

Glass

Executive Summary

Glass is being effectively reused in many Pacific Island Countries by local beer brewing and bottling facilities and soft drink manufacturers. Glass beverage containers can only be reused a number of times and there is waste glass produced in other product packaging. Glass is one recyclable material for which recycling may only be marginal as a revenue raising exercise, but should be considered anyway as a means of minimizing the requirements for disposal to landfill.

Recycling glass has environmental benefits. Less energy is used and less air emissions are generated through recycling glass than manufacturing glass totally from new (virgin) materials. Refer section – Health and Environmental Impacts.

Activities happening around the region with glass include: reusing glass beer and soft drink bottles, manufacture of artworks from melted glass products, crushing glass for gravel and also export glass to New Zealand for recycling. Refer section – Present Situation.

Glass pulverisers can be used to crush glass into a gravel mix for such uses as gravel for pipe laying and sand in pre-mix concrete. The smallest pulverizing system is a 2T/hr system costing from USD35,000. Refer sections – Equipment, and Management Options.

Production of gravel from glass products is an alternative which should be given consideration due to the low economic return from glass recycling, the relatively high cost of gravel, and its limited availability in PICs, especially on atolls. Refer section – Crushing Glass for Reuse and Economic Analysis.

Glass collected for recycling needs to be carefully sorted as small amounts of contamination (even with other glass colours) can spoil large volumes of otherwise recyclable glass. A basic economic analysis for sending shipments of glass containers to New Zealand from Samoa shows that costs will not be recovered (a loss of over \$1,400 for a shipment). Refer section – Collect Glass for Recycling and Economic Analysis.

Introduction

Glass is being effectively reused in many Pacific Island Countries by reusing beer and soft drink bottles at local breweries and drink distributors. Glass bottles can only be reused a number of times and there is waste glass produced in other product packaging. Glass is one recyclable material that is unlikely to pay for itself, but recycling should still be considered as a means of minimizing the costs and other adverse effects associated with disposal to landfill.

Health and Environmental Impacts

The potential environmental impacts of glass include taking up valuable landfill space, and the direct physical hazards from broken glass (cuts, etc).

The environmental benefits of reusing glass containers include reduced requirements for raw materials in making new containers, and also reduced energy costs. Glass reuse does have some minor negative impacts, however, through the generation of wash water.

The environmental benefits of recycling glass (ie. incorporating used glass as a replacement for raw materials in glass manufacture) include:

- reduced demand on natural resources, recycled glass is the same quality of glass sourced from virgin materials,
- energy savings, as recycled glass melts at a lower temperature than the virgin raw materials (soda ash, limestone and sand),
- reduced air emissions as the used cullet has already been through the fusion process and is close to the final product quality,
- reduction of demands on landfill space.

Present Situation

Glass reuse is being carried out at beer and soft drink bottling facilities in many Pacific Island Countries, including Tonga, Samoa, Solomon Islands, Vanuatu and Fiji. Beer bottle reuse is operating effectively in most countries as a small monetary reward is paid for returned bottles. Some countries which do not have their own beer breweries export the bottles to the source for reuse ie. American Samoa to Samoa. Glass bottles can only be used a certain number of times before they are damaged through overuse and are then disposed to landfill.

Glass beer bottles in Tonga are sold with a Panga \$0.10 deposit per bottle to encourage reuse. Vailima Brewery in Samoa use glass bottles for its beer and soft drinks. The company reimburses 40 sene (USD0.12) for a large (1 litre) empty bottle returned to its plant and 20 sene for a small bottle. It is thought that about 95% of the bottles are returned. Vailima beer bottles exported to American Samoa are also shipped back to Samoa for reuse.

The Cook Islands have opened a Recycling Station in 2002 that collects recyclables from Rarotonga's domestic waste. Part of the recycling service is

for the collection of glass bottles in three colours: clear, green and brown. Collection is by a truck which picks up recyclables and follows the domestic waste collection truck around the island. The Station is open six days a week and was funded by NZAid who provided a large proportion of the equipment. Although it is currently being managed by the Public Works Department, it is proposed that Environment Services will manage it soon.

In Tonga, a womens group called 'Aloua Ma'a Tonga Association started melting beer and wine bottles in an oven to form a flat oval surface. The glass plaque is then painted with scenes representative of the country, and offered for sale.

American Samoa Power Authority (ASPA) has purchased a glass pulveriser. There are plans that the gravel produced will be used in construction works and the glass diverted from disposal will extend the life of the landfill in the main island of Tutuila.


Table 1 outlines the amount of available glass that is predicted in a number of countries.

Table 1: Amount of colour sorted glass in each country.




| Country | Area in Country | Amount (tonnes/year)* |
|------------------|-----------------|-----------------------|
| Fiji | Lautoka | 535 |
| Kiribati | Tarawa | 238 |
| Papua New Guinea | Port Moresby | 3,900 |
| Samoa | Apia | 460 |
| Solomon Islands | Honiara | 490 |
| Tonga | Nuku'alofa | 165 |
| Tuvalu | Funafuti | 68 |
| Vanuatu | Port Vila | 295 |

* figures taken from the SKM/SPREP Country Reports: "Solid Waste Characterisation Study and Management Plan" , 2000.

Undesirable Practices

-  Littering or dumping of glass in streams, the ocean or by the roadside.

Desirable Practices

-  Collection of glass, removal of contaminants, and reprocessing,
-  Crushing and mixing with cement as a sand substitute,
-  Use as storage containers eg. cooking oil, flour, screws, nails, and other items.

Equipment

Glass Crusher

A glass crusher can be used to minimize the volume of glass bottles to allow glass transportation to be more cost effective. Refer to Figure 1 for an example of a glass crusher. This unit crushes up to 7,000 pounds of glass per hour and breaks the glass into 1" pieces. The end product (pieces of glass) is then called "cullet."



Figure 1 – CP GC100 Glass Crusher.

(www.twequip.com)

The Rarotonga Recycling Station uses a handmade glass breaker. The glass bottles are thrown against some metal rods and the broken glass falls into a collection bin. It is reported that this method produces cullet that has larger pieces than that produced with a crusher.



Pulveriser

Figure 2: The Andela Glass Pulveriser with trommel and surge hopper.

(www.andelaproducts.com)

Glass pulverisers crush the glass into gravel or sand size pieces so that the material can be used in construction projects. The units are suited for remote areas where recycling back into bottles is not economical. There are several units used in Hawaii and Guam, and another has been ordered for American Samoa.

A 20T/hr system would cost in the vicinity of USD130,000, 10T/hr system – USD110,000 and a 2T/hr system – USD35,000.

Management Options

There are three options for reusing and recycling glass in PIC's. These options are detailed below.

1. Return Glass for Reuse

Many Pacific Island Countries reuse glass beer and soft bottles. This should be a cost-effective approach for PICs, and the preferred method of glass reuse, as it saves a lot of energy and requires a minimum amount of effort in comparison to other options. The key requirement is that the bottles be thoroughly cleaned prior to reuse. Beer bottles can be used approximately 10 times with this approach before disposal to landfill, or reuse/disposal by other means (see below). After a bottle has been used to its capacity, PIC's should consider crushing the glass and either shipping for recycling or reuse as a sand substitute, rather than landfill disposal.

Reuse should also be encouraged for other glass containers such as food jars and other drink bottles. This option is most likely to be applied at the householder level, by using the jars as storage containers, for example. However, it may also be suitable for small cottage industries, such as honey and jam making.

2. Crushing Glass for Reuse

It is possible for glass to be pulverized into material that has no sharp edges, for use as a gravel or sand replacement in drainage trenches, pipe laying and in concrete. The substitute gravel material can also be used in tar and stone mixtures for asphalt on roads. In this case, the small pieces of glass that migrate off the road will provide a reflective surface for the road shoulder.

Pulverised glass has also been used in soft clay soil as a base for maintenance roads. As the soft clay and glass mix dries in the sun it becomes hard and firmly packed. When it rains the clay-glass base stays compacted and resists the moisture longer, much like an asphalt-hard surface.

Pulverized glass, sand and gravel mix sparkles, making an interesting decorative feature (refer to Figure 3). It can be used as a cover for bare parking lots to hold down the dust and provide a firmer base. It can also be used in beautification projects such as addition of the fine mix to wet paint for reflectivity.

Some glass pulverizers (refer to Figure 2 for a diagram) can pulverize all glass, including ceramic and window glass. The associated benefits include no longer finding it necessary to color sort the glass or be concerned about colour and ceramic contamination.



Figure 3: The bare-footed children show how safe the glass is to walk on.

Glass that is crushed and screened is strong, safe and economical and has the potential to be used as a sand substitute in concrete. A supplier of glass pulverisers, Andella, report that the basic specifications to successfully include crushed glass into premix concrete include:

- crushing and screening to 2.46mm
- replacement of sand up to 20% proven,
- Inclusion of 25% Class F fly ash should be incorporated into the mix to ensure durability (though probably not an option for PICs)

Any glass colour or mix of colours is suitable (www.andelaproducts.com).

Glass aggregate blends are strong clean and safe. Finally crushed glass contains few sharps as crushing produces more round and less sharp material. The compressive strength of concrete made with glass sand substitute is comparable to premix concrete. (Glass a sand substitute in Concrete, CSIRO).

3. Collect Glass for Recycling (Export)

Glass needs to be carefully sorted for recycling and the different coloured glass separated. Bottles and jars can be exported for recycling as either whole containers sorted by colour, or as broken glass composed of a mix of colours. (Whole containers are an inefficient method of transporting glass, because of the relatively high unit transport costs). Crushed mixed glass, however, sells for a lower price than uncrushed sorted glass.

Certain materials if placed with glass bottles and jars for recycling can lead to the rejection of thousands of bottles and jars. The following items must not be included with glass bottles and jars intended for recycling: china, ceramic bottles, window glass or foreign objects such as pieces of metal or stones.

The following is a typical specification for acceptance of glass by a glass recycling operation:

Colour

- i) Flint (clear) Min flint glass 99%, max. glass of other colours 1% of which not more than 0.1% (1kg/tonne) may be green or blue glass.

- ii) Amber (brown) Min. amber glass 90%, max. glass of other colours 10% of which not more than 5% may be green glass and not more than 5% may be blue glass
- iii) Green Min. green glass 90%, max. glass of other colours 10% of which not more than 1% may be blue glass.

Contaminants

- ceramics which include stones, plates, china cups, ovenware and bricks are not to exceed 25gm/tonne
- essentially free of aluminium, plastic and steel containers (not to exceed one container per 2.5 tonne sample)
- essentially free of other non-glass material
- a moderate number of bottle caps (steel or aluminium) attached to bottles are acceptable.

Size

Glass should not be crushed. Typically, pieces should not be less than 60mm across (approximate size of a stubby bottom).

Safe Storage Facility

When storing glass containers for recycling, the containers should not be allowed to collect water (to prevent mosquito breeding) and site access should be restricted to avoid problems due to vandalism, etc.

Export and Import Permits

There are no particular permits required.

Economics

Glass Pulverisation

Gravel (6mm) purchased in Samoa costs approximately 95tala/tonne (USD29). Conventional gravel costs include excavation and crushing of rock from virgin ground, which can be eliminated when considering the production of gravel from glass. The costs of the machine will possibly not be recovered in most Pacific Island Countries as quickly as the capital costs of an excavator and associated crushing equipment due to the lower usage demand for the equipment.

Glass Recycling

A 20 foot container of glass generally weighs between 15 to 20 tonne. This range will depend on how small the glass has been broken, a container of crushed glass will be heavier than broken cullet.

The present value for glass, sorted and delivered in Auckland is NZ\$25-45 per tonne (Waste Awareness, November issue, 2002).

Case Study of fees

The cost of transporting a 20 foot container of glass, from Samoa to New Zealand is outlined in the following table. This economics analysis does not take into account collection costs which can form a large component of resources and time, nor capital costs.

Table 1: Outline of costs for transporting glass from Samoa to New Zealand.

| Fee | \$ Value | Unit charge | Total |
|---|-------------------------------|--|----------------------|
| Hire of container for two days to load | ST14 (USD4) | Day | - ST28 (USD8) |
| Transport cost of container from company to wharf | ST150 (USD45) | For 20ft container | - ST150 (USD47) |
| Port Service charge in Samoa | ST30 (USD9) | Per container | - ST30 (USD9) |
| Wharfage fee in Samoa | ST2.5 (for 20ft cont.) (USD1) | Per m ³ (cont is 33m ³) | - ST82.5 (USD26) |
| Shipping cost from Samoa to NZ | NZD1200 (USD600) | Per 20ft container | - NZD1,200 (USD662) |
| BAF (as at 5/8/02) | 12.1 | % | - NZD145 (USD80) |
| CAF (as at 5/8/02) | 18.7 | % | - NZD224 (USD124) |
| Import service charge in NZ | NZD130 (USD72) | Lump sum | NZD130 (USD72) |
| Customs Clearance | NZD85 (USD47) | Lump sum | - NZD85 (USD47) |
| GST | 12.5 | % | -NZD92 (USD51) |
| Transport to Company in NZ | NZD | Lump sum | -NZD135 (USD75) |
| Total cost to door of company | NZD | | -NZD2,178 (USD1,203) |
| | | | |
| Income from Product | NZD45 | tonne | +NZD765 (USD422) |
| | | | |
| | | Income – Cost = | -NZD1,413 (USD780) |

Note: * 17 tonne has been taken as an average container weight of glass.
 * Conversion rates used at 23/1/03 are: 1NZD = 0.552USD, 1WST = 0.573NZD
 * Costs have been calculated in NZD and converted to USD after calculations
 * Figures have been rounded to the nearest whole dollar

It can be seen from the above economic analysis of the shipping costs of glass, costs are not recovered. The use of levies on individual containers or some other economic instruments will be required to recover costs for glass recycling.

Recycling Facilities

There are companies in both Australia and New Zealand that will buy glass from Pacific Island Countries. These include:

Australia

- Cospack (NSW) Pty Ltd
- Combined Packaging (Hunter Region)
- Plasdene Glass-Pak Pty Ltd
- McCarthy J. & Co
- The Bottle People
- Warabrook Containers
- Cospak Pty Ltd
- ACI Glass Packaging

New Zealand

- All-Brite
- Frank Renshaw Ltd
- Arthur Holmes Ltd
- Paper Reclaim

ACI does not accept glass directly, instead dealing through Paper Reclaim as initial contact.