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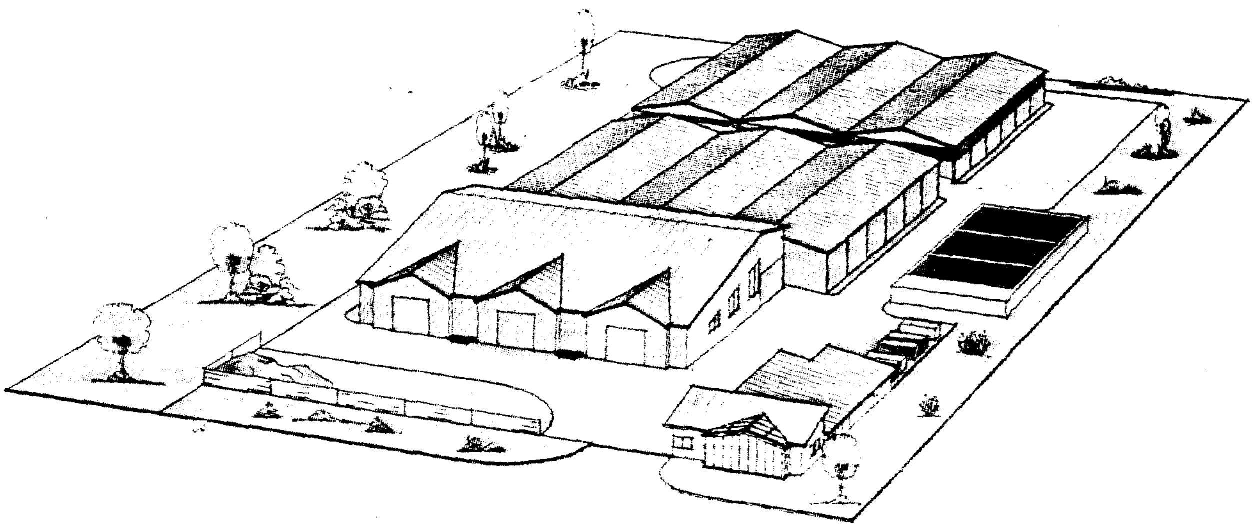
How to Start Manufacturing Industries

Composting plant



Introduction

Every day from nature's circulation system vast amounts of organic materials are being removed, used and finally discarded in the form of burdensome and even harmful waste. Cornposting can help by working against this careless removal and its disastrous consequences.

Composting is an ancient agricultural process for the reutilization of organic waste as a carrier of nutrients for plants and for the improvement of the earth's fertility. The decomposition of organic substances through vegetable or animal micro-organisms which takes place in a damp medium under the admission of air and which leads to a humus-type product, is known as composting or rotting.

Composting is technically a more simple process than waste incineration, it reduces the ever increasing use of land for rubbish dumps and it can use the large amounts of organic waste materials, which arise. to produce an organic fertilizer and a texture improver.

The following waste materials are used today for cornposting:

Organic parts of household waste;

Sludge;

Leaves and other waste from parks:

Garden and kitchen waste;

Organic residues from the food industry as well as from winemaking;

Bark peelings;

Waste of abattoirs (contents of entrails);

Dung, remains of harvesting and other agricultural waste (including' those from factory farming).

Basically all waste with a high degree of materials, which can be easily broken down biologically, are suitable for cornposting. The potential of waste capable of being composted (household waste, waste of agricultural concerns or of factories in the food industry) is very different, depending on the country and the type of waste.

The problems of composting lie above all in a continuai collection of as pure organic waste as possible; in the varying composition (quality) of the product; and thus in the sales of the ready compost, which have a decisive influence on the economy of the plant.

Cornposting and influential factors

Composting

Composting is an aerobic process in which organic materiais are broken down by means of micro-organisms into substances which create humus. Anaerobic conditions are usually not desirable, because among other things they create problems of smell and can restrict the actual process of composting.

After processing the raw material (crushing, sieving, mixing, separation of ferromagnetic particles) composting basically follows the following chemical-biological phases, whereby there are no strict boundaries between the phases.

The first phase is called the intensive rotting or the prerotting phase. Its characteristics are:

Bacterial activity with a relatively high mebabolic performance and as a consequence a high material conversion:

High rate of utility of the offered oxygen (approx. 20%);

Tie required approx. 2-4 weeks.

Through the intensive bacterial activity many exotherm reactions take place, which lead to a maximum temperature of approx. 70-80 "C. This is accompanied by a desired pasteurizing effect. The result is fresh compost, which cannot yet be used for most areas of application, as the biological conversions are still not complete and the fresh compost is putrefactive.

The pre-rotting phase is followed by the conversion phase (main rotting) and then the post-rotting phase, which is necessary to obtain nature, i.e. ready, compost. These phases are characterized as follows:

A considerably slower material conversion, as the composition of the microbial community shifts away from bacteria to mycetes and fungi, whose metabolism is considerably smaller than that of bacteria;

The available oxygen is only utilized to approx. 5%;

The temperature drops again gradually and approaches towards the end of the rotting period the temperature of the surroundings;

The result is ready compost.

For the technical realization of the composting processes it is important to note that only the first phase of bacterial activity can be influenced, i.e. accelerated, by optimizing the parameters. In contrast the metabolic performance of the following mycetes and fungi cannot be influenced, so consequently it is also not possible to accelerate time-wise the post-rotting phase.

The aim of composting (rotting) is to gain a humus like decomposed product, compost. This compost can be used for garden vegetable growing, in agriculture for the production of field crops and fodder, for fruit and wine growing, in orchards, for the development of barren land and in private gardens. It is rich in organic substances and the nutrients, nitrogen (N), phosphorous (P), potassium (K), calcium (Ca) as well as magnesium (Mg). The use of compost leads to an increase in the amount of humus and to erosion stability, it activates life in the soil, improves the structure of the soil. its warmth and water households as well as its store of nutrients. In the case of sandy ground compost raises the capacity of water retention and reduces desiccation, in the case of heavy clay soil it improves air and water permeability and reduces thereby surface erosion.

Influential factors

Nutrients

For the bacterial activity there must be a balanced supply of main nutrients and trace elements. Of particular interest is the supply of the main nutrients, carbon (C), phosphorous (P) and nitrogen (N). As a lack of phosphorous is normally not to be expected, the observations can be limited to the carbon/nitrogen ratio, as this alone can be subjected to larger fluctuations.

The carbon/nitrogen ratio influences the speed of decomposition and thereby the composting process both qualitatively and quantitatively. A carbon/nitrogen ratio of 30-35:1 is considered to be optimal.

If the ratio is too small (a relative nitrogen surplus), then the result can be the formation of NH_3 with a consequential displacement of the pH value. This situation can be remedied by specifically adding carbon sources (e.g. straw, sawdust).

Should the ratio be too large (a relative carbon surplus), then the lack of nitrogen will lead to a slower and incomplete decomposition. The remedy for this is the addition of materials with a close carbon/nitrogen relationship (e.g. sewage sludge: C/N approx. 10:1; green silage).

Water content

The water content is also an important parameter, because the bacteria can absorb the substrates only out of a watery solution; the optimum-amount is approximately between. 40-55%.

A water content of less than 30% slows down the transportation of the nutrients and finally prevents their intake, so that the rotting process comes to an end.

In the case of a water content of over 70%. too many pores are tilled with water, so that there is a reduction in oxygen intake and anaerobic conditions arise. Depending on the water content of any sewage sludge, possibly to be treated, then this will influence the water content of the compost itself.

Oxygen supply

As the composting process should take place aerobically and anaerobic processes are undesired then the main parameter is a sufficient supply of oxygen. The need for oxygen is at its greatest during the pre-rotting phase on account of the intensive bacterial activity, thus making it essential, particularly in this phase, to take corresponding measures: this can be by changing silos or by turning the compost over in the rotting reactors or channels.

Temperature

The aerobic composting process is exothermal with the result that the generation of heat in the pre-rotting phase leads to an increase in temperature in the rotting reactor. There, peak temperatures of 70-80 °C can be reached. If this temperature level is maintained over several days, then the compost is hygienized.

The temperature of the outgoing air is subject to considerable fluctuations during the first phase and falls strongly during the last third of the intensive rotting. It is therefore better to define the intensity of the rotting processes in terms of the specific heat loss (in W/m^2), because the temperature of the outgoing air depends too strongly on the distribution of temperature and dampness in the bulk of the compost,

The specific heat loss reaches its maximum after almost 100 hours at approx. 1,800 W/m^2 and then steadily drops to about 200-300 W/m^2 after 500 hours.

The highest decomposition speeds for compost gained from waste materials in the intensive rotting phase are achieved with effective process temperatures of 40-45 °C (determined from the amounts of water and heat carried out with the outgoing air, based on the saturation level of the air with water vapourj.

In order to maintain the optimal temperature the process must-after the hygienisation effect at higher temperatures has been reached or through renunciation of this effect-be cooled by continual watering and optimal ventilation cycles.

pH value

The pH value is normally within the area of the chemical neutral point. It can however, influenced by intermediate products of the decomposition process (e.g. organic acids), be shifted at intervals. The entire community of the various bacteria is however not sensitive to these limited fluctuations in the pH value, thus the pH value must not be considered as a limiting factor of the rotting process.

Automatic cornposting plant

Because of the necessity to ease the burden of the rubbish dumps and the controversial discussions on refuse incineration, composting should be given more importance in waste disposal. Decentralized smaller plants, which among other things considerably reduce transportation distances and costs, should in the main be preferred as against technically more complicated plants. In smaller plants, with a flow rate of for example 20,000-25,000 m^3/a, an efficient load (decisive for their economy) is more likely to be achieved than in large centralized works. Moreover several composting plants offer altogether greater safety in waste disposal than one central plant.

Design

The plant described here corresponds to the above-mentioned capacity. As can be seen from the schematic chart (see figure 1) of an automatic composting plant, it comprises of the following:

A delivery and processing area (1);
A rotting area (2);
A fine processing area (3).

All areas are built into a hall, in order to avoid material drifting on the plant. To prevent corrosion by rotting material or waste air on parts of the machinery, these are covered with a corrosion-resistant paint.

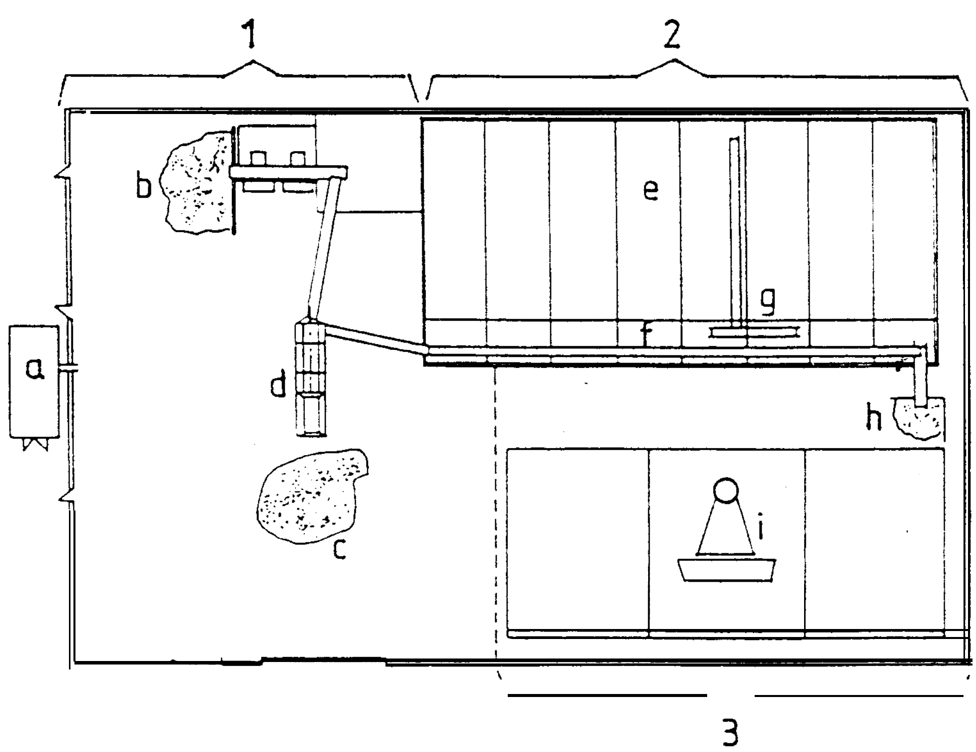
Delivery and processing area

This area serves the delivery, sorting and separation of impurities of the waste; it is divided into two separate treatment areas, namely one for biological waste (b) by means of a screening drum, a sorting belt and metal separation facility, as well as one for green waste, waste from industry or agriculture (c) with the additional use of a crushing machine. This division has the advantage that each of the two sorts of waste can be properly pre-treated, regarding their composition, before being put into the mixing and homogenizing drum (d) so that unnecessary work and costs are saved. Furthermore, correct pre-treatment is an important step in achieving a high composting quality.

Rotting area

This area is the heart of the plant in the case of the plant described here and on account of the required

Figure 1. Automatic cornposting plant



Key:

1 Delivery and processing area	a Hall extraction fan	d Homogenizing drum	g Rotating equipment
2 Rotting area	b Delivery area of biological waste	a Rotting channel	h Material discharge
3 Fine processing area	c Delivery area of green waste	f Feed-in area	i Sieve

capacity it consists of eight parallel rotting channels (e) with charging area, which are made of corrosion-free concrete and which are 12 m long, 5 m wide and 3 m high; this corresponds to an actual volume of 180 m^3 per rotting channel or 1,400 m^3 for the complete plant. The transformation of the collected waste materials into compost takes place in these channels. A shifting machine (g), which consists of: a horizontal spiral conveyor; an ascending spiral conveyor; a horizontal dividing spiral; a suspended frame as well as a watering device, provides for the rotation of the compost.

Fine processing area

To achieve a compost low in impurities and thus of a high quality, a technical fine processing line is used, which consists of a sieve device. The completely rotted material is after a short period of storage in the material discharge area (h), sieved using different sieve sizes (drum sieves with different hole sizes). Therefore several compost qualities can be produced for the individual areas of application.

Operation procedure

The operation procedure described here concerns an automatic composting plant with the following data:

Flow rate m^3/a	24 000
of which:	
biological waste (m^3/a)	13 600
green waste (m^3/a)	10 400
Eight rotting channels with a total volume (m^3)	1 440

To run the plant six persons with the following qualifications are required:

1 works manager
1 driver for the wheel loader
1 assistant
3 workers for the sorting section.

The process is divided into the following three stages: preparation; composting; and fine processing.

Delivery and preparation

The waste, separately delivered on vehicles according to whether it is biological or green waste, is registered and weighed and then deposited separately in the delivery area, generally in flat bunkers. For both types of waste there is a separate treatment.

The biological waste materials are taken by means of a conveyor belt to a screening drum; here they are loosened, homogenized and sorted. The sieve usually has a hole size of 60 mm in diameter. However, the screen lining is easily exchangeable, thus making it possible to react to the true structure of each individual waste material. The sieved part of the biological waste is taken via a conveyor belt to the mixing and homogenizing drum, before it proceeds to the next phase, the rotting area.

The sieve overflow. waste materials larger than 60 mm in diameter, are transported by conveyor belt to a sorting station; here recognizable impurities (non-compostable materials) are sorted out by hand and sent to a rubbish dump. After this the hand-sorted material passes under over-head magnets to separate the metal; the sorted metal objects are collected and proceed to further processing. After the removal of the metal the now "pure" biological waste is sent through a slow-running crushing aggregate, from where it is also taken, after an intermediate storage period, to the mixing and homogenizing drum. Parallel to the preparation of the biological waste materials there is the preparation of the green waste materials, which undergo only one stage of treatment, namely comminution in a shredder, before also being transported to the mixing and homogenizing drum. After remaining in the drum for approximately 30 minutes all the waste is transported by a conveyor belt to the next treatment phase, the rotting area; where the waste passes a-metal separator, in order to eliminate the last pieces of metal, which were not sieved away at the beginning of the treatment.

Composting in the rotting area

In the rotting area, which consists of eight rotting channels, the transformation of the waste into compost takes place; this biological-chemical process lasts 8- 10 weeks. It is therefore important, to prepare a time and feeding plan for charging the individual channels.

The rotting material, i.e. the pre-treated biological and green waste materials, is continually transported from the preparation area by conveyor belt to the charging area of the channel. It is dumped there and then taken up by an automatic shifting machine and distributed in the channel to be charged. This shifting machine, which is on rails and which can be moved to any position above each individual rotting channel, carries 'out not only the filling of the channel but also its mixing and discharging.

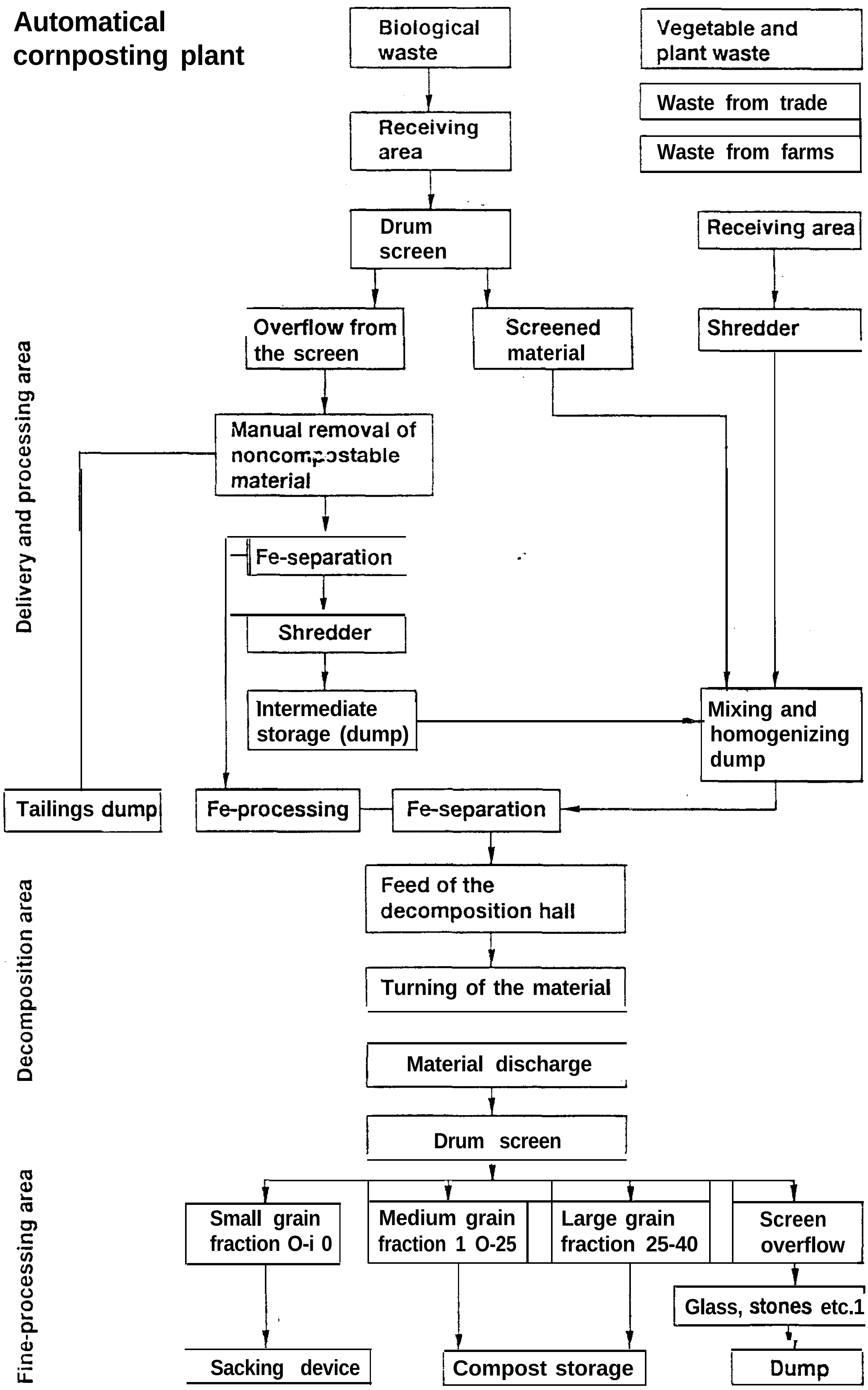
The composting process requires a regular mixing of the rotting material and, as it should take place aerobically, also requires a sufficient supply of oxygen and a sufficient dampness of the rotting material. The oxygen is supplied through a system which allows the individual ventilation of the rotting material in each separate channel depending on the temperature prevailing there. If the rotting material is too dry through ventilation, then watering is carried out by means of a watering device installed on the shifting machine. The temperature and the dampness of the rotting material are regularly controlled and registered.

After approximately 8-10 weeks storage of the waste in the rotting area, the composting process is ended and the fine processing phase can begin.

Fine processing phase

This processing phase serves to prepare the compost for use. The compost is removed from the rotting channel by the shifting machine, deposited in the material discharge area, and from there transported by means of a wheel loader to a screening drum with three fractions: a fine fraction (O-10 mm), a medium fraction (10-25 mm) and a rough fraction (25-40 mm). The fine fraction goes to a bagging installation. the other fractions, for reasons of quality and sale purposes, are transported to their own individual storage area for further use; this takes place either by means of a

Figure 2. Flow chart of an automatical cornposting plant

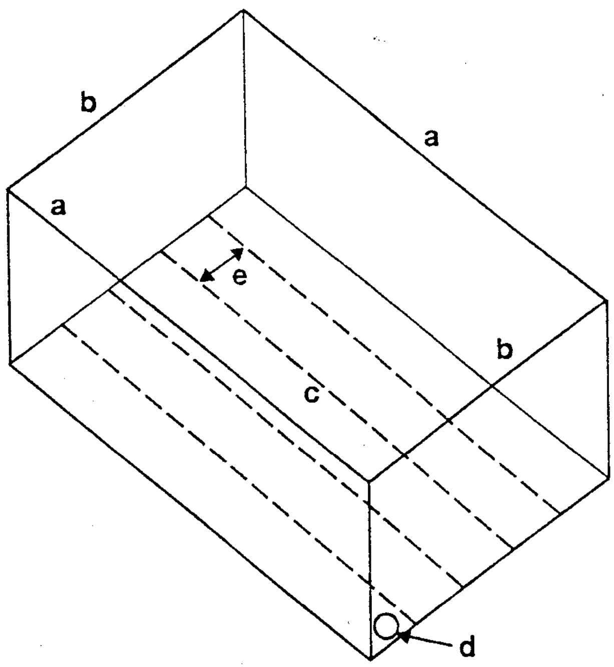


wheel loader or a conveyor belt. From the sieve overflow, stones, pieces of glass, etc., still contained in it, are separated; these materials are then deposited on a rubbish dump.

Description of the production of a rotting channel

An automatic composting plant comprises, as presented above, many aggregates, machines, etc. From these the production of a rotting channel with the following characteristics (see figure 3) has been chosen:

Figure 3. Rotting channel



Material: corrosion-free steel-reinforced

Method of building: for reasons of transport pre-fabricated concrete parts
2 side walls (a)
2 front walls (b)
1 floor (c)

Measurements:

Front wall: height 3 m
width 5 m

Side wall: height 3 m
length 12 m

Floor: length 12 m
width 5 m

The walls have a thickness of 10 cm; on one front wall at the bottom on the left there is a hole (diameter 25 cm (d)) for the in-take of the ventilation system.

The floor is 18 cm thick; in addition it has four longitudinal rows of slit-shaped openings (2.5 cm wide, 12 cm long (e)) to let the water out.

All other machines, systems and aggregates, belonging to a functionable automatic composting plant are delivered from outside and integrated into the plant on the site.

Description of the production process

The description of the production process concerns the manufacture of two front walls, two side walls and the floor for a rotting channel with the above-mentioned measurements in a concrete factory. In practice these parts are only produced according to demand or on order and their production has to be integrated into the daily production process of the factory.

The production process begins with the determination of the amounts of cement, gravel, sand and perhaps any necessary additional materials, which are required to produce in a mixer the necessary volume of concrete in the desired quality; also the amounts of steel armouring or necessary protective paint have to be calculated.

Parallel to concrete production-or even before— the preparation of the moulds for the individual channel walls and the channel floor can take place. This means that the steel armourings as well as the different recesses (on one front wall the circular opening for the ventilation connection, on the floor the longitudinal openings for the water flow) are prepared.

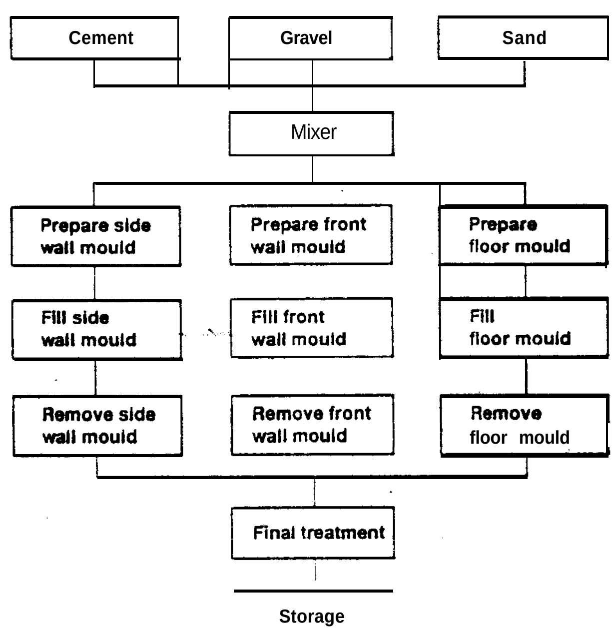
If, after taking a sample, the concrete is shown to have the required quality, then this is poured into the prepared moulds by means of a pouring bucket suspended from a crane and condensed through even vibration.

When the concrete has set, after approx. 48 hours, the moulds can be carefully removed; this is followed by the after-treatment. In this case any existing seams are removed. Special attention should be given to the circular recess on the one front wall and to the water exit slits in the channel floor.

Finally all produced parts are coated with a concrete-protecting paint; because of the relatively large surfaces it is advisable to use either a paint roller or a paint spray.

When the paint has dried all the prefabricated concrete parts can either be stored or prepared for transport to the site, where the rotting channel is assembled and fitted into the composting plant.

Figure 4. Flow chart



Example of a production plant

It has already been mentioned, that a concrete factory does not normally produce a rotting channel or rather the five prefabricated concrete parts each day, but instead integrates their manufacture according to demand into its production; for this reason it is not very easy to give exact details on the energy and personnel required for their specific manufacture. However, in order to obtain some basic values, it is presumed that the concrete factory only produces rotting channels and in this case three units per day.

Required machinery and equipment

Description	*Pieces*
Cement silo	1
Gravel/sand silo	1
Mixer	1
Casting moulds	15
Vibrators	5
Crane with pouring bucket	1
Fork-lift truck	1
Work-benches	3
FOB-price for machinery and equipment (199 1)	Approx. US$ 2 million

Required manpower

Manager	1
Technical Manager	1
Economic Manager (also responsible for administration, accounting, advertising, etc.)	1
Administration personnel	2
Foreman	1
Skilled workers	2
Semi-skilled workers	4

Required buldings and areas

	Square metres
Production, total area	650
of which:	
Silos and mixer (outside, whereby the mixer should be covered by a roof)	330
After-treatment, assembly (in a hall)	320
Management and administration	110
Social facilities	140
Storage	250

Required energy

Electricity	230 kW
Water	60 m^3/day

Required area

Concrete		30 t/day
made up from:	40% gravel	
	25% sand	
	35% cement	
Steel		1.5 t/day
Paint		1.8 m^3/day

This information has been prepared by UNIDO as a result of the financial contribution to UNIDO from the Government of Germany and the close cooperation extended to UNIDO by the relevant industries in Germany. Any inquiry should be sent to Registry file no. 312/07 (003), UNIDO, P.O. Box 300, A-1400 Vienna, Austria.