Circular Metals Case Study:

Sustainable Packaging of drink containers in a Circular Economy

Two recent studies (1,2) of the materials predominately used for drinks packaging have recently been published one by Wood Mackenzie for the International Aluminium Institute (IAI) and one by Sphera for the Ball Corporation. The IAI study covered the cost competitiveness and greenhouse gas emissions for PET, aluminium and glass whilst the Ball study covered the same materials but also included beverage cartons. The results of the Ball study that concentrated on Life Cycle Analysis were subjected to a critical review by an external pane of experts.

Aluminium, if used in its primary form, can be the most carbon intensive especially if it is smelted using coal fired electricity generation in China. Glass containers have a high carbon intensity both in their primary form and if 100% recycled glass is used although PET has a lower carbon intensity in its primary form than either glass or aluminium but a higher carbon intensity than aluminium in its 100% recycled form. However, a high recycled content is only achieved with aluminium, and the low carbon intensities for PET and glass can only be reached with significantly increased recycling. If GHG emissions are compared in terms of carbon per litre PET has the advantage in both its primary and 100% recycled form although the low intensities for aluminium in its recycled form are much the same as for PET.

Input materials make up most of the cost of producing a PET bottle (PET resin for primary or PET flakes after recycling) and an aluminium can (aluminium sheet both primary and recycled), but a much smaller fraction of a glass bottle (silica sand, soda ash and limestone for primary and glass cullet after recycling). Labour and utilities, gas and electricity make up the largest fraction of glass bottle costs as the raw materials costs are relatively low. PET bottles perform well due to being relatively lightweight, with little secondary packaging, and relatively low manufacturing energy demand. Although the combination of low recycling rates at end of life and lack of recycled content, means that there is a major potential for future improvement. Returnable bottles would have a significant potential to improve the impact of these packaging systems as well although neither study examined this factor.

For non-carbonated beverages, the best performers were beverage cartons and PET particularly for thin wall designs. For carbonated beverages, aluminium cans and PET bottles compete for best performance. Aluminium cans show low impacts partly because they are lightweight, so less material is needed to manufacture them, but mainly because of the high average levels of recycled content used during manufacturing and the high recycling rates at end of life. Design for a circular economy and a renewable energy supply for manufacturing would help aluminium packaging to reach its potential.

For the aluminium can the most significant contributions to environmental impact are from aluminium smelting. The simplest way to reduce this is by increasing collection rates (for example via deposit return schemes) and closing the loop. Most energy consumption occurs in aluminium smelting, and to a lesser degree in sheet rolling, and the use of renewable energy and further light-weighting would help together with a solution for the can end alloy that is presently made from prime aluminium as can ends are always recycled back into can body stock.

Cartons have an intrinsic advantage, being made from paperboard, and produced from virgin natural and renewable fibres that are sourced from integrated mills that are usually powered by biomass. However, it is important that the paperboard used in cartons is sourced from sustainably managed

forests as if fibre is sourced by deforestation, the burdens would be much higher, although this is difficult to assess and include into Life Cycle Analysis.

The variation in rankings found in the two studies had a lot to do with differences in recycled content and recycling rates but was also affected by the choice of LCA methodology. Neither of the studies included consideration of the reuse and refilling of returnable containers which makes the situation more complicated and brings glass as a beverage packing material back into contention.

In summary, aluminium is the most sustainable choice for single-use drink containers due to its high recyclability and lower lifecycle impact when recycled. PET is potentially more cost-effective but is only a viable solution where an effective recycling capability is in place. Paperboard containers are a good option where there is good access to composting or specialised recycling facilities. However, the best long-term impact would be achieved by moving away from single use packaging and encouraging the use of reusable containers.

References

(1) Ball Corporation, “Beverage packaging: A Comparative Life Cycle Assessment”, Sphera, June 2020
(2) International Aluminium Institute, “Economic Analysis of Beverage container Materials, Final Report, Wood Mackenzie, Aug 2022