Suitability of MBT Facilities in Treatment of Different Kinds of Wastes

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Eignung von MBA zur Behandlung unterschiedlicher Abfallarten

Abstract

The results of Ecodeco's long-term experience in managing MBT plants based on the Biocubi aerobic process are presented. These plants are based on a modular architecture that ensures great reliability in the treatment of so-called Residual Waste and at the same time guarantees a reduction in the environmental impact of the activities.

More in detail, the performances of plants treating waste from areas where collection is implemented in different ways are shown and discussed. Finally, some indications on the compost plant based on the same architecture are given.

Keywords

MBT plant, aerobic treatment, Biocubi, weight loss, Refuse Derived Fuel, RDF, biological stability

1 Introduction

The Ecodeco group has been developing treatment plants for wastes of municipal origin based on the Biocubi process since the early 1990s. **(1)**

The Biocubi process is an aerobic treatment for solid waste composed of organic materials.

Through forced, controlled aeration, the process favours aerobic bacterial proliferation which transforms part of the easily biodegradable (putrescible) organic matter chiefly into carbon dioxide. The respiration process raises the temperature of the waste mass and in these conditions the mass dries and stabilises.

The reaction on which the process is based is as follows:

$n_1C_{x1}H_{y1}O_{z1}N_{w1}+n_2O_2 \text{---->} C_{x2}H_{y2}O_{z2}+n_3CO_2+n_4H_2O+n_5NH_3$

An example of a balanced reaction formula that occurs in the organic matter from Municipal Solid Waste (MSW) is:

$1.37\ C_{3.73}H_{4.94}O+1.71O_2 \text{---->} C_{3.67}H_{4.9O}+1.43CO_2+0.93H_2O$ **(2)**

The aerobic treatment generally lasts two weeks. After the treatment the characteristics of the input waste are considerably changed in terms of weight loss (due to water evaporation and consumption of organic matter) and biological stability (respirometric index).

The currently operating plants here considered treat the Residual Waste (RW) remaining after separate collection of recyclable-reusable fractions pof MSW. One plant treats the wet (kitchen) waste from separate collection.

The material obtained from the aerobic treatment, called the Biodried Material, can be considered a metamaterial that is usable in multiple ways.

The currently utilisations of this material are:

- Further mechanical refining for separation of Refuse Derived Fuel (RDF), recoverable fractions. The chief advantage of working on a biodried material is represented by the greater separating efficiency in the recovery of RDF and the other usable fractions.
- Landfilling. In this case the stability of the material mitigates the environmental impacts.
- Separation between the methanogenic fraction (rich of biodegradable materials) and the biologically inert fraction (rich of plastics) of the biodried material and transfer of the methanogenic fraction into an anaerobic reactor. In this case biogas extraction occurs as the result of an activation reaction of material that is otherwise stable and therefore inert.

Below, we want to demonstrate the flexibility of MBT treatment, which makes it perfectly suitable for treating the RW coming from different collection methods. This means that MBT plants are usable over a long time span within which the methods and the amounts of the separately collected frctions can vary widely and adapt to the contingent socio-economic realities. In all these cases the production of a biodried material with homogeneous, comparable characteristics is achieved.

To demonstrate this we present below the data from treatment plants that are up and running in areas where the implementation of separate waste collection is very different.

The plants currently in operation are: Giussago (PAVIA); Corteolona (PAVIA); Bergamo (BERGAMO); Montanaso (LODI); Lacchiarella (MILANO); Cavaglià (BIELLA); Villafalletto (CUNEO); Frog Island (LONDON) and Dumfries (Dumfries&Galloway-SCOTLAND). The following table summarises the data of these plants.

Table 1 Characteristics of Biodrying Plants Currently in Operation

Plant	**Production starting date**	**Annual treatment capacity (Mg/Year)**	**Type of waste**
Giussago	February 1996	40,000	RW
Corteolona	September 1996	120,000	RW
Bergamo	December 1998	60,000	RW
Montanaso	May 2000	60,000	RW
Lacchiarella	November 2002	75,000	RW
Lacchiarella	November 2002	30,000	WW
Cavaglià	May 2003	120,000	RW
Villafalletto	September 2004	65,000	RW+NBW
Frog Island	September 2006	180,000	RW
Dumfries	November 2006	65,000	RW

Legend: RW=Residual waste; NBW=Non Biodegradable Waste from other collection channels; WW=Wet (Organic) Waste from separate collection.

Since all the plants are modular, uniformity of treatment and comparability of the qualities of the produced materials are assured.

Modularity means that the required treatment capacity is achieved by flanking several basic treatment modules. Specifically, the basic treatment module is one that permits the annual treatment of the equivalent of 60,000 – 75,000 Mg of MSW.

By basic treatment module is meant a compact building with floor measurements of around 100 m x 20 m, containing all the electromechanical installations necessary for the reception, treatment, moving and extraction of the waste and treatment of the exhaust air. From the plant engineering standpoint this translates to great reliability since the module can be considered a series-built machine whose performances can be reproduced with certainty.

To illustrate the concept, the following figure shows the Frog Island plant, which is based on three basic modules placed alongside each other.

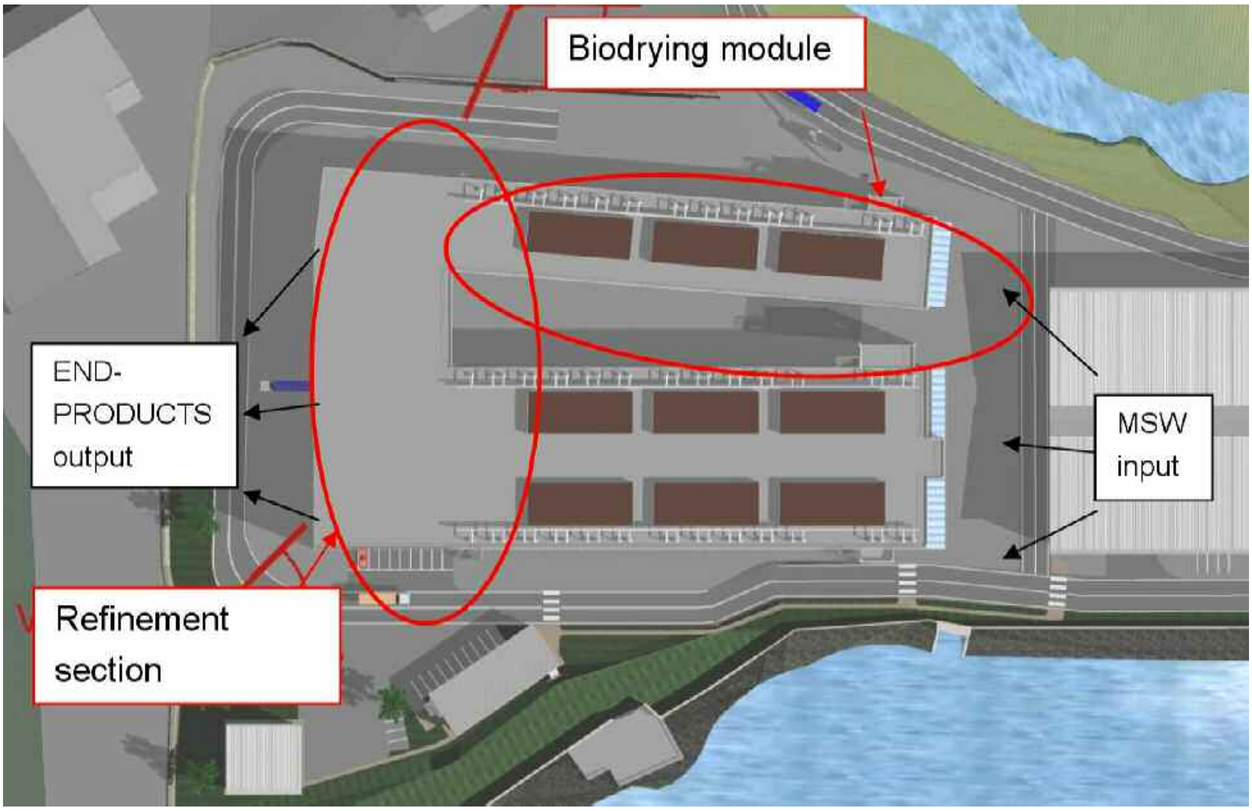

Figure 1 Overhead view of the London plant (Frog Island) indicating the different sections.

Table 2 Input waste composition, weight loss, end material in output from London plant (3)

Input waste composition	**% referring to weight of incoming waste**
Glass	3.9
Plastics	20.6
Metals	6.1
Non-combustible	2.2
Organics (Biodegradable Municipal Waste)	67.1
Input waste moisture content	
Moisture content	40.2
Weight Loss	
Weight loss	28.4
Output end products	
RDF	39
Fine material <8mm to further composting step	11
Glass and stones sized between 8 and 20 mm	1.6
Fe material	2.6
Aluminium	0.3
Rejected material to landfill	17.5

In this case, behind the aerobic treatment modules is positioned the so-called Refinement Section, that is, an area devoted to mechanical separation of the various fractions of the biodried material that can be turned to account.

The incoming waste composition analysis of London Plant, the weight loss and various fractions recovered in the Refinement section are shown in Table 2. See also the next chapter for the meaning of keywords here used

2 Analysis of the data

The considered plants are representative of various environmental realities and operating conditions.

1. The Corteolona and Giussago plants have been in operation since 1996, so it has been possible to identify a decade-long historical trend. In addition, these plants stand in areas where wet waste collection is not yet at high levels.
2. The Montanaso and Lacchiarella plants are representative of a reality in which separate waste collection is at very high levels.
3. The London plant is located in an area that is geographically very distant from the ones where the other plants were built and is representative of waste sorting situations that are in the growth phase. **(4)**

The parameters taken into consideration to compare the performances of the various plants were as follows:

1. Waste composition analysis of the incoming waste, including the following parameters:
   - Glass
   - Plastics
   - Metals
   - Non-combustibles
   - Organics (Biodegradable Municipal Waste [BMW], that means cellulose-based fraction + wood + wet (kitchen) waste + green waste)
2. Per cent of water content in incoming waste stream
3. Per cent weight loss, defined as percentage difference between the weight of the incoming waste and that of the waste exiting the plant
4. Net Calorific Value (CV) of the produced RDF
5. Per cent of total waste sorting and of the organic fractions of the waste collection area.

The following graph presents the average annual values of the weight loss and of the increase of fractions separately collected and sent to recycle-reuse of the area regarding the Corteolona plant **(5)**.

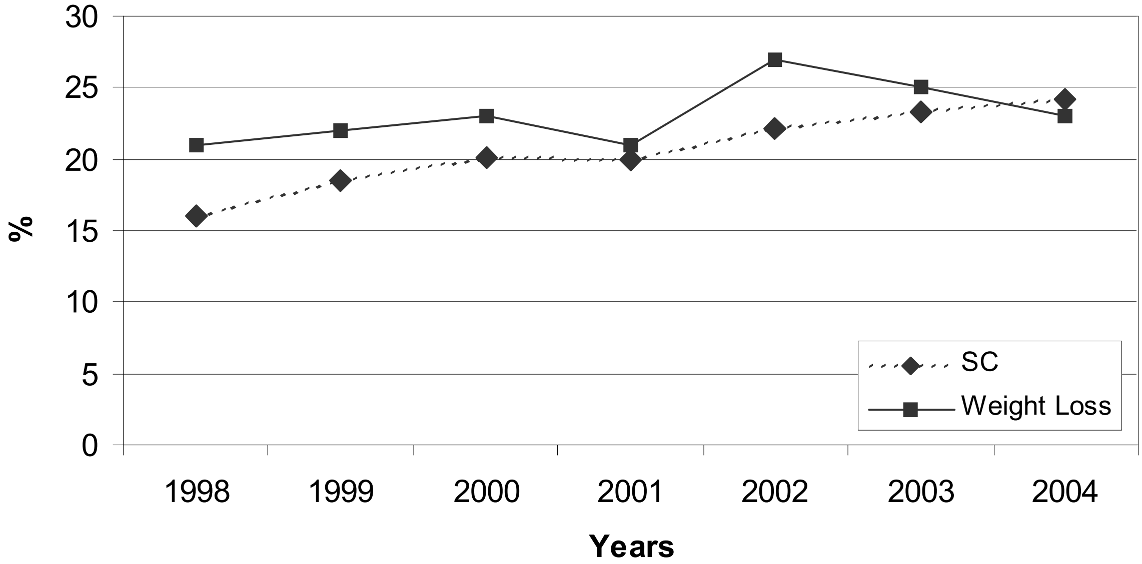

Figure 2 Trend of weight loss for Corteolona plant and trend of waste collected in a separate way for recycling and reuse (SC) in the area of interest.

The data representing the average yearly weight loss of the Corteolona, Montanaso, Lacchiarella and London plants for 2006 are presented in the graph below, together with the percentage of moisture in the incoming waste. **(3), (6), (7)**

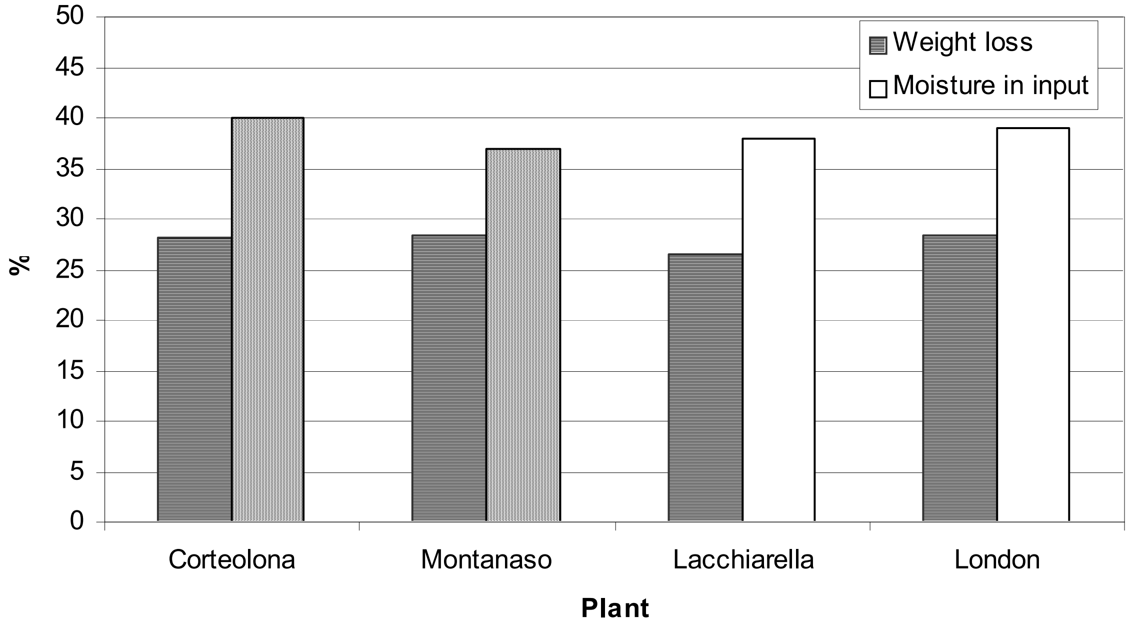

Figure 3 Weight Loss and Moisture (% H_2O referred to weight of incoming wastes) of input waste to different plants. Averages for 2006. For London the data refer to the performance tests of August, September and October 2006.

The waste composition analyses of the incoming material of the London, Villafalletto, Montanaso and Corteolona plants are shown in the following graph. **(3), (7)**

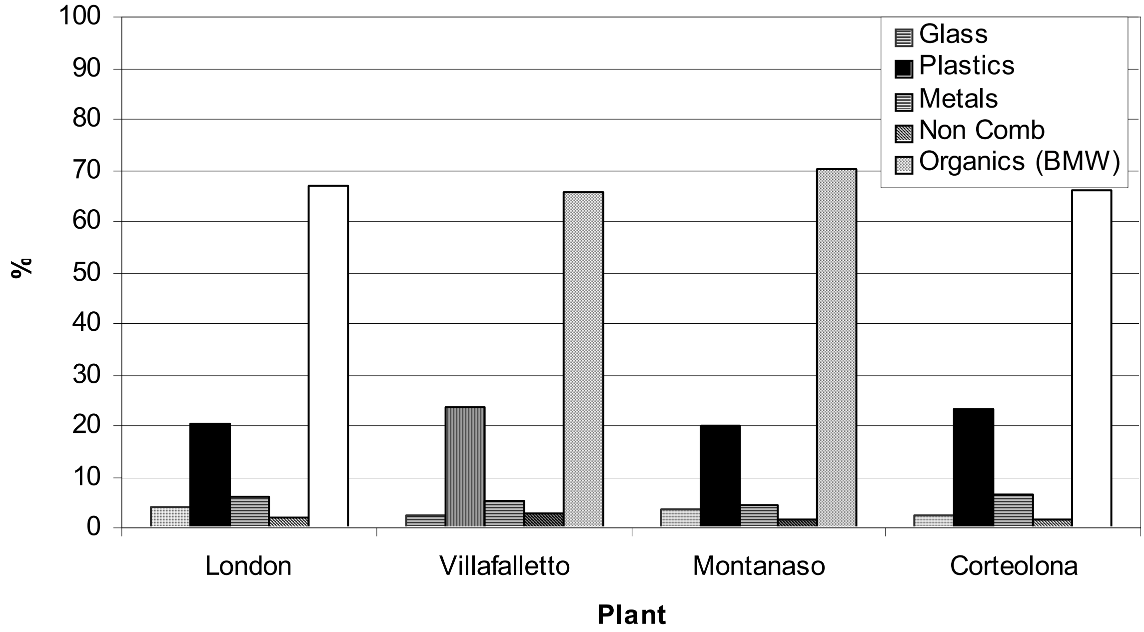

Figure 4 Composite analysis of waste in input to different plants. All data except for London are based on CONAI analysis campaign of June 2006. For London the data refer to the performance tests of August, September and October 2006.

The data on separate collection in the areas where the considered plants are located are shown in the graph below. **(8)**

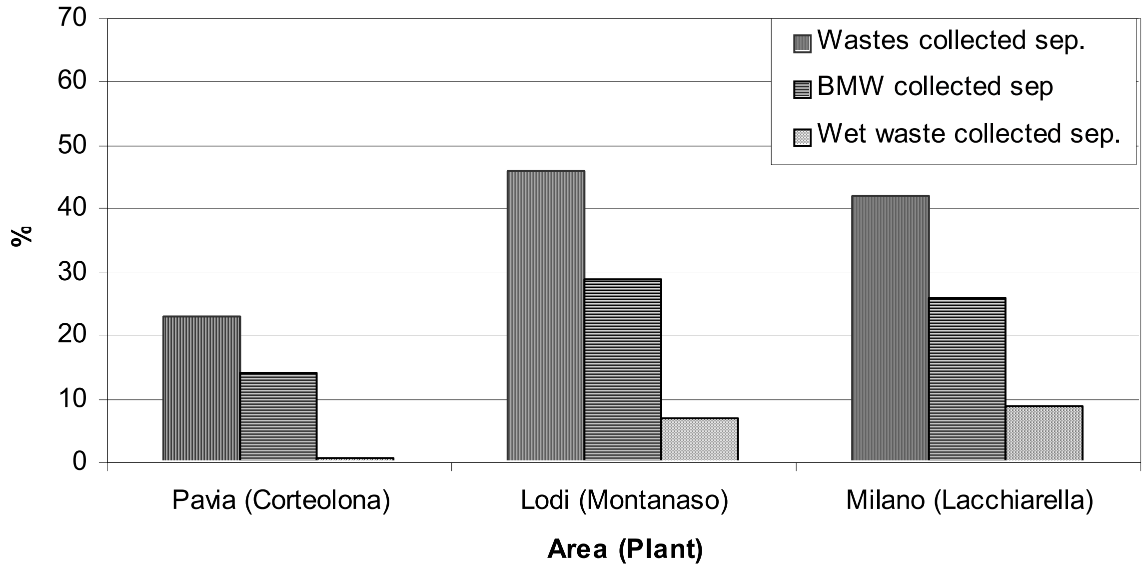

Figure 5 Total wastes collected separately in the areas where the plants are located (average 2004), BMW and Wet fractions.

The Net CV data of the RDF produced by the London, Villafalletto, Montanaso and Corteolona plants are presented in the following graph. **(3), (6)**

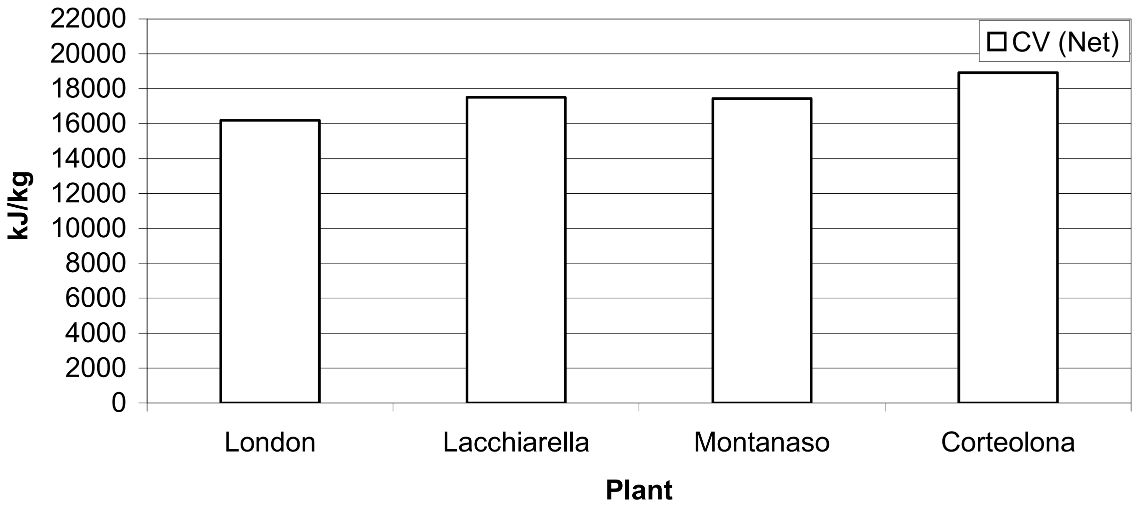

Figure 6 Calorific value of RDF from different plants. All data except those for London are based on CONAI analysis campaign of June 2006.

3 Discussion

Analysis of Figure 2 shows that as the trend of the percentage of waste collected separately steadily rises, the weight loss trend do not decrease. The weight loss trend is highly representative of the trend of the aerobic process. High weight loss implies strong evaporation of water, achievable only through high bacterial activity. The constant weight loss trend over the years indicates that, despite the diversion of the stream of material that arrives at the plants toward separate collection channels, the treated waste is nevertheless sufficiently rich in organics and water.

This supposition is confirmed in Figures 3 and 4, which show that all the plants display high and constant weight loss and that the water content, is always considerably higher than the levels in which phenomena of inhibition of the aerobic process take place. Also the historic weight loss trends of the various plants show that the weight loss parameter as an annual average stays substantially constant, within the 25 to 30% range. **(6)**

Figure 5 is aimed at giving a representation of the separate collection of recycled-reusable fractions in the different areas from which the various plants collect the residual waste. Even if the data refer to 2004, we feel the comparison is still meaningful given the stability and the constancy over the years of the performances of the different plants. In this sense a substantial independence of the performances of the plants from the ways of implementing the separate collection seems to be evidenced. This represents a confirmation of the analytical works, which have shown a relatively high presence of organic material even in residual waste from areas in which separate collection systems that provided for the collection of wet waste were implemented. **(9)**

On the basis of these considerations the relative constancy in the calorific value of the RDF produced in the various plants, shown in Figure 6, is not surprising. Obviously this phenomenon is amplified by the production methods, which, acting by separation of the undesired non-combustible materials from the stream, tend to produce a material that is particularly rich in light plastics and paper. However, the evidence of the historical data shows a production of RDF, with the qualities defined in Figure 6, that is always close to 40% by weight of the incoming waste **(6)**, and this suggests a relatively limited effect from the different performances of the refinement section.

The constancy in the quality of the RDF produced is fundamental for ensuring long-term contracts with end-users. In this area the Villafalletto plant supplies RDF to the cement plants of the UNICEM group; the Lacchiarella plant provides RDF to the cement factories of the HOLCIM and ITALCEMENTI groups; the Montanaso plant supplies RDF to the BAS waste-to-energy plant of Bergamo; and the London plant provides RDF to the cement works of the SRM and CEMEX groups.

4 Conclusion

Analysis of the data has shown that MBT plants keep the efficacy of the process unchanged even in the presence of different separate collection methods and are a reference base for the recovery of RDF and other materials whose qualities remain constant over time.

The reliability characteristics of the system have made it possible to use the same construction module as the basis for various types of plant. By way of example we cite the compost production plant of Lacchiarella and the enriched RDF production plant of Villafalletto.

The former produces compost from separately collected wet waste.

It is based on the classic processing scheme of differentiating a first phase of Active Composting Time (ACT) from a second phase of maturing. In our case, the ACT phase is carried out in a “plant module” analogous to that of the plants that treat RW, while the maturing phase is effected in static heaps beneath a roof. Such an ACT phase guarantees high environmental mitigation.

The input-output table summarising the first six months of 2006 is shown below.

Table 1 Characteristic Data of the Compost Production Plant of Lacchiarella (January-June 2006)

Materials	Quantity (Mg)
Wet waste in input	13,813
Wood in input	1,261
Compost in output	4,527

The Villafalletto plant produces an RDF with improved characteristics thanks to a final mixing with materials with high calorific value. This mixing is done downstream of the biodrying module, since the materials to mix are devoid of biodegradable organic matter.

The input-output table summarising 2006 is shown below.

Table 2 Characteristic Data of the Villafalletto Plant (1996)

Materials	Quantity (Mg)
Biodried material to Refinement Section	10,080
High CV wastes in input	9,355.
RDF in output	17,657

NOTE: The Net CV of RDF is >20.000 kJ/Kg

In case of unavailability for pickup of the waste by the end-user, the biodried material can be stored in a landfill in a way complying with the directives on stability. Typical limit of Dynamic Respiration Index **(10)** for biodried material is <1,000 (mg O_2) (Kg^{-1} SV) (h^{-1}). It is important to outline that it is possible to manage the plant in order to drive the process to reach higher weight loss in few days (High Speed Process Management, HSPM), depending on the air flow and inside moisture conditions. In this case the biological stability is lower.

In the following two weight loss trends obtained in two different air flow rate conditions of Montanaso plant are shown.

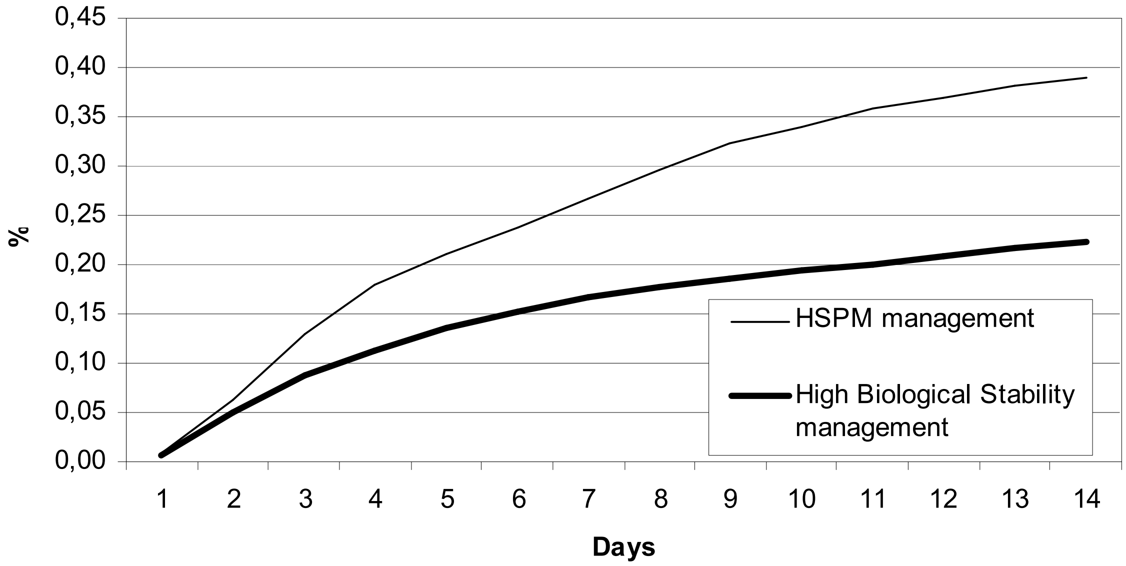

Figure 7 Trend in weight loss of two 15 days cycle in Montanaso plant managed in two different ways – Data collected in 2006 **(6)**.

5 References and Literature

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