Decision for packaging waste management from a Life Cycle perspective. The FENIX project

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Abstract. This work is part of the "FENIX-Giving Packaging a New life" project, a 3-year European LIFE+ funded project. The main objective of this project is to develop a flexible software tool for the Spanish and Portuguese municipalities and other territorial organisation, to obtain Life Cycle Assessment (LCA) results for packaging waste management system, integrating environmental, economic and social aspect. The tool will allow the different users to introduce and modify parameters (km travelled, selection between different collection and treatment options, plant efficiency, etc.) to adapt the models created in the tool to the real situation. Specifically, this paper is the first part of the study focused in the stage of packaging waste incineration. According to this, a review of the main treatment and technologies applied in waste incineration and the inventory data of the incineration plants sited in Spain and Portugal has been done.

1 Introduction

This work is part of the “FENIX-Giving Packaging a New life” project, a 3-year European LIFE+ funded project. The main objective of this project is to develop a flexible software tool for the Spanish and Portuguese municipalities and other organisation to obtain the environmental impact of the packaging waste management system using the LCA methodology. Specifically this paper is focused in the incineration process, which main objective is to treat waste so as to reduce its volume and hazard, while capturing or destroying potentially harmful substances. Incineration processes may also allow recovery of the energy, mineral and/or chemical content from waste [1]. Basically incineration process includes the pretreatment, thermal treatment and energy recovery and flue-gases treatment.

1.1 Pretreatment, handling and storage

This is previous preparation stage to the thermal treatment. The different types of wastes that are incinerated may need different types of pretreatment, storage and handling operations. Specifically in the case of the Municipal Solid Waste (MSW), the local collection and pretreatment applied can influence the nature of the material received at the incineration plant.

1.2 Thermal treatment

This treatment comprises basically the combustion of the MSW in a furnace. In this process, slag is generated as solid residue while the flue-gases are used in the energy production through a turbine. Different types of thermal treatments are applied to the different types of wastes, however not all thermal treatments are suited to all wastes. Specifically the most common technologies are grate incinerators, rotary kilns, fluidised beds and pyrolysis and gasification systems. However in Spain and Portugal just the grate incinerators and fluidised beds are used.

1.2.1 Grate incinerators

This type of incinerators is widely applied for the incineration of mixed municipal wastes. Grates usually have as main components:

- Waste feeder.
- Incineration grate: rocking, reciprocating, travelling, roller and cooled grates are the main types of grates.
- Bottom ash discharger.
- Incineration air duct system.
- Incineration chamber.
- Auxiliary burners.

1.2.2 Fluidised bed

Fluidised bed incinerator is a lined combustion chamber in the form of a vertical cylinder. In the lower section, a bed of inert material (such as sand or ash) on a grate is fluidised with air. Normally this type of incineration requires a preparatory process step which makes raise the process costs. The main types of fluidised bed are stationary or bubbling fluidised bed, spreader-stoker furnace and rotating fluidised bed.

1.3 Flue-gases treatment

Gases generated in the combustion before be emitted must be treated using different treatment system depending on the type of pollutant to be removed.

- *Reduction of particulate emissions:* electrostatic precipitators, ionisation wet scrubbers, bag filters and cyclones and multi-cyclones are used to removed these pollutants.
- *Reduction of acid gases (HCl, HF and SO_x)*: usually this reduction is carry out by dry, semi-wet and wet processes adding CaO or $Ca(OH)_2$.
- *Reduction of emissions of nitrogen oxides (NO_X)*: in this case two process are applied, the Selective Non-Catalytic Reduction (SNCR) process where NO_X are removed using ammonia or urea as reducing agent and the Selective Catalytic Reduction (SCR) process where the flue-gas passed over a catalyst.
- *Reduction of Dioxins and Furans:* most usual treatment is adsorption on activated carbon but also bag filters and SCR could be applied.

1.4 Waste treatment

In the incineration process bottom, boiler and fly ashes and slag are the main waste generated. Ashes are usually disposed of, but could be used as a filling material in civil construction. On the other hand slag is disposed of by landfill without further treatment, or may be recycled.

2 Result and discussion

According to the European Pollutant Release and Transfer Register E-PRTR, in Spain and Portugal there are respectively 10 and 3 installations of incineration of non-hazardous waste with a capacity 3of tons/h [2]. Figure 1 shows the incinerators location.

Fig.1: Location of Spanish and Portuguese incinerators.

2.1 Planta de Valortització Energética Sant Adrià de Besòs (TERSA)

The energy valorisation plant sited in Barcelona (Catalonia, Spain) serves out to 750,000 inhabitants. In 2008, 321,728 tons of wastes were incinerated, producing 167,504 MWh of electricity. In relation to waste, 12,039 tons of ashes were generated, 55,642 of usable slag and 7,002 tons of scrap. Some technical data are given in the Table 1.

Tab.1: Technical data of TERSA [3].

Incineration capacity	14.5 t/h
Type of furnace	Von Roll grate
Combustible LHV	1,900-2,200 kcal/kg
Flue-gases treatment	Electrofilter, SNCR, scrubbers, activated carbon, bag filter

2.2 Tractament i Revalorització de Residus del Maresme, S.A. (UTETEM)

The incineration plant gives service to 407,000 inhabitants of Barcelona. In 2009, 170,274 tons of wastes were incinerated; generating 86,104,879 kWh of electricity. Regarding to waste, 24.65% in weight of waste were slag and 4.25% ashes, being stabilized 7,213 tons. Likewise 854 tons of scarps were generated. Some technical data of the plant are given in the Table 2.

Tab. 2: Technical data of UTETEM [3].

Incineration capacity	10 ton/h
Type of furnace	Travelling grate of bar
Combustible LHV	2,100 kcal/kg
Auxiliary combustible	Natural gas
Flue-gases treatment	SNCR, semidry and dry system, activated carbon, bag filter

2.3 TRARGISA

This plant serves out to 125,000 inhabitants of Girona (Catalonia, Spain). In 2009, 30,179.68 tons were incinerated producing 7,595,100 kWh of electricity. About waste, 21% in weight of the waste were slag, 650 tons ashes and 1,073.55 tons scrap were obtained. In the Table 3 some technical data are shown.

Tab. 3: Technical data of TRARGISA [3].

Incineration capacity	2.5 ton/h

Type of furnace	MARTIN reverse acting grate
Combustible LHV	≈1,800 kcal/kg
Electricity production	7,595,100 kWh
Flue-gases treatment	Electrofilter, bag filter, activated carbon and $Ca(OH)_2$

2.4 TIRMADRID

The incineration plant serves out to 1,000,000 inhabitants of Madrid (Spain). In 2009, 311,205 tons of wastes were incinerated generating 234,840,800 kWh of electricity. In relation to the waste, 7,035 tons of scraps were recovery from the slag. Some technical data are given in Table 4.

Tab.4: Technical data of TIRMADRID [3].

Incineration capacity	9.17 ton/h
Type of furnace	Bubbling fluidised bed
Combustible LHV	3,500 kcal/kg
Auxiliary combustible	Gasoil C
Flue-gases treatment	Cyclones, scrubbers, bag filters, activated carbon

2.5 Zabalgarri, S.A.

The energy recovery plant serves out to 700,000 inhabitants of 10 municipalities of Vizcaya, (Basque Country, Spain). In 2009, 223,933 tons were incinerated and 661,160,000 kWh of electricity were generated. In relation to the waste, 3.74% in weight of the MSW were ashes, 19% slag and 2% recovery scrap. In the Table 5 some technical data are shown.

Tab. 5: Technical data of Zabalgarri [3].

Incineration capacity	30 ton/h
Type of furnace	Reciprocating grate

Combustible LHV	2,000 kcal/kg
Auxiliary combustible	Natural Gas
Flue-gases treatment	Bag filter, SNCR, activated carbon injection

2.6 Incineradora de Tarragona (SIRUSA)

The incinerator of Tarragona (Catalonia, Spain) serves out to 350,000 inhabitants. In 2009, 142,418 tons of MSW were incinerated, obtaining 44,552 MWh of electricity. In Table 6 some technical data are shown.

Tab. 6: Technical data of SIRUSA [3].

Incineration capacity	9.6 ton/h
Type of furnace	Roller grate with Dusseldorf system
Combustible LHV	1,900-2,200kcal/kg
Auxiliary combustible	Gasoil
Flue-gases treatment	Semidry system, bag filter, activated carbon injection

2.7 PIR Melilla (REMESA)

The incineration plant of Melilla (Spain) gives service to 74,000 inhabitants. 39,155.9 tons of MSW were incinerated in the plant in 2009. In this year 8,044 MW of energy were consumed being selling 11,298 MWh of energy. In relation to waste, 2.66% of the MSW were ashes (1043 ton/year) and 24% slag from which 1,043 t/year of scrap were recovered. Some technical data of the plant are shown in the Table 7.

Tab. 7: Technical data of REMESA [3].

Incineration capacity	4.5 – 6 ton/h
Type of furnace	Serrated grate
Combustible LHV	1,700
Auxiliary combustible	Gasoil
Flue-gases treatment	Semidry system with bag filter, activated carbon

2.8 Complejo medioambiental de Cerceda (SOGAMA)

The incineration plant serves out to 211,708 inhabitants of Galicia (Spain). In 2009, the plant had a nominal capacity of 550,000 tons/year, with an electricity production of 335.078.400 kWh. In relation to waste, 33,239.74 tons of wastes were ashes, 69,037.55 slag, 8,334.1 iron scrap and 213.94 tons aluminium scrap. Some technical data of the plant are shown in Table 8.

Tab. 8: Technical data of SOGAMA [3].

Type of furnace	Circulating fluidised bed
Combustible LHV	3,500 kcal/kg
Auxiliary combustible	Natural Gas
Flue-gases treatment	Semidry system, bag filters, hydrate lime and activated carbon

2.9 TIRME, S.A.

The incineration plant serves out to approximately 846,210 inhabitants of Mallorca (Balearic Islands, Spain). In 2009, 294,185 tons were incinerated obtaining 152,389 MWh of electricity were produced, being selling 119,759,000 kWh of energy. In relation to waste, 9.6% of wastes were ashes, 23.5% slag and 28,345 tons of scrap were recovered. In the Table 9 some technical data are given.

Tab. 9: Technical data of TIRME [3].

Type of furnace	2 roller grates and 2 cooled grates
Combustible LHV	1,800 kcal/kg
Auxiliary combustible	Gasoil C
Flue-gases treatment	Semydry scrubber, SCR, bag filter, activated carbon

2.10 Planta de Tratamiento Integral de RSU de Cantabria (URBASER)

The incineration plant of Cantabria (Spain) gives service to 580,000 inhabitants.

In 2009, 113,338 tons of MSW were incinerated in the plant producing 82,800 MWh/year of electricity. About waste, 4.01% of wastes were ashes and 13.21% slag. In Table 10 some technical data are shown.

Tab.10: Technical data of URBASER [3].

Type of furnace	12 ton/h
Type of furnace	Roller grate
Combustible LHV	2,800 kcal/kg
Auxiliary combustible	Natural gas
Flue-gases treatment	Scrubber, bag filter, activated carbon injection

2.11 VALORSUL

The incineration plant of Valorsul situated in the municipality of Loures, (Lisboa, Portugal) has an incineration capacity of 662,000 ton/year. Wastes (LHV 7,820 kJ/kg) are incinerated in a Detroit stocker, reciprocating grate generating 30 kg/Mg MSW of ashes and 200 kg/Mg MSW of slag. To the flue gas treatment a semidry process with lime injection, a SNCR, and activated carbon injection are applied [4].

2.12 Valor Ambiente - Gestão e Administração de Resíduos da Madeira

The incineration plant sited in Madeira (Portugal) has an incineration capacity of 16 ton/year and an electricity production of 473 kW/t. Wastes received in the plant have a LVH 2,800 kcal/kg and are treated in a roll grate. About waste, 160 kg/t MSW of slag and 59 kg/t MSW of waste from FGT are generated [5].

2.13 LIPOR - Serviço Intermunicipalizado de Gestão de Resíduos do Grande Porto

The Energy Recovery Plant located in Maia (Oporto, Portugal) has an incineration capacity of 400,000 ton/day, producing 200,000 MWh/year of electricity. Wastes

received in the plant with a LVH of 7,700 kJ/kg are treated in combustion grids 26º inclination [6].

3. CONCLUSIONS

The most relevant technologies applied in the MSW incineration in Spain and Portugal have been reviewed and will be included in the future model based on LCA. About thermal stage, grate incinerator, rotatory kilns and fluidised bed could be applied. However in Spain and Portugal just grate incinerators and fluidised bed are used.

Different cleaning systems are applied depending on the pollutants contained in the gases. In Spain and Portugal electrostatic precipitators, electrofilters, bag filters and cyclones are the main techniques used for reducing particulate emissions. Acid gases are treated through dry, semi-dry and wet processes, while NO_x are eliminated by means of Selective Non Catalytic Reduction (SNCR) and Selective Catalytic Reduction (SCR) processes. About dioxins and furans, these substances are usually treated by absorption on activated carbon.

4. References

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