REFUSE DERIVED FUEL AND THE INDUSTRIAL SECTOR: THE ROMANIAN PERSPECTIVE

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Since January 1st 2007 Romania belongs to the European Union. That means that some scenarios in waste management could change. Presently in Romania the generated waste is mainly landfilled. Energy recovery from municipal solid waste (MSW) and special waste is an option slightly developed.

The aim of the present work is to present an option that could be developed in Romania in the frame of the European Union Directives.

Keywords: refuse derived fuel, sewage sludge, biomass, energy, environmental impact.

1. Introduction

Since January 1st 2007 Romania belongs to the European Union. That means that some scenarios in waste management could change. Presently in Romania waste is generally landfilled. Energy recovery from municipal solid waste (MSW) and special waste is still to be improved.

In the present work the scenarios that will be taken into account regards the use of refuse derived fuel (RDF) obtained from the treatment of municipal solid waste (MSW) or the use of special waste like sewage sludge obtained from thermal drying treatment, and also the use of biomass like wood chips for energy recovery in the industrial sector.

An important aspect regards the balance of CO_2; a part of the Carbon contained in a RDF can be related to green house effects (for instance C in plastics) but another part can help to reduce the emissions of CO_2 according to the aim of the Kyoto protocol. Indeed some industrial sectors could be interested in substituting fossil fuel with RDF. To this concern it is clear also the important role of wood chips as alternative fuel.

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Additional advantages are related to the possible reduction of CO emissions thanks to a favourable ratio Hydrogen/Carbon and also the more favourable economic balance (conventional fuels must be paid; on the contrary for the use of RDF from MSW the companies could receive money).

2. Methods

Starting from their elementary composition, the lower heating value (LHV) of coke (0 - 3mm), anthracite (0-5 mm), wood chips [1], sewage sludge [2] and also RDF from Romanian and Italian MSW (Table 1) has been calculated. All these values are shown in figure 1 (LHV). The ones of thermal dried sewage sludge and of RDF from MSW bio-drying are assessed theoretically: in Italy we can find such products, on the contrary in Romania there is not yet experience on it.

The Romanian waste used for the calculations has an organic fraction content of 50% and has been bio-dried in pilot scale for 30 days [3]. The Italian waste had an organic content of only 21% and has been bio-dried for 11 days (usual bio-drying time: 7-14 days) [3]. For the Italian waste it was taken into account the one from a region where the selective collection is developed for many fractions but not fully developed for the organic fraction. This solution was preferred for having a scenario similar with the one that could be found in Romania in the next years. An additional case-study concerns RDF of high quality according to the Italian regulations, that we shall name $RDF\_{high\_quality}$.

In this paper it is evaluated also an aspect of the environmental impact of the industrial sector taking into account the CO and CO_2 values resulted from the combustion of those fuels.

In table 1 the considered sewage sludge comes from a thermal drying plant that allows a water content of 10%. It is clear that the overall balance of CO_2 of this option varies depending on the use or not use of fossil fuels for the thermal drying process.

Table 1

Elementary composition

	kg_{H2O}/kg	kg_C/kg	kg_S/kg	kg_H/kg	kg_N/kg	kg_O/kg	kg_{ash}/kg
Coke	8,5%	90,0%	1,0%	0,0%	0,0%	0,0%	0,5%
Anthracite	8,82%	75,70%	0,76%	0,0%	0,0%	0,0%	14,73%
Wood chips	22,00%	47,88%	0,02%	0,37%	0,37%	27,33%	1,90%
Sewage sludge	10,0%	27,0%	0,5%	5,4%	2,2%	18,9%	36,0%
RDF_{RO}	24,46%	41,52%	0,00%	5,58%	0,31%	21,89%	6,25%
RDF_{IT}	9,17%	50,49%	0,09%	3,50%	0,30%	25,59%	7,77%

When thermal drying is performed in a decentralized plant the usual fuel is methane. On the contrary in case of integrated solutions methane can be substituted by heat recovered from off-gas generated from industrial activities with additional benefits from the economical point of view.

3. Results

Referring to the LHV all the values are presented in Figure 1. The different energy content of Romanian and Italian MSW affects the characteristics of the obtainable RDF.

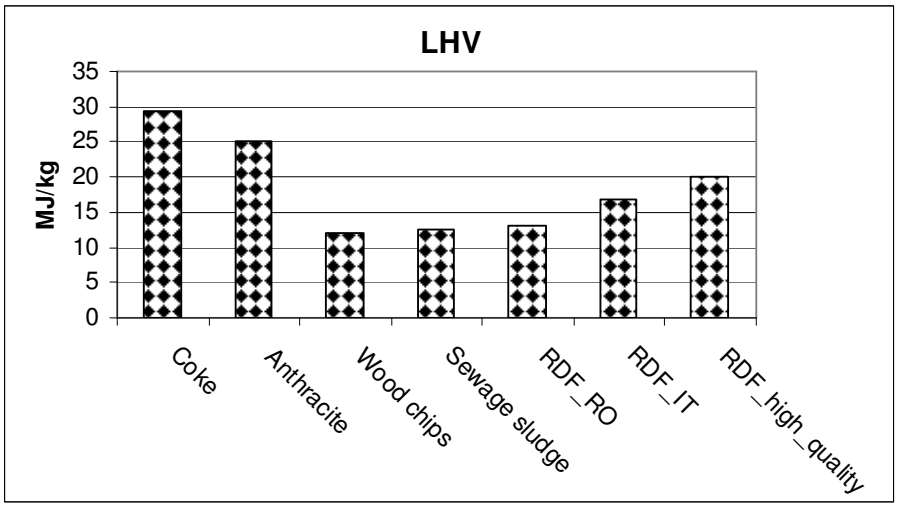

Fig. 1. Lower heating value for each considered fuel

An important result regards the LHV of thermal dried sewage sludge that could be similar with the one of wood chips. With this solution two problems can be solved: on the one hand the problem of sewage sludge landfilling that is against the principle of the EU Directives on waste management and on the other hand the use of this secondary fuel in industrial sectors saving emissions of CO_2 (sewage sludge can be classified as biomass).

However, it must be pointed out that only a part of conventional fuel can be replaced with the secondary one when the industrial process is based on the mixing of raw material and fuel (for example coke and anthracite): indeed ash remains in the final product and this aspect limits the addition of alternative fuels depending on their composition. For this reason the following balances are made taking into account only a partial substitution on coke and anthracite in an industrial process were the conventional mixing is 50% and 50 %.

It must be pointed out that the need of guaranteeing a steady power for the industrial process makes it necessary to substitute an amount of conventional fuel with a higher amount of alternative fuel. In Table 2 some examples are reported.

Table 2

Fuel mixing

	MIX1	MIX2	MIX3	MIX4	MIX5	MIX6
Coke	50,00%	40,00%	40,00%	40,00%	40,00%	40,00%
Anthracite	50,00%	40,00%	40,00%	40,00%	40,00%	40,00%
Wood chips	0,00%	47,00%	0,00%	0,00%	0,00%	0,00%
Sewage sludge	0,00%	0,00%	45,00%	0,00%	0,00%	0,00%
RDF_RO	0,00%	0,00%	0,00%	34,00%	0,00%	0,00%
RDF_IT	0,00%	0,00%	0,00%	0,00%	32,00%	0,00%
RDF_high_quality	0,00%	0,00%	0,00%	0,00%	0,00%	31,00%

The higher is the Lower Heating Value, the lower is the amount of alternative fuel to be added. This aspect affects the balance of mass according to the showed values. Concerning the environmental balance we can take into consideration both CO_2 emissions from fossil fuel combustion and CO emissions (more interesting for local balances of impact).

In Figure 2 the specific emissions of CO_2 from each fuel are reported. Of course CO_2 from biomass has not to be taken into account as greenhouse gas. To this concern RDF and thermal dried sewage sludge are preferable (but the role of sewage sludge can be affected by the use of fossil fuel for its drying).

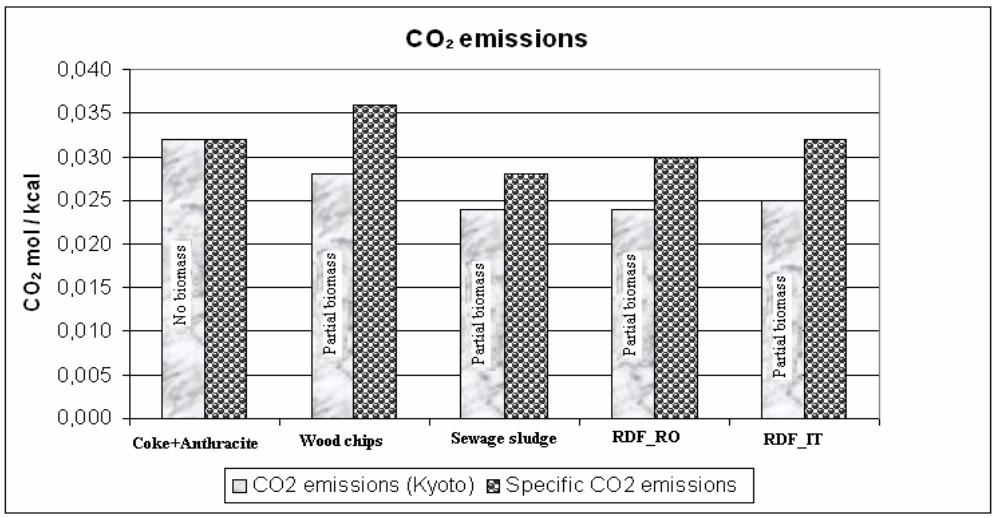

Fig. 2. Specific CO_2 emissions

The balance of CO can be made from a qualitative point of view. Assuming that the emission of CO could decrease if the ratio H/C in the fuel is higher, the values reported in Table 3 point that the use of wood chips does not have advantages to this concern.

Table 3

Hydrogen/ carbon ratio for each fuel

H/C	MOL/MOL
Coke + Anthracite	0,00
Wood chips	0,02
Sewage sludge	0,37
RDF_RO	0,28
RDF_IT	0,17

In reality me must take into account that a mixing with alternative fuels at lower LHV needs more fuel than the one substituted and thus affect the presence of Carbon in the final mixing. Supposing CO directly dependent on the C content, it seems to be a better option the addition of alternative fuels with a higher LHV. To this concern $RDF_{\_high\_quality}$ should be preferred. A deeper point of view can take into account the role of Oxygen in the mixing of fuel. All the considered alternative fuels have an O content that could make it available a better contact between the combustible elements (C, H) and the comburant, thus decreasing the CO generation.

4. Conclusions

RDF from MSW can really help to decrease the amount of waste sent to landfilling. As a percentage of RDF is biomass-like, its use can support a decrease of CO_2 emissions.

Many wastewater treatment plants must be built in Romania. The management of the generated sludge could be designed with a final use as fuel. To this concern, the introduction in Romania of thermal driers should be encouraged together with the adoption of non-fossil fuels to perform the drying process.

For instance, the sewage sludge generable from the treatment of the Bucharest wastewaters, after thermal drying, could substitute conventional fuels giving about 20 MW_t for industrial use.

RDF from MSW and sewage sludge could be the base of an energy strategy both for co-combustion and for substituting fuel oil in a few industrial areas that are expanding around Bucharest.

Waste from wood industry can be an interesting alternative to fossil fuels but dust emissions must be minimised for a real environmental benefit.

However when the conventional fuel is co-combusted with other secondary fuels the quality of ash and its utilization in the products must be taken into account.

In Table 4 the contents of the present paper are summarised.

Table 4

Final balance for alternative co-combustion

Balance	RDF	RDF_high_quality	Thermal dried sewage sludge	Wood chips
Energetic balance	😐	😐	😐	😐
CO_2 balance	☺	☺☺	☺	☺
CO balance	☺	☺☺	☺	😐

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