Aluminum Recyclability Index

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Abstract

As it is in the recycling of any products, energy cost and sustainability are two major concerns that are constantly dealt with. Addressing such problems, we developed an index that ranks the recyclability of different aluminum alloys so that it is easier for designers to choose what alloys should be used to make their products more recyclable. The Earth, much like an island, only has a finite amount of resources, and in these current times is being consumed at continuously increasing rates, and not enough is being recycled. If industries begin designing their products with the end in mind, this including the materials used, the actual process of recycling would be made much more cost effective and environmentally friendly. However, designers do not have a standard index that describes aluminum alloys by how recyclable they are to aid in the practice of selecting alloys for industries. Through creating these indexes, we hope to reduce new aluminum being produced by transitioning towards a more recycle-orientated industry. There needs to be a change in mind set of industries to have a greater focus on sustainability rather than creating new alloys to up the competition, thus reducing the recycling capabilities of their products.

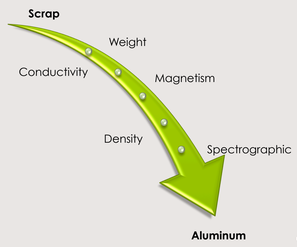
Background

COLLECTION: A collection infrastructure needs to exist for each application.

- Transportation, construction, and electrical applications have good recycling infrastructure.
  - Rates between 70 and 80 percent.
  - Other applications have very low levels of recycling.
- Only 60% of aluminum materials are recycled.
- There is currently 25 billion metric tons of aluminum in landfills.

Industry	Percent of Market	Percent Recycled
Transport	28%	70%
Construction	22%	80%
Electrical	17%	70%
Packaging	14%	40%
Electronics and Machinary	20%	30%

SORTATION: Once scrap is collected it must be sorted before being reused.



- Different methods for sorting scrap:
  - Air jets blow of light weight debris
  - Magnets pull off iron compounds
  - Elements can be consolidated based on density by a series of solution baths.
  - Spectrographic methods can identify wavelengths emitted by these sorted scraps
- Results in sortation of specific alloys

These alloys, if meeting compositional purity requirements can be directly recycled.

UPGRADING:

- Sweating: Separates elements with lower melting points than aluminum.
- Distillation: Separates elements with lower boiling points than aluminum.
- Fluxing: Adds salts or gases to the melt; reacting certain impurities to form fluorides and chlorides.
- Electrolysis: A cathode of pure aluminum and an anode of scrap; aluminum in the scrap will collect at high purity at the cathode.

Project Goals/Objectives

Our goal is to develop a set indexes to educate industries to select more sustainable and recyclable aluminum alloys for their applications.

Specific Objectives

- Reduction: Limit number of alloys and decrease primary production (processing of new aluminum materials).
- Reuse: Increase secondary production (processing from recycled aluminum materials).
- Recycling - Energy cost: Recycling uses approximately five percent of the energy that producing new aluminum uses, and thus much more energy efficient.
- Reorganization of Industry: Recommended “green” alloys for different products or industries and must be applicable to any alloy.

Methods/Process

Analyze data:
- Tolerance Ranges
- Collection / Sortation
- Purifying / Upgrading

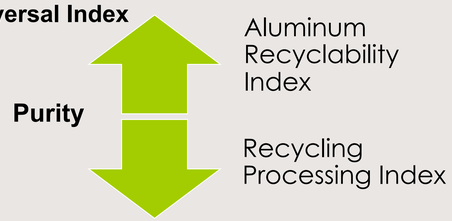
Critical Literature Review:
- Aluminum Recycle Index (ARI)
- Recycle Production Index (RPI)

Create Universal Index

Library database

Interviews
- Dr. Subodh Das
- Dr. Randolph Kirchain

Presentations
- Dr. David Spencer



Recommendations: A Universal Index

1) Raise consumer awareness
2) Create infrastructure
3) Implement technology for sortation
4) Give information at upgrading costs
5) Combined Purity Index
6) Tolerance Index

Combined Purity Index

$$A = 100 - (k - a)^2$$

A = Recyclability
k = industry ideal percentage
a = percentage of aluminum

Tolerance Index

$$T = kt$$

T = Recyclability
k = industry tolerance coefficient
t = tolerance range percentage of alloy

Results/Outcomes

PROPOSED INDEXES:

Aluminum Recycling Index

Favors things that are more pure since it has less alloying elements and is closer to being equivalent to pure aluminum. It is easier to create new alloys by starting with pure aluminum and add new alloying elements.

Recycling Processing Index

Favors alloys that are less pure since it is being created from impure scrap. If scrap is being used to make this alloy, the scrap will need to be upgraded if the purity is below that of the alloy.

Overall these two indexes proposed indexes favor opposing sides of the same factor.

TOLERANCE RANGES: Product collects mass, or impurities.

- There are ranges for the percent composition for each alloying element.
- If the impurities collect in a large concentration then it will not meet the performance requirements of the alloy.
- The larger the tolerance range of an alloy, the longer it may remain in the industry before requiring alloy upgrading.

Impacts

- The indexes will make it easier for designers to select alloys.
- Increase of Recycling in Aluminum Industry.

For the Future:

- Promote the index to industrial sector companies.
- Implement the index into designers everyday work.
- Look to Center for Resource, Recovery & Recycling for help.

Acknowledgments

Advisors

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Peer Learning Assistant: Patrick Bobell

Interviews

Dr. Subodh Das

Dr. Randolph Kirchain

Presentation

Dr. David Spencer

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