Considerations regarding aluminium beverage cans recycling in Romania

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Abstract: Aluminium can be recycled without loss of properties and can be used again and again in applications. The aim of the aluminium recycling industry is to recycle all sources of aluminium scrap, whenever it is technically feasible, economically viable and ecological desirable. Aluminium recycling saves raw materials and energy, and also reduces demands on landfill sites. Recycling aluminum beverage cans saves 95% of the energy used to make aluminum cans from virgin ore, aluminum beverage cans being the most recycled and most recyclable beverage container in the world because it is easy to collect, crush and recycle. Recycling rates for aluminium packaging in Romania are still low, due to differences between collection systems, frequency of collections and what is collected. A more standard format would remove confusion for the public and allow useful national recycling campaigns and information to take place.

Key-Words: packaging industry, environment protection, waste, collection, sorting systems

1 Aluminium and recycling

Aluminium is the third most abundant chemical element in the earth's crust and the most abundant metallic element. The aluminium industry is the largest non-ferrous metal industry in the world economy. Since its industrial production, demand for aluminium has been continuously increasing and its application has extended to wide variety of economic sectors, e.g. transport vehicles, construction, packaging industry, electronic production, household appliances, etc., and consequently the economic activities of these industrial sectors determine the overall demand for aluminium. [1]

Aluminium is worldwide used due to its many favorable qualities, which are summarized in Table 1.

Table 1. Summary of aluminium properties [2]

Property	Description
Strength	Alloys of aluminium can provide the strength of steel with only a third of the weight
Lightweight	Using aluminium in transport applications reduces weight, thereby increasing fuel efficiency, reducing energy consumption and greenhouse gas emissions
Corrosion resistance	The surface of aluminium naturally oxidizes to aluminium oxide which prevents the deterioration caused by air, temperature, moisture and chemical attack
Flexibility	Aluminium and its alloys are easily shaped by all the main industrial methods making it useful for a wide range of applications
Impermeability	Aluminium is a highly efficient barrier to air, light and microorganisms making it useful for packaging applications
Recyclability	Aluminium can be recycled indefinitely without any loss in quality
Conductivity	Aluminium is an excellent conductor of both heat and electricity, while also being non-magnetic and non-combustible making it useful for electronics

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Aluminium is a permanently available material resource to be used again by recycling. It is the product application (can, car, etc.) that reaches the end of its life, and not the material. Aluminium can be recycled without loss of properties and can be used again and again in applications.

Aluminium can be produced from natural resource (bauxite) and from recycled scrap metal. The first process is called the primary production, and the latter secondary production. Bauxite has to be processed into aluminium oxide (alumina) before it can be converted to aluminium by electrolysis. This is achieved using the Bayer chemical process in alumina refineries.

The production of the primary aluminium from bauxite is electricity intensive process and consumes majority of the energy used in the sector. Furthermore, primary aluminium production process emits carbon dioxide and two kinds of perfluorocarbon gases (PFCs), which are all important greenhouse gases (GHGs). Therefore energy price and GHGs reduction policy has great influence on the technology evolution and the economy of the sector. [1]

Aluminium produced by the secondary production process is using the old scrap and new scrap (excluding the so-called run around scrap or internal scrap). Aluminium scrap comes from either post consumption products containing aluminium, i.e. old scrap, or from the dross during the production process, and cut offs during semi and final fabrication of products, new scrap. [1]

The second source, old scrap, is an aluminum part or product that has reached the end of its useful life.

Old aluminium scrap comes into the secondary industry via a very efficient network of metal merchants who have the technology to recover aluminium from vehicles, household goods etc. This is often done using heavy equipment such as shredders, together with magnetic separators to remove iron, gravity separation (sink-float, heavy media), optical and eddy current separators to separate aluminium from other materials. [3] Usually, it is more difficult to separate other non-ferrous metals from aluminium.

Old and new scraps are processed prior to melting by methods that depend on any contamination that may be present. For example aluminium beverage cans are processed to remove the lacquer coating that would otherwise lead to an increase in fume emission during melting. Several melting process are used depending on the scrap quality. [3]

New aluminium scrap, being readily identified and within the control of the industry, has a recycling rate of virtually 100%. From an ecology viewpoint, the recycling rate of old aluminium scrap is more interesting. The industry calculates that the recycling rate for old scrap is of the order of 75%. That means that of all the aluminium previously sold to end consumers in transport, packaging, engineering, building, etc., 75% of this aluminium is now being returned to the industry to be recycled. This calculation takes into account the life time of the product. [3]

The aluminium recycling process uses only 5% of the energy required for its initial extraction and processing [4] and 10% of the initial capital equipment costs. [5] Recycling also saves 97 % of the greenhouse gas (GHG) emissions generated in the primary production process. [6]

The main challenges when recycling scrap aluminium are the problems caused by contaminants. If steel is not separated by the magnet it migrates into the finished aluminium. Any contamination with flammable substances, such as paper and plastic becomes problematic in the decoater where it causes a rapid increase in temperature as it ignites and possible fire danger. The decoater would normally have to be shut down until the temperature lowers. Excess moisture is also problematic as it causes excessive oxidation and decreases the efficiency of the decoater, which leads to increased melt losses. The presence of lead is also extremely undesirable as even a very small amount would push the smelter off specification. Zinc is also detrimental as it has a tendency to explode. [2]

The aim of the aluminium recycling industry is to recycle all sources of aluminium scrap, whenever it is technically feasible, economically viable and ecological desirable. Material recycling is deemed economically viable if the added value exceeds the recycling costs. In specific cases, for instance for very thin aluminium foil laminated to paper, plastics foils, etc., thermal incineration and energy recovery is often preferable to the recovery of the minute amount of aluminium metal. Almost all aluminium used commercially contains one or more alloying elements to enhance its strength or other properties. Aluminium recycling therefore contributes to the sustainable use of copper, iron, magnesium, manganese, silicon, zinc and other elements. [7]

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2 Key environmental issues

The main environmental concern of the industry is related to primary aluminium production, where GHGs including two perfluorocarbons (PFCs), CF_4 and C_2F_6, are generated as a result of the anode effects during electrolysis. Both PFCs have a global warming potential much higher than CO_2. Primary aluminium production is electricity intensive; therefore CO_2 emissions of the industry highly depend on the primary fuel for electricity generation. [1]

As a result, the aluminium industry alone is responsible for around 1% of global greenhouse gas emissions. [8] Critically, because of the much lower energy requirements involved in recycling, each tone of aluminum recycled avoids nine tones of CO_2 equivalent emissions. [9]

There are also large amounts of solid waste, such as undissolved bauxite known as red mud, generated during the extraction of alumina. The insoluble mud is generally alkaline therefore it needs to be neutralized before being discharged. Current practice is to deposit the treated mud on or near the site in specially designed, sealed ponds. [1]

Environmental issues related to the secondary aluminium production are relatively less significant. However, emissions to air consist of particulates with traces of metals, chlorides, hydrochlorides, as well as organic hazardous compounds including dioxins. The type and quality of scrap has the major influence on the emissions. Various techniques, e.g. hood, baghouses, cyclones are used to capture the fumes/gases and control air emissions to meet the standards. Filter dust collected is deemed to be hazardous and is currently land filled or partly recycled. [1]

Salt slag, a mixture of salts, aluminium oxide, aluminium metal and impurities, is a typical residue from aluminium scrap melting. The salt slag is now being completely recovered and reused on site for the same purpose. Meanwhile, aluminium metal is also recovered and the remaining residues are, whenever possible, used in cement production or land filled. [1]

Bauxite deposits are generally extracted by open cast mining. In most cases the topsoil is removed and stored. Since between 4 and 5 tones of bauxite are required to produce 1 tone of primary aluminium, and for each tone of bauxite up to 1 m^2 of land is disturbed, the land use for mining is reduced by recycling. Nevertheless, the impact of bauxite mining is greatly lessened by the industry's sustainable post-mining rehabilitation measures. [10]

3 Aluminium packaging recycling

For aluminium packaging, the material is thinly spread across the whole population and the problem is one of recovery, so that recycling can take place. The aluminium industry works closely with local authorities to ensure the maximum recovery of aluminium from the waste stream, since it is a high value component. Once recovered, the industry has the infrastructure to recycle all of the recovered aluminium packaging. [3]

Aluminium packaging waste is a large short term source of scrap. Most of the products used in food packaging have less than a one year life time. Two different types of aluminium products are usually distinguished in this sector, i.e. rigid and semi-rigid, and flexible packaging, with the first one having high aluminium content and the latter low in aluminium content. Used beverage cans are the most recycled aluminium products of the sector, while the others are rarely recovered. [1]

Recycling aluminum cans saves 95% of the energy used to make aluminum cans from virgin ore, aluminum cans being the most recycled and most recyclable beverage container in the world because it is easy to collect, crush and recycle.

Per capita, the world's average use of aluminium cans is 26 units; however, it ranges from six in Germany and Asia to 334 in USA. The difference is due to the fact that in some countries the alternatives, steel and paper cans/cartons, are more popularly used. [1]

In Europe, two-thirds of aluminium beverage cans were recycled in 2010, representing a record number of at least 24 billion cans, and tripling the recycling rate over 20 years. Belgium, Finland, Germany, Switzerland and Norway collect more than 90 % of their aluminium beverage cans. These countries have achieved such high aluminium can recycling rates due to efficient and well-established collection and sorting infrastructures. Relatively low levels of beverage can recycling are prevalent in Eastern European countries. Used Aluminium Beverage Can Recycling Rates in Europe 2010 detailed per country is presented in figure 1. [11]

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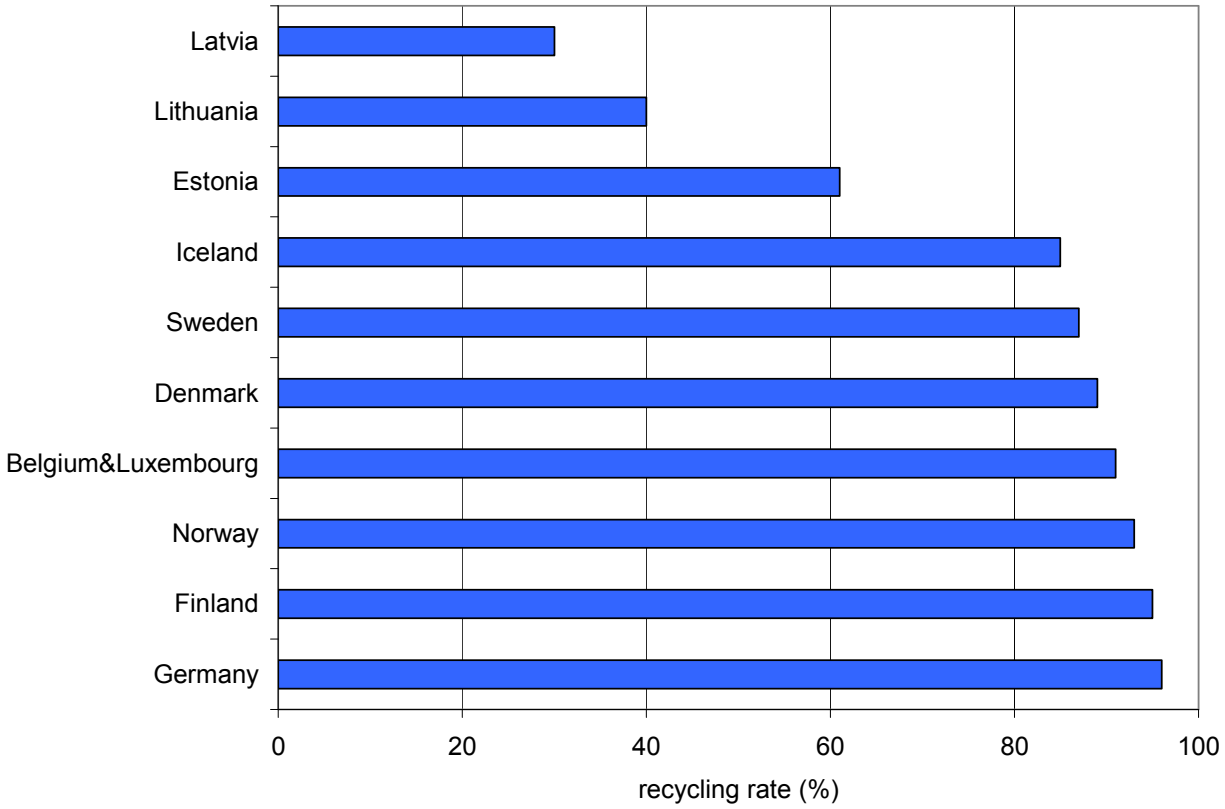

Fig. 1 Used Aluminium Beverage Can Recycling Rates, Europe 2010 [11]

Most European countries have nationwide aluminium packaging recycling schemes in place. These can be grouped into three main routes:

1. Separate collection of used beverage cans, either in designated deposit systems (Scandinavian countries and Germany), voluntary take back systems (Switzerland and Poland) or incentive based projects (UK, Ireland, Hungary and Greece) such as charity events. Moreover aluminium containers are included in separate collection schemes in the UK and Switzerland; the later covers aluminium packaging tubes as well.
2. Multi-material packaging collection systems, where aluminium containing packaging is part of the "light packaging flow" containing plastics, tinplate, beverage cartons and sometimes paper packaging, newspapers and magazines. Here, aluminium is separated during the final step of sorting at the plant (e.g. Italy, Spain, Germany, Portugal, France, Belgium, Austria).
3. Extraction from the bottom ashes of municipal solid waste incinerators as aluminium nodules (Netherlands, France, Belgium and Denmark, in particular) In many European countries municipal solid waste is entirely or partly incinerated, in this case the contained thin gauge aluminium foil is oxidized and delivers energy while thicker gauges can be extracted from the bottom ash. [7]

During 2012 were recycled in Romania 5000 tons of aluminum scrap, which translates into 29% of the aluminum on the market. Of the total recycled, 80% were aluminium beverage cans. Romania managed to recycle 29% of aluminum cans on the market, with 8% more than regulations.

In our county, Maramures, there are 13 operators for packaging waste collection. Fluctuation in quantities of used aluminum beverage cans collected and recycled during 2008-2012 is presented in Figure 2. Total quantities of used beverage cans collected are: 699463kg in 2012, 640674kg in 2011, 629152kg in 2010, 492923kg in 2009 and 409250kg in 2008. A slight upward trend can be observed for used beverage cans collection in Maramures County.

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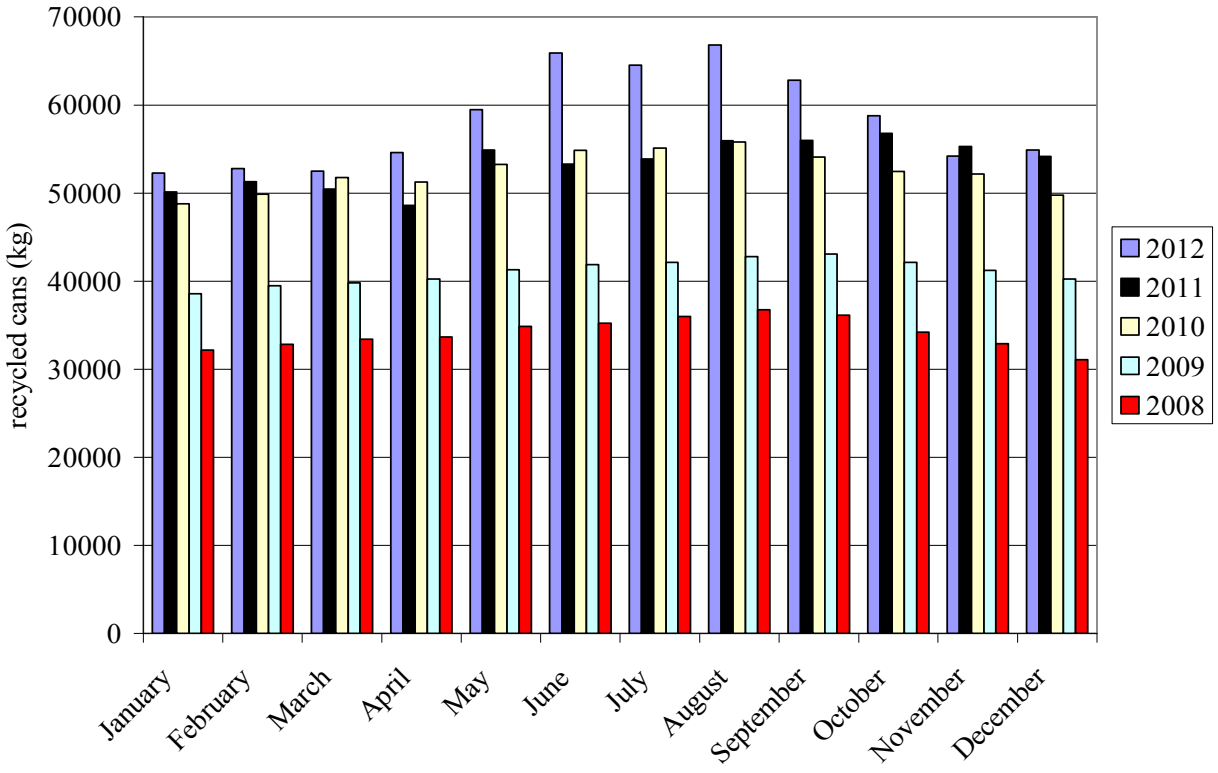

Fig. 2 Used Aluminium Beverage Can collection 2008-2012

Romania has an annual collection target for aluminum waste representing 50% of the market, proposed to be achieved by January 2014. Alucro Organization run in Romania the program 'Every Can Counts', an European platform that promotes recycling aluminum cans in 120 locations in 12 counties and aims to implement a system of long-term collection in homes, offices or public events.

4 Conclusions

Aluminium recycling saves raw materials and energy, and also reduces demands on landfill sites. It is important to maximize the collection of all available aluminium, and develop the most efficient scrap treatments and melting processes.

Recycling rates for aluminium packaging in Romania are still low, due to differences between collection systems, frequency of collections and what is collected. A more standard format would remove confusion for the public and allow national recycling campaigns and information to take place.

With a growing number of industry initiatives and the help of appropriate authorities, local communities and society as a whole, the amount of aluminium collected could be increased further.

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