MBT before landfilling in France – state of the art and results of mass balance in SDEE – Mende Landfill

J. de Araújo Morais, F. Achour, G. Ducom, R. Bayard

Laboratory of Environmental Analysis of Industrial Systems and Processes (LAEPSI) - National Institute of Applied Science (INSA), Villeurbanne, France.

Abstract

Recently, several French communities have shown interest towards the installations of mechanical and biological treatment of their domestic waste in order to respond to the requirements of the European regulation. This paper presents the current situation of MBT waste in France, based on the experience of the French units, and approaches in particular: the process configurations, the pre-treatment durations, the landfilling capacity, the quantity of processed waste per year and the expected residual waste quality.

Furthermore, the first results related to the mass balance of the SDEE – Mende MBT unit are presented. The mass balance of the MBT plant is exposed in relation to the Dry Matter (DM), Volatile Matter (VM), Oxidative Organic Matter (OOM) and Inert Matter (IM) like plastics and inorganic products.

Keywords

MBT, France, process configurations, mass balance, dry matter, stabilisation.

1 Introduction

The EU Landfill Directive (1999/31/EC) asks for a stepwise reduction of the amount of biodegradable waste to be landfilled. Mechanical and Biological waste Treatment (MBT) is one option to achieve this target. However, the Directive does not specify the requirements concerning the installations of MBT units, nor the evaluation criteria of the products which result from this process and which will be intended for landfilling. Therefore, European countries will have to define the treatment conditions and the objectives to be reached in term of quality of waste, in order to guarantee its acceptance in the landfill.

In France, many platforms of composting have been developped to compost municipal solid waste (MSW) in the objective of producing compost intended to be an organic soil conditioner of the arable lands. The low effectiveness of the sorting operations (before or after composting) has seriously penalized this path because of the bad quality of the products and, in particular, the presence of many undesirable elements such as plastics. In addition, the fixing of rigorous criteria concerning the quality of the composts resulting from MSW implies an adaptation and/or an optimization of the treatment processes. Consequently, many platforms closed down, due to the lack of outlet for the MSW composts.

In recent times, several French communities have shown interest towards the installations of mechanical and biological treatment of their domestic waste, in order to respond to the requirements of the European regulation. At the moment, there are four MBT units in activity or under development in France: Mende, Carpentras, Lorient and Lille.

2 Situation of MBT waste in France

2.1 Process configurations

The four French MBT landfills have different configurations. The Carpentras plant, which is operational for some time and the Mende plant both receive municipal solid waste, which undergoes a screening before being evacuated towards different treatments. Contrary to these, the last two plants (the Lorient plant, which construction has just finished and the Lille plant, which construction is almost finished), will receive refusal of the sorting unit and/or refusal of the composting plants.

2.1.1 SDEE – Mende landfill

The Mende plant (figure 1), first French plant of mechanical-biological treatment of municipal solid waste before landfilling, was carried out with the financial support of the ADEME (French Agency for Environment and Energy Management) and is opened since July 2003. It receives approximately 25,000 tons per annum (Tpa). It comprises a control field of entering waste (with radioactivity detection), the MBT unit, three different residual waste storage cells, associated with three leachate collection basins and with a basin for rain water.

Waste is poured using a loader on a carpet supplying the first trommel screen. This trommel screen, equipped with knives and two grids of meshes 70 and 450 mm, allows the plastic bags dilaceration and granulometric separation: the bigger fraction (> 450 mm) is evacuated towards the storage cell reserved for voluminous waste; the fine fraction (< 70 mm) is evacuated towards an aerobic stabilization open tunnel where it undergoes during 6 to 10 weeks a forced aeration (alternated air blowing and air aspiration, by the bottom of tunnel) and two mixings (by tunnel change); the 70 - 450 mm fraction is introduced (with leachate addition) into the RSB (Rotating Sequential Bioreactor), where it remains 2 to 3 days.

At the RSB exit, a second trommel screen, provided with a 50 mm grid, carries out a new granulometric separation, in two fractions: the > 50 mm fraction undergoes a metal separation and the residual one is baled before being evacuated towards the storage cell which is reserved to them; the < 50 mm fraction, like the < 70 mm fraction from the previous step, is evacuated towards an aerobic stabilization open tunnel where it undergoes the same treatment as the latter.

Both fine fractions (< 70 mm and < 50 mm) are then laid out in windrows where they undergo a new biological stabilization step during 10 to 20 weeks (two turnings). Then, they are sent towards the third landfill storage cell, reserved to the stabilized organic fraction.

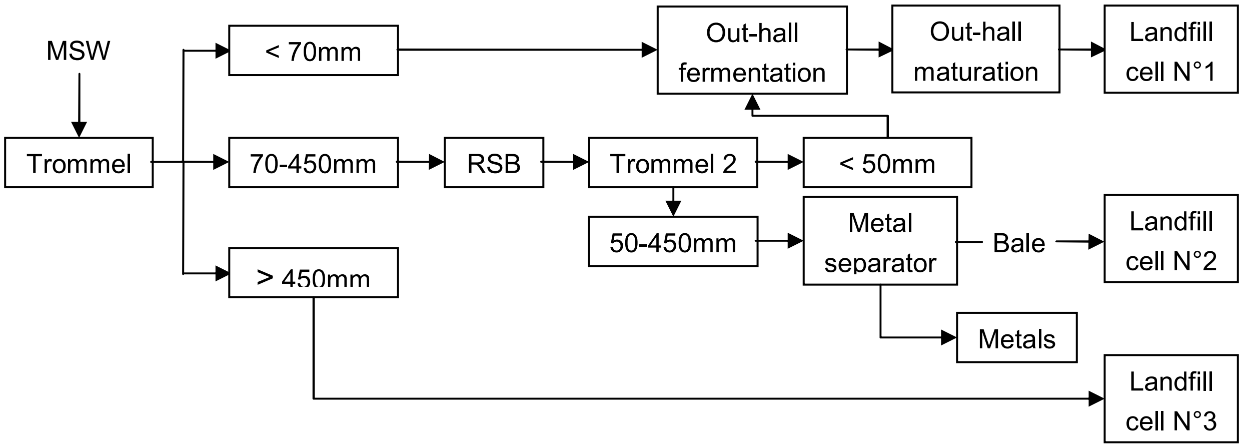

Figure 1 : Mende MBT process.

2.1.2 Carpentras landfill

The Carpentras plant (figure 2) capacity is 30,000 tons per annum. After the incoming waste control, the waste is sent to a trommel screen (two grids of meshes 80 and 300 mm) where it is separated into 3 fractions: the > 300 mm fraction is manually sorted, in order to remove of the pile the matter which may be recycled, before it is baled and then landfilled; the < 80 mm fraction is put in windrow in a composting tunnel (hermetically closed, where the air is treated by biofilters) during 6 weeks; after that, the fraction is sent on a maturation platform in the open air and then stored; the 80 - 300 mm fraction is energetically upgraded in an incinerator.

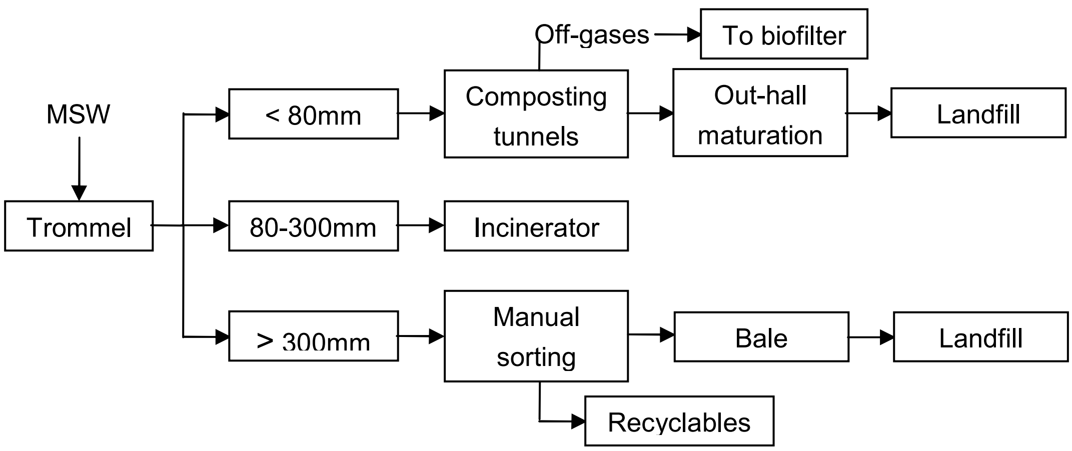

Figure 2 : Carpentras MBT process.

2.1.3 Lorient landfill

The Lorient plant (figure 3), which has just opened, receives 2 types of waste from 2 different collections (selective collection and biowaste collection) and which are first sent either in a unit sorting or in a composting plant. Refusal of the sorting unit and the composting plant (approximately 57,000 Tpa) is recovered for then undergoing a mechanical-biological treatment. First stage of the MBT is shredding, followed by an extraction of ferrous metals and by a homogenisation. Then, the totality of homogenized waste is treated in composting tunnels closed hermetically during 5 weeks (with one turning) and then sent to a maturation platform in the open air. The air is treated by washing and biofilters.

The whole stabilized waste is landfilled on a second site, which was conceived for this type of waste. This landfill is situated 25 km from the treatment installation.

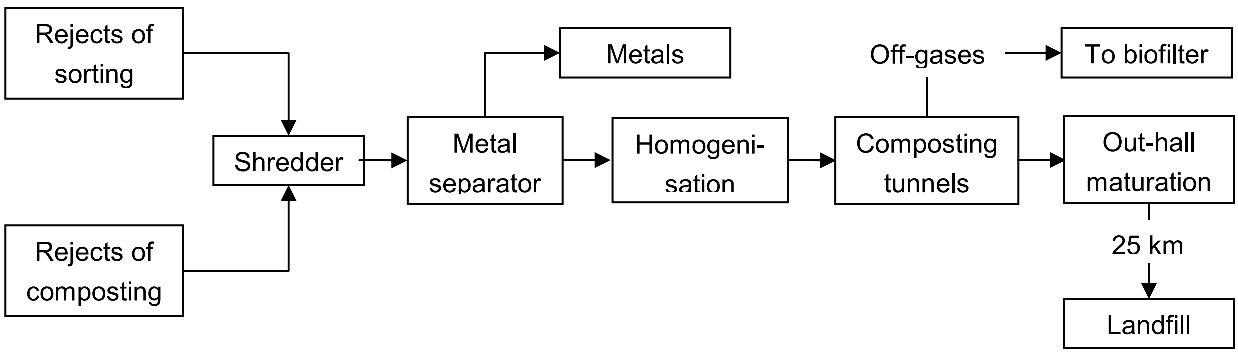

Figure 3 : Lorient MBT process.

2.1.4 Lille landfill

The Lille plant (figure 4) is the only one which, currently, is not in operation. The project is to create an organic matter valorization center, with a capacity of 100,000 tons per annum. Lille plant will shelter a biomethanization unit; therefore, the objective is to produce a compost but, also, to recover the biogas (methane) which will be produced.

Once shredded, the biowaste undergoes a biological pre-composting step by aeration. Then, the matter remains approximately 25 days in digesters. The digestate is mixed with the green waste, shredded and sent to the post-composting step, which is carried out in two successive stages: an intensive composting stage (in a line of 22 composting tunnels) and a maturation stage (carried out in windrows in a covered and closed tunnel). All the buildings have air collecting networks used for deodorization by washing then by filtration (biofilters).

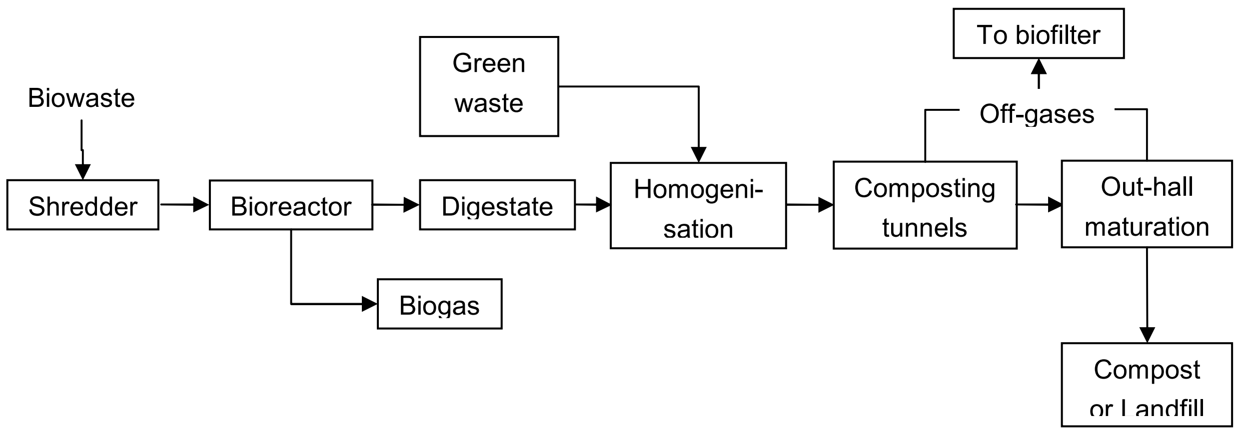

Figure 4 : Lille MBT process.

2.2 Landfills characteristics

The principal characteristics of the French sites is summarized in table 1.

Table 1 Landfills characteristics

Landfill	Mende	Carpentras	Lorient	Lille
Delivered waste	MSW	MSW	Refusal of sorting	Bio waste
Processed waste	25,000 Tpa	30,000 Tpa	57,000 Tpa	100,000 Tpa
Fermentation duration	6 – 10 weeks	6 weeks	5 weeks	Not defined
Maturation duration	10 – 20 weeks	12 weeks	12 weeks	Not defined

3 Mass balance in Mende landfill

3.1 Introduction

One of the major objectives of Mechanical and Biological Treatment is volume and mass reduction and density increase of waste. Indeed, mechanical pre-processing of waste (particle size reduction and separation of fractions which may undergo benefici-ation) and partial mineralization of the organic matter during the biological treatment mean more space in the landfill. Mass reduction during biological treatment was deter-mined via water and organic matter content decrease.

Volatile Matter content (VM) was measured by calcinations of the dried sample. Calci-nations were performed at 550°C for 6 hours. This standardised method is described in the French gravimetric procedure AFNOR NF U-44-160 (1985).

Oxidative Organic Matter (OOM) was determined using the gravimetric procedure AF-NOR NF XPU 44-164 (2004) initially developed for inert material quantification in urban compost. The global solid matter analysis was first determined, then the method consisted of a total chemical oxidation of Organic Matter. This step was followed by a solid matter fractionation by sieving and weighing of Raw Plastic Material (RPM), Raw Inert Material (RIM), Fine Inert Material (FIM). Finally, OOM is estimated by difference: OOM = Total Solid Matter – RPM – RIM – FIM.

The VM and OOM content are the usually used parameters in most of MBT studies. These parameters tend to decrease during biological treatment, mainly during the fermentation phase.

3.2 Results

The first results related to the mass balance of the SDEE – Mende MBT unit are presented in figure 5. These results have been collected during two different sampling campaigns, which were performed respectively in September 2004 and March 2005.

The two campaigns gave very similar results. Consequently, only the results from the first campaign are given in this paper.

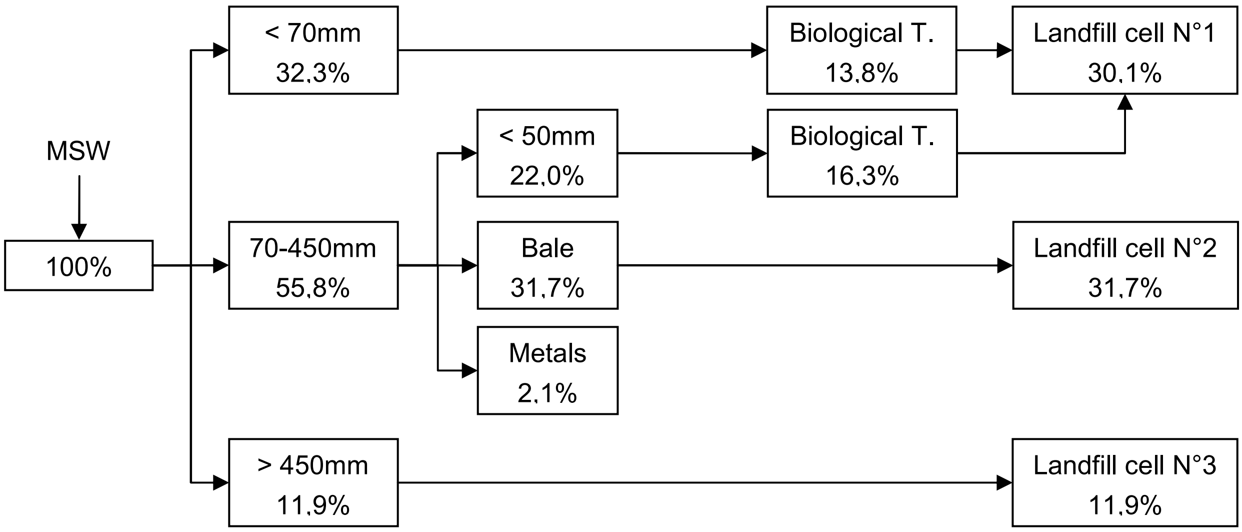

Figure 5 : Indicative mass balance for sampling campaign in Mende landfill (wet weight).

Figure 5 shows that after two particle size separations, the fractions which will undergo the biological treatment (< 70 mm and < 50 mm) represent a little more than 54 % of the incoming waste mass. After the biological treatments, only 30.1 % of the total incoming waste mass remain, which corresponds to a reduction of a little less than 50 % of the treated waste.

One other important information obtained from the figure is the percentage of baled waste: 31.7 %, which is relatively high. Concerning the other fraction that does not undergo biological treatment, that is to say the voluminous waste, it approaches a total of 12 %. A quantitative characterization of the fractions composition made on the 70-450 mm fraction (bale) and on the > 450 mm fraction during the sampling campaigns showed that the proportion of paper, cardboard, metal and plastic (which can be recycled) represents approximately 60 %. This means that if citizens sorted their recyclable waste better, both fractions could be significantly reduced.

Moreover, after the first trommel screen, the 70-450 mm fraction enters the RSB and then, in the second trommel screen, another fine fraction (< 50 mm), which represents 22 % of the incoming waste (approximately 40 % of the 70-450 mm fraction) is separated. The fact that this fraction had not been seperated in the first trommel screen can be explained by 3 facts: some plastic bags were not well dilacerated, leaving some fine particles inside the bags or there may be clogging of the 70 mm holes in the first trommel and finally, there are probably some first biological degradations happening in the RSB.

3.3 Dry matter, volatile matter and oxidative organic matter

The mass balance of the MBT plant is exposed in relation to the Dry Matter (DM), Volatile Matter (VM) and Oxidative Organic Matter (OOM). In this way, the present study provides the expected informations to evaluate the effectiveness of the biological steps of the process: the fermentation operation in the controlled aerobic tunnel and the maturation operation in the platform.

The matter characterization of the fractions sampled at these different stages of the MBT process is summarized in table 2.

Table 2 DM, VM and OOM for fractions sampled at different stages of the MBT process.

Sample	DM (%)	VM (%)	OOM (%)
Incoming waste (< 70 mm)	50.6	49.3	46.7
Fermented waste (< 70 mm)	55.0	42.8	39.7
Matured waste (< 70 mm)	71.6	42.8	32.9
Incoming (< 50 mm)	44.1	76.1	60.6
Fermented waste (< 50 mm)	48.7	61.6	40.8
Matured waste (< 50 mm)	46.3	59.3	25.4

Reduction in the content of VM and OOM of the two fractions (< 70 mm and < 50 mm) is faster in the first part of the aerobic treatment (fermentation). This decrease continues until the end of the treatment especially as concerns OOM content. The phenomenon is accentuated definitely more in the case of the < 50 mm fraction, which shows that this fraction is more quickly biodegradable. The residence in the RSB probably modified the characteristics of the < 50 mm fraction.

The more rapid degradation kinetics of the < 50 mm fraction compared to the other fraction can be associated with the fact that the first fraction is more homogeneous and is mainly composed of fine fragments, making the fermentable matter more accessible to micro-organisms. In addition, the residence in the RSB in the presence of leachate could favour the development of micro-organisms populations.

3.4 Mass reduction and the bio-stability of the MSW

The objective of MBT is to achieve a low environmental impacts material for landfill disposal. A condition for that is that the waste must have a low biological activity after treatment. In this way, the aim of the process is to reduce the organic content of the material as far as possible to form a stabilised product.

A mass balance could be established after weighting the waste at different steps of the biological treatment.

The mass reduction of the fractions during the biological treatment was calculated with regard to dry matter, volatile matter and oxidative organic matter. The mass balance is presented in table 3.

Table 3 Mass balance and mass reduction.

Sample (< 70 mm)	Incoming waste	Fermented waste	Matured waste
Mass (DM)	139.4 t	88.3 t	85.2 t
Mass loss (DM)	-	36.6 %	38.8 %
Mass (VM)	68.7 t	37.8 t	36.5 t
VM mass loss	-	45.0 %	46.9 %
Mass (OOM)	65.1 t	35.1 t	28.0 t
OOM mass loss	-	46.1 %	56.9 %
Sample (< 50 mm)	Incoming waste	Fermented waste	Matured waste
Mass (DM)	82.5 t	74.0 t	65.2 t
Mass loss (DM)	-	10.3 %	21.0 %
Mass (VM)	62.8 t	45.6 t	38.7 t
VM mass loss	-	27.4 %	38.4 %
Mass (OOM)	50.0 t	30.2 t	16.6 t
OOM mass loss	-	39.6 %	66.9 %

The beneficial effect of the biological treatment is obvious for both fractions since the VM and OOM mass losses are very high.

The main difference between the two fractions is that the mass loss is twice higher in the case of the < 70 mm faction and it is particularly high, for the < 70 mm faction, at the end of the fermentation step.

This mass balance shows that the VM and OOM mass losses are quite similar for both fractions. It seems that VM mass loss is higher for the < 70 mm fraction (46.9 %) and that OOM mass loss is higher for the < 50 mm fraction (66.9 %). The main difference between VM and OOM is that, contrary to OOM, VM takes some plastic materials into account.

4 Conclusion

Results obtained during the sampling campaigns in Mende landfill show that a little more than 54 % of incoming waste (wet weight) undergo the biological treatment. Approximately 50 % of mass loss is reached.

The mass balance shows the beneficial effect of the biological treatment on the 2 fine fractions. Indeed, the biodegradation rate of the oxidative organic matter for the fraction < 70 mm fraction was 56.9 % and for the fraction < 50 mm fraction was 66.9 %.

This good result is due to the fact that the incoming waste contains a high proportion of degradable waste.

It is important to evaluate also the maturated waste stability.

These good results justify the MBT efficiency and it is now necessary to continue investigations into MBT, to improve its performance and to minimize the remaining environmental impacts.

Author's address(es)

Dipl.-Civil Engineer and PhD student Joácio de Araújo Morais
Laboratory of Environmental Analysis of Industrial Systems and Processes (LAEPSI)
National Institute of Applied Science (INSA)
20, Avenue Albert Einstein – Bâtiment Sadi Carnot
Villeurbanne
France
Phone +33 472 43 81 76
Email joacio.de-araujo@insa-lyon.fr