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WASTE PRE-TREATMENT BEFORE FINAL DISPOSAL: THE ROMANIAN PERSPECTIVE

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Since the beginning of 2007, Romania belongs to the European Union. The management of municipal solid waste (MSW) in the next years must comply with the European Union Directives. Aim of the present work is to present advantage and disadvantage of the waste disposal in Romania using different methods for treating the waste in order to decrease the putrescibility of the lanfilled material. The processes taken into account for treating the waste before landfilling are the aerobic (bio-stabilisation and bio-drying) and the anaerobic ones.

The paper will present some consideration and results regarding mass and volume balance, environmental and energy balances that will be compared with the ones from a landfill that receives MSW without pre-treatment.

Keywords: municipal solid waste, bio-drying, bio-stabilization, anaerobic digestion, life cycle analysis, energy.

1. Introduction

Since the beginning of 2007, Romania belongs to the European Union. The management of municipal solid waste (MSW) should show significant changes in the next years in order to comply with the European Union Directives.

Presently in Romania MSW can be directly landfilled, but a clear target of the European Union Directives concerns the decrease of biodegradable material landfilling in order to decrease the uncontrolled emissions of methane (even a modern landfill can catch only about 50% of the generated biogas).

The present work shows advantage and disadvantage of the waste disposal in Romania using different methods for treating the waste in order to decrease the putrescibility of the lanfilled material. The processes taken into account for treating the waste before landfilling are the aerobic (bio-stabilisation and bio-drying) and the anaerobic ones.

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In many Romanian regions the MSW has an average organic content around 50%. The amount of MSW generated in Romania accounts for more than 7 millions of tons per year.

For the mass and volume balance, data regarding humidity, density of the waste and also volatile solids dynamics during the processes have been used. For the environmental balance, some considerations on the most significant pollutants were made using literature environmental factors. The energy balance was made taking into account the energy consumption needed for the plants, the production of biogas and the efficiency of the engines used for generating energy with the biogas resulted from anaerobic treatment in reactor and from landfilling. The results are compared with the ones from a landfill that receives MSW without pre-treatment.

The literature of the MSW sector allows developing studies useful for decision makers. Romania will have to set a national strategy on landfilling. Some results of the present paper could help to clarify which strategy will be the best.

2. Methods

In Romania the MSW is collected as is: no selective collection is activated, apart from few pilot experiences. MSW is then disposed mainly in uncontrolled landfills.

In Table 1 the MSW merceologic and ultimate composition [1] is reported. Fine materials have been considered organic fraction (70%) and inert (30%).

Table 1

Merceologic and elementary composition of MSW

	kg/kg_{MSW}	kg_{H2O}/kg	kg_C/kg_{TS}	kg_H/kg_{TS}	kg_O/kg_{TS}	kg_N/kg_{TS}
Cellulosic material	21,09%	21,20%	43,41%	5,82%	44,32%	0,16%
Plastic material	11,40%	5,80%	81,80%	9,80%	0,80%	0,08%
Glass	2,39%	2,00%	0,52%	0,07%	0,36%	0,03%
Inert	5,14%	7,00%	0,52%	0,07%	0,36%	0,03%
Organic material	50,00%	79,20%	44,99%	6,43%	28,76%	0,45%
Textiles	2,45%	27,60%	30,00%	10,40%	18,60%	4,65%
Mixed material	2,05%	16,80%	34,10%	3,80%	26,90%	0,08%
Wood	3,05%	19,90%	41,50%	5,10%	32,40%	0,09%
Aluminium	1,56%	2,00%	4,50%	0,60%	4,30%	0,05%
Metals	0,86%	2,00%	4,50%	0,60%	4,30%	0,05%

The scenarios taken into account are presented in Figure 1, 2 and 3. The first scenario (Fig. 1) consider bio-drying like main treatment. The MSW are first shredded and then sent to mechanical treatment of the bio-drying treatment stage. Because of the high organic content, 50% of MSW and for obtaining good results the bio-drying treatment lasts between 14 and 30 days [1]. Then the bio-dried material is sent to a mechanical separation for obtaining Refused Derived Fuel (RDF) and metals and inert. The RDF is used for energy production in a grate incineration plant, that has an efficiency of 27,5% in terms of electricity generation. The residues are divided in fly ash and slag and finally are landfilled.

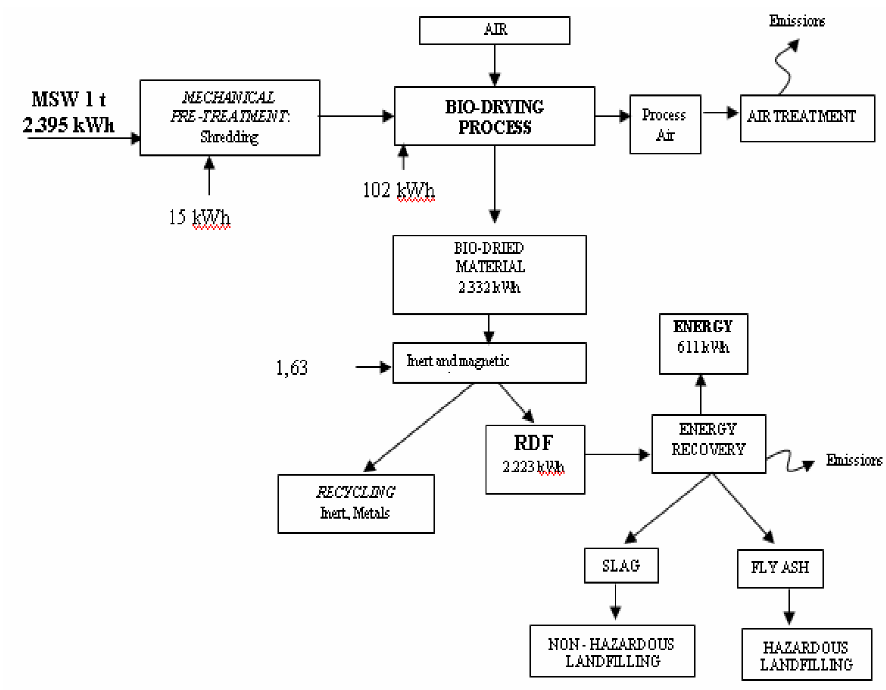

Fig. 1. Bio-drying. Process scheme and energy balance for 1 t_{MSW}

In the second scenario, the MSW are first shredded and screened (80 mm) and divided in two fluxes: wet and dry fractions. The wet fraction is sent to the bio-stabilization treatment. During this treatment, one ton of wet fraction looses 100 g_{H2O} and 54 g_{VS} [2]. After this treatment the final bio-stabilized material is sent to the landfilling supporting the biogas production. The biogas is then collected and used in an engine with a 40% efficiency (we must point out that practical efficiencies could be assumed as 31-35%). The dry material is treated like in the first scenario, obtaining RDF and then energy.

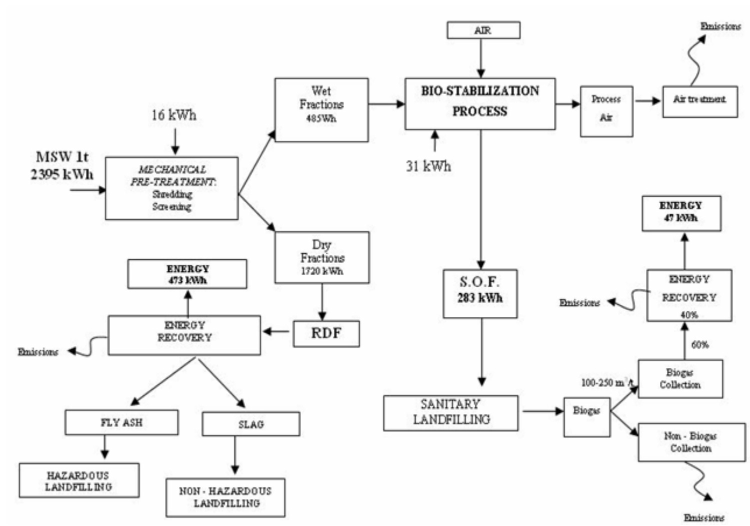

Fig. 2. Bio-stabilization. Process scheme and energy balance for 1 t_{MSW}

In the third scenario (Fig. 3), MSW is first treated like in the second scenario, but the wet material has another destination, the anaerobic one. The anaerobic digestion is made in a thermophilic environment (55°C) [3]. From the anaerobic digestion result two fluxes: biogas with a percentage of CH_4 about 55% [3], that will be used in an engine for energy generation and digested material. The digested material is treated for arriving to a 40% of dry content with a filterpress and finally landfilled.

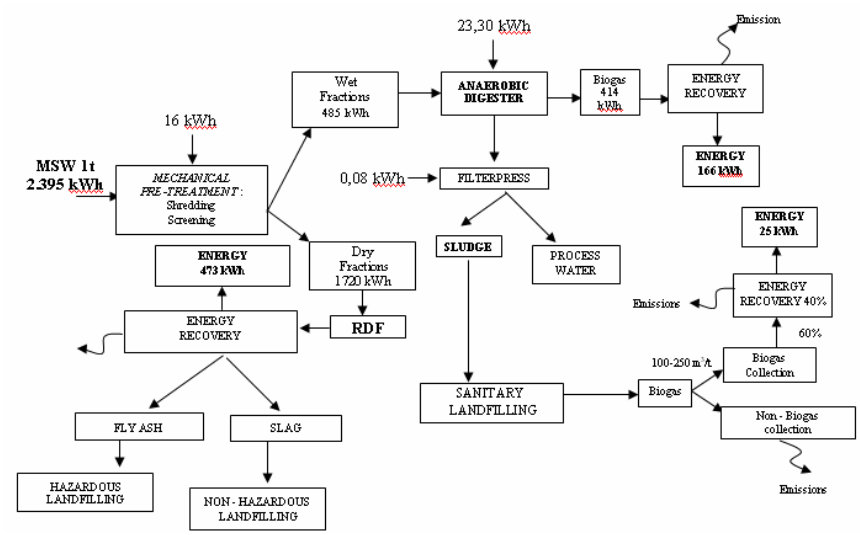

Fig. 3. Anaerobic digestion. Process scheme and energy balance for 1 t_{MSW}

3. Results

The results will be presented in term of energy balance, CO_2 production, landfilling volume and PCDD/F emissions.

Concerning the energy balance it was taken into account the energy content for each step and the consumption and generation of energy for each system (Figure 4). Results are presented for each scenario in the respective figure.

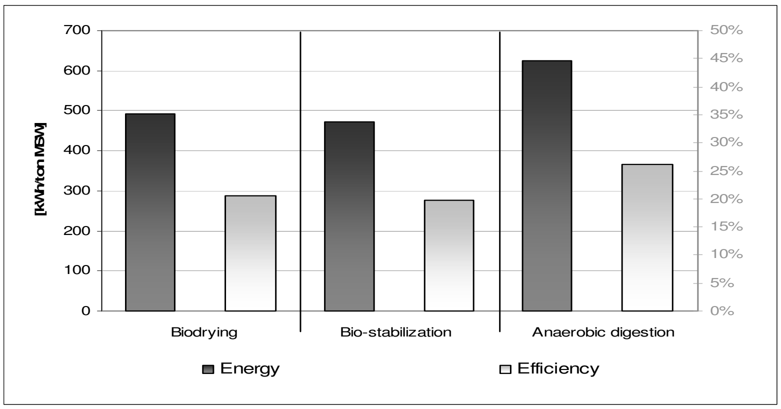

Fig. 4. Net energy production and efficiency for each scenario

However even if the third scenario is the one with interesting results from energetic point of view, it must be taken into account the initial investment because for this scenario two engines were needed.

The CO_2 balance is one of the most important parameter because of its contribution on green house effect. CO_2 from an aerobic plant is biogenic, but the role of the process is not zero. It can be useful to implement some conversion potential [4], and also the parallel action of other gas, like N_2O that contribute at the global heating balance.

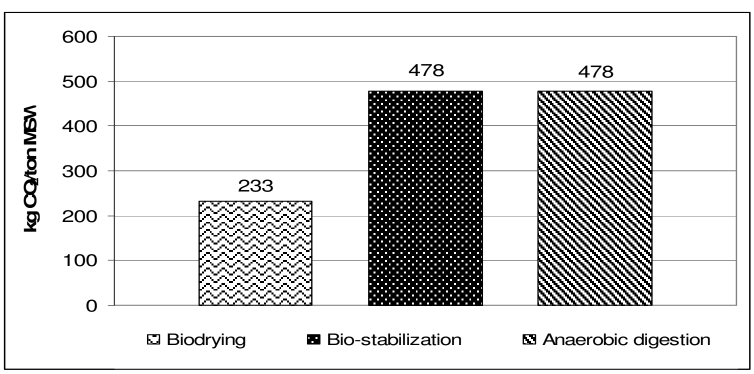

Fig. 5. CO_2 production for each scenario

Because of the data lack regarding other gas, in this paper is presented only a balance that evaluate CO_2 quantity resulted from the fossil fraction produced from each scenario.

Another balance is the one regarding the landfilling volume the role of selective collection being also quantified. This balance was made taking into account residues that can be landfilled from each step of each scenario. For this reason it was used the specific density for each material that will arrive in the landfill. For the slag (1,25 t/m^3) [5] and fly ash (0,60 t/m^3) [6] it was used data from the literature while for the stabilized organic fraction (0,70 t/m^3) and for the digested organic fraction (1,11 t/m^3), the values of density were calculated in function of the volatile and non volatile solids content and of humidity.

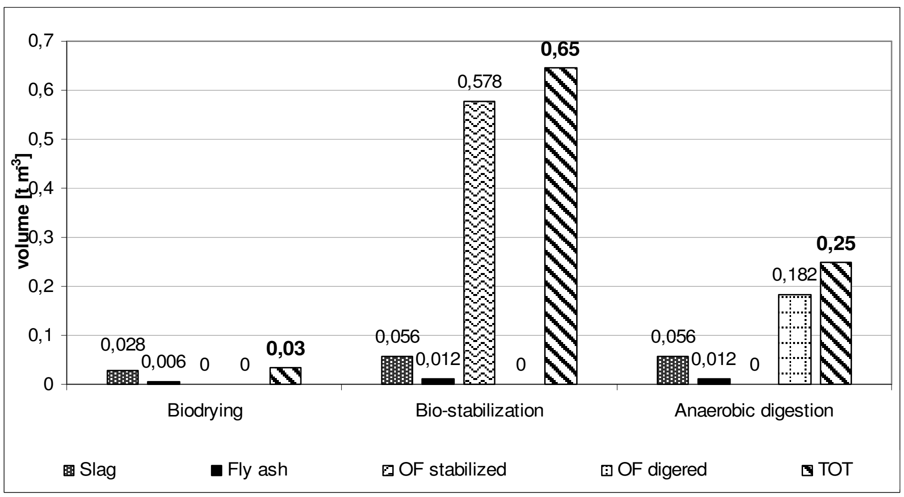

Fig. 6. Landfilling volume for each scenario

It is obvious that for the first scenario (bio-drying) the landfilling volume is the most little because all the MSW are sent to the energetic valorisation or recycling. For the other two scenarios in the landfilling will arrive a big part of the treated wet material (more from bio-stabilization than from the anaerobic digestion thanks to the filterpress step) but also a bigger quantity than the one from the first scenario regarding the slag and the fly ash. This is because the RDF from the first scenario is sent to a refining step for separating the inert and metals which will be reused, before sending it to the energy valorisation step.

The last balance is the one regarding the PCDD/F emissions. For this balance some specific emission factors for the MSW treatment were used [7]. However the emission quantity for each scenario depends on the gas treatment line for each step. For the incineration of RDF data regarding the emission factors from the literature were used (Table 2).

Table 2

Emission factors for MSW incineration

Plant type	Emission factor [$\mu g_{I\text{-}TEQ}/t$]	Reference
Old incinerator	3 - 50	[8]
New incinerator	0,6	[8]
Incinerator with BAT	0,007 – 0,18	[8]
Incinerator emitting at the limits	< 0,6	[9]
Incinerator with BAT	0,01	[9]

The emission regarding the biogas are calculated taking into account the emission factors for the biogas collected from the landfilling and combusted in an engine and also the average concentration of PCDD/F that is dispersed with the not collected biogas. The values are presented in Table 3.

Table3

PCDD/F emission factors for biogas utilization

Plant type	Emission factor	Reference
Biogas combustion (engine)	4,3 -12 $ng_{I\text{-}TEQ}/t_{MSW}$	[10]
Biogas concentration	0,23 $ng_{I\text{-}TEQ}/m^3_{biogas}$	[11]
Biogas combustion emission	0,045 $ng_{I\text{-}TEQ}/m^3_{biogas\_alimentation}$	[11]

The results of the PCDD/F emission balance are presented in Figure 7. It was highlighted differences between the results obtained from the RDF incineration plant having a BAT treatment and from the one that have a traditional system for the emission treatment. Also for the bio-drying and bio-stabilization treatment the results were calculated taking into account quantity of PCCD/F existing in the MSW and also the use of BAT or not for the emission treatment.

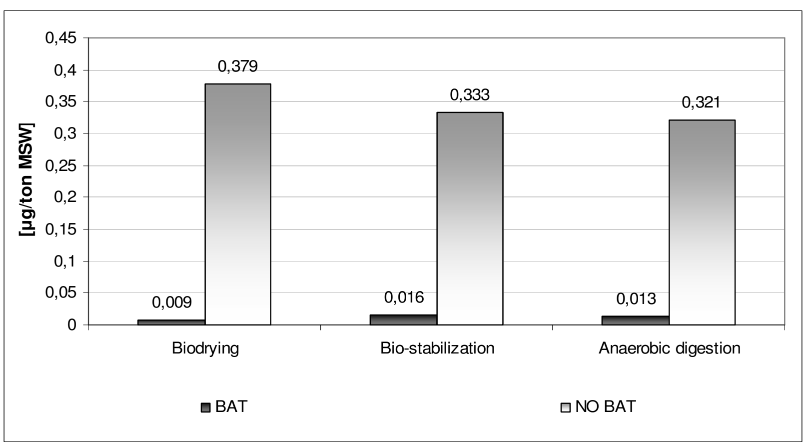

Fig. 7. PCDD/F emissions for each scenario

4. Conclusions

The presented balances allow to build a critical approach for the analysis of various MSW management systems. Through the work of modelling (referring to a typical Romania MSW) it was possible to point out advantages and disadvantages of each scenario. The Table 4 presents a synthesis of the results.

Table 4

Balance final results

Balance	Bio-drying	Bio-stabilization	Anaerobic digestion
Energetic balance	😐	😐	☺
CO_2 balance	☺	😐	😐
Landfilling volume	☺	☹	😐
PCDD/F emission (BAT)	☺	😐	😐

R E F E R E N C E S

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