

Recycling of Aluminum Beverage Cans

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Abstract

Aluminum offers the ideal prerequisites for recycling that is economically and ecologically sound. Aluminum is readily recycled without any loss of quality and hence scrap aluminum has significant value.

Aluminum beverage cans is the most recycled packaging material because of the high value of the scrap and ease of collection, unlike other materials, aluminum retains its properties throughout the process. So, no matter how many times a can is used

The recycling of aluminum beverage cans eliminate waste. It saves energy reduce emissions, reduce use of city landfills and provides added revenue for recyclers.

This research deals with aluminum beverage cans recycling process in Iraq and explain the limited sides of the present and suggest a national program to collect, sort and melt these cans to develop this industry in Iraq since it has great economical and environmental advantages.

الخلاصة

يوفر الألمنيوم الشروط الاقتصادية والبيئية المثالية لإعادة التصنيع حيث يتم إعادة تصنيعه بدون أن يفقد خواصه كما إن للألمنيوم المستخدم قيمة اقتصادية عالية.
إن علب المشروبات المصنعة من الألمنيوم من أكثر أنواع علب التعبئة التي يتم إعادة تصنيعها نظراً لكثرتها وسهولة جمعها حيث إن الألمنيوم ليس كباقي المواد لأنه يحتفظ بخواصه بعد عملية إعادة التصنيع لذلك فإن عدد مرات إعادة تصنيع علب المشروبات المصنعة من الألمنيوم لا يؤثر على خواص الألمنيوم المعاد.
إن إعادة تصنيع علب المشروبات يقلل من تبديد الألمنيوم ويوفر طاقة ويقلل من الغازات المنبعثة كما انه يقلل من استخدام الأراضي كمكبات للنفايات ويوفر أرباحاً لجامعي هذه العلب.
إن هذا البحث يتطرق إلى طرق إعادة تصنيع علب المشروبات في العراق ويشرح سليات الطريقة الحالية ويقترح نظام لجمع وخرن وصهر هذه العلب لتطوير هذه الصناعة لما لها من أهمية اقتصادية وبيئية.

1. Introduction

High percent of drink cans are made of aluminum.. While almost all food cans are made of steel, aluminum's unique properties make it ideal for holding carbonated beverages. Aluminum is a light metal its density is 2.7g/cm^3 , which is one third of steel yet its thin walls withstand the pressure exerted by the carbon dioxide in the drinks. Aluminum's shiny finish also makes it an attractive background for decorative printing in addition to all this Aluminum beverage cans do not go rusty ^[1, 2].

Aluminum is a silver white metal obtained from bauxite world primary production of aluminum was 20.5 million metric tones in 2001. Aluminum has to go through many different processes before it is transformed from its natural state to complete commercial product so the production of aluminum is costly and demands large quantities of energy. Four tones of bauxite are needed to produce each tone of aluminum. Aluminum has a high scrap metal value and aluminum can be recycled by melting down and used to make similar products again ^[3].

Aluminum was not used for beverage cans until after World War II the first model was a steel can the next model was steel can with an aluminum top. This hybrid can have several distinct advantages. The aluminum end altered the galvanic reaction between the drink and the steel, resulting in drink with twice the shelf life of that stored in all-steel cans. Perhaps the more significant advantage of the aluminum top was that the soft metal could be opened with a simple pull tab. The old style cans required the use of a special opener. The first aluminum beverage can manufactured in 1958. Its two-piece cans could only hold 198 g, instead of the usual 340 g, and there were problems with the production process. Aluminum cans represent less than one percent of the solid municipal waste stream, but their high value and ease of collection can generate good revenue to the recyclers ^[4].

2. Aluminum Beverage Can Raw Materials

The raw material of the aluminum beverage can is, of course, aluminum. The aluminum base, for beverage cans consists mostly of aluminum, but it contains small amounts of other metals as well. These are typically magnesium, manganese, iron, silicon, and copper. The lid is made of a slightly different alloy than the aluminum for the base and sides of the can, the beverage cans are made of two aluminum alloys (3004 ASTM for the main body and 5182ASTM for the lids) having different compositions, **Table (1)** represents the composition of these alloys ^[2, 4, 5].

Table (1) The composition of aluminum beverage can alloys ^[6]

Alloy	Weight of Elements %		
	Al	Mn	Mg
3004	97.8	1.2	1.0
5182	95.2	0.35	4.5

The inward bulge of the bottom of the can helps it withstand the pressure exerted by the liquid inside it, but the flat lid must be stiffer and stronger than the base, so it is made of aluminum with more magnesium and less manganese than the rest of the can. This results in stronger metal, and the lid is considerably thicker than the walls. The 3004 ASTM alloy has the exceptional form ability needed to perform the deep drawing process, the 5182 ASTM alloy is harder and permits the pull tops to function properly ^[2,4]. **Table (2)** shows the mechanical properties of these alloys.

Table (2) The mechanical properties of aluminum beverage can alloys ^[6]

Properties in 25 (°C)	Alloys	
	3004	5182
Density (×1000 kg/m ³)	2.6-2.8	2.6-2.8
Poisson's Ratio	0.33	0.33
Elastic Modulus (GPa)	70-80	70-80
Tensile Strength (Mpa)	215	420
Yield Strength (Mpa)	170	395
Elongation (%)	10	25
Hardness (HB500)	52	25
Shear Strength (MPa)	<u>115</u>	<u>150</u>
Fatigue Strength (MPa)	<u>105</u>	<u>140</u>

A large portion of the aluminum used in the beverage can industry is derived from recycled material ^[7].

3. Secondary Aluminum Processing

Because the remelting of aluminum scrap consumes only 5 percent of the energy required to make primary aluminum from bauxite, “in-process” scrap metal from fabricating sheet, forgings, and extrusions has found its way back to the melting furnace ever since production began. In addition, shortly before World War I, “new” scrap produced during the fabrication of commercial and domestic products from aluminum was collected by entrepreneurs who began what is known as the secondary aluminum industry. The chemical composition of new scrap is usually well defined; consequently, it is often sold back to the primary aluminum producers to be remade into the same alloy. “New” scrap is now greatly supplemented by “old” scrap, which is generated by the recycling of discarded consumer products such as automobiles or lawn chairs. Because old scrap is often dirty and a mixture of many alloys, it usually ends up in casting alloys, which have higher levels of alloying elements ^[4,8,9].

Used aluminum beverage containers constitute a unique type of old scrap. Although the bodies and lids of these cans are made from different aluminum alloys, both contain

magnesium and manganese. Consequently, recycled beverage containers can be used to remake stock for either product ^[4, 8, 9].

4. Benefits of Aluminum Recycling

1. The recycling of aluminum saves up to 95% of the energy needed to produce primary metal because the recycling of aluminum requires only 5% of the energy to produce secondary metal as compared to primary metal and generate only 5% of the green house gas emissions.
2. Recycling one kilogram of aluminum can save about 8 kilograms of bauxite, 4 kilograms of chemical products and 14 kilowatt hours of electricity.
3. Reduce the volume of aluminum in landfills
4. Reduce landfill disposal fees.
5. Provides added revenue for recyclers ^[10, 11].

5. Aluminum Beverage Can Recycling Rate

The recycling rate of aluminum cans is higher than for any other used packaging material because of the high value of the scrap metal and this accompanied by over more highly developed technologies for sorting and recovery for example twenty aluminum cans can be recycled with the same energy needed to produce one new can from the raw materials.

Aluminum beverage cans recycling is profitable and successful industry and most industrial countries have a national can recycling association which offers collectors in touch with purchasing organizations, but still differ from country to country depending on the collection, sorting and recycling schemes in place and on the progress of its implementation ^[7, 12]. **Table (3)** represents the estimated values of the aluminum beverage can recycling rate at 2003.

Table (3) Aluminum beverage can recycling rate 2003 ^[7]

Country	France	Greece	Spain	UK	Italy	Austria
Recycling %	33	36	39	42	44	50
Country	Turkey	Germany	Denmark	Sweden	Switzerland	Finland
Recycling %	60	71	82	85	91	95

6. The Estimated Quantities of Aluminum Beverage Can Recycled in Iraq

The estimated number of population in Iraq is 28,807,000, according to this number the used aluminum cans in our country are estimated The estimated numbers of people between 10-50 years old are 15,000,000 ^[14, 15] and 1/3 of them use one Aluminum beverage can daily so there is 5,000,000 cans daily so in one year there is:

$5,000,000 \text{ can/day} * 360 \text{ day/year} = 18*10^8 \text{ can/year}$

The average weight of one aluminum beverage can is 14 gr

$18*10^8 \text{ can/year} * 0.014 \text{ kg/can} = 25,200,000 \text{ kg/year}$

$25,200,000 \text{ kg/year} \div 1000 \text{ Kg/ton} = 25200 \text{ ton/year}$

7. Recycling Aluminum Cans in Iraq

The present scheme in recycling aluminum cans in Iraq done by a private sector and in the areas which have a very low income as a way to provide extra cash money living to some families searching in the landfill to collect different materials that can be of value and beverage cans one of them, the collected cans are dirty and contaminated.

The small recyclers used a furnace made of steel sheet embodied with firebricks and heat-proof sand 20-30 cm in thickness, connected with an air current outlet via blower air; beside an upper tube where furnace resulted gases get in to reverse heat.

Kerosene (or paraffin oil), diesel, or crude oil may used as fuel. Cans hand feeded into the furnace "Kurra" while temperatures adjusted to 600° aluminum melting point. This process is classified as primitive and dangerous in food industry because:

1. Lack of typical purification process.
2. Using petroleum products as fuel which eventually yields toxicated vapor and materials.
3. Melting different kind of scrap without sorting which yield in using the recycling aluminum in casting arm chairs and other similar products.

As mentioned earlier the beverage cans are made of two aluminum alloys (3004 and 5182) having different compositions when the cans are remelted the resulting alloy contain both magnesium, and manganese and is not suitable for either application.

8. Aluminum Beverage Can Recycling

Aluminum recycling can be corporate into residential and commercial or industrial recycling programs with minimal capital costs. Either drop-off or curbside services need to be available in the offices, schools, universities or other commercial/industrial area to be properly diverted from disposal and to increase aluminum recovery from the commercial/industrial waste streams. To improve the efficiency of recycling programs to increase the quantity of aluminum collected, waste reduction based collection systems such as pay as you throw, which is a program based on the amount of waste generated, providing financial incentives to reduce and recycle. An another collection option available for collection cans is an automatic machine in which recyclers insert their used aluminum cans into automatic machine for weighting and receive cash or vouchers in exchange.

Aluminum cans can be compacted into bales or shredded to reduce storage and transformation requirements to where they are melted down for reuse.

Aluminum beverage cans are made of two alloys as mentioned earlier (3004 ASTM for the main body and 5182 ASTM for the lids) to melt these cans the two alloys must be

separated from the cans. The cans are shredded, then heated to remove the lacquer that helps protect the can during use, further the material could then shred at temperature where the 5182 alloy begins to melt. The 5182 alloy has a wider freezing range than the 3004 alloy and breaks into very small pieces, the more ductile 3004 alloy remains in large pieces. The small pieces of 5182 can therefore be separated by passing the material through a screen. The two separated alloys can then be melted, cast and rolled into new can stock [5].

An alternative method would be simply remelt the cans, Once the can have been melted chlorine gas could be bubbled through the liquid alloy. The chlorine reacts selectively with the magnesium, removing it as chloride. The remaining liquid can then is adjusted to the proper composition and be recycled as 3004 alloy.

Many researches are made to separate magnesium and manganese from molten used beverage can alloys by different ways such as the using of a novel recessed-channel cell [15].

9. Economic Analysis

Aluminum beverage cans recycling costs include:

- + Purchase of curbside recycling containers.
- + Purchase of large collection bin.
- + Collection cost.
- + Materials handling cost (e.g. separation of aluminum container from other materials).
- + Transportation cost.

These costs can be offset with

- + Reduce landfill disposal fees.
- + Revenues from the sell of aluminum.

10. Conclusions

1. Developed countries should contribute to protect the environment by making use of all recycled materials to save money, energy and raw materials for the incoming generation.
2. The recycling of aluminum saves up to 95% of the energy saves 8 Kilograms of bauxite, 4 Kilograms of chemical products and 14 Kilowatt hour of electricity for each kilogram of aluminum extracted for new raw material [10, 11].
3. The recycling rate of aluminum cans is higher than any other used packaging material
4. The recycling rate depending on the collection way, sorting and recycling schemes in place and on the progress of its implementation.
5. The collection ways of aluminum beverage cans in Iraq are primitive and there is a misunderstanding of ecological and economical benefits of recycling process.
6. The aluminum beverage cans recycling process in Iraq classified as dangerous in food industry because there is lack of proper purification process and using petroleum product instead recycled aluminum could be used in other less important industries such as decoration.

7. Ministry of environmental and ministry of industry should start a national scheme to collect and reuse the beverage aluminum cans by the corporation with other establishment in Iraq like mayoralty of Baghdad.

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