Producing an agriculturally usable fine fraction by MBT of municipal solid waste

Morvan Bernard

Cemagref, Rennes, France

Abstract

In France more than a hundred MBT plants were working twenty years ago. Most of them stopped because without maturation there was little difference with direct land spreading.

There is not a fundamental difference between a composting plant and a MBT plant to treat MSW. Due to the production of compost, the quantity of stabilised waste to be put in landfill (composting rejects) are reduced.

If the quality of compost obtained from MSW and from separately collected biowaste is the same, a composting plant of MSW will be technically and economically very interesting, considering the costs of landfilling or incineration and the recovery ratio of organic matter. The global cost of MSW collection and treatment can decrease by about 25%, compared to separate management of biowaste.

Keywords

MBT, MSW, Municipal Solid Waste, Biowaste, Compost, Composting, Heavy metals, Impurities.

1 Introduction

Some years ago we had MSW composting plants that produced bad compost mainly in terms of impurities and heavy metals. Some North European countries decided to make good composts with the selective collection of biowaste and then incineration or MBT plants for the rest of MSW. An alternative solution could be to improve the composting process of MSW, in order to obtain MSW composts with the same quality as biowaste composts. We proved that it is possible in the French plant of Lantic that has worked very well since May 2004. Of course, further MBT is a good way to treat composting fresh rejects.

The table 1 shows the current points of view on what is best to do. With a high quality of MSW composts the opinion changes.

Table 1 different point of view

Process	Europe	High quality of MSW compost
Selective collection of dry materials	Yes	Yes
Selective collection of biowaste	Yes	No
MSW composting plant	No	Yes
MBT for MSW	Yes	No
MBT for composting plant rejects	Yes	Yes

2 The composting plant

2.1 What quality of composts?

Agriculture demands good quality composts, but other uses also: municipalities, for public space re-use of fallow industrial sites, or forestry. It is not admissible to produce bad quality composts with high levels of heavy metals, glass and plastics, when the adequate technology is available. Disposal of good quality composts has never been a problem. The thresholds for heavy metals contents in composts, according to the European draft for the EC directive on biowaste in 2001[1] and 2004[2] are presented in table 2. Thresholds for impurities, 0.5% dm for high quality compost and 3% dm for a second quality, are also presented. The considered impurities are glass, plastics, and textiles, also called man-made fragments. Table 2 present the thresholds of ECOLABEL[3].

Table 2 Milestones for heavy metals (mg/kg) and impurities (%) contents in compost

Heavy metals	Class 1	Class 2	Stabilised Biowaste	Ecolabel
Pb	100	150	500	100
Cd	0.7	1.5	5	1
Hg	0.5	1	5	1
Cu	100	150	600	100
Ni	50	75	150	50
Cr	100	150	600	100
Zn	200	400	1500	300
Impurities	0.5	0.5	3	-

Class 1 compost of the draft biowaste directive is very difficult to achieve without dilution with a clean material, but not impossible. The problem now is that, in France, some MSW composts are better than biowaste composts. The values on mature composts being around 1.6 fold those on fresh composts, due to organic matter losses (about 50%) during maturation. Mechanical sorting, in some cases, is as efficient as man-made sorting of households, in terms of compost quality! That is the main message of this paper.

2.2 The best available technology

For successful MSW composting, it is necessary at first to create conditions for the separate disposal of special waste, mainly batteries. Then, a treatment scheme like the one depicted in figure 1, which corresponds to the composting plant of Lantic in France, is appropriate for successful MSW composting. To evaluate the overall efficiency of biologic treatment plants, a methodology was published in 2004[4].

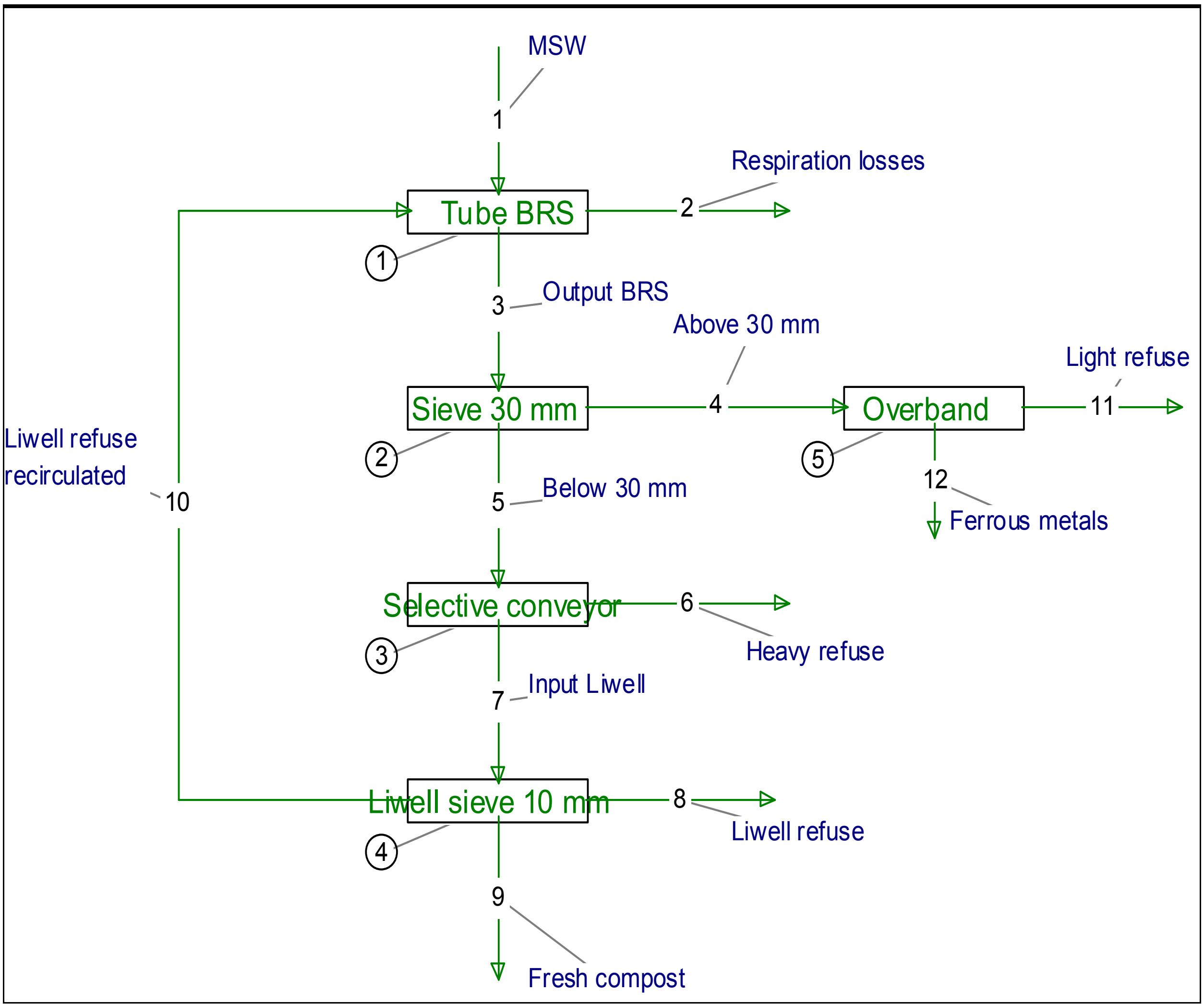

Figure 1 Scheme of Lantic composting plant in France

2.2.1 What is FORBIDDEN?

Shredders or hammer mills are absolutely prohibited for MSW composting, because the size reduction of organic matter particles is accompanied by the size reduction of contaminants particles, and the extraction of small size impurities is then impracticable. Moreover, batteries, if present, are destroyed and cause the contamination of compost.

Compost sieving at a small sieving size is essential, as the presence of plastic or glass fragments in compost has a bad visual impact.

The use of densimetric tables cannot be made on materials with high wet matter contents, as their efficiency will be impaired.

Sieving MSW at 100 mm at the beginning of the process is commonly practiced, but one should be aware that around half or organic matter is lost, mainly due to paper and cardboard losses.

2.2.2 The rotary drum

The rotary drum is used to decrease the particle size of organic waste and to start the fermentation in closed conditions, making sure that all the material flow achieves appropriate temperature and humidity levels. This is not the case in windrows, where there is a temperature profile with lower temperatures on the outer layer of material, as well as humidity profiles.

Particle size is a very important issue in composting. For example, for paper, which is a very significant part of organic matter in MSW composting, its particles size has to be reduced below a certain limit, normally around 30 mm, in order to keep paper in the composting mass and, at the same time, be able to take off contaminants like plastic and glass pieces which have a particle size above that value. This paper particles size reduction can be easily achieved in a rotary drum if adequate levels of humidity and temperature, respectively around 50% and 60ºC, are maintained during long enough. With these conditions and the mechanical action caused by the rotation of the drum, which is generally around one rotation per minute, these organic fragments are properly reduced in size.

The length of a rotary drum depends on the flow, and is normally designed to achieve a 3 to 4 days retention time, which is enough to reduce the size of organic matter particles. The length of the rotary drum is calculated considering a material density of 0.70 t/m^3 and a filling ratio of 65%. In practice, drums with diameters from 3.6 to 5 m and lengths from 20 to 60 meters can be found. In a typical size drum of 48 meters, the total MSW load comes near to 300 metric tons, which represents a MSW daily input of around 100 tons, or slightly higher if the plant works during the weekend.

2.2.3 The first sieving at 30 mm

If paper particles are reduced in size, sieving can be done at 30 mm, but in practice sieving at 20 to 50 mm is observed. The reject of the drum, i.e., the fraction above the sieving size, has a very low organic matter content and is therefore not valuable for compost production. This fraction is directed to landfilling or incineration, after being passed in an overband in order to extract ferrous metals, packaging and non-packaging, which represent 2.5 to 3% of the global MSW input.

The rejected fraction of the sieve is often called light reject, due to its low density, on account of the high content of plastics and textiles.

2.2.4 The selective conveyor

The selective conveyor is densimetric separation equipment that is used to take off heavy particles like glass, metals, stones, and also batteries, if these are present in the waste. The material falls on an inclined conveyor belt of about 1 meter long, heavy particles rebound and fall on the low side, light ones remain on the belt and are carried towards the high side. A double selective conveyor is more effective than a simple one, but it demands for a big height of fall, higher than 1.5 meter for each conveyor. The advantage of this equipment is that it allows matter with relatively high water contents to be treated, unlike other densimetric separation equipments, as the densimetric table.

2.2.5 The second sieving

The second sieving, performed at a smaller size than the first sieving, is aimed at taking off more plastics and glass, after or before maturation. Direct sieving is possible, as in the Lantic plant, in France. After the selective conveyor, the material is sieved in a special screen with a small sieving size, 6 to 10 mm. That is possible with the flip-flow Liwell technology, which accepts matter with relatively high water contents without plugging.

The second sieving size is mainly dependent on the contaminants particle size distribution in the stream to sieve and on the aimed compost quality.

If there is a high content of organic matter in the reject of the screen, i.e., the fraction from 10 to 30 mm, it is possible to put it back in the pit of the plant. That is done on Thursday and Friday, so that during the weekend this reject receives further treatment in the drum, and its organic matter particles are further size reduced and this way incorporated in the compost.

The advantage of performing the second sieving before maturation is that a good quality product is obtained at this stage, giving the possibility of mixing it with other clean wastes, like green waste. Furthermore, the compost produced after maturation needs no further treatment operations, e.g., it is not necessary to use a loader to take again the compost for refining.

2.2.6 The maturation

There is a wide range of possibilities to maturate organic matter, ranging from the classical windrow systems to the aerated static pile and the hybrids of these systems. In the forced aerated systems, blowing or suction can be used, as well as a mix of both. Composting can be carried out in the open air or in closed buildings, some of which with complex output gases treatment systems.

In the end of the maturation step, different compost maturation degrees can be achieved, depending on the requirements for the end use of compost.

2.2.7 The option of refining after maturation

After the selective conveyor, the stream below 30 mm can be directly maturated during 5 to 8 weeks in order to stabilise the organic matter. When this is the case, the maturated material is relatively dry and easy to sieve at 6 to 8 mm. After that, it is possible to use a densimetric table to take off glass and other heavy particles, as is the case of the plant of Champagne sur Oise, in France.

The advantages of refining the material only after maturation are that more organic matter is recovered in the compost, and that many types of screens can be used.

2.3 The results in Lantic composting plant[5,6]

2.3.1 Quality of compost

The table 3 shows the heavy metals content. Sometimes (once per ten) a metal content reach the threshold, but the mean is always good. The table 4 shows the results of impurities. We have to notice that when you find 1% of impurities by manual sorting method, we find 1.6% by French method using bleach. The table 5 shows the levels of pathogens are low, but further and more precise analysis is needed on these parameters. The table 6 shows that MSW contain very few pesticides.

Table 3 Heavy metals content

ETM (mg/kg dm)	Mean of fresh compost at Lantic	Mean of mature compost at Lantic with 30% of green waste	Mean of biowaste composts in France	90th percentile of biowaste composts in EC
Copper	**66**	**103**	**71**	**80**
Zinc	**235**	**294**	**235**	**284**
Chromium	**42**	**29**	**39**	**37**
Cadmium	**0,8**	**0,7**	**0,7**	**0,89**
Mercury	**0,3**	**0,3**	**0,2**	**0,35**
Nickel	**23**	**17**	**19**	**30**
Lead	**59**	**86**	**119**	**105**

Table 4 Impurities

Impurities (% dm)	Mean of fresh compost at Lantic	Mean of mature compost at Lantic with 30% of green waste	Mean of biowaste composts in France	French standard U44 051
Glass, metals >2 mm	**0.7**	**0.9**	**1.5**	**2**
Hard plastics >5 mm	**0.4**	**0.4**	**0.1**	**0.8**
Films > 5 mm	**0.11**	**0.08**	**0.0**	**0.3**

Table 5 Pathogens

Pathogens	Mean of mature compost at Lantic with 30% of green waste	Mean of biowaste composts in France	French standard U44 051
Escherichia coli (per g)	<10	**1.5**	**2**
Helminths eggs in 1.5 g	No	**0.1**	**0.8**

Table 6 Pesticides

Pesticides (mg/kg)	Mean of mature compost at Lantic with 30% of green waste	Mean of bio-waste composts in France	French standard U44 051
Fluoranthen	0.18	**0.5**	**4**
Benzo(b)fluoranthen	0.08	**0.5**	**2.5**
Benzo(a)pyren	<0.05	**0.2**	**1.5**

2.4 Material balance in MSW composting plant, Lantic example

To do a relevant comparison we must take in account all the main streams of household waste, table 7.

Table 7 waste productions in France

Production Kg per year per inhabitant	Lantic Without bio-waste	Simulation With biowaste
Selective collection of materials	110	110
Selective collection of biowaste	0	180 (a)
Drop-off centre	130	100
MSW	290	200
Total	530	590

(a) We find around 40 kg of food waste, but with green waste we reach on average 180 kg per year per inhabitant.

After treatment these streams will produce rejects, table 8.

Table 8 Waste to be landfilled after treatment in France

Landfill Kg per year per inhabitant	Lantic Without biowaste	Simulation With biowaste and MBT
Selective collection of materials	22	22
Selective collection of biowaste	0	36
Drop-off centre	7	5
MSW	131	134
Total	160	197

In the end there is 37 kg less to put in landfill or incinerate, in the MSW composting solution.

2.5 Simulation of MBT after composting, all waste streams taken in account

It is possible to do better than the Lantic process if we put the rejects of the packaging waste sorting centre in the composting plant and if we make MBT on composting plant fresh rejects.

The table 7 shows in the end that we have 160 kg of residual waste in Lantic scheme. The MBT process would easily divide by 2 the non-synthetic organic matter of each reject (sorting plant and composting).

Generally we have two kinds of rejects with 20 to 30% of non-synthetic organic matter on DM: plastics, textiles and iron upper than 30 mm called light rejects; glasses, batteries below than 30 mm called heavy rejects.

The aim is to maturate these rejects in order to reach an AT4 level of 5 mg/g (German threshold for landfilling), the time of treatment depending on the intensity of the fermentation: 45 days in the laboratory, six months or perhaps more than one year outside.

So in our simulation we would have only **125 kg** of stabilised waste to put in landfill, mainly glasses, stones, textiles and plastics.

3 The economic point of view

Probably the different costs can be different from one country to another, but our data based on the French case is shown in table 9. We consider here that the subsidies cover the costs of packaging waste selective collection, sorting and disposal. The landfill tax is now at 9.15 euros per ton.

Table 9 Costs simulated

Costs in euros per ton	Collection	Composting	MBT
MSW	100	60	50
Biowaste	120	70	
Composting rejects			30
Drop-off centre	0	50	

We are able to calculate the global cost per inhabitant. It is clear that the global costs are 20% lower without the selective collection of biowaste.

Table 9 Global cost per inhabitant

Costs in euros per inhabitant	Biowaste and MBT for MSW	MSW composting, MBT for rejects
Biowaste	33.8	0
Drop-off centre	5	6.5
MSW composting	0	45.8
MBT for MSW	30	3.3
Landfilling and tax	5.5	3.5
Total	74.3	59.1

4 Conclusion

Biowaste and MSW composts are made with the same organic matter sources. Only the dilution with green waste changes, tending to be higher in biowaste composts.

The quality of composts made from MSW can be the same as the quality of those made from biowaste, if the best available technology is used.

The best technology used for MSW composting consists on the following sequence: separate disposal of special waste, mainly batteries and WEEE (waste electrical and electronic equipment); rotary drum during four days; sieving at 30 mm; double selective conveyor; second sieving at 10 mm; maturation. It is possible to do better, but already the compost of Lantic in France is not far from the Ecolabel standard!

Instead of landfilling 200 kg per inhabitant with selective treatment of biowaste and MBT process, it is possible to landfill only 125 kg without selective collection of biowaste, MSW composting and MBT for all rejects.

The costs treatments are similar for composting and MBT but the total waste treatment cost increases about 20% when the selective collection of biowaste is introduced.

5 References

1 Brussels DG ENV.A.2/LM	2004	Draft discussion document for the ad hoc meeting on biowaste and sludges
2 Brussels DG ENV.A.2/LM	2001	Biological Treatment of Biowaste – Working Document (2nd draft)
3 JOCE 2001/688//CE	2001	Eco label
4 Baptista, M. Morvan, B.	2004	Methodology for evaluating the overall efficiency of biological treatment plants, AWAST Deliverable 15
5 Briand, M.	2004	Analysis of heavy metals, composting plant of Lantic
6 Morvan, B. Blanquart, JP. Le Saos, E.	2004	Composting plant test of Lantic

Author's address

Research engineer Bernard Morvan
Cemagref
17, avenue de Cucille
CS 64427
35044 Rennes cedex
France
Phone +33 2 23 48 21 43
Email: bernard.morvan@cemagref.fr
Website: www.cemagref.fr