Journal of Mines, Metals and Fuels, *70(4) : 161-164; 2022. DOI: 10.18311/jmmf/2022/30062*

Print ISSN : 0022-2755

Journal of Mines, Metals and Fuels

Contents available at: www.informaticsjournals.com/index.php/jmmf

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(April 2022 Issue)

Mine and Return ™

How Aluminum Industries can Get Involved in Environmental Stewardship

Aluminum as Waste

The demand for aluminum has been increasing drastically since 1950 due to the global population's growth and the improved standard of living (European Aluminum Association, 2021). Till today, aluminum is the second most-produced metal, preceded only by steel. Aluminum is produced more than all other non-ferrous metals combined. In the last two decades, the demand for aluminum has grown faster than that for any other metal, increasing at a significantly faster rate than the global GDP. Its lightweight, high strength, good corrosion resistance and high conductivity make aluminum an attractive choice for many products, including food packaging, car parts, airplane components and building features. The increased use of aluminum has led to significant weight reductions of components in the automotive and aerospace sector, which has saved a large amount of fuels in the use phase of cars, trucks, and planes (European Aluminum Association, 2013). However, aluminum production itself has a substantial environmental impact, in the form of toxicity, acidification, greenhouse gas emissions, and resource depletion. In 2020, the primary production of aluminum was responsible for the emission of more than 1 billion metric tons of CO_2-equivalents, accounting for almost 2% of the global human-caused emissions in that year. In order to reduce the aluminum industry's environmental impact, companies and policymakers increasingly focus on aluminum recycling as a potential solution, with as main driver as substantial difference in energy consumption: producing 1 kg of recycled aluminum requires an average of 9.2 MJ compared to 144.6 MJ for producing 1 kg of primary aluminum.

The European Aluminum Association (EAA), the organization representing the European aluminum industry, forecasts a rise in the share of recycled aluminum in European end-use products from 26% in 2000 to 49% in 2050 (European Aluminum Association, 2019). In its "VISION 2050" report, the EAA explains that this is an ambitious but realistic evolution that will significantly contribute to the European decarbonization efforts. However, most collected aluminum scrap today contains a mixture of different alloy types. As a result, different alloying elements and impurities are present in the scrap. Removing these elements metallurgically from the secondary aluminum is notoriously difficult. Therefore, most collected aluminum scrap is "downcycled" and used for the production of cast aluminum alloys, which have high tolerances for impurities. A smaller share of the collected scrap is used to produce wrought aluminum alloys, which have much lower tolerances for alloying elements and impurities. To

produce wrought alloys from mixed scrap, it needs to be diluted with large amounts of primary aluminum.

Current Practice

Although this downcycling practice has been a successful strategy because of the high demand for cast aluminum alloys for the production of combustion engines, this is expected to change with the electrification of the automotive industry. Due to this transition, the global demand for cast aluminum alloys will stagnate or is even expected to decline. Simultaneously, the amount of aluminum scrap collected from end-of-life products and the demand for wrought aluminum alloys will keep growing. Previous research has suggested that, if the current practice of systematic downcycling is maintained, the collected amount of aluminum scrap will soon exceed the capacity of wrought and cast alloy production to absorb the secondary aluminum. As such, an amount of aluminum scrap would be collected for which there is no suitable application. This amount of aluminum scrap is commonly referred to as a scrap surplus. One estimate suggests the scrap surplus size at 6.1 million tons in 2030. The scrap surplus of 4.2 million tons in 2030 that will grow to a size of 14 million tons by 2050. However, they add that due to the uncertainty in their parameters, the scrap surplus's actual size could lie anywhere between 3.3 and 18.3 million tons in 2050.

Al Packaging

The Aluminum Laminated (AL) packaging meets many of the packaging requirements of the food industry. Al packaging is inert, lightweight, tough and the aluminum layer with a thickness of 6–150 µm provides a life-long barrier against aroma loss. Also protects the food against ingress of moisture, air, microorganisms, UV light, and other food spoiling agents, resulting in an extending shelf life. These advantages resulted in annual AL packaging growth rates of 10–15%, and in 2015 about 190,000 tons of aluminum were consumed for its production in Europe alone.

Plastic Pouch and the Flow Wrap

Two popular AL food packaging presentations are the AL plastic pouch and the flow wrap. The AL plastic pouch is often used for baby food, coffee, pet foods, pasta sauce, and cereals, whereas the flow wrap is used for crisps, chocolate bars, and other snack foods. The typical AL plastic pouch is made from three primary materials or layers: (1) a polyethylene terephthalate (PET) layer of ca. 12 µm thickness, also displays packaging information on the outside, (2) an aluminum foil of ca. 7 µm thickness and (3) an inside layer of polyethylene (PE) with a thickness of ca. 75 µm providing food compatibility and other properties. The typical AL flow wrap comprises a polypropylene (PP) layer of 35 µm thickness providing strength and stiffness. The aluminum layer of 0.04 µm thickness is typically vapor deposited onto the PP plastic. A primer applied to the aluminum layer allows printing onto the aluminum.

Tetra Pak

A more rigid AL packaging is the Tetra Pak carton due to the inclusion of a paperback layer. This package is layered from inside to outside with PP, Aluminum foil, PP, paperback and, finally, PP with the package information printed on it (Website, 2021b). A Tetra Pak carton composition is typically 63 wt% cardboard or paper, 30 wt% plastic, and 7 wt% aluminum.

Recycling AL Packaging

Various methods to recycle AL packaging, of which none is currently employed on an industrial scale. There is the possibility of delaminating Al packages with solvents to remove the plastic layers. Under supercritical conditions of 255 °C and a pressure of 11.65 MPa, metallic Aluminum was obtained. Potential drawbacks of this process are the high operating pressures and solvent use, which in combination may result in an expensive process. Wet torrefaction to recycle Aluminum from AL packaging waste. Again, high operating pressures may also result in an expensive process.

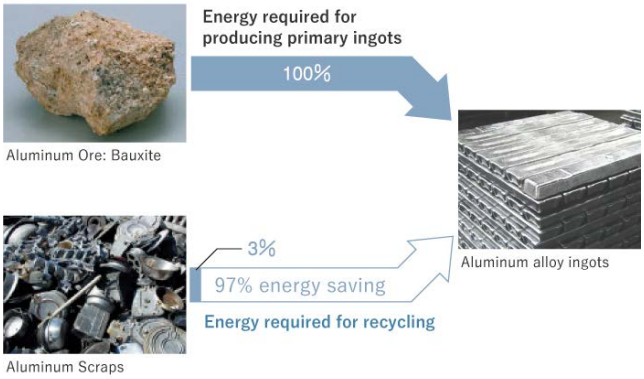

Figure. Why recycling (Courtesy https://www.ahresty.co.jp/assets/images_en/company/csr/al_recycle/al_recycle_)

Pyrolysis

Pyrolysis has long been identified as an ideal process to recycle mixed plastics. Plastic pyrolysis is a depolymerization process executed at temperatures above 400 °C, in an oxygen-free environment and typically at ambient pressures. Products of mixed plastic pyrolysis are pyrolysis oil (ca. 80–95%), pyrolytic carbon (ca. 1–5%; also referred to as char or ash in the literature) and gases (5–15%) depending on pyrolysis temperature, catalyst, and the mixed plastic composition. The pyrolysis oil may be upgraded to diesel or other petroleum products, the char would be landfilled, and the gases (methane, propane, etc.) would heat the process. The capability of pyrolysis to treat mixed plastics, i.e., PET, PE, and PP, is important in AL packaging recycling as these plastics are present in AL packaging. Moreover, because it is difficult to obtain a clean AL packaging waste stream from municipal waste without other plastics, this advantage of pyrolysis becomes ever more critical.

Figure. The recycling process (courtesy: https://www.ahresty.co.jp/assets/images_en/company/csr/al_recycle/al_recycle_03.png)

Company Initiatives

Novelis

Novelis is a subsidiary of Hindalco Industries Limited, an industry leader in aluminum, copper, and metals; and a flagship company of the Aditya Birla Group based in Mumbai, India. As the world's largest recycler of aluminum, Novelis has always been a champion of recycling and will continue working with all relevant stakeholders across companies, industries, and governments to increase recycling efforts and provide more sustainable packaging solutions to the beverage and can industries. Novelis has made an effort to promote Aluminum as the model of sustainable packaging for bottled water and other beverages. Aluminum water cans are being proposed to environmentally conscious consumers and mainstream media. In addition, the London Zoo has collaborated with Canowater to replace their plastic water bottles with a special edition of Aluminum cans. Novelis "is committed to leveraging the benefits of infinitely recyclable Aluminum to help curb the plastics epidemic and shape a sustainable world together."

Alcan

Alcan Aluminum Can Recycling (AACR) is part of Alcan Inc, the world's second largest aluminum company. Alcan Inc, a Canadian company based in Montreal, has operations in 38 countries, and employs over 48,000 people worldwide. In 1989 Alcan invested £28 million in building Europe's largest dedicated used aluminum beverage can (UBC) recycling plant in Warrington, Cheshire, which is operated by Alcan Recycling. The plant produces ingots for the beverage can manufacturing industry and has the capacity to recycle every aluminum drink can sold in the UK. AACR promotes aluminum can recycling and purchases UK sourced aluminum cans and foil for recycling.

Ahresty

At its plant, die casting products that have been produced in the die casting plant and finished their life on the market, come back to have their life renewed as new material. The plant produces 3,000 tons of aluminum alloy ingots each month. Recycled ingots are widely used for die casting, foundry casting and sheet and extrusion at various customers.

From cans to rolls

Source: Various company website sources