Greenhouse Gas Reduction Through Reusable Glass Bottles From A Life Cycle Perspective

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INTRODUCTION

Various of beverage container materials are used in Japan. Although there are both advantages and disadvantages of each container types, glass bottles are traditional containers that contribute Reduce-Reuse-Recycle (3R). Although previous studies conducted in Japan have shown that glass bottles have a smaller environmental impact than PET bottles and others (Inter-container comparison study group, 2001). Their distribution volume is declining in Japan (Glass Bottle 3R Promotion Association, 2020). Efforts have been made to develop new uses for glass bottles and reduce their weight, suggesting that glass bottles be reviewed from a plastic-countermeasures. This study aims to clarify the environmental impact of glass bottles through Life cycle analysis.

MATERIALS AND METHODS

In this study, Life cycles analysis was conducted for three scenarios: non-recyclable, recyclable, and reuse. The target bottles were the 1.8 L bottle (950g) mainly used for rice wine, the medium beer bottle (460g, 500ml), the marusho bottle (450g, 900ml), and the wine bottle (462g, 720ml), which are widely distributed bottles in Japan. In this abstract, the method and result were those for the 1.8 liters bottle. The system boundary is the process from raw material procurement to final disposal, but the use process of glass bottles will be excluded from this study because there is no difference in the use process in each scenario. Reuse scenarios include collection, washing, and reshipment. The functional unit determined from the domestic consumption that, " To supply of 200,005 (kL/year) annually supplied with in Japan using 1.8 L bottles". Referring to previous studies (Inter-Container Comparison Study Group, 2001; Industrial Information Research Center, Inc., 2016), each transportation distance other than collection was set at about 100 km, and collection after use was set at about 50 km. However, the transportation distance of imported raw material resources from USA was set at 6960 km. The collection rate from the place of consumption was assumed to be 74.8% from the interview survey. In the Recyclable scenario, after collection and sorting by local governments and businesses, used bottles are recycled at a cullet factory into cullet for bottle and roadbed, and cullet for bottle is used as recovered cullet at a bottle-manufacturing factory. In the Reuse scenario, the used times of the bottle was assumed to be 5 times, and the collection rate of returnable bottles by businesses was assumed to be about 99%. Through life cycle analysis, greenhouse gas (GHG) emissions were estimated. The global warming potential 100 value was set as the GHG characterization factor.

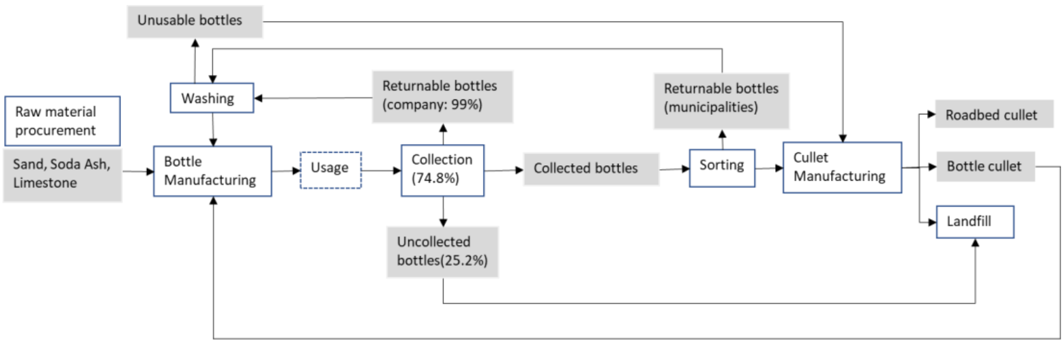

Figure 1 System boundary of glass bottle reuse/recycling system (white box: process grey box: material, dotted white box: excluded process)

RESULTS AND DISCUSSION

The GHG emissions per ton of 1.8 L bottles is shown in Figure 2. The substitution effect of roadbed cullet is accounted for in cullet manufacturing. The non-recyclable, recyclable, and reuse scenarios emissions yielded of 953, 623, 183 kg-CO_2/t, respectively. Compared to the non-recyclable scenario, the reduction rates were 35 % and 81 %, respectively. The processes with the highest reduction were raw material procurement and bottle manufacturing, In the raw material procurement, the recyclable and reuse scenarios could reduce GHG by 141 kg-CO_2/t and, 151 kg-CO_2/t, respectively. In the bottle manufacturing, improved energy efficiency through the use of recycled cullet resulted in the recyclable and reuse scenarios could reduce GHG by 213 kg-CO_2/t and, 606 kg-CO_2/t, respectively. The reuse scenario had a high reduction rate of 81%, but the GHG emission composition ratio of the washing and bottle manufacturing is higher than other process. To reduce more bottle's the environmental impact in the future, the washing process should be improved and the bottle weight reduced, the number of reuses increased.

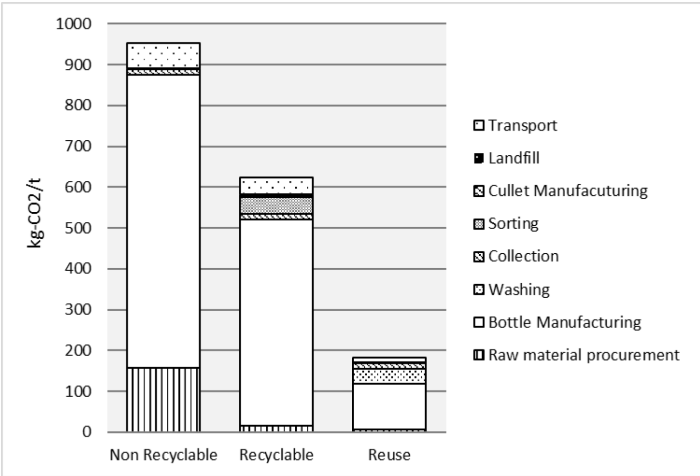

Figure 2 GHG emissions of each scenarios

CONCLUSION

In this study, the reuse can reduce GHG emissions by 81%. We limited the transportation distance and the number of times the bottles are reused. We will consider setting various transportation distances and vary the number of times the bottles.

REFERENCE

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