Recyclable materials recovery after biological treatment of the residual fraction: quality improvement and contribution to landfill diversion targets

Sergio Scotti

Ecodeco S.r.l. Loc. Cassinazza di Baselica 27010 Giussago (PV) Italy

Abstract

Even in districts where source separated collections are implemented, a Residual Fraction remains. This fraction can be treated in MBT (Mechanical Biological Treatment) Plants that, other than stabilising biologically the waste, can produce a fuel and other recyclable fractions. Further materials recovery for recycling purpose is possible: the critical point is the quality of the materials that should be recycled.

Results of experimental and industrial experiences of simple materials recovery techniques applied to residual waste in different plants where the residual fraction has been submitted to aerobic biodrying process are presented.

Keywords

MBT, Biodrying, recycling, residual fraction

1 Introduction

A simplified schema of Municipal Solid Waste Management shows that the usual disposal systems for the Residual Fraction, the waste that remains after the source separated collection, are: landfill; Waste to Energy (WTE) plant; co-combustion in cement factory or electrical power plant.

For each solution a pre treatment in Mechanical Biological (MBT) Plants could be useful in order to further decrease the residual biological activity, to produce a combustible of constant characteristics and to allow a better selection of recyclable fractions. The landfill disposal modalities must comply with 1999/31/CE directive (landfill directive) requiring a progressive reduction of the biodegradable waste to be disposed. At the same time it is important to avoid that potentially recyclable fractions will be conveyed in landfill. Deep evaluation of each recycling process is need to be sure to get real benefits (first of all for the environment). The critical point is the quality of the extracted fraction to be recycled: the quality requirements for a good acceptability are, in many cases, difficult to fulfil or fulfilling with complicated processes making the project unfruitful.

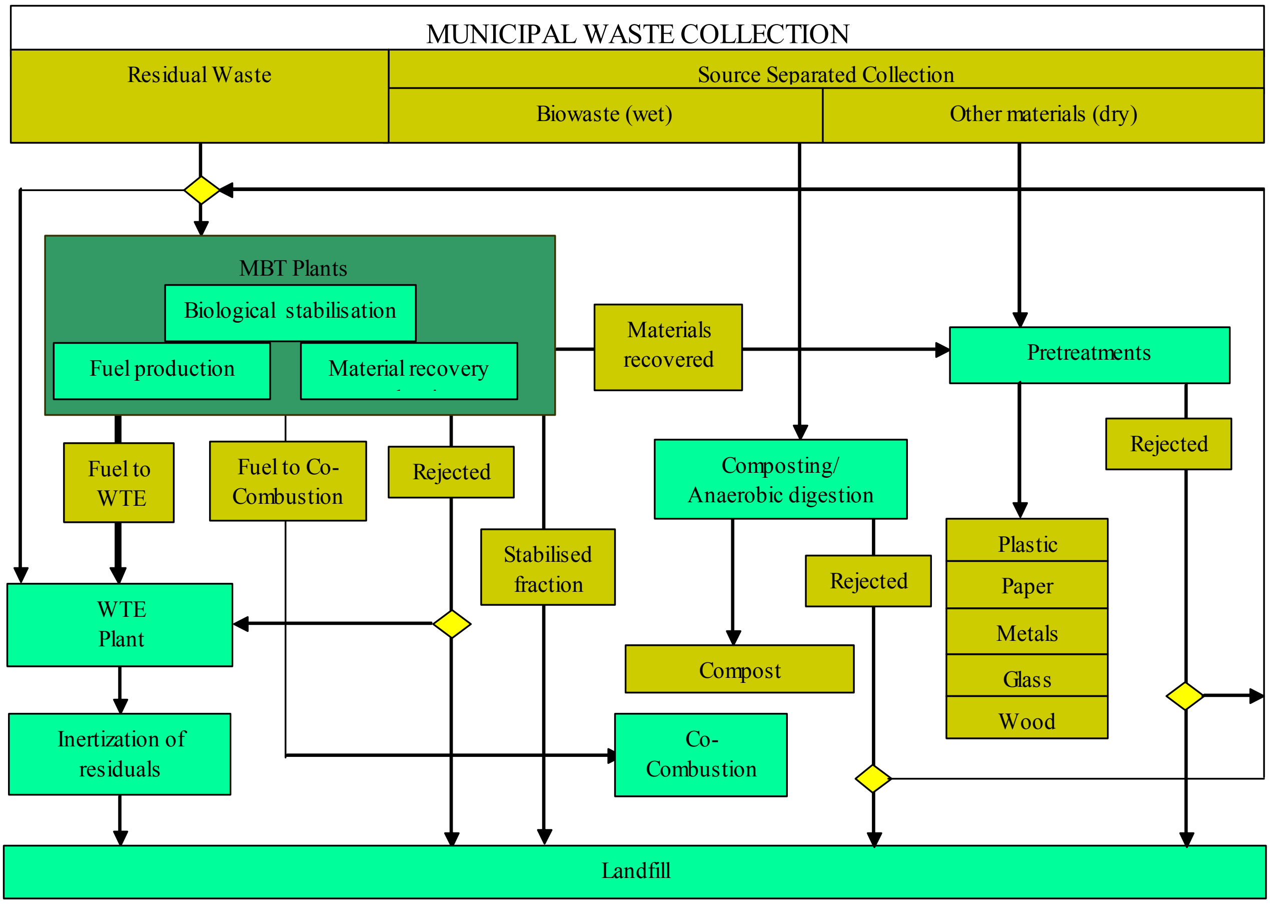

Figure 1 Simplified schema of Municipal Solid Waste management system

Results of experimental and industrial experiences of simple materials recovery techniques applied to residual waste in different plants where the residual fraction has been submitted to aerobic biodrying process are presented.

2 Trials and Data Collection

Ecodeco Group built in Europe 10 MBT biodrying-based plant (year 2008) treating more than 1.000.000 t/y of Municipal Solid Waste (MSW) and producing more than 250.000 t/y of Refuse Derived Fuel (RDF). In this kind of plant the waste is dried by forced ventilation that increases bacterial activity, i.e. the temperature, producing an evaporation of water. The process stops when low moisture content does not allow the sustainability of bacterial activity.

Data for this study were collected in two different ways.

In the first, historical data from “in operations plants” producing RDF, Ferrous material, Non Ferrous Material and Grits (Namely U.K. plants of London and Dumfries in Scotland, where grits are collected) are retrieved (ECODECO 2008).

In the second, because no plants are equipped with devices able to separate plastics and paper, a pilot plant where simple mechanical selections (screening, air separations) connected with optical scanner separation (NIR IR OPTICAL Scanner) was prepared.

This machine was placed in the plant of Cavaglià (Biella district, Piemonte Region) and the biodried material has been tested in it. The experimental trials were performed in 2008.

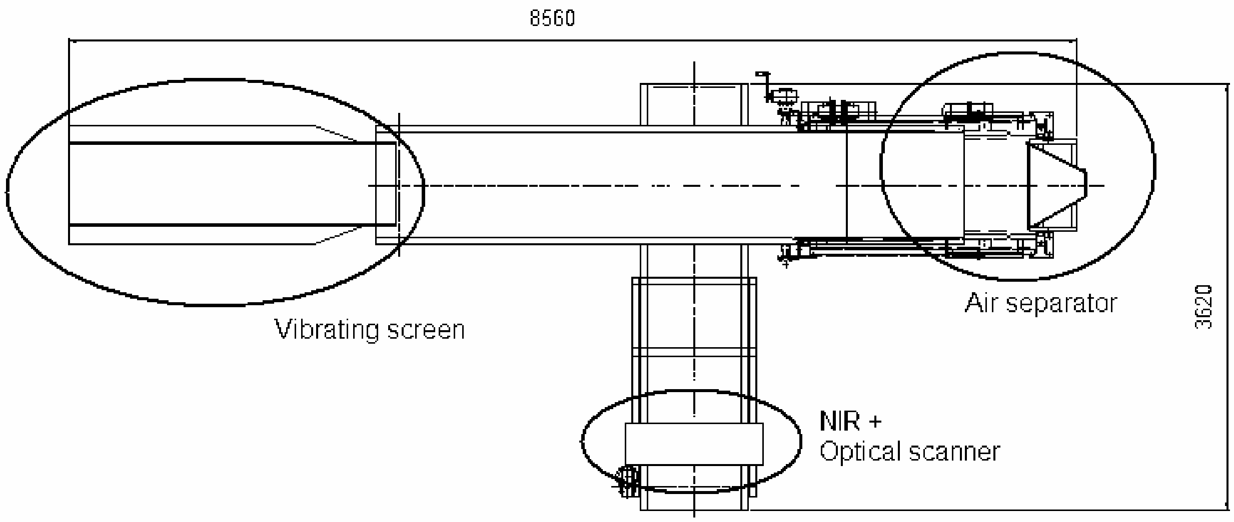

Figure 2 Layout of the Pilot Plant

The input data of Cavaglià plant were analysed on the basis of the official Piemonte source separated collection data (REGIONE PIEMONTE 2008) and local evaluation of MSW composition.

Table 1 Composition and source sep. collection data

Source Separated Collection Rate		45,3 %
Residual Fraction Composition		**Fraction Interception****
organic	25,9 %	33,4 %
green	3,0 %	73,2 %
plastic	17,9 %	22,3 %
paper	26,4 %	46,9 %
wood	1,5 %	81,8 %
textiles	4,4 %	9,4 %
glass	5,5 %	63,9 %
metals	3,4 %	37,8 %
other*	12,0 %	7,0 %
TOTAL	100,0 %	
Residual Fraction characteristics		
Moisture		33,0 %
BMW ***		65,0 %
NCV****		11.726 kJ/kg

* inerts, leather, battery, sanitary towels
** referred to the sum of Residual Waste and source separated waste
*** Biodegradable Municipal Waste
****Net Calorific Value

The biodried material that represents the input to the above described pilot plant is the biodried material where plastic and paper content aren't changed because only organic content and moisture are decreased. The averaged weight loss (due to water evaporated and organic material converted in CO_2) was 28% of the input weight.

Comparative results of input-output data coming from these trials are presented in the following. All data are referred to the content in input MSW to MTB plant (before the biodrying process). Three types of plastics (pet=polyethylene terephthalate, pe=polyethylene, pp=polypropylene) were selected in output.

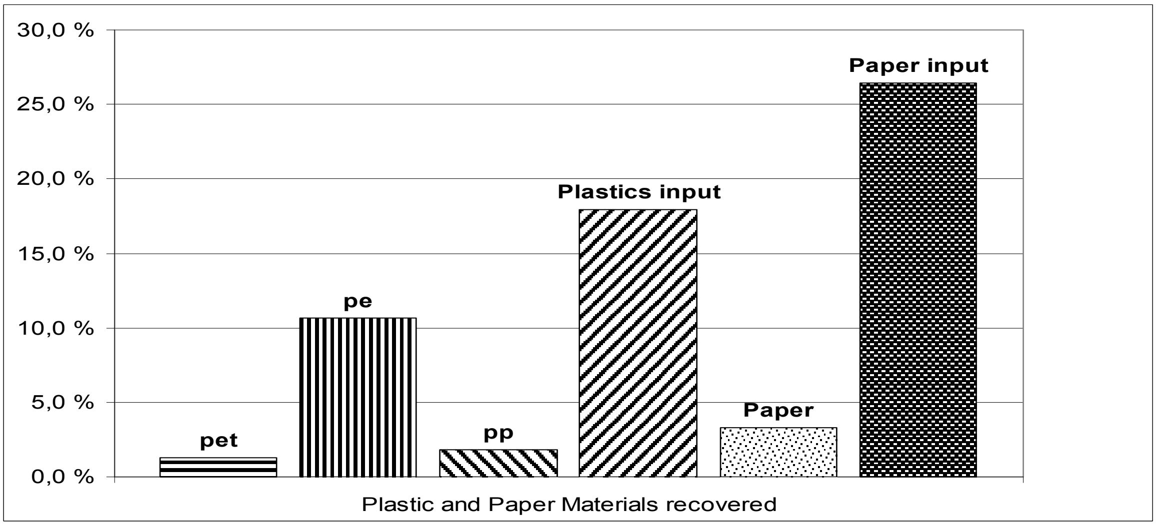

Figure 3 Recovery of Plastics and Paper compared with the input content

The historical data based upon 2008 average input/output materials coming from U.K. plants are shown in the following.

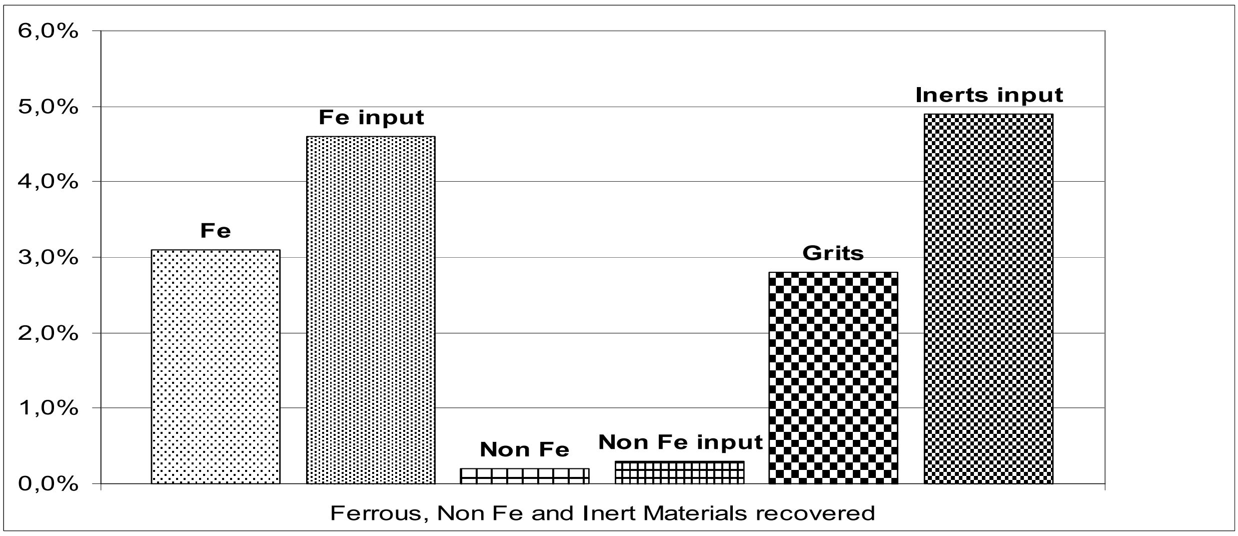

Figure 4 Recovery of Fe, non Fe, Grits compared with the input content

3 Discussion

It has to be outlined that the pilot plant was set in order to maintain purity standards for the materials recovered that allow them to be accepted by the recycling industries.

The same quality for recycling was reached in U.K. plants.

Based upon the above presented data, some scenarios can be analyzed.

In the following table a comparison between a plant oriented only to produce RDF for Cement industry and one modified in a way that recyclable materials are diverted is presented.

Table 2 Comparison between only RDF production and RDF plus Recycling scenarios

Input data		**Scenarios**			
Recovery Rate		**Only RDF production**		**RDF and material recovery**	
Paper	12,5%	**Output Fraction**		**Output Fraction**	
Plastics	76,5%			Plastics recovered	13,7 %
Fe	67,4%			Paper recovered	3,3 %
Non Fe	66,7%			Metals recovered	2,3 %
Inerts	57,1%			Inert recovered	3,1 %
Aer. Treat.Weight Loss**	28%	<20 mm rejected	12,0%	<20 mm rejected	12,0%
		>20 mm rejected	21,3%	>20 mm rejected	15,4%
		RDF High Quality	38,7 %	RDF Low Quality	22,1 %
		Characteristics of RDF		**Characteristics of RDF**	
		RDF NCV	17372 kJ/kg	RDF NCV	12732 kJ/kg
		RDF Ash	15%	RDF Ash	17,0 %

** Weight difference between input and oputput waste to/from aerobic treatment due to water evaporation and organic fraction degradation

The composition for the input waste are those of Cavaglià plant and the recovery rates are the same as found with the pilot plant and recorded data from U.K. plants.

A more detailed analysis using well know tools (like LCA methods) have to be made on specific cases. From a general point of view, the literature is in agreement in considering favourable the recycling option (WRAP 2006); LCA study on RDF production and utilisation in cement plants showed positive results too (SCOTTI ET AL, 2008).

A simulation of process from residual fraction with high rate of source separated collection (Treviso district, Veneto Region), is shown in the following (CONSORZIO PRIULA 2008)

Table 3 Expected output in a district with high rate of source separated collection.

Source Separated Collection Rate	70,0 %	Weight Loss	17,6 %
Residual Fraction Composition		**Expected output***	
Glass	1,6 %	RDF	11,4 %
Plastics	58,0 %	<20 mm Rejected	9,3 %
Metals	1,6 %	>20 mm Rejected	16,6 %
Non Combustibles	0,7 %	Fe	0,7 %
Paper	29,9 %	Paper	3,7 %
BMW**	8,2 %	Non Fe	0,1 %
TOTAL	100,0 %	Plastics	40,6 %
Moisture	24,8 %		
*set up for paper and plastics recovery enhanced **BMW=Biodegradable Municipal Waste			

The simulation has been done using a trivial mathematical model derived from trials above described and completed with weight loss trials on samples of this kind of waste. The difference between this simulation and the above data in table 2 is that here the inert recycling fraction has not been considered.

A more detailed economical analysis is not easy without focusing on a specific case due to the large spread of the recycling materials value and rejected disposal cost.

An important feature of this kind of process must be the flexibility allowing the plant to modify the quantities between RDF and Recycling fractions depending on markets requests; and this is possible because the plastic-paper recycled fractions are mixed in RDF stream before the optical scanners separation.

At the end, attention has to be paid at the chlorine content of RDF due to the PVC fraction. As usual PVC materials can be selected by NIR IR scanners devices.

4 Conclusion

Data show that the residual fraction contains materials that can be recycled.

The combined utilisation of biological treatment, recycling techniques and RDF production is a useful option to fulfil landfill directive and recycling targets.

Flexibility is an essential feature to ensure the real disposal of all the end products coming from MBT plants.

Further development of this research is the modification of an "in operation" industrial plant to make it able to collect recycling fractions and analyze data over one year period. This further step will give basic data to evaluate in detail operational costs and I/O parameters for LCA study.

5 Literature

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Scotti S., Barone F., Minetti C.	2008	Integrated system of RDF production and cement factory utilisation: environmental analysis of an industrial example. Second International Symposium on Energy from Biomass and Waste- Venice 17-20 November 2008
Consorzio Priula	2008	Preliminary report on Waste Composition and Source Separated Collection Rate. See http://consorziopriula.it

Author's address:

Dr. Sergio Scotti
Ecodeco S.r.l.
Loc. Gerbido
13881 Cavaglià (Bi) ITALY
Telefon +39 0161 9690 535
e-mail s.scotti@ecodeco.it
Website: www.ecodeco.it