 day [see reference [t], p 20, recommendation h)]..
b) The recommended minimum temperature and moisture should be maintained continuously over a period of 7 days. However, it is recognized that continuous monitoring and recording of temperature and moisture for 7 consecutive days will not be achieved where the composting process does not have a monitoring system that continuously records such data. It is also recognized that where monitoring procedures are carried out manually by staff who use equipment that takes discrete readings, monitoring is not carried out on any days when such staff do not work on-site (e.g. Sundays). Under those circumstances, proof that minimum temperature and moisture has been maintained continuously over a period of 7 days would not be possible. Thus, the composter should ensure that the CLs set for the sanitization step is clear and appropriate given the nature of the composting and monitoring systems.
c) In systems where the composting batch remains static, insulation or auxiliary heat might expose the entire composting batch to sanitizing conditions without mixing/turning. In systems that utilize batch mixing/turning, each mix or turn should be carried out after the batch has been exposed to Table B.1's recommended minimum

temperature and moisture conditions over a period of 7 days. However, it is recognized that some composting systems might rely on more frequent batch mixing/turning in order to move composting material through the sanitization step.
For systems composting ABPs inputs, the regime in Table B.1 can be integrated with, or enhance, the sanitization regime for human and animal pathogens in the approval from the competent authority. To maximize sanitization performance, thermophilic temperatures should be maintained between 45°C and 80°C and moisture should be maintained at least at 40% mass/mass throughout the subsequent stabilization step.

The Netherlands

The Environmental Activities Degree ('Activiteitenbesluit') also specifies that anaerobic conditions are not allowed in the composting process within facilities (that does not apply to the pre-digestion of household waste for biogas production) and that facilities have to turn over the material as often as required to prevent anaerobic conditions.
Today, most compost in the Netherlands is certified under the Keurcompost standard (www.keurcompost.nl). Keurcompost is a voluntary industry standard, containing requirements which go beyond legal requirements. The requirements are enforced by independent third party audits and accredited auditors. Keurcompost requirements are on processing (time-temperature) in particular, quality management, and on impurities standards in compost (differentiated between glass, stones and others). These requirements have been set in collaboration between the composting sector and organisations representing the agricultural food industry (agriculture and processing industry), in order to meet the industry's strict food safety requirements. Keurcompost scheme management is executed jointly by BVOR and DWMA (contact details below). Members receive a yearly Keurcompost certificate after a successful audit, which is updated in an online, public registry.

Green compost

The control of the process conditions must be carried out by measuring the temperature in the compost. The temperature of the composting material must demonstrate at least two periods of three consecutive days over 60ºC. Between these two periods of measurements, the material must be turned.
The two periods of three days, in which is measured may be freely chosen, as long as between these periods there is a conversion. Shredding and sieving are not considered converting.
This can be demonstrated as follows:
1) The producer has to implement batchwise composting to prove sanitisation and has to measure the temperature at the beginning and at the end of a period of three consecutive days. When the temperature at the beginning and end of the period of three days is 60°C or above, it can be assumed that this was the case during the entire period of three days, on the condition that the batch has not been converted during this period. For each batch, at least four temperature measurements are required: at

the beginning and at the end of both of the three-day period. More temperature measurements are recommended.
2) Registration of temperature measurements (batch, date, temperature measurement and transaction date) in printed or digital logbook.
In addition, the composting material during the overall composting process should at least be turned three times. Batches and dates of conversions must be recorded in the logbook.

The combination of temperature requirement and a minimum number of conversions guarantees that all the composting material has received a temperature above 60 ºC for the required period, which demonstrates effective hygienisation.

Vfg-compost
The composting sites for composting vfg-waste must have an approval according to the Animal By-Products Regulation (Regulation (EC) Nr. 1069/2009). The requirements for the treatment facilities are described in Regulation (EU) 142/2011. The certified location needs to describe the process flow.
Process requirements for the composting of vfg waste to ensure that the compost is free of plant pathogens and weed seeds is a minimum of 3 days at 55°C.

Greenwaste compost for growing media application
At least the following process conditions are maintained: 14 days of minimum 55°C.

Denmark

In Denmark there are 2 different types of composting plants:

- Biowaste[2]
- Greenwaste[3]

The executive order on the use of waste for agricultural purpose (https://www.retsinformation.dk/Forms/R0710.aspx?id=202047#id50b1f0b6-fb4c-426d-b496-4148ab4cb7be) establishes the extent to which waste can be used for agricultural purposes without harmful effects on the environment, people, plants and animals. Composted and not-composted garden and park waste can be used for agricultural purposes without prior permission.

[2] In most cases composting of biowaste (garden waste, fruits and vegetables, …) is without animal by-products. Till 2023 wet waste must be sorted out and will be treated in anaerobic digestion. Compost from biowaste: farmers must charge 20% of the applied total N, whereas 100% of the P has to be taken into account.
[3] Farmers should not charge N and P. In the short term future the farmers will be charged for P by a 100 % in accordance with bio-waste compost, but won't be charged for the N.

For composted biowaste there are maximum concentrations for heavy metals and organic pollutants (annex 2). The analysis values must comply with the limit values. Regarding the last 5 analyses, the results from at least 75% should be below the limit values. However, no analysis results may exceed the limit value with more than 50 %. If an analysis result exceeds a limit value with 0 - 50 %, a new sampling and analysis must be carried out immediately.
When mixing several waste types, each individual waste type must be tested before mixing to determine whether the limit values are complied with. No dilution is allowed.
There are also limit values for physical impurities in the pre-treated biopulp (input for composting or anaerobic digestion, impurities >2 mm max 0,5 % by weight/dry matter, plastic content particles larger than 2 mm max 0,15 % by weight/dry matter and 1 cm^2/% dry matter measured in 1 liter of biopulp) and for compost (max. 0,5 % by weight/dry matter).
Annex 3 gives the hygienic requirements for the different types of waste. For biowaste controlled composting is required for agricultural application.

Controlled composting: composting with daily temperature measurement, so that all waste is subjected to a temperature of at least 55°C for a minimum of 2 weeks. The treatment must be documented in the form of registered temperature measurements.
In the legislation to get a permit for composting there are also minimum requirements for turning, treatment time, ...

Questions about sufficient hygienisation for Potato cyst nematodes (Globodera pallida and Globodera rostochiensis)

Horizontal - Hygienisation (chapter 5.4, Nematodes)
Nobel and Roberts (2004) found that all seven nematode species affecting plants studied during composting were eliminated within 1 day at temperatures of at least 52 °C. These were:

- *Globodera pallida*
- *Globodera rostochiensis*
- *Heterodera schachtii*
- *Meloidogyne hapla*
- *Meloidogyne incognita*
- *Meloidogyne javanica*
- *Pratylenchus penetrans*

However, some cyst-forming spp. such as the beet cyst nematode (*Heterodera schachtii*) has the ability to survive in compost at lower temperatures (31°C) for long periods (Ryckeboer *et al*. 2002b). All nematode pests are expected to be eliminated during well managed composting processes under quality standards (e.g. BSI PAS100).
Globodera pallida and Globodera rostochiensis
The lethal temperature for potato cyst nematodes (PCN) in sugar beet compost has been determined as 40 °C for 10 days or 50 °C for 5 days (Nishinome *et al*., 1996). PCN was also killed in potato processing sludge below the lethal temperature at only 34 °C, probably due to toxicity of the sludge (Bollen, 1985). However viable PCN cysts have been recovered from sewage sludge after anaerobic digestion although populations were reduced (Turner *et al*., 1983). Similar studies by Catroux *et al*. (1983) showed that almost 100% of the cysts of *G. rostochiensis* and *G. pallida* were killed during anaerobic sewage digestion; composting with temperatures rising to more than or equal to 40 °C also killed most of the cysts whereas aerobic digestion destroyed only a small proportion of the cysts. Live cysts could survive up to 3 months of storage in the outer layer of sludge. In limed sewage sludge at pH 10 or more, the cysts were killed in 14 days.

➔ no risk with Time/temperature diff regions

WRAP PAS 100/2011:
[s] NOBLE, R., and Roberts, S.R., *A review of the literature on eradication of plant pathogens and nematodes during composting, disease suppression and detection of plant pathogens in compost*. Horticulture Research International, Wellesbourne. Published by the Waste & Resources Action Programme, Banbury, November 2003, ISBN 1-8-4405-062-9.
http://www.wrap.org.uk/sites/files/wrap/LitReviewPlantPathogensNematodes.pdf

[t] NOBLE, R., Jones, P.W., Coventry, E., Roberts, S.R.,Martin, M., and Alabouvette, C., *Investigation of the Effect of the Composting Process on Particular Plant, Animal and Human Pathogens known to be of Concern for High Quality End-Uses*. Warwick HRI (Wellesbourne), BBSRC Institute for Animal Health (Compton) and UMR INRA-Université de Bourgogne (France). Published by the Waste & Resources Action Programme, Banbury, December 2004, ISBN 1-84405-141-2. http://www.wrap.org.uk/sites/files/wrap/InvestigationOfTheEffectofTheCompostingProcess.pdf

Fate of Potato Cyst Nematode Globodera rostochiensis During Composting
Compost Science and Utilization (2006), Vol. 14, No 2, 142-146 A. Bøen,B. Hammeraas,C. Magnusson &R. Aasen
Effects of composting on survival and reproduction of the potato cyst nematode (PCN) Globodera rostochiensis were investigated in 150-liter pilot scale reactors. Small bags containing cysts of PCN were incubated in organic waste and composted for 8, 15 or 29 days. Temperatures in the areas close to the cyst bags were monitored. Survival, measured by hatching, was reduced by 99.9% already after 8 days of composting and at 29 days no hatching was recorded. A few eggs, however, still hatched after being composted for 15 days and exposed to temperatures higher than 60°C for several days. Maximal temperatures and thermal exposure time as such could not explain the hatching pattern of PCN, so other factors are likely to be involved in causing lethality. PCN failed to reproduce after 8 days of composting with temperatures reaching a minimum of 50°C during the period. Hence, eight days of composting where all material have reached a temperature of minimum 50°C during the period, could be regarded as a satisfactory method for sanitation of PCN.

➔ **Turning and humidity control are also important**