



The 6th International Conference on Life Cycle Management in Gothenburg 2013

LIFE CYCLE MANAGEMENT IN A NOVEL CONSUMER PRODUCT: SELF-CHILLING BEVERAGE CANS

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Keywords: consumer product; product design; chilling; desorption; beverage.

ABSTRACT

ChillCan® is a new consumer product launched commercially in 2012 developed by The Joseph Company to chill a beverage on demand: i.e. to cool it to the desired temperature at the point of consumption, avoiding refrigerated storage. In addition to providing convenience, the ChillCan® can also deliver beverages with lower environmental impact, specifically reduced contribution to climate change. The chilling action is provided by utilizing endothermic desorption of carbon dioxide previously adsorbed onto a bed of activated carbon contained in an inner component of the ChillCan®. LCA reveals that the adsorbent dominates the environmental impacts. Life cycle management therefore focusses on the processing and properties of the sorbent, and on recovery, re-use and recycling of the cans and sorbent after use.

INTRODUCTION

The ChillCan®, launched commercially in 2012, is a device and delivery system which provides a service which the beverage industry has long sought: a canned drink which chills at the point of consumption and does not need refrigerated storage. It is evident that this idea could disrupt the beverage market: for instance, it may be possible to reduce or even eliminate refrigerated storage with a consequent revolution in the whole supply chain of beverages. Therefore, it is likely that the ChillCan® system can make a significant contribution to reducing global warming particularly if compared with poorly maintained refrigerated beverage storage cabinets or dispensers which are common in low-income countries, frequently utilized in middle-income countries and encountered under some circumstances even in wealthy countries.

Each ChillCan[®] is formed by an outer steel can containing the beverage and an inner aluminium can, called the Heat Exchange Unit (HEU), which contains activated carbon (AC) and an amount of carbon dioxide adsorbed onto it. The packed bed of sorbent and the gas have no contact with the 300mls of beverage that are contained in the space between the outer can and the HEU. A button in the base of the ChillCan[®] allows the carbon dioxide to be released to the atmosphere, releasing the pressure inside the HEU; the desorption of carbon dioxide from the activated carbon is endothermic and provides a cooling action that should ideally lower the temperature of the beverage by about 15°C.

MATERIALS

The principal components of the ChillCan[®] are listed in Table 1. The carbon dioxide is recovered from the vent gases from a methanol plant; therefore its environmental impacts arise from collection, purification and transport but the gas itself is not included because at the current time it would have been emitted to the atmosphere anyway. The activated carbon adsorbent is produced from waste coconut shells and transported from Indonesia. The impacts are evaluated making the most pessimistic “default” assumption that the carbon will be sequestered if not actually used (BSI, 2011); this assumption has a strong effect on the results and will therefore be revisited in the light of field data on the alternative fates of waste coconut shells. The beverage itself is excluded because it is common to all systems considered. Transport is also excluded although the larger overall can size requires transport to be included in any comparison with a conventional beverage system or in assessing post-use recovery systems. Minor materials – primarily plastic components – contribute much less to the life cycle environmental impacts and have therefore been omitted from this brief summary.

Functional unit	Volume of beverage (ml)	300
Material quantities, kg		
Steel	M_S	0.029
Aluminium	M_A	0.039
Activated carbon	M_C	0.11
Carbon dioxide	M_G	0.055

Table 1. Components of ChillCan[®] (excepting plastic components).

RESULTS

Life cycle assessment of the principal constituents of the ChillCan[®] was carried out using the GaBi 4.4 software (PE International, 2013) with primary data for the carbon dioxide (Rice, 1997) and for the carbon adsorbent, covering the most commonly used impact categories (Baumann and Tillman, 2004). Comparing the normalized impact scores showed that the environmental performance of the ChillCan[®] system is dominated by climate change; this confirmed the results of an earlier study (unpublished) in which the ChillCan[®] was compared with conventional refrigerated storage and delivery. Figure 1 shows the contributions to

climate change of the different constituents, for one scenario of recovery and re-use (see below): the activated carbon sorbent dominates the system even when there is a high level of post-use recovery and re-use.

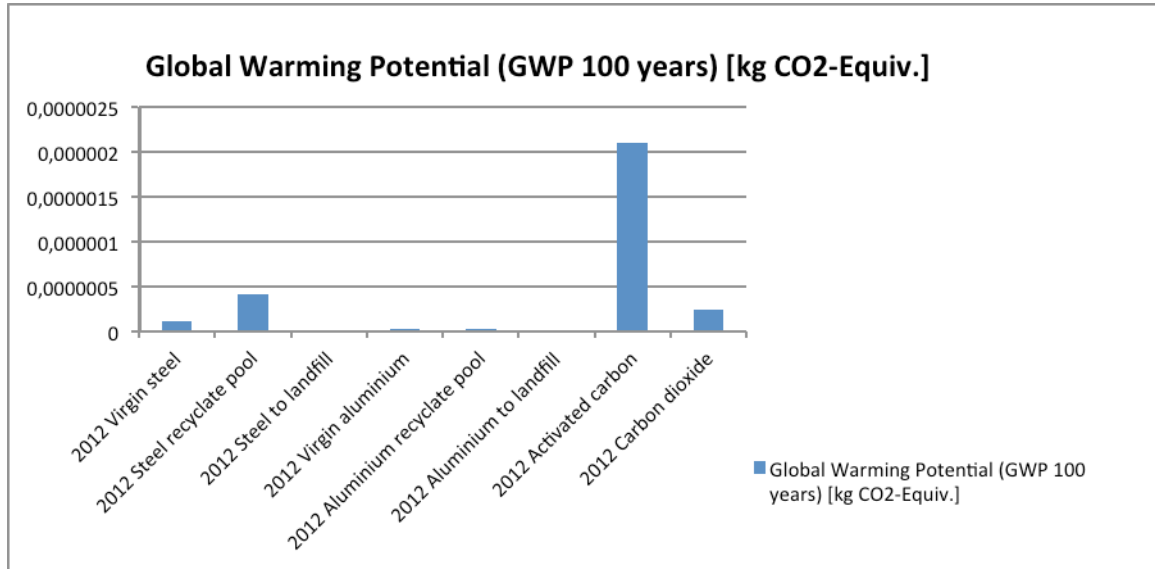


Figure 1. Contributions of constituents of ChillCan[®] to global climate change (kg CO₂-equivalent; 100-year GWP).

System data:

Steel: 80% recycled input; 95% recovered post-use.

Aluminium: 80% recycled input; 90% recovered and re-used post-use.

Adsorbent: 90% recovered post-use; all recovered material re-used.

DISCUSSION

The finding that the GHG emissions embodied in the adsorbent are the dominant environmental impact means, in turn, that management of the life cycle of the ChillCan[®] must focus on recovering the cans after use and re-using the carbon. Figure 2 shows the overall product system. To have the carbon available for re-use, it is necessary to keep the ChillCans separate from the general waste stream of beverage containers; a specific recovery system from retail outlets is therefore being developed, based on the Swedish RETURPACK system (Pantamera, 2013). Recovered cans will be separated mechanically so that the steel outer can is returned for recycling. The inner HEUs are inspected; if they are undamaged then the carbon can be re-used, although it is not yet clear whether the whole HEU can be re-charged or whether the unit must be opened and the carbon repacked into a fresh HEU. Carbon not re-used is assumed to be sequestered in a land-fill. Aluminium not re-used directly as an intact HEU can be recycled, but the aluminium in HEUs not recovered is assumed to go to landfill.

A simple spread-sheet has been developed, so that the life cycle impacts of the overall product system in Figure 2 can be calculated from the embodied impacts of the four principal material constituents listed in Table 1 allowing for different levels of recovery, recycling and re-use.

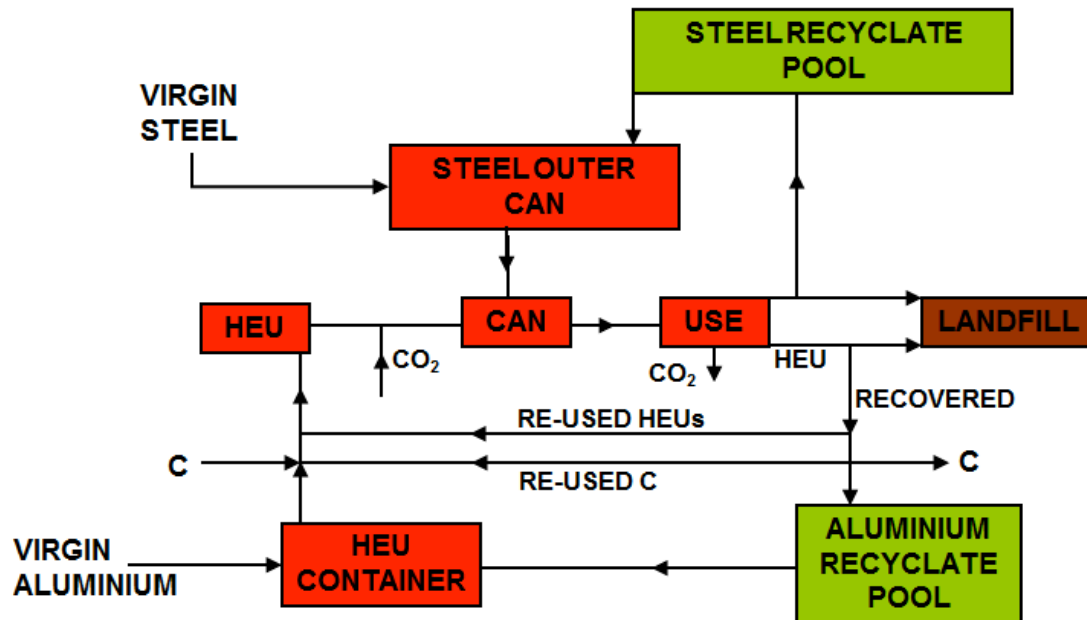


Figure 2. Chillcan[®] product system.

CONCLUSIONS

The ChillCan[®] system provides an illustration of a consumer product for which convenience delivered by a more complex device requires a more considered and individually designed system for recovery, re-use and recycling. The delivery system currently being developed, shown in Figure 2, represents a move towards “closed-loop” use of materials. This introduces some further questions and uncertainties. How many times the carbon adsorbent can be re-used without losing its capacity remains to be determined. In any case, the environmental performance will be dependent on consumer behavior: how effectively customers can be encouraged to return their cans after use rather than mixing them with packaging waste or merely discarding them.

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