Model Composting Plant

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I Basic data

The decision, to collect compostable waste separately in the whole district and treat it in a composting plant was met end of 2007 as part of a general economic master plan of *Muster*. The concept included measures of waste prevention and waste recycling which helped to reduce the total annual waste produced in the district from 248, 000 tons to 72,900 tons. The remaining quantity is treated thermally in a combined heat and power plant for residual waste.

Part of the waste recycling measure was to promote self-composting for which financial aid was given for obtaining composters and compost laying.

However, since not all households had the facility for self composting to prevent waste, the district authorities decided to collect organic waste separately for a year as an experiment and to compost it in a bio-waste composting pilot plant. This was called “Campaign bio-waste container.”

1 The campaign „Bio-waste container“

1.1 Objectives

The attempt to collect organic waste and to compost it in a pilot plant had the following objectives:

- Testing publicity measures in preparing the citizens for a system of waste separation and collection.
- Assessing the citizen’s willingness to participate in separate collection of organic waste, with the help of opinion polls and by determining the percentage of waste disposed in the wrong container as well as the development during the testing period.
- Producing compost from separately collected organic waste and chaff and determining the process and quality features. Choice of suitable collecting systems for the separate collection of organic waste.
- Assessing odor emission at the location of the collecting bin for organic waste.
- Ascertaining basic data for calculating costs for the introduction of the system on a larger scale.

1.2 Location of the experiment

A residential area was selected as the location for carrying out the experiment. The residential area showed most of the settlement features commonly found in the district of *Muster*. Apart from row housing and high rise buildings there were also a number of one-family detached houses both closely constructed as well as far apart. The residential structure comprised of 16% one-family houses, 48% apartment houses, 11% two-family houses and 25% row houses. There were 1,002 private households with 2,628 inhabitants with a balanced population structure.

The residential area was suitable for the experiment as the diversity in the house constructions and the population structure could be regarded as representative for an urban residential area in the district of *Muster* to a large extent. Thus it was possible to transfer the results and the experience gathered from the experiment of separate collection and recycling of organic waste to other areas in the district as well.

The complete experiment was carried out in four steps:

- Informing and motivating the citizens in the test area,
- Collecting and composting the organic waste,
- Inspection of the composting procedure from the quality of the compost on the basis of biological and chemical analysis and tests on plants,
- Checking the environmental compatibility by analyzing the ground water and the surface water flowing from the area the compost was used as well as assessing other emissions e.g. odor, noise.

1.3 Collection, Transport and Costs of bio-waste collection

In addition to containers for residual waste separate containers had to be provided for collecting organic waste. The bio-waste is directly placed in the container, and it is recommended that a relatively dry, structure rich material is used for the bottom layer in order to avoid anaerobic conditions in the container itself.

The weekly emptying of the bio-waste containers was an addition to the weekly emptying of house-hold waste containers and therefore considerably more costs and efforts were necessary for collection and transport.

One driver and four workers had to be additionally employed for 4 hours per week for emptying the bio-waste containers and transporting the waste. In addition to this there was also a certain percentage of extra administrative work which has to be taken into account.

A compactor garbage truck was employed for collecting bio-waste. Since the quantity of bio-waste was small there were no problems e.g. the water that was squeezed out during the compressing process was negligible. This disadvantage cannot be ignored for larger quantities and higher compacting pressure.

Therefore a truck with a revolving drum would be an advantage, which however, is seldom used by waste disposal companies. These vehicles have the advantage that the compost-raw material is mixed well during the collection. The positive effect of homogenization is an advantage to the subsequent decomposition process.

It was intended to use a truck with a revolving drum in the further course of the test.
The costs incurred for the collection and transport of bio-waste was approx. 50,000 € annually. Taking an average of 4 Mg bio waste/week (at the time the costs were calculated), it was deduced that the collection and transport would be about 200€/Mg.

1.4 Publicity work during the experiment

The success of separate collection of organic waste considerably depends on the information provided to motivate the citizens. Raising the awareness of the citizens through the press, radio and television are important publicity media. Apart from this it is also important that the citizens are given specific help and information at the local level.

Objectives of publicity work are:

- Maximum separate collection of possibly pure bio-waste,
- Spread information,
- Help while implementing the concept,
- Create and develop communication between the citizens and public authorities,
- Accept criticism, and integrate the wishes and suggestions of the citizens. A

The district of *Muster* has employed the following means to succeed in their objectives:

- Information prior to the experiment,
- Interviews with the local radio,
- Presse release and reports in the communal bulletins and the local section of newspapers, Personal contact to the participants in the experiment,
- Publicity events in the experimental area,
- Prepare and conduct projects in Kindergartens and schools in the experimental area through a „waste counselor“
- Detailed information in the bio-waste brochures,
- Intensive waste counseling on location through the test-supervisor,
- Telephone-counseling,
- Guided trips to the composting plant for interested citizens,
- Campaigns by local clubs, especially in rural areas as this usually has a strong multiplier-effect.
- Conduct an „open-day“, on which compost produced from bio-waste is distributed free of charge with recommended use.

Direct counseling was without a doubt the main focus of publicity work. Very often misunderstandings could be cleared and vague information clarified in a direct talk.

In addition to this the experiment also showed that not all the possible publicity measures should be used at the same time. It is better to work with a few, well prepared and well worded information material. On the whole it was proved that a continuous publicity played a decisive role on the success of the “campaign bio-waste container”.

1.5 Mass balance

In relationship to the degree of decomposition and other criteria, it was possible to produce three different kinds of compost according to general definitions:

- Fresh compost: is sanitized but contains a number of easily and not easily degradable organic substances. It is usually won after preliminary decomposition. Fresh compost is altogether rich in nutrients, but can be used only to a limited extent owing to the strong degrading processes. .
- Ready compost: is a sanitized and to a large extent completely decomposed compost won after the main decomposition. It is not so rich in nutrients as fresh compost and the application is considerably uncomplicated subsequent to the higher degree of maturity
- Ready compost: won after maturing phase. It is characterized by the clearly advanced mineralization. Not only is the nutrient content a special property but it is also rich in humus and the life forms that contribute to the formation of more humus.

The mass balance for the 38 weeks of experimenting is shown in the following:

Composting about 154 tons of bio-waste mixed with about 103 tons of green-waste chaff produced approx. 129 tons of compost. 13 tons of the residue after screening was included in the composting process as so-called mattresses. The decomposition- loss was therefore approx. 115 tons.

1.6 Costs for the „Campaign bio-waste containers“

The estimation and calculation of the total costs for the “Campaign bio-waste containers” was done taking known marginal conditions for a period of 2 years.
Local characteristics of the collection area (e.g. the location of the composting area in the water protection area III involving larger earth and basis sealing work, the large extent of drainage and the construction of a retention basin) considerably increased the total costs of the tests.

Other additional costs were those for the housing, infrastructure, collection, transport, composting and publicity work.

List of costs for the pilot plant and the „Campaign bio-waste container“.

Construction costs	200,000.00 €
Publicity work	10,000.00 €
Collecting containers	5.000,00 €
Transport incl. windrows	45.000,00 €
Operating the composting plant :	
Composting	10.000,00 €
Implementation	13.000,00 €
Screening	3.000,00 €
Analyses	3.000,00 €
Total costs	**289.000,00 €**

1.7 Summary of the results

The „Campaign bio-waste container“ was a great success.

As a consequence to the intensive publicity and the high degree of motivation resulting from this, the separation of organic waste was conducted by the participants in a very disciplined manner enabling the production of a compost of very good quality. The percentage of impurities and foreign matter was far less than that in comparable projects. Subsequently, there was very little heavy metal pollution in the compost.

In addition to technical and organizational duties a very intensive preparatory as well as accompanying publicity work was necessary in order to produce compost minimized of harmful matter with very little technical effort. The voluntary participation in the “campaign bio-waste container” project was certainly an important requirement for strong motivation and cooperation of the participants, and the good sorting quality with very little foreign matter and impurities in the bio-waste.

Inspection of the bio-waste collector showed that all the desired conditions such as minimized odor development and flies, the quantity of bio-waste to be transported and the water content in the bio-waste were not to be found in any of the inspected containers.

The participants were able to manage with the containers provided and the volume specified by the district authorities also proved to be sufficient in spite of this. The odor nuisance, which is a deciding factor for the acceptance of the collecting procedure turned out to be very little.

The amount of organic waste produced in the area tested was subject to considerable seasonal fluctuations. The amount of organic waste from kitchen waste only was almost 2 to three times in the summer and the autumn months than in winter. This showed that the transport would have to be organized in a flexible way if an area wide collection of organic waste was to be economical.

A collection and transport frequency of once a week together with residual waste proved to be the ideal.

The objective of recycling as much organic waste through composting was reached with an average collected quantity of about 1.9 kg/unit and week. It was thus possible to reduce the residual waste by approx. 30% which proved that the separate collection and recycling or organic waste was an important building block in the waste management concept of the district in more ways than one.

Personal dialogue with the citizens e.g. house visits, questionnaires, inspection of the containers etc., a press release in the communal bulletins and daily newspapers as well as the distribution of information brochures demonstrated a strong publicity work adapted to local interests and which was very positively evaluated by the participants.

2 Introducing separate collection of bio-waste district wide

After the bio-waste had been separately collected and composted in the test area, the municipal authorities decided to introduce the system district wide and to then treat the waste to compost in their own composting plant at *Muster.*.

The population of the district was recorded at approx. 200,000. The amount of compostable material expected and which the plant was built to treat was approx. 18,350 yearly. According to the planned approach this was

13,113 Mg	compostable matter from households,
5,037 Mg	green waste in barrels from the municipal waste collecting points,
200 Mg	fruit fermentation residue

The construction will be completed according to schedule and the composting plant *Muster* could go into operation on April xxx. The operation of the plant and marketing the compost will be done by the waste management company.

This was the bio-waste disposal option for a section of the district of *Muster*. Other areas had to use other composting plants owing to limited capacity.

2.1 Separate transport of compostable matter

Compost-barrels will be provided in the respective quarters with the start of operation of the composting plant.

The compostable matter will be collected fortnightly, alternating with residual waste collection.

2.2 Composting points for waste from tree cuts and trimming hedges

The operation of composting plants for waste from tree-cuts and trimming hedges was handed over to a commercial enterprise for the whole district.

Before the contract was placed, the new conception of collecting, chaffing and composting points were to be implemented. 34 collecting points were available in the whole district for green waste especially from tree-cuts and trimming hedges, operated in cooperation with the waste management company and the municipal and communal authorities. As a consequence to the precise requirements specified by the water management and soil protection authorities, the super structure and sealing of the operating areas of the green-waste collecting and composting facilities of the corporation and municipalities as well as the district had to be modified accordingly.

The investment made by the corporation and municipalities, for the proper operation of the public collecting facilities and the composting facilities to be built was subsidized by the district authorities.

Subsequent to the introduction of compost-barrels and the recycling of compostable matter, a large percentage of green-waste (mainly from tree-cuts and hedge trimmings) was required as bulking material for the composting plant. In order to make the material available, the very effective system of placing the containers for green waste close to where it was produced was continued and the waste from tree-cuts and hedge trimmings not required by the composting plant was treated in the green-waste composting facilities of the district. The 34 collecting and chaffing locations were to be used as follows:

2.3 Green-waste collecting points of the corporations

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The corporations and municipalities provided facilities for collecting green waste in their areas and kept these open as long as possible that is at least 2 weeks in the spring and two weeks in the autumn of each year. Unlimited quantities of green waste from private households could be brought to these collecting facilities but from commercial and public institutions only a quantity of 1 m³ was permitted from the time the composting plant started operation.

Most of the municipal facilities continued as collection stops for green-waste and were available for accepting and crushing green-waste. The mulch that was not treated immediately (collected) was transported to the compost plant or to a green-waste composting plant in the district and treated there. The compost thus produced was then provided to the citizens at the collection stops.

The collection and chaffing areas were provided with a stable crushed stone road so that supply, operation and transport vehicles could be driven there at all times of the year, even in bad weather. In addition to this the surface of the area was to be profiled according to the characteristic of the surroundings so such that precipitation water could be drained systematically i.e. long „standing water“on the surface could be avoided.

In order to prevent leachate polluted with organic matter and to avoid the hazard of ground water contamination, no cut grass or leaves and other compostable material was accepted here. For the same reason, the delivery of agricultural waste in the form of residual waste from harvests was also exempted.

If required the collecting stops were to be fenced in and the delivery of green-waste monitored in order to prevent the accumulation of house-hold waste or other exempted material.

2.4 Green waste composting facilities of the corporation

Several centrally located collecting stops were provided and operated in the district.
The green waste was collected from the land-marked municipalities and composted. Apart from this the green waste chaffed in other public collecting points and was not required in the composting plants was also delivered and recycled.

In order to avoid possible hazards to the ground water, infiltration of leachate into the ground water and surface water had to be prevented.The composting areas had to be provided with a basis seal (asphalt, concrete) for this.The waste water that collected was to be continuously drained into a canal or discretely collected in a catchment basis and then transported to a purification plant. If applicable, the collected water could be used for humidifying the compost windrows.

2.5 Green waste composting plants of the rural district

At the rural landfills, new collecting stations and composting facilities were constructed in which green waste that was delivered and green waste from public waste transport as well as surplus mulch or chaff material from the municipal collecting stations could be composted. Additionally treating leaves and grass in the newly constructed green-waste composting plant had to be stopped due to odor nuisance.

2.6 Transport of green waste

Public waste collectors have since long been collecting and transporting green-waste four times a year at the time when trees and hedges are trimmed.

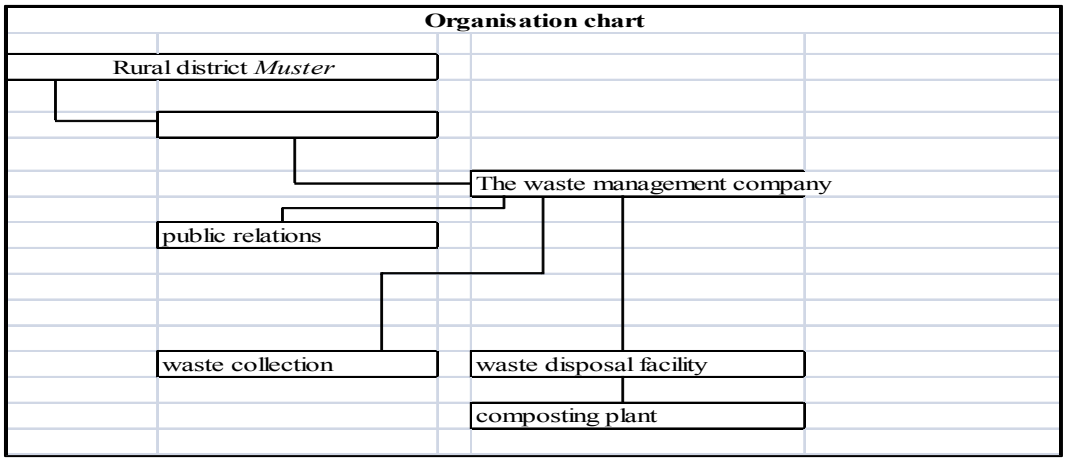
II Composting plant *Muster*

View of the waste delivery hall

1 General

1.1 Preliminary note and und organization chart

The facility for composting bio-waste and green waste is operated by the rural district authorities of *Muster*. The organic waste collected in the southern area of the district is composted here.



1.2 Description of the location

The composting plant *Muster* was built in xxx. The area of the plot covers 18,760 m², the area under roof 10.939 m², not built-up area 7,821 m², the net ground-plan area 7,275 m² and the gross capacity 77,878 m³.

2 Procedure

A special procedure with following functional groups is taken as the basis for this composting plant:

- Acceptance and treatment.
- Main decomposition (decomposition hall).
- Fine treatment.
- Maturing phase.

2.1 Acceptance and treatment

2.1.1 Receiving point

At the receiving point, bio-waste and bulking material are stored term as reserve charge for the processing. The bio-waste transport vehicles are unloaded in a corner of the building on to a transfer station. South of this storage space is the receiving point for chaffed bulking material.

The charge for the treatment is fed in by the feeder. He specifies the proportion of the bio-waste and the bulking material. The quantity of bulking material is directly proportional to the moistness of the bio-waste. The feeder also has to take care that no inadmissible large components are present in the charge. The bio-waste is loaded on a conveyor in the pit with the help of a wheeled loader.

A bunker attachment provided on this conveyor enables the material to be introduced on the longitudinal side by means of the wheeled loader. The speed of the conveyor can be regulated between 0.05 m/s and 0.5 m/s, so that the material to be composted can be fed as required for the treatment. Conveyors for which the speed is not specified run at a constant 1 m/s.

2.1.2 Processing hall

The processing serves to manufacture the material that will be composted. The mixture of both the material flows from the bulking material and the bio-waste forms the end of the processing. The bulking material is not treated prior to mixing. The size reduction required for composting is done at the chaffing points.

The bio-waste is treated prior to mixing. It is classified into two different material flows: sieve underflow (<60 mm) and sieve overflow. The top third of the revolving drum is fitted with sack ripping so that possible bags in the material flow can be opened. The revolving drum has a diameter of 1.600 mm and an effective screen length of 5,000 mm. The revolving drum is tilted by 5° to the horizontal. In order to prevent possible accumulation of dust, the drum is fitted with a detachable enclosure which is exhausted in the outlet box.

The scrap iron is separated from the screen underflow before the material flow is fed to the mixture. The iron parts are collected in a container via a chute. The impurities are first manually sorted from the screen overflow, then the scrap iron is separated and the bio-material reduced to a size of max. 100m feed size. The separated impurities are deposited as residual waste whereas the scrap iron is given for scrap trade.

The bulking material, the return fines from the fine treatment and possibly received rape are fed on a bin stoker. The bulking material is variably proportioned by the conveyor speed of the stoker in the range of 0.05 m/s to 0.3 m/s. The material flowing out of the stoker is conveyed to the mixing drum together with the fines of the drum screen and the crushed screen overflow.

Fig. 2: Manual sorting

The material flows mentioned above are homogenized in the mixing drum at a dwelling time of at least 30 minutes and moistened if required. A platform is fitted in front of the inlet chute to enable a visual check of the influent and the extension of which serves for servicing the driving station of the conveyor belt at the same time.

Fig. 3: sieve drum **feed stock in the bunker**

2.2 The main decomposition

Composting is a biological process which according to the procedure applied would be windrow composting with forced ventilation.
The material mixture is transported to the decomposing hall and transferred to the automatic feeding system. The conveyor transports the raw compost to a belt located below it, that is operated with a bridge such that a continuous loading of the upper belt lying on the bridge is possible. This belt transports the load to a parallel belt lying below it, which is reversible and displaceable.

The windrows are erected on five segments of the decomposition floor. Each segment is provided with its own air flow duct for ventilating the respective windrow. The air from the hall is drawn in through the windrow and the ventilation slots in the floor and air ducts. The waste air from the air ducts is released into the atmosphere after blowing over a bio-filter for deodorizing.

Fig. 4: bin charger **revolving drum**

With the help of a feeding bridge the first windrow of 15 m x 25 m x 3 m (max.), is evenly filled in layers of 30 cm to 40 cm.

8 windrows are attended to on five aerated segments. After five days, the last windrow located in the last position is conveyed to the fine processing. The last position is therefore vacant and windrows can move up one position.

Fig. 5: Feeding bridge **Transfer bridge**

For this the bucket wheel of the transfer bridge is driven 10 cm into the windrow and cuts a horizontal strip of the decomposing material. This material is then transferred to the belt-system arranged behind the bucket wheel and again settled. The automatic volume control is ensured by the movability of the lower belt.

The aeration floor provided in the decomposition hall is constructed according to the BIOKOVENT system. The individual stones are laid form-fit in an interference fit assembly without the use of compo. Each stone is 20 x 15 x 20 cm. A foil for sealing and a protective membrane is laid between the concrete floor and the aeration stones.

A wood-chaffing layer is placed on the aeration stones for fulfilling two functions:

- Leveling the inclination of the decomposition panel for the transfer,
- Preventing decomposition material from the aeration slits.

When the chaff material is decomposed, it is exchanged with fresh material.

The forced ventilation windrow composting was realized for 5 composting fields operated separately. The decomposition process is regulated by the temperature gradation in the windrows during the decomposition process. For these different temperatures are required for the individual segments as the optimum process temperature drops with composting time. The process temperature is measured in the exhaust air.

Temperatures (desired value) in the segments:

1. Segment	**65 ° C**	**to**	**75°C**
2. Segment	**60 °C**	**to**	**70°C**
3. Segment	**50 °C**	**to**	**60°C**
4. Segment	**30 °C**	**to**	**40 °C**

The aeration of the windrows can be regulated with relation to the temperature in the range

0 m³/m²/h to 45 m³/m²/h.

As a consequence of the transferring, the material passes through all the five aeration elements. An O2 measurement in the suctioned airflow of windrow regulates the rotting process simultaneously.

The respective desired temperature values are controlled by the regulator of a shutter, which varies the suction capacity of the windrow ventilation as required in order to prevent a „cold blowing" of the compost. A parallel shutter additionally allows the suction of ambient air to a total amount (ambient air + windrow suction) of 18,300 m³/h per segment. During the transferring process, the amount of air in the aeration segment lying below is regulated to almost zero as the desired temperature value in this operating condition is not possible.

The air suctioned out of the decomposition hall is channelized over a humidifier for exhaust air to ensure a moisture content >95 %. These humidifiers are fitted with circulating pumps that realize a water circulation of 20 m³/h in the internal water cycle of each humidifier. Approx. 300 l/h evaporates in the exhaust air per humidifieer.

As the injected water binds a part of the dust present in the air current, about 600l/h of water is repelled. An equal amount of water is again supplied to the humidifier from the waste water basin. A biofilter deodorizes the exhaust gas before it is released into the atmosphere.

The compost that leaves the main decomposition is termed fine compost. This compost is then treated to matured compost.

2.3 The fine treatment

Three days a week, the compost from the decomposition hall is transported for fine treatment on conveyor belts. Platforms accessible by ladders are installed at the transfer points to enable the servicing of the taughtening i.e. the driving stations of the conveyor belts. The transport belts are covered in the outside section to exclude environmental influences from the composted material. In the fine treatment, the material is placed on a special sieve inclined at about 23° and having a screening surface of 7.56 m² and screened to 20 mm on easily

changeable plastic sieve mats.
The sieve overflow is transported by a conveyor belt to a collector. This material is either taken to a landfill or fed back return material for processing.

The fine compost is collected on a conveyor and fed into a hard solid trap. A conveyor belt is arranged over the four sorting tables of the hard solid trap so that all the sorting tables are evenly loaded.

Fig. 6: Special sieve

On the sorting tables, each of supplied with a fan, the hard solids are separated from the fine compost. The sorting section is inclined towards the compost discharge. The hard solids are transported from the conveyor into a container. The compost is channelized to the maturing phase.

Abbildung 7: Hartstoffabscheider

The amount of air required to operate the hard solids trap is regulated at the head of the trap and led to a bag filter over an air pipe, purified and recycled into the process.

A fractional amount of about 5 000 m³/h is fed to the filter together with the waste gas. The hard solids trapped in the filter (fine compost, foils) are separated on a conical drum sieve. The sievings and the mature compost are transported to the curing phase. The sieve overflow and the hard solids are collected in the container.

The fine treatment is provided with a separate ventilation unit. Fresh air from the outer section enters the hall through the after flow openings in the walls. The air from the hall is suctioned over a ridge ventilator and reaches the biofilter fitted in the curing section over a bag filter. The suction fan of the sieve shaker is connected to the exhaust of the hall. 13 300 m³/h

air is fed to the bio filter while operating the fine treatment.

2.4 The curing phase

Till it is collected, the mature compost is piled to 3 m high windrows to save space. The storing time is used for curing.

III Instruction manual for the composting plant at *Muster*

The instruction manual for the composting plant Muster presented here can be generally understood as the description, illustration, and implementation of information and documentation requirements as specified in different waste management guidelines for waste disposal facilities.

Instruktion Manual:

- Includes measures for the normal operation, maintenance and system malfunctions (operating plan)
- Is to be coordinated with the alarm plan and plans for measures.
- Includes duties and areas of responsibilities for the staff, work instructions, controlling and service measures.
- Specifies reporting, documentation and safe-keeping requirements.
- Is to be update.

1 Mass balance

Log books are available at the *Muster* composting plant in which the quantities of material delivered and the quantities leaving the composting plant are to be recorded:

- Bio waste delivered,
- Delivered bulking material,
- Material directly delivered,
- Impurities (manual sorting, sieve overflow, metal, hard solids),
- Compost produced

2 Operating instructions

2.1 Implementation

The normal implementation cycle, provided there are no malfuncitons is as follows:

- Monday morning : Servicing the turning device,
- Monday afternoon, Tuesday and Wednesday: Discharge after fine treatment, parallel to this incorporate the first windrow
- Thursday, Friday, Saturday and Sunday: Change over the windrows, wet the windrows.

2.2 Determining the water content, wetting

A material sample is to be taken daily at the *Muster* composting plant in order to determine the water content immediately after the mixing drum. This intended to estimate the water content in the material entry windrow.

While the material is lying in the decomposition hall, another sample is taken 2 days before it is transferred. In order to determine the actual water content of the windrow just prior to transfer, experience showed that it was necessary to decrease this water content around 4%. To test whether the desired water content was reached, sample is taken from another windrow after transfer. The windrow delivered to the fine treatment hall is also to be inspected.

Determining the water content
In order to roughly estimate the water content of a windrow, three different samples are taken. One is taken 2m from the top, then from the middle and the last sample 2 m from the bottom. The average from the three samples is taken as the water content of the windrow.

The weight of the sample should be 350 g and should be taken from a depth of 1.50m of the windrow. This sample is then placed in a drying chamber at 100°C for 24 hours and subsequently weighed. The difference in weight will give the water content of the sample.

As the material lying in the centre of the windrow is not uniformly moist, determining the water content by the method described above is not accurate and as the plant manager has been doing it for a long time, he is experienced enough to estimate the water content. Therefore these samples are not analyzed anymore. Alternative practical methods are feeling with the hand and visually estimating the water content.

Wetting

The desired values for the water content of each windrow are specified as follows:

Windrow 1	Windrow 2	Windrow 3	Windrow 4	Windrow 5	Windrow 6	Windrow 7
60%	**60%**	**60%**	**55%**	**50%**	**45%**	**40%**

Formula for calculating the amount of water to be added:

X : Weight of a windrow (Mg)
Wak : Actual water content (prior to changing over)
Wwü : desired water content (after changing over)
WZG : water to be added in m³

It is:

X x Wak + WZG / (X + WZG) = Wwü
X x Wak + WZG = Wwü x X + Wwü x WZG
WZG x (1 – Wwü) = X x (Wwü – Wak)

WZG (m³) = X . (Wwü – Wak) / (1 – Wwü)

Formula for the feed and für den Vorschub und die Umsetzzeit des Umsetzgeräts:

Feed = Windrow width x 0,0025 x 311 / (2 x WZG x 100)

0,0025 (m³/s) the set flow of water at the valve
311 (s) time required by the transfer device to make two transverse drives

Time = Width of the windrow x 150 x 100 / (feed x 3600)

In an alternative system, the water content of the different windrows is estimated visually and by feeling the sample in the hand. The windrows should be sufficiently watered. If the water content is too high, the material arranged on the belts following the transfer device would slip. This would subsequently cause blockages leading to a break-down of the transfer device. The danger of blockages could be further reduced by installing profiled belts.

Blockages are also caused if the feeder of the transfer device is adjusted to more than 10cm as then the belts would be overloaded.

The plant is designed such no leachate will have to transported to the purification plant as far as possible. To solve the problem of blockages, the nozzles for spraying the leachate were replaced by ones having outlets with a larger diameter. The mesh basket at the inlet of the leachate tank was removed and a pump fitted with a cutter was installed as an alternative. Recycling the seepage water in this manner watering the windrows has helped to save disposal costs for waste water to about 50,000 €/a.

In order to operate the hard solid trap properly, we start drying the material in the fifth week of decomposition. The ideal water content for an optimum efficiency of the hard solids trap is about 35%. If the water content is higher than this, an increasing amount of compost also gets eliminated with the hard solids.

2.3 Temperature recording

The temperature of the different windrows is recorded by the stationary recording apparatus daily. Examples of observed temperatures in the different windrows:

The table gives the average value of the temperatures measured in the course of the day

Windrow 1 : 25° C
Windrow 2 : 60° C
Windrow 3 : 55° C
Windrow 4 : 50° C
Windrow 5 : 50° C
Windrow 6 : 45° C
Windrow 7 : 40° C
Windrow 8 : 35° C

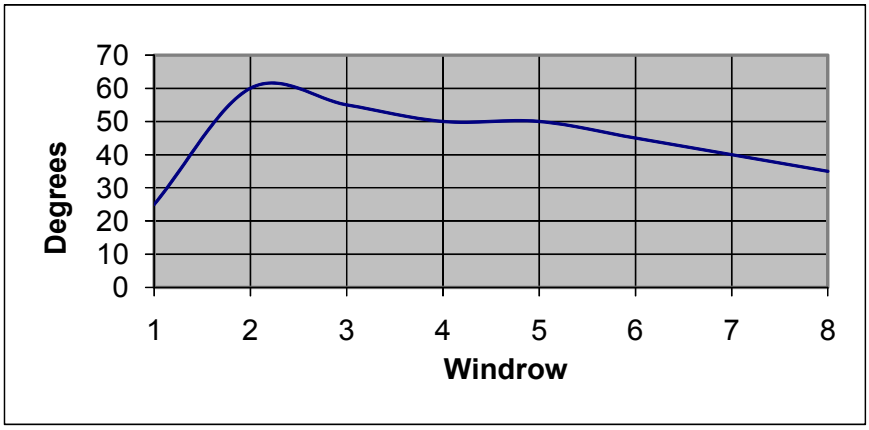


Fig. 8:

2.4 Ventilation unit Reception / Treatment

The areas in which the waste is received and the area in which it is treated are each supplied with an independent ventilation unit. The exhaust air pipes are place below the roof-ridge. The suctioned air is blown into the main decomposition with the help of axial fans. These are installed on the wall between reception and main decomposition and arranged in the main decomposition.

The pit in the reception is aspirated by a pipe branching out from the pipe below the roof-ridge.

The equipments located in the treatment hall, sieve drum and rotating drum each have a fixed suction pipe also branching off the pipe below the roof-ridge.

Capacity:

a) reception:

1. Ventilation number during operation : 3 h^{-1}
2. Ventilation number outside operation time : 50 % = 1,5 h^{-1}
3. Volume flow during operation : 16.400 m³/h
4. Volume flow outside operating time : 8.200 m³/h
5. Volume flow exhaust ambient air : 12.900 m³/h

6. Volume flow pit exhaust : 3.500 m³/h

b) Treatment:

1. Ventilation number during operating time : 2,5 h^{-1}
2. Ventilation number outside operating time : 50 % = 1,25 h^{-1}
3. Volume flow during operating time : 15.900 m³/h
4. Volume flow exhaust ambient air : 14.900 m³/h
5. Volume flow sieve drum : 500 m³/h
6. Volume flow mixing chamber : 500 m³/h

2.5 Ventilation system at sorting station

The sorting system is aerated with a ventilation system. The system simultaneously serves as room heating too. The supply air is blown into the room via twist outlets. The exhaust air escapes through the chutes into the container room.

Performance Sorting station:

1. Ventilation number during operating time : 15 h^{-1}
2. Ventilation number outside operating time : 0
3. Volume flow : 1.200 m³/h
4. Room temperature : 17 °C

2.6 Ventilation system in the control room

The control room is aerated with a ventilation system. The system simultaneously serves as room heating too. The supply air is blown into the room via twist outlets. The exhaust air escapes via the relief shutter flap in the outer wall.

Performance control room:

1. Ventilation number during operating time : 5 h^{-1}
2. Ventilation number outside operating time : 0
3. Volume flow : 900 m³/h
4. Room temperature : 20 °C

2.7 Ventilation system in the main decomposition

The main decomposition is divided into five aeration fields. Each aeration field is equipped with its own ventilation system. Each facility draws air from the composting windrow (windrow suction ventilation), and ambient air over the aeration field (exhaust air). Windrow – suction ventilation and ambient air are connected parallel to a fan on the suction side. The required volume flow is adjusted by motor-driven control butterfly valves over the SPS (programmable controller).On the pressure side both the flow rates are squeezed into the atmosphere through a bio-filter after passing over an air washer.

Dividing the flow rate for each ventilation unit to exhaust ambient air and windrow suction ventilation is deduced from the biological requirements of the respective aeration fields or decomposition material. Thus e.g. should the decomposition material require a large amount of air, the exhaust air suctioned out from the respective exhausts will be lesser and vice versa. The rate of flow at the fans is constant for all the ventilation units and is regulated by a FU (frequency-transformer).

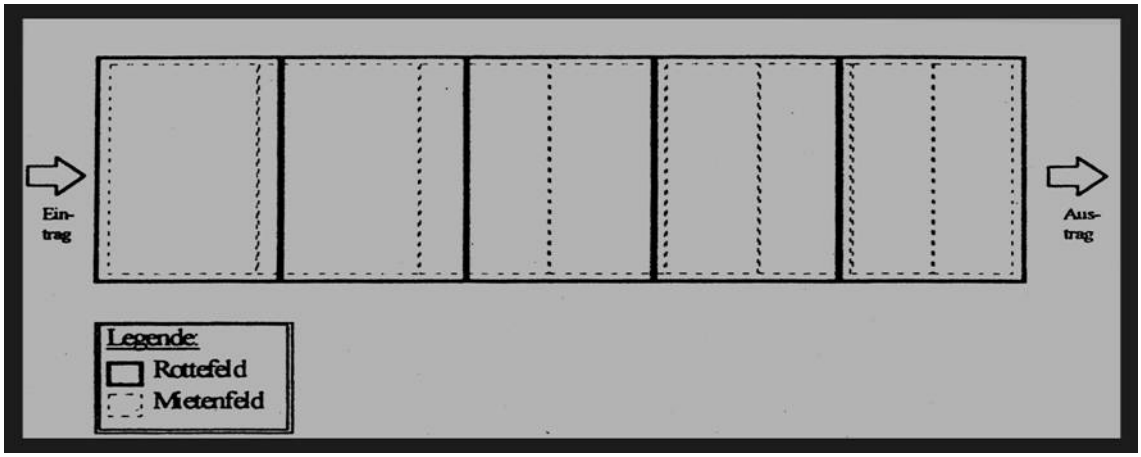


Fig. 9: Chart decomposition fields and windrow field positions (not to scale)

Performance main decomposition:

1.	Ventilation number, main decomposition	: 2 h^{-1}
2.	Toal flow rate from the main decomposition	: 91.500 m³/h
3.	Flow rate per ventilation unit pro	: 18.300 m³/h
4.	Flow rate per windrow min / max.	: 0 – 11.840 m³/h
5.	Flow rate per space min / max.	: 6.460 – 18.300 m³/h
6.	Humidifyer performance	: 95 % relative humidity

2.8 Der Lüftungsboden

In the main decomposition, windrows are built on the aeration floor. The air is suctioned through the decomposition material, laterally over the aeration floor. The aeration floor also serves the purpose of draining off seepage water from the compost and condensate into the waste flow canal.

1. Number of ventilation slots m² : 34 Stück

2. Uncovered areas pro m² : 0.01 m²/m²

The base layer comprises of a concrete slab which is sealed by a PE foil having a protective membrane at the top and bottom. The foil enables an air and water tight connected to the air ducts which are lined by a plastic sheet material.

The layer of chaff on the aeration floor should be replaced regularly inorder to enable a suction ventialation.

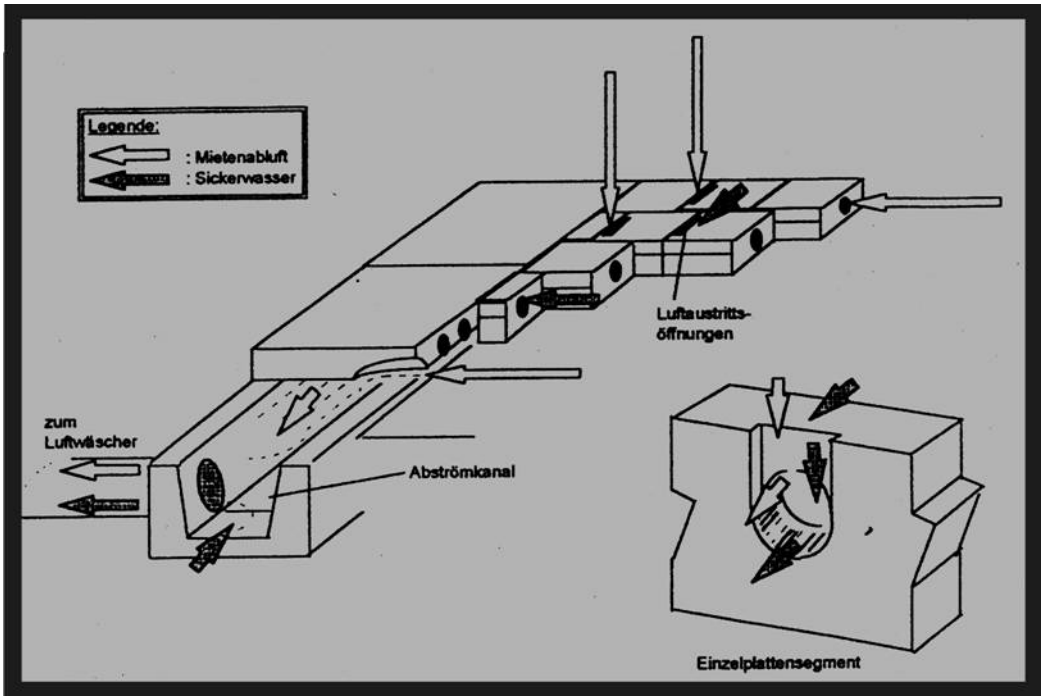


Fig. 10: Construction of the ventilated slab floor (Biokovent – System)

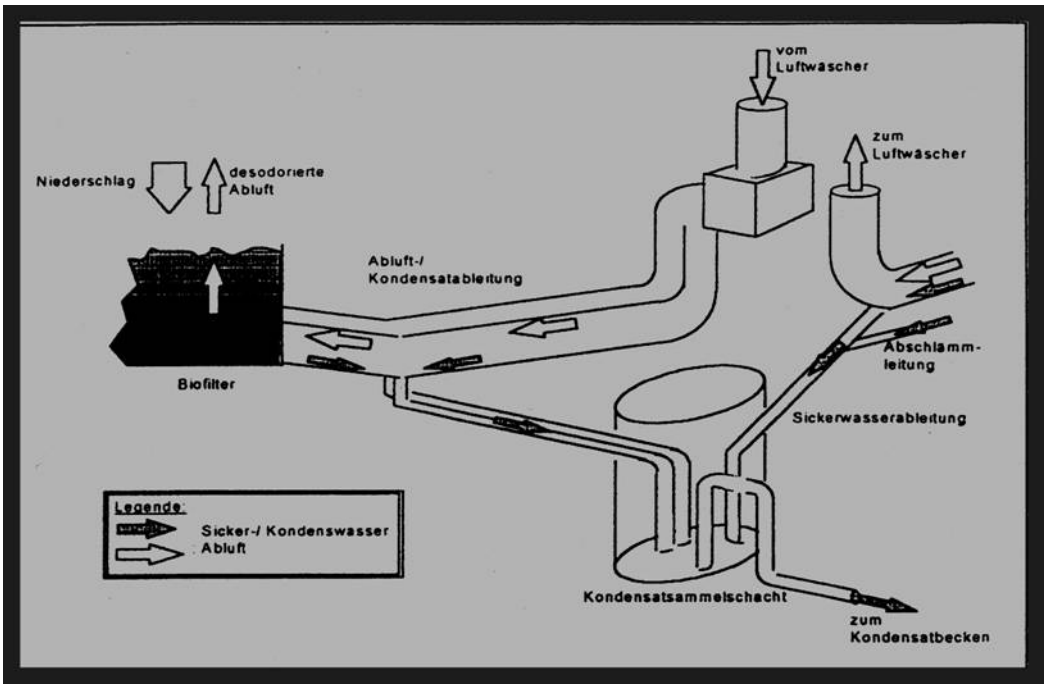


Fig. 11: Waste water and exhaust air chart of a ventilation section

2.9 Ventilation system fine treatment

The air from the fine treatment section is exhausted by a ventilation system. The exhaust air ducts are located below the roof. The exhaust air is pushed out into the atmosphere over the ventilation of a section in which compost in the maturing phase is deposited. The supply air freely flows in from outside through automatically operating air pressure shutter slots.

The screen and the hard solids trap are systematically suctioned. An air duct branching off from the roof-ridge duct and connected to an air vent on the aggregate provided for this purose. If no air is suctioned by the aggregate, all the exhaust air is channelized through the roof-ridge duct.

Performance data fine treatment:

Ventilation number during operating time	: 3 h^{-1}
Ventilation number outside operating time	: 0
Flow rate during operating time	: 13.300 m³/h
Flow rate exhaust ambient air	: 7.800 m³/h
Flow rate exhaust air screen	: 500 m³/h
Flow rate exhaust air hard solids trap	: 5.000 m³/h

2.10 The bio-filter

The ventilation floor laterally discharges the exhaust gas into the bio-filter. The condensate formed is discharged over the floor into upstream flow drains and removed from the system with the help of an outlet. The material constitutes of a bio-mass made suitable for the application, whose main component is specially treated compost. The constituents of the exhaust air are at first sorbed on the surface of the carrier substances and then degraded by micro organisms in a second step. A continuous regeneration process of the bio-mass therefore takes place. According to present knowledge, a dwelling time of over 2 years can be assumed.

With a suitable composition, the bio-mass that is used should fulfill the following quality criteria:

Parameter	Dimension	Minimum value in starting material
ignition loss	%	> 55
moisture content	%	40 - 60
pore space	%	> 80
d60 - value	mm	> 4
pH - value	----	7 - 8,5
breathing properties	mg O2 / (kg . h)	> 20
total bacteria count	n / g TS	$> 10^8$

The main constituents are:

- compost, graining 8 / 20 mm, degree of decomposition III, no infection hazard, fraction 30 Vol-% ;
- broken root wood, fraction 70 Vol-% ;

While installing the filter material and during maintenance work following considerations should be made:

- The bio-mass should be placed in three layers at the base of the filter:
  1. Layer : 70 cm broken root wood as the first active filter layer,
  2. Layer : 30 cm filter compost as second active filter layer,
  3. Layer : 10 cm broken root wood as covering layer for minimizing the growth of weeds.
- The bio-mass is to be loosely and evenly applied at the base with every new filling. The filling height should be about 1.00 m, so that a total filling height of 1.10m is given in the preliminary stage taking the overlay into consideration. The material should be sloped in the protective wall area (height 1.0m) if required. Owing to subsidence, the operating height very soon shrinks to 1.0 m; The border areas should be filled accordingly.
- Do not directly tread on the filter surface at any time while working on the filter system. If work on the filter surface should be required, broad planks or boards should be placed on which to stand.

- The filter surface should be evened (approx. 15 – 20 cm deep). Filter failures should be dug up. The bio-mass taken out, treated and depending on the operating life of the facility installed again under light pressure (adjusting the filter resistance).

- While building-in the bio-mass, each layer (approx. every 25 cm) should be watered if the moisture content is below 40%.

- Fungus covering the biomass in the start-up phase is normal and does not harm the efficiency of the facility (indicates biological activity). Weeds on the other hand should be removed regularly so that the structure of the bio-mass does not get destroyed by roots.

- The bio-mass should be visually inspected regularly to ensure that there are no peripheral displacements and should be corrected either with the help of a rake or new bio-mass.

2.11 Leachate

Leachate (digestate and endogenous seepage water from the decomposing and treatment sections) is discharged into drains connected to the outlets in the slabs.

The pipes leading to the bio-filter sections have a trough close to the collecting chamber for condensate. This enables water condensing from air and rain water to flow into the chamber through the delivery pipe provided with a spillover in the form of a siphon tube. This spill over empties into the condensate collecting pipe in the inspection chamber which collects the waste water from all five collecting chambers, and which having a continuous downward slope drains the water into a catchment basin with a capacity of approx.170 m³.
The water stored in the condensate collector, together with the digestate and waste water from the delivery area can be then pumped up and fed to the watering unit of the automatic transfer system.

2.12 Laboratory equipment

- 1 drying cabinet,
- 1 Muffle furnace,
- 2 Dewar flask (self heating experiment)
- 1 CO_2 gauge,
- 2 Temperature lances,
- 1 pH-value electrodes

4 Description of work area

4.1 Reception

Plant area : Receiving house

Duties	Responsibility	Periods
a) : Visual control of the material delivered (Bio waste and bulking material) :	driver of the wheel loader	each delivery
- sorting coarse materials and disturbing impurites with wheel loader, - make an entry in the weight note, - forward to technical manager.		
b) : place the delivered bio waste on the bunker belt	driver of wheel loader	Each delivery
c) : Continuously fill up the box feeder : for facilitating the ratio bio waste / bulking material, (The belt speed is to be adjusted such that the material, that that is brought from the mixing drum to the decomposing section, is of loose consistence : pore space is an important indicator of decomposition capability of the material	driver Plant manager	each delivery/ depending on material from the mixing drum
d) : Cleaning the recieving section, keeping recieving area clean : - place disturbing impurities in the container, - cleaning to be done on every working day - Fill bulking material in the box feeder	wl operator	every day
e) : The gates arranged in the recieving section should be closed after a delivery vehicle has left in order to minimize odor and dust emissions.	wl operator	each time a vehicle moves
d) : The gangway of the decomposition section should be cleaned	wl operator	every week

4.2 Manual Separation

Plant Section : Manual separation

Tasks	Responsibility	Period
a) : At the separating section, disturbing impurities are sorted out and placed in a container : - Plastic bags and components, - diapers, - Metal parts, - Paper (newspapers, catalogues) - ...	Sorter	before each loading
b) : Keep the processing section clean.	sorter	daily
c) : Documenting the impurities separated out	sorter	daily

4.3 Intensive decomposition

Plant area : Intensive decomposition

Duties	Zuständigkeit	Fristen
Determining water content:	plant manager	
- Material after post mixing drum,		daily
- Material prior to transfer,		weekly
- Material post transfer,		weekly
- Material during placement.		weekly
watering :	plant manager	weekly
- Calculating the amount of water to be added for each windrow,		
- Determining the watered transverse drives of the transfer device,		
- Entering the values in the control program.		
transfer cycle :	plant manager	weekly
- Entering the start and stop values in the control program,		
Observation of temperature:	plant manager	daily
- Check whether the temperature of every windrow has reached the		
desired value,		
- the aeration should be controlled according to the existing temperature,		
Waste air treatment :	plant manager	weekly
- check to see whether the air led to the bio-filter is <40°C		
- check whether the moisture in the air led to the bio-filter is >90%,		
Bio filter :	plant manager	
- even the filter surface,		when required
- dig out recesses,		when required
- check for peripheral displacement		regularly
- check for weed-growth		regularly
leachate treatment:	plant manager	
- Check and record water level,		daily
- check functioning of leachate pump		monthly
- leachate tank for functioning, soiling,		yearly
damages, changes, if necessary check emptying and cleaning		

Tasks	Responsibility	Periods
Motor driven fan :	Plant manager	monthly
Check tightness, holding temperature,		
if required clean or repair with spare parts.		
(observe manufacturers instructions)		
air ducts :	plant manager	2 x yearly
- visual check,		
- if necessary clean and reseal,		
- check for corrosion and if required refinish		
- Check movable joints for tightness,		
- check functioning of drainage,		
- check functioning of inspection valves,		
- check whether tight and if required re-tighten,		
- Clean if required.		
Air humidifyer :	plant manager	weekly
check for tightness, elutriating rate, water level, water temperature,		
check pump nozzle pressure, check sieves and nozzles for dirt		
dampness efficiency > 90 %, manual measurement.		
transfer system :	plant manager	weekly
maintenance		
butterfly valves with electric servo mechanism :	plant manager	monthly
check functioning,		
clean if required or repair with spare parts.		
(observe manufacturers instructions)		

4.4 Fine treatment

Plant area : Fine treatment

Tasks	Responsibility	Period
a) : Filling the hard solids, screen overflow container :	mechanic	with each screening
Push the container forward with a wheel loader according to rate of filling in order to even the material.		
b) : Keep the fine treatment section clean	mechanic	with each screening
c) : Documentation of:	mechanic	with each screening
- quantity of disturbing impurities,		
- Sieve diameter,		
- Sievings,		
- screen overflow,		
- arrival from screen overflow.		
- operating times		
d) : visual check of the screen overflow container.	Betriebsleiter	when moving out a container
Depending on the fraction of disturbing impurities in the screen overflow, ob man overflow it is decided whether the material is to be re-circulated or taken for dumping		
e): Visual check of pressure wave filter :	mechanic	at every start up of plant
- check for possible congestion,		
- check functioning of the individual aggregates,		
e) : visual check of trap for hard solids :	mechanic	at every start up of plant
- check functioning of the individual aggregates,		
- Keeping the four oscillating units clean,		

4.5 Die Nachrotte

Plant area : Maturation phase

Tasks	Responsibility	Period
The material screened from the fine treatment is placed on the stacking ground	mechanic plant manager	at every placement
- the discharged material is to be piled on a single windrow		
- Load the compost acceptor – truck,		
- Screen the material at 10 mm		
- Documentation of:		
- stacking ground,		
- decomposition loss,		
- screen overflow,		
- special incidents.		

4.6 Tasks fort he plant manager

1. Start up the plant, control the different plant areas
2. Personnel planning, distribution of staff
3. Eliminate errors
4. Conduct repairs
5. Maintain specific safety regulations
6. On-call duty, week-end duty.
7. Obtain spare parts.
8. Inventory of spare part stocks
9. Compile weekly schedule
10. Administration / book keeping.
11. Obtain quotes for repair work, compare quotes.
12. Conduct plant tours for groups.
13. Instigate quality control
14. Reporting to waste management authorities

5 Specifications for maintenance – Instructions for lubrication

Inspection reports should be written after carrying out the different maintenance work

- Report on the maintenance work done,
- Report on the parts replaced ,
- Report and evaluation of the gauging.

5.1 Maintenance specifications for the whole plant

1. While cleaning the plant, attention should be paid to the areas in danger of being contaminated during operation i.e. mobile parts, rollers and inter spaces have to be regularly cleaned, at least every fortnight. The condition of the plant should be inspected by the operating staff.

2. The operating staff should be present when starting up the plant so that disfunctions during the start up can be immediately recognized and corrected.

3. Plant components sealed against dirt (control cabinets) should be kept shut. Available covers e.g. cable ducts, maintenance and repair work is over.

4. The storage batteries of the energy supply for saving data shouuld be checked every six months and replaced with new storage batteries every year as a precaution.

5. During the start-up operation of the compost delivery, blockages can occur at the beginning as the material on the floor is usually shoveled against the windrow. Therefore care should be taken that the material is placed on the windrow and that the feed rate is slow at the beginning.

6. In order to ensure that the repiling system gets sufficient water, the suction strainer in the leachate tank should be cleaned out at least every fortnight.

7. The bag filter in the fine treatment should be checked at monthly intervals. The five maintenance caps should be opened and any deposits removed. The fan belts of the compressor should be checked every week and re-tightened if necessary. The condensate from the pressure tank should be drained daily.

5.2 General plan of maintenance specifications

	Maintenance procedure after operating hours													
Description	Require	10	40	100	150	200	400	500	700	1.000	2.000	4.000	10.000	20.000
Conveyor belt			x			x		x						
Rope switch	x													
Motors	x													
Control cabinets							x				x			
Steel construction											x			
Reception and treatment														
Magnet separator			x											
Mixing drum	x				x									
Sieve drum	x				x									
Screw mill	x													
Slewing crane	x										x			
Chain hoist		x									x		x	x
Main decomposition (Decomposition section)														
Windrow piling system	x	x	x			x		x						
Windrow repiling system	x	x	x			x		x						
Ventilation						x								
Main humidifyer pump	x								x					
Decomposing floor														
Bio filter														
Fine treatment														
Pressure wave filter	x					x		x		x				
hard solids trap	x	x		x		x				x				
Trough screw conveyor	x													
Elevator	x	x												
Geared motors, AC-motors	x													
Intensive - Bag filter		x		x		x								

5.3 General plan of lubricating instructions

Description	Lubrication after n hours of operation													
	Require	10	24	40	100	200	500	1.000	2.000	2.500	4.000	6.000	8.000	10.000
Conveyor belt									x		x			
Rope switch	x													
Gear motors, gears, AC motors											x	x		
Drum motors													x	
Reception and treatment														
Magnet separator														x
Mixing drum				x					x					
Sieve drum				x					x					
Screw mill		x			x	x			x					
Slewing crane														x
chain hoist					x	x								
Main decomposition (Decomposition section)														
Windrow piling system							x							
Windrow re-piling system							x							
Ventilation										x	x	x		
Main humidifyer pump						x			x					
Decomposing floor														
Bio-filter														
Fine treatment														
Pressure wave filter					x									
Hard solids separator			x					x				x		
Trough screw conveyor			x											
Elevator								x						
gear motors, AC-motors												x		

5.4 List of lubricants

Individual components :

Maschine parts	**Name of lubricant**	
Main humidifyer pump :		
Oil chamber	Biologically degradable oil Water hazard class 0	
Feeding bridge, transfer brid		
Running gear (general)	Machine oil consistency grade 3	
Running wheel (wheel sets)		
Roll guides (main running gear)	Type	Manufacturer
flange	LUB MS	SNR
Cardan shaft	BEACON EP2	ESSO
Chain wheel drive		
Shaft bearing		
Lantern wheel gear teeth		
Mounting bucket wheel (swing bearing chain)	Long-term lubricant	
	Type	Manufacturer
	MLK 32	Dow Crowning
	Structovis BHD	Klüber
	Structovis EHD MF	Klüber
	Ekalub LA 8	Chemie Technik
Gear motors	Synthetic oil viscosity grade ISO VG 220	
	Type	Hersteller
	Degol GS 220	Aral
	BP Energol SG-XP 220	BP
	Syntheso D 220 EP	Klüber
	Mobil Glygoyle 30	Mobil
	Shell Tivela Öl WB	Shell
Conveyor belt :		
Tensioning screws,	lubricant K DIN 51825 part1	
Bearing of bend pulley		
Bearing of drive units		
Bevel spur gear motor	Synthetic oil viscosity grade ISO VG 220	
	Type	Manufacturer
	Degol GS 220	Aral
	BP Energol SG-XP 220	BP
	Syntheso D 220 EP	Klüber
	Mobil Glygoyle 30	Mobil
	Shell Tivela Öl WB	Shell
	Tribol 800/220	ICI Tribol

Individual components :

Maschine parts	**Lubricant**	
Conveyor belt :		
Worm gear motor	Gear oil of viscosity grade ISO VG 680	
	Type	manufacturer
	Degol GS 680	Aral
	BP Energol GR-XP 680	BP
	Spartan EP 680	Esso
	Mobilgear 636	Mobil
	Shell Omala Öl 680	Shell
	Falcon CLP 680	DEA
	Lamora 680	Klüber
	Tribol 1100/680	ICI Tribol
	Ersolan 680	Wintershall
Drum motors	Synthetic oil viscosity grade ISO VG 220	
	Type	Hersteller
	Degol GS 220	Aral
	BP Energol SG-XP 220	BP
	Syntheso D 220 EP	Klüber
	Mobil Glygoyle 30	Mobil
	Shell Tivela Öl WB	Shell
	Tribol 800/220	ICI Tribol
	Wiolan IT 100	Wintershall
Sieve drum :		
Vertical bearing for gear wheels	lubricant DIN 51502 K 3 K	
Vertical bearing for driving wheels		
Belt tightener	Type	manufacturer
	Aralub HL 3	Aral
	BP Energrease LS 3	BP
	Dura-Lith Grease 3	Chevron
	Beacon 3	Esso
	Mobilux 3	Mobil
	Alvania Fett R 3	Shell
	Multifak 30	Texaco
Driving chain	Chain oil with corrosion protection	
Spur gear	Synthetic oil viscosity grade ISO VG 220	
	Type	manufacturer
	Degol GS 220	Aral
	BP Energol SG-XP 220	BP
	Syntheso D 220 EP	Klüber
	Mobil Glygoyle 30	Mobil
	Shell Tivela Öl WB	Shell
	Tribol 800/220	ICI Tribol

Individual component :		
Machine part	**Schmierstoffbezeichnung**	
Post slewing crane :		
Bearing	Synthetic oil viscosity grade ISO VG 220	
	Type	manufacturer
	Degol GS 220	Aral
	BP Energol SG-XP 220	BP
	Syntheso D 220 EP	Klüber
	Mobil Glygoyle 30	Mobil
	Shell Tivela Öl WB	Shell
	Tribol 800/220	ICI Tribol
Chain pulley :		
chain	Common motor oil SAE 20W/50	
Deflector roll of bottom flange	Special – roller bearing grease	
	Type	manufacturer
	NBU 12	Klüber
Hared solids separator, elevator, trough screw conveyor :		
Bearing	Roller bearing grease	
Gear motors	Synthetic oil of viscosity grade ISO VG 220	
	Type	manufacturer
	Degol GS 220	Aral
	BP Energol SG-XP 220	BP
	Syntheso D 220 EP	Klüber
	Mobil Glygoyle 30	Mobil
	Shell Tivela Öl WB	Shell
	Tribol 800/220	ICI Tribol
Magnet separator :		
Worm gear motors	Synthetic oil viscosity grade ISO VG 220	
	Type	manufacturer
	Degol GS 220	Aral
	BP Energol SG-XP 220	BP
	Syntheso D 220 EP	Klüber
	Mobil Glygoyle 30	Mobil
	Shell Tivela Öl WB	Shell
	Tribol 800/220	ICI Tribol
Bearing of conveyor drums	Roller bearing grease	
	Type	manufacturer
	Gargoyle 1200	Mobil

6 Details of inspection and maintenance work

6.1 Ventilation technology, fermentation area, bio-filter

A Inspection

Individual components	prescribed monitoring	Periods
scrubber	• check tightness, rate of elutriation, water level, water temperature, Pump pressure, • check strainers and jets for dirt, humidification capacity > 90 %, manual reading	1 x weekly
MSR – apparatus	• sensor (pressure, quantity of air) • protection against dry running / floatation valve • visual check on the functioning, fastening, dirt i.e.as specified in the repairing instructions of the manufacturing procedure	1 x weekly
shut-off valve with electrical drive	• check functioning • clean if necessary or repair with spare parts. (take manufacturer's instructions into consideration)	1 x monthly
motor driven fan	• check tightness, storing temperature • clean if necessary i.e. repair with spare parts. (consider manufacturer's instructions)	1 x monthly
air passage network	• visual check • if necessary, clean and re-tighten • check for corrosion and if needed refinish	2 x yearly
Bio filter	• visual check • displacement of biomass at the edges, apertures, weed covering, • treat if necessary	1 x monatlich

B Care and maintenance

individual components	prescribed servicing	Periods
Bio filter : readings	• air temperature to bio filter<40°C • Relative moisture content to bio filter>90% • pressure difference to bio filter • pressure difference in channel filter :<500 Pa passage / treatment • pressure differnce in channel filter : <400 Pa fine treatment • pressure difference in channel filter: <300 Pa sorting station / control room	1 x weekly
ventilation technology and mechanics : **fans**	• check functioning of alarm device and preset threshold values, • check for dirt, damages, corrosion and the base of the fixtures, • check rotor disc and imbalance • check bearing and sound, • lubricate bearings, • check tightness of flexible joints, • check earthing • check vibration damper • check fan belt and if necessary retighten • clean if required • consider manufacturer's instructions	4 x yearly
it is recommended to lubricate the fan bearings after every 2500 operating hours		
Electro-motor running the fan	• check for dirt, damages, corrosion,base of fixtures and • direction of rotation • check for noise in the bearings • clean if necessary consider manufacturer's instructions	4 x yearly

individual components	**prescribed servicing**	**periods**
shut off valve with electrical drive	• check for dirt, damages, corrosion and base of fixtures, • check that connecting rods are properly fixed and accessible, • if necessary apply special lubricants to rods and bearings • clean if necessary observe manufacturers instructions	2 x yearly
pipe lines and jets	• check for damages, check tightness and fastening, • visual inspection • check thermometer for damages and correct reading • check manometer for damages and correct values, • check the functioning of safety devices observe manufacturers instructions	4 x yearly
shut off devices and control fittings	• check for dirt, damages, corrosion and accessibility of shaft • check functioning (seal seat) • check that shaft ducts are tight, • if required adjust stuffing box • clean if necessary observe manufacturers instructions	2 x yearly
Main humidifyer pump	• check for dirt, damages, corrosion, base of fixtures • direction of rotation • check the functioning • check whether shaft feed-through is tight • check bearings for noise • if necessary adjust stuffing box • if required clean floating ring seal • oil change (Bio 46 ISO/SE) observe manufacturers instructions	2 x yearly

individual components	**prescribed servicing**	**periods**
Electro-motor of pump	• check for dirt, damages, corrosion, base of fixtures • direction of rotation • check bearings for noise	2 x yearly
Washer tub	draining (observe manufacturer's instructions)	
air channel network	• check for dirt, damages, corrosion, if required • treat damages according to material • check that flexible joints are tight • check that drainage is functioning • check whether inspection latches are functioning • check tightness and if required re-tighten • clean if required	2 x yearly
BIKOVENT ventilation floor	After the composting plant has been designed, following procedure is recommended: • The air supply ducts of the slab floor are to be exposed fully or partially as per requirement, by removing the loosly placed cover plates. The cover plates can be lifted by means of eye bolts. • the surface of the ventilation floor should be swept, the air outlet slots should be cleaned of materials that may have entered, with a high pressure cleaning device. • The air outlet slots widen at the bottom towards the end-to-end air channel, so that material that may have entered can be flushed out. • The BIKOVENT – channels are cleaned with high pressure jets, as those used for cleaning pipes and sewers, via cleaning stones arranged at the rear of each BIKOVENT – row of stones, and / or by way of the air supply channel. • After cleaning the slab floor, the air supply channels, drainage pipes and the corresponding ducts are also to be cleaned.	1 x yearly

individual components	prescribed maintenance work	periods
Humidifyer Related to the moisture of the biomass, the fan should not operate longer than 24 hours without the humidifyer as otherwise there is the danger of damaging the biomass owing to too less moisture.	**inspection of installations :** • operate air washer over several hours and check functioning and tightness as • well as check spray chamber right and left. Droplet seperator and flow straightener • require to be operated several days with water, to ensure that it is puncture proof. (weathering effect) • clean at time intervals of 2-5 weeks depending on the degree of pollution: • remove deposits, carefully clean inner casing and built in compo-nents with • high pressure cleaner, detach filter and clean, clean tank, check functioning of • the electrical filling level monitor	depends on de-gree of pollution
	• clean as above, in addition also droplet seperator, flow straight-ener, nozzle holders. • check nozzles, pumps etc for depositions and if required clean with the help of softening agents, re-flush for neutralizing all wetted areas. • if formation of algae is noticed, clean at closer intervals and adjust emptying at dry washing.	every sixth months
	• Clean as before, and in addition detach nozzle holders, disjoint nozzles and clean in a cleaning solution. • if there are deposits on the droplet seperator and flow straightener • these are to be detached (latest every 3 years) and placed in a cleaning solution or exchanged . • It is recommended to lubricate the roller bearing of the humidifyer having 50% hollow space after 15,000 hours of operation with lithium base grease • The chemicals and cleaning agents used as well as the quantities	Jahres Service

	• are to be recorded in the maintenance book.	

6.2 entry bridge, transport bridge

Care and maintenance

Teilaggregat	**Prescribed maintenance**	**Periods**
Gear motors	visual inspection for damages, wear and tear, moisture penetration, corrosion	daily
	• check slipper clutch and if required re-tighten • check roller bearing by stressing and relieving the bearing and thereby measuring the slackness of the outer-ring to the inner-ring if the slackness is obvious, the bearing will have to be replaced the same should be done if the bearing causes noise	every 90 days
	Fresh gear oil is filled upto the level of the inspection screw	every 360 days
Running gear, carrying wheel, roll guides, flanges cardan shaft, chain drives, shaft bearing	visual check on damages, wear and tear, penetration of moisture, corrosion	weekly
	the lubricating point fitted with the lubrication nipple should be lubricated with motor oil check roller bearing for slackness, squeaking	every 90 days
Gear teeth of lantern wheel	visual check for damages, wear and tear, moisture penetration, corrosion	weekly
	lubricate chain and open gear teeth	every 90 days
conveyer belts	visual check for damages, wear and tear, moisture penetration corrosion	weekly
buffer, end switch, distribution of energy	visual check for damages, wear and tear, moisture penetration, corrosion	monthly
Energy chain, feeding pipes, watering, compressed air system, paddle wheel	visual check for damages, wear and tear, moisture penetration corrosion	weekly
cable routing	clean	when required
paddle wheel bearing (swing bearing)	lubricate with motor oil	every 90 days
machine chains	check and if required re-tighten	when required

Motor on telescope conveyor	clean	when required

6.3 belt conveyor

Care and maintenance

individual components	**prescribed maintenance**	**periods**
drive roller and deflector roller, shielding angle, carrying roller, inner belt cleaner, outerbelt cleaner	clean	weekly
conveyor belt	check whether belt is in the centre of the conveyor	weekly
screws and nuts	check whether they are tight, if required tighten	monthly
carrier rollers, drive pulley, bend pulley	check for free movement, wear and tear on the lateral area, soiling remove dirt and grease residues	monthly
conveyor belt	• check for damages, wear and tear and dirt remove dirt and grease residues • check tension of conveyor belt	monatlich
tensioning screws	lightly lubricate with about 5 cm^3 of common lubricant	monthly
Safety devices : emergency switch of cable pull, emergency stop switch, off-track running guard	check functioning	every 3 months
Motor, bearing and gear mechanism	check temperature and check for noise develepment	every 3 months
gear of bend pulley	slightly lubricate with about 10 cm^3 of common lubricant	every 2000 hours of operation
worm gear motor	• regular check of lubricant grease filling : valid for case temperature <70°C, near the oil drain plug • An increase in temperature of upto 15°C lessens the lubricating period to half the output value	every 10000 hours of operati-on or every 2 years

6.4 Motors, gear motors, three-phase motor

Care and maintenance

Individual components	**prescribed maintenance**	**periods**
motors	• regular check of lubrication • oil change • check tension of belt regularly, re-tighten if required	About every 8000 hours of operation
Gear motors	• check lubrication regularly • change lubricant	Every 10000 hours of operation or every 2 years
	if synthetic lubricant is used, change lubricant regularly clean cooling air passages	every 4 years
Drehstrommotore	• cooling air passages to be cleaned regularly • monitor bearings and if required lubricate	

6.5 Sieve drum, revolving drum

Care and maintenance work

Individual components	**prescribed maintenance**	**periods**
fixing screws : of the carrying wheels of the drive section of the screen plate	check and if required retighten at the right moment	Ca all 150 operation hours
carrying wheels/ driving wheels in the roller bearing	re-lubricate with grease	yearly
	check that least diameter is 680 mm, if required replace	regularly
	check wheel covering for tears and defects	regelmäßig
Stabilizer wheel	re-lubricate check that least diameter is 280 mm if required replace	weekly regelmäßig
Spur wheel gear	oil change	yearly
driving chain	grease with chain oil in aerosol cans	weekly

Careful !
maintenance work in sieve drum to be undertaken with breathing protection and protective clothing

6.6 Shaft axle sieve

Care and maintenance work

individual components	**prescribed maintenance**	**periods**
Motors	clean the entire length of the cooling air passage	regelmäßig
driving rod **rear wheel**	visual check for damages, wear and tear, corrosion	every 3 months
Sieve matting **(rubber toe guard)** **terminal block**	visual check for damages, wear and tear, corrosion	1 month
cross-beam	visual check for damages, wear and tear, corrosion	6 months
wear plate bearings **feeding** **discharge**	visuall check for damages, wear and tear, corrosion	3 months
side cover **wear plates** **- edge of axle** **- rubber foam**	visual check for damages, wear and tear, corrosion	 3 months 1 month 1 month
fan-belt drive	visual check for damages, wear and tear, corrosion	6 months
rubber springs	visual check for damages, wear and tear, corrosion	6 months
bearings	re-lubricate	every 120 hours
pedestal bearings	re-lubricate	of operation
rotary current motor	re-lubricate	

6.7 screw mill

care and maintenance

individual components	**prescribed maintenance**	**periods**
counter blade	reverse or exchange	by wear and tear
screw roller	exchange	by wear and tear
Filter element, suction filter	change	when required
lubrication chart, lubricating nipple	lubrication of the open gear wheel steps lubricate flange bearings	daily daily
Hydraulic unit	oil change	every 2000 hours of operation or yearly

6.8 cable winch switch

Care and maintenance

individual components	**prescribed maintenance**	**periods**
slilding points	re-lubricate	when required

6.9 revolving crane, chain hoist

Care and maintenance

individual components	**prescribed maintenance**	**periods**
revolving crane	inspection through specialists or experts	yearly
anchoring nuts	check that they are tight	regularly
screwing the trolley buffer **screwing the through bolt**	check initial tension	regularly
lifting equipment **chain**	inspection through specialists or experts lubricate with motor oil	yearly every 100 hours
idler pulley of the lower block **brakes**	lubricate ball bearings check the functioning of brakes re-adjust	of operation every 200 hours of operation regularly 10 Jahre
break pad	change	>10 years
safety clutch	check functioning of brakes	daily
hoeing mouth opening	visual check of condition	daily
driving power	check functioning	
suspended push button		
screws	check whether tight	daily

6.10 Hard material trap

Care and maintenance

individual components	**prescribed maintenance**	**periods**
Hard material trap	check for sound	daily
Sieve bottom	Clean with strong water jet or steam blower, wire brush if required remove glass parts from sieve openings	daily daily
fan belt	check tension, if required retighten	100 operating hours
air distribution unit	• check for glass pieces, if present check fine glass outlet • clear, glass waste pipe to be checked for blocking	daily
air intake	air intake area to be kept clean always	daily
screening unit	check that the unit runs quietly	daily
interior of strainer	check for caking and residues and clean if required	once a month
Spur gear motor	lubricate 0.6 L	
flange bearing	lubricate 50 ccm	every 6 months
tension bearing	lubricate 50 ccm	every 6 months
rotary current motor	lubricate 10 ccm	every 3 years
pedestal bearing	lubricate 50 ccm	every 6 months

6.11 Trough conveying screw

Care and maintenance

individual components	**prescribed maintenance**	**periods**
Screw **screw trough** **inlets** **outlets**	clean of transport material residue	regularly
spur gear motor	lubricate 0.6 L	
hanging bearing	lubricate 50 ccm	24 operating hours
flange bearing	lubricate 50 ccm	every six months

6.12 Elevator

care and maintenance

individual components	**prescribed maintenance**	**periods**
Elevator	check for noise, e.g.when the belt is moving at the shaft or foreign bodies in the conveyor cycle	during operation
belt	• check tension of belt and if required re-tighten • check that belt is in the centre and if required re-adjust • visual check for damages	regularly dialy when required
clutches	• check starting torque • check clutsch spur for wear and tear and if required replace	when required
spur gear motor	lubricate 0.6 L	
vertical bearing	lubricate 50 ccn	every 6 months

6.13 Intensive - bag filter

page 1

care and maintenance

individual components	**prescribed maintenance**	**periods**
U - pipe - manometer	check the filter bag differential pressure	daily
Filterschläuche	• check tightness between filter bag bottom and inlet nozzle, if required re-tighten cap nuts check for wear and tear and damages, to be recognized through dust deposits in the clean gas section or inlet nozzle or dust plume in the clean gas if required pipes to be detached and replaced by new ones • check whether filter bags are stuck owing to temperature falling below dew-point if required change bags and clean impurities. • eliminate cause!	2 weeks 4 Wochen
Magnet valves and control device	• check whether the control lamp ofthe electronic control device switches off after a short time. If not there is an interruption in the magnet coil or feed line : replace magnet coil • check whether valve is operating, if required replace valve • check whether pressurized air is continuously escaping from vent, if required clean magnet valve of possible foreign bodies, substitute defect valves	4 weeks 4 weeks 4 weeks
diaphragm valve **Düsenstock**	• check whether permanent escape of pressure, observe whether pressure at manometer increases again to operating pressure between two pulses. If required substitute diaphragm valve • check all membranes check O - rings and replace if required	4 weeks
dedusting cycle	check normal setting, dedusting cycle of the filter 120 s If the cleaning is not satisfactory, filter bag differential pressure too high, re-set clock cycle. Observe operating pressure at clock cycles under 12 s	

door sealing	check whether gaskets are brittle or damaged if necessary replace	4 weeks
maintenance unit	• check oil and water separator • check operating pressure, should increase to full operating pressure between 2 pulses in case of need screw off the filter glass and clean with water or petrol. if pressure at manometer drops, check compressor, , possibly clock cycle to be increased. Re-set to pre-scribed pressure	2 Wochen
dust collecting chamber	if dust collects check the functioning of dust discharge devices	2 Wochen

6.14 Magnet separator

care and maintenance

individual components	**prescribed maintenance**	**periods**
discharging transport belt	check belt run and belt tension	1 week
belt tighteners **deflection pulley**	regulate tracking ability of the belt by slightly changing the belt tightness regulate leads	
ball bearing of deflection pulley	Clean: • lubricate for a surrounding temperature of about 40°C • lubricate for a surrounding temperature > 40°C	Regularly 10000 operating hours 5000 operating hours

6.15 control cabinets

care and maintenance

individual components	**prescribed maintenance**	**periods**
control cabinents	clean	8 weeks
screwed connections	check, if required re-tighten	yearly

7 Duty to furnish information, obligatory documentation requirement, record retention requirement

The composting plant *Muster* specifies that for the duty to furnish information, obligatory documentation requirements and record retention requirement, different protocols/reports have to be written:

- Weighin log (quantities delivered, quantities given out),
- Protocol for the windrows,
- Results of analyses and investigations,
- Annual reports

7.1 Weighing log

Following data should be recorded in the weighing log for the quantities delivered:

- Date, Time,
- Place of origin,
- Vehicle no.,
- Type of material (Bio-waste, bulking material),
- Quantity,
- Quality (visual check),
- Weight note no.

For the compost handed over:

- Date, Time,
- Recipient,
- Type of compost,
- Quantity,
- From which windrow,
- Purpose of use,
- Weight note no.

For the disturbing impurities sorted out(hard solids, sieve overflow, disturbing impurities, metal):

- Date, Time,
- Type of material,
- Amount,
- Name of disposal company
- Weight note no.

7.2 Windrow protocol:

For the entry windrow :

- Quantity of bio-waste
- Quantity of green waste,
- Quantity of sieve residues (no. of buckets).

For all windrows:

- Temperature,
- Water content / desired water content,
- Water added,
- Time of transfer,
- Set feed rate

7.3 Results of analyses and investigations

The compost produced should be analyzed regularly as part of self-monitoring. Following parameters should be recorded for each type of compost every **three months**:

- Raw density,
- Degree of decomposition,
- Salt content,
- pH-value.

Pollutants:

- Mercury,
- Cadium,
- Lead,
- Chromium,
- Nickel,
- Copper,
- Zink

Plant nutrients:

- Total plant nutrients:
  - Nitrogen(N),
  - Phosphoros (P_2O_5),
  - Potassium (K_2O),
  - Magnesium (Mg) und
  - Calcium (Ca).
- Soluble plant nutrients:
  - Nitrogen (N),
  - Phosphoros (P_2O_5),
  - Potassium (K_2O).
- Organic substances as ignition loss.

In addition to this a quality control should be done by a third party every six months for the parameters given above:

Name of testing institute for third party survey ….....

Following **standard values for compost** should be maintained when handing over to a third party:

1. **….....**
2. **….....**
3. **….....**
4. **….....**

7.4 Annual report

- Annual reports should be given for the composting plant which should inclued the evaluations from the protocols given above:
    - Annual – Mass balance:
        - The quantities delivered to the plant (bio waste, green waste),
        - The different kinds of compost handed out,
        - The disturbing impurities produced at the plant
            - Manual sorting,
            - Sieve overflow,
            - Hard solids,
            - Metal
- Realization of the annual load curve for the three points mentioned above.
- Results of the analysis and investigations conducted.
- Documentation of the replaced machine parts.
- Personnel planning for the coming year.
- Investments and profits balance
- Suggestions for improvement