european aluminium association

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European Aluminium Foil Association e.V.

FACT SHEET
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More aluminium packaging recovered from incinerator bottom ashes than expected!

Over the past 20 years several studies have been carried out regarding the behaviour of metals during and after incineration in Waste-to-Energy (WtE) plants but little is known about one of the most well-known non-ferrous metals, aluminium. Aluminium (Al) is, after iron (Fe), the most abundant metallic component of the incinerator bottom ashes (IBA) and originates largely from used aluminium packaging not (yet) collected separately for recycling. This fraction usually ends up in the residual household waste which, in most Western-European countries, is then sent for incineration. Today, many WtE plants extract a non-ferrous metals fraction from the incinerator bottom ashes (IBA) in quantities ranging from 0.5 to 3.0%, with aluminium constituting 55-70% of it.

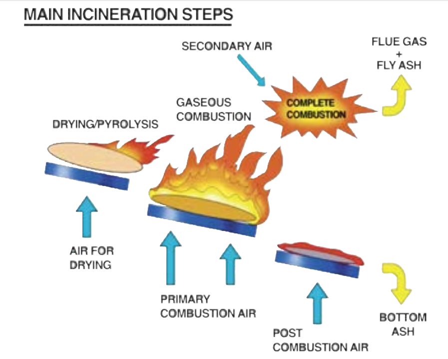
Aluminium metal to bottom ash transfer ratios measured in WtE plants

With a melting point of 660°C, aluminium can be found as melted and re-solidified particles of Al in the IBA, most certainly for aluminium foil thus converted into small droplets. Some larger and thicker aluminium packaging items can even be recognized as they (partially) retain their shape. This is mainly due to the heterogeneous nature of the incineration process which results in there being some relatively cooler regions in the furnace.

Aluminium does not burn during incineration but its surface oxidizes to form the oxide Al_2O_3 (alumina). This oxidation process delivers 31.6 MJ of energy per kg of aluminium which is equivalent to that resulting from the combustion of plastic, paper and even oil. This outer alumina layer offers a major advantage as it prevents the remaining processed aluminium from further oxidation.

Pictures of molten cans and aluminium recovered from bottom ashes

During 2011-2012, the European Aluminium Association (EAA) was actively involved in a significant study at two different Italian incinerators to better understand the behaviour of several aluminum packaging items as they move through the incinerator. These tests were initiated by the Italian aluminium packaging recovery scheme Consorzio Imballaggi Alluminio (CiAl) and the Polytechnic University of Milan and the main results, on which this article is based have been published.



The main steps in the incineration process are pictured here in a diagram based on a similar model used by Professor Buekens of the VUB University of Brussels. Obviously modern incinerators as used in Western-Europe have to meet the highest EU environmental and health and safety standards in terms of emission controls and energy efficiency.

The results from this Italian project, combined with those of prior experiments in three other West-European countries, have shed some new light on the basic understanding behind the transfer ratios of aluminium from metal packaging to the IBA. With only five controlled trials and there being more than 400 WtE plants in Europe, the results could not be processed via a proper statistical analysis; especially as each incinerator is different in size, waste input, operating parameters, etc. However, the converging results allow for some very interesting conclusions.

Types of aluminium packaging tested

The basic hypothesis is that the thinner the gauge of the aluminium packaging the higher the percentage of material oxidized as the depth of the oxide layer should be roughly the same under the same incineration conditions. The big question was how much material is actually oxidized? Standard thicknesses for the various aluminium packaging items vary a lot and can range from relatively thick for rigid items such as aerosol and beverage cans to very thin for household foil and laminated foil as used in flexible packaging. Because of this, a wide range of packaging items had to be used in controlled additions for the tests to be representative of a real life situation.

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Table: Aluminium packaging items tested

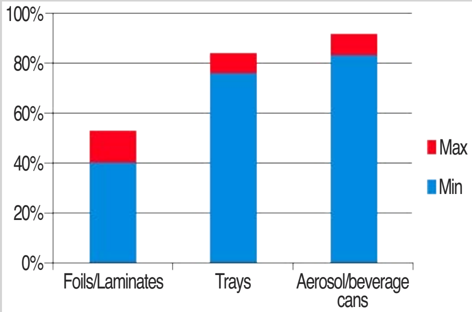
Aluminium packaging used		Thickness levels (in microns)		Comments
Rigid	Aerosol can	900*μ*	High	Bottom of a high pressure aerosol can
	Beverage can	90*μ*	High	Thickness of the wall of a beverage can
Semi-rigid	Foil container	50-150*μ*	Medium	Menu tray, as representative example
Flexible	Plain foil	8-40*μ*	Low	As used in household aluminium foil
	Laminated foil	6-7*μ*	Low	As used in flexible packaging

Unexpectedly high transfer ratios; even for foil!

The tests which measured the metallic Al (and total Al) in both the fly ash (extracted with the combustion gases) and in the incineration bottom ashes (IBA) show that the metal transfer ratios are more coherent for the IBA than for the fly ash. However, as the quantity of aluminium contained in the fly ash is minimal, the results provide a relatively consistent picture, confirming to a large extent what could already be assumed on the basis of the thickness levels of the packaging items used.

Whilst the scope and scale of the five tests were limited, the results are converging and this allows us to draw the following conclusions:

- Minimum metal transfer ratios for thin Al foils are at least 40% and for Al cans well above 80%;
- Minimum metal transfer ratios for mixed Al packs (from flexible to semi-rigid and rigid) in a typical situation are between 50-75%, depending on the foil share in the mixed aluminium packaging fraction;
- The grain (particle) sizes of metallic Al in the IBA varies significantly. This appears to depend on the operational parameters of each plant. Metallic Al was found in all grain sizes, also in the fractions below 5mm and even below 1mm.



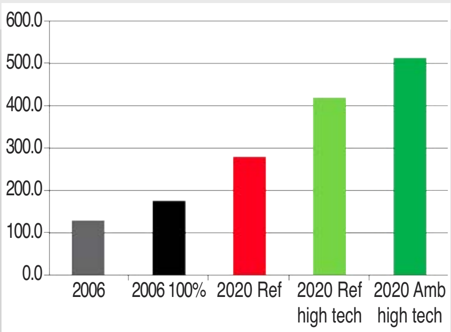
Therefore, to optimally process the IBA, each incinerator requires an individually arranged combination of Eddy Current Separators (ECS) and/or other advanced sorting technologies to be able to achieve high non-ferrous metal extraction levels; even at the very small grain sizes.

Potential for increased Aluminium Recovery

The Aluminium Industry's preferred recycling solution for aluminium packaging is via separate collection and sorting. Well managed metal packaging collections systems can reach recycling percentages of 80% or more. Smaller aluminium packaging items, such as screw caps/closures, are usually included in existing packaging recovery schemes and some also allow for thin foil to be added although this is still less common.

However, because these packaging collection schemes differ from country to country and taking into account that the thinner aluminium (and laminated) foil usually ends up in the household waste fraction sent to the WtE plant for treatment, it is strongly recommended to keep all options open; including the recovering of aluminium from the bottom ashes at the WtE incinerators. In addition to the recovered aluminium, the oxidized aluminium contributes energy which is used to generate electricity or district heating.

However, as not all European WtE incinerators currently recover the metal from the IBA, it has been estimated that, taking 2006 as the reference year, there should still be an average of 2.3% metallic Al in the European bottom ashes. This represents an impressive tonnage of 'hidden' aluminium waiting for recovery; equivalent in tonnage to the annual production of a modern smelter!



Remaining potential Non-Ferrous Metals Extraction (Kt) – various scenarios (standard, high technology, ambitious)

It is expected that the pressure from new EU waste legislation targeting the phasing out of landfilling, increased recycling and more efficient energy recovery of waste will result in an increase in the volume of waste being processed by WtE incinerators in the next decade. This should result into two to three times more aluminium recovered from bottom ashes by 2020 (see graph), offering some important economic and environmental benefits to Europe in terms of raw materials saving – provided all WtE facilities make the relatively small investment to recover it!

This fact sheet summarises an article published earlier in the International Aluminium Journal no. 6 of June 2013 by François Pruvost

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