



GLASS CONTAINER FOR HEALTH & ENVIRONMENT

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INTRODUCTION

- ▶ Glass has been used for packaging food, beverages, pharmaceuticals, cosmetics and other products for centuries.
- ▶ Even today, despite the availability of plastics, metals and paper-based packaging, glass remains an important packaging material.
- ▶ The reason is simple: **glass is chemically stable, hygienic, transparent, impermeable and highly recyclable.**
- ▶ However, glass packaging also has certain environmental disadvantages, particularly its **high weight and energy requirement during manufacturing and transportation.**

APPLICATIONS OF GLASS CONTAINERS



Beverage Bottles



Food Jars



Pharmaceutical
Vials & Bottles



Cosmetic &
Perfume Bottles



Laboratory
Glassware

IS GLASS SAFE ?

We should consider two important questions:

- ▶ Is glass safe for human health?
- ▶ Is glass environmentally sustainable?

Let us discuss these aspects one by one.



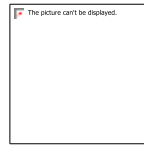
What is Glass?

- ▶ The major raw materials used for ordinary container glass are:
- ▶ **Silica sand (SiO_2)** - main glass former
- ▶ **Soda ash (Na_2CO_3)** - reduces melting temperature
- ▶ **Limestone (CaCO_3)** - provides calcium oxide and improves durability
- ▶ **Dolomite** - provides calcium and magnesium oxides
- ▶ **Feldspar/alumina sources** - improve chemical and mechanical properties
- ▶ **Cullet** - recycled broken glass

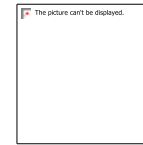
TYPICAL GLASS COMPOSITION (SODA-LIME GLASS)

Component	wt% (Typical Range)
SiO_2 (Silica)	70 – 72 %
Na_2O (from Soda Ash)	12 – 16 %
CaO (from Limestone)	8 – 12 %
MgO (from Dolomite)	0 – 4 %
Al_2O_3 (from Feldspar)	1 – 3 %
Others (K_2O , SO_3 , etc.)	0 – 1 %

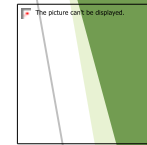
Main Types of Container Glass



Soda-lime-silicate glass
- most common for bottles and jars



Borosilicate glass - used where higher thermal and chemical resistance is required



Amber, green and flint glass - selected according to product protection and appearance requirements.

Why is Glass Important for Health



- ▶ One of the **major advantages** of glass is that it provides a **highly inert packaging surface**.
- ▶ Glass generally **does not readily react** with the food, beverage or pharmaceutical product contained inside it.
- ▶ This is particularly important when packaging:
 - ▶ **Food Product**
 - ▶ **Pharmaceutical**
 - ▶ **Cosmetics**
 - ▶ **Essential Oil**

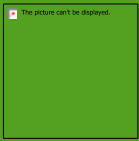
Is Glass Chemically Inert?

- ▶ We should not say that glass is **100% chemically inert under every condition.**

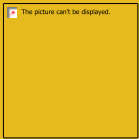
Glass can be attacked by certain aggressive chemicals, particularly:

- Hydrofluoric acid
- ▶ Strong alkaline solutions
- ▶ Some high-temperature chemical environments.
- ▶ Therefore, **chemical compatibility must always be considered for a particular product and application.**

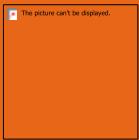
Does Glass Contain Plasticizers?



Conventional glass does not require plasticizers such as those used in some polymeric materials.



Glass is fundamentally a mineral-based material and does not behave like plastics in terms of migration of polymer additives.



This makes it particularly attractive for products where **very low interaction between package and product** is desired.

Glass and Food Safety



Food Safety Benefits

- ✓ Maintains food freshness and flavour.
- ✓ Prevents contamination from external sources.
- ✓ Provides an effective barrier against moisture, oxygen and light (with proper closure).
- ✓ Safe for a wide range of foods and beverages – including acidic foods, dairy, juices, sauces, pickles, jam and oils.

Food Contact Safe



Glass bottles used for food are made from food-grade ingredients and comply with relevant standards (e.g. IS, FDA, EU regulations).

- ▶ Glass is widely used for: Jams, Pickles, Sauces, Baby food, Honey Spices, Beverages, Dairy products.
- ▶ The smooth internal surface of a glass container makes it relatively easy to clean and sterilize.
- ▶ It also does not absorb:
- ▶ Food colours
- ▶ Odours
- ▶ Flavours
- ▶ Therefore, glass can help maintain the **original taste, aroma and quality** of many food products.

Glass and Pharmaceutical Packaging

Vials



Glass containers with rubber stoppers and aluminium caps used for injectable medicines and vaccines.

Ampoules



Sealed glass containers with a narrow neck, used for single-dose injectable medicines.

Syrup Bottles



Glass or PET bottles used for oral liquid medicines like syrups, elixirs and suspensions.

Injection Bottles



Glass bottles with rubber stoppers and aluminium caps used for sterile injectable medicines.

Infusion Containers



Large flexible or rigid containers used for intravenous fluids and nutritional solutions.

Tablet and Capsule Containers



Plastic or glass containers used for solid dosage forms like tablets and capsules.

Type of Glass

- ▶ Pharmaceutical glass is classified according to its chemical and hydrolytic resistance.
- ▶ For example:
- ▶ **Type I glass**
- ▶ Usually borosilicate glass with high hydrolytic resistance.
- ▶ **Type II glass**
- ▶ Soda-lime glass with specially treated internal surface to improve hydrolytic resistance.
- ▶ **Type III glass**
- ▶ Soda-lime glass with comparatively lower hydrolytic resistance.



Glass and Product Contamination

PLASTIC BEER CAP



- ▶ Glass provides an excellent barrier
- ▶ The container itself is also **non-porous**.
- ▶ A properly closed glass container therefore provides excellent protection to the product.
- ▶ However, the **closure system is equally important**.
- ▶ For example, a glass bottle with **a poor-quality cap may allow:**
- ▶ Oxygen ingress
- ▶ Moisture ingress
- ▶ Microbial contamination
- ▶ Leakage.
- ▶ Therefore:
- ▶ The safety of a glass package depends on the complete packaging system—not only on the glass container

Colour of Glass and Health

Glass colour can also influence product protection:

- ▶ **Flint or clear glass:** Provides excellent visibility but allows more light transmission.
- ▶ **Amber glass:** Provides much better protection against ultraviolet and visible light. It is therefore used in light-sensitive products.
- ▶ **Green glass:** used for: Wine, Certain beverages.
- ▶ Thus, glass colour can be selected according to the **light sensitivity of the product**.
- ▶ If proper colour is not used the packed product may harm our health



Important Health Risks Associated with Glass

- ▶ **The biggest physical hazard is breakage:**

Therefore, glass containers must have adequate:

- ▶ Mechanical strength
- ▶ Wall thickness
- ▶ Thermal resistance
- ▶ Impact resistance.



- ▶ If a bottle or vial breaks, small glass particles may contaminate the product.
- ▶ Therefore, manufacturing plants and filling operations require appropriate inspection and quality-control systems.

Environmental Advantages of Glass

- ▶ Glass is highly recyclable.
- ▶ Waste glass can be collected, processed and converted into **cullet**, which can then be used as a raw material in new glass production.
- ▶ The basic cycle is:
- ▶ **Glass container → Collection → Sorting → Cleaning → Crushing → Cullet → Melting → New glass container**
- ▶ This can significantly reduce the requirement for virgin raw materials

Glass Can Be Recycled Repeatedly

- ▶ Unlike many materials that experience degradation during **repeated recycling**, glass can **theoretically be recycled repeatedly** without changing its basic material properties.
- ▶ This is an important **sustainability advantage**.
- ▶ The material can remain within the recycling loop.
- ▶ However, actual recycling rates depend on:
 - ▶ **Collection systems**
 - ▶ **Sorting infrastructure**
 - ▶ **Consumer participation**
 - ▶ **Contamination**
 - ▶ **Transportation economics**
 - ▶ **Availability of glass-processing facilities.**

Role of Cullet for Environmental Advantages

- ▶ **Waste or recycled glass that is used as a raw material in glass manufacturing.**

Using cullet provides several advantages:

- ▶ Reduce the requirement for virgin raw materials
- ▶ Reduce melting energy
- ▶ Reduce the quantity of waste going to landfill
- ▶ Support a circular economy.
- ▶ Therefore:
- ▶ **Increasing the use of good-quality cullet is an important strategy for improving the environmental performance of glass packaging.**

Glass and Energy Consumption

- ▶ Glass manufacturing requires **high-temperature melting**.
- ▶ The furnace operates at temperatures of roughly **1,400-1,600 °C**, depending on the glass composition and process.
- ▶ Consequently, glass manufacturing is energy intensive.
- ▶ Therefore, the environmental footprint of glass depends significantly on:
 - ▶ Furnace efficiency
 - ▶ Fuel used
 - ▶ Amount of cullet
 - ▶ Container weight
 - ▶ Manufacturing technology

Weight of Glass Containers

- ▶ A glass bottle can be considerably heavier than an equivalent plastic or flexible package.

Higher weight means:

- ▶ **More weight → More transport energy → More fuel consumption → More transportation emissions**
- ▶ For example, transporting glass bottles over a long distance requires moving not only the product but also a relatively heavy package.
- ▶ Therefore, lightweighting is an important environmental strategy.

Lightweighting

- ▶ **Lightweighting** means reducing the weight of a package while maintaining the required:
- ▶ Strength
- ▶ Performance
- ▶ Safety
- ▶ Barrier properties.
- ▶ Modern glass container manufacturing uses improved forming technologies to produce lighter bottles and jars.
- ▶ The objective is:
- ▶ **Less material without compromising package performance.**
- ▶ This can reduce both:
- ▶ Raw-material consumption
- ▶ Transportation impacts



Reuse versus Recycling & Environment

Reuse means:

- ▶ **Bottle → Washing → Filling → Consumer → Collection → Washing → Reuse**

Recycling means:

- ▶ **Bottle → Collection → Crushing → Cullet → Melting → New bottle**

Where a suitable collection and washing system exists, **reuse can avoid the need to remanufacture a new container for every use.**

But reuse also requires:

- ▶ Collection
- ▶ Reverse transportation
- ▶ Washing
- ▶ Inspection
- ▶ Additional handling.

Therefore, environmental performance should be evaluated across the entire life cycle.

Glass and Carbon Footprint

The carbon footprint of a glass container depends on several factors:

- ▶ Raw materials
- ▶ Manufacturing
- ▶ Transportation
- ▶ Use: Generally little environmental impact during normal use.
- ▶ End of life
- ▶ Recycling can reduce the need for virgin materials and furnace energy.
- ▶ Therefore, we should avoid saying simply:
- ▶ "Glass is environmentally friendly."

A more scientifically correct statement is:

- ▶ Glass has significant environmental advantages, particularly recyclability and material stability, but its high-temperature manufacturing and relatively high weight can increase its environmental footprint



How Can We Make Glass Packaging More Sustainable?

There are several strategies:

- ▶ 1. Increase recycled glass content
- ▶ 2. Lightweight the container
- ▶ 3. Improve furnace efficiency
- ▶ 4. Use renewable or lower-carbon energy
- ▶ 5. Improve collection systems
- ▶ 6. Improve colour sorting
- ▶ 7. Encourage reuse
- ▶ 8. Reduce transportation distance: Local supply



Conclusion

From a health perspective, glass offers:

- ▶ Chemical stability + excellent barrier + hygienic surface + low interaction with the product

From an environmental perspective, it offers:

- ▶ Recyclability + durability + potential for reuse + repeated material recovery

But we must also recognize:

- ▶ High weight + high-temperature manufacturing + transportation impacts

Therefore, the future of sustainable glass packaging will depend on a combination of:

- ▶ Lightweighting + higher cullet use + energy-efficient manufacturing + effective collection + recycling + appropriate reuse systems..

*Thank
You!*