Lecture 10 Aseptic packaging

Aseptic packaging is a process of filling a commercially sterile product into a sterile container under aseptic conditions. To prevent recontamination, the package is hermetically sealed under aseptic conditions. Aseptic packaging enables shelf-stable storage of food products without refrigeration. It is widely used for the packaging of food products like milk, juices, and soups in a systems like Tetra Pak.

- **The term aseptic implies the absence or exclusion of any unwanted organisms from the product, package or other specific areas.**
- **The term hermetic (means air tight) is used to indicate suitable mechanical properties to exclude the entrance of microorganisms into the package and gas or water vapor into or from the package.**
- **The term commercially sterile is defined as absence of microorganisms capable of reproducing in the food under non-refrigerated conditions of storage and distribution, thus implying that the absolute absence of all microorganisms need not be achieved,**

Reasons for the use of aseptic packaging

- **To enable containers to be used that are unsuitable for in-package sterilization.**
- **To take advantage of high-temperature-short-time (HTST) sterilization processes which are thermally efficient and generally give rise to products of a superior quality compared to those processed at lower temperatures for longer times.**
- **To extend the shelf life of the products at normal temperatures by packaging them aseptically,**

Process Steps

Ultra-high temperature (UHT) sterilization of the food product

(135-150°C for seconds)

Rapid cooling of the food product

Sterilization of the packaging materials

(Hydrogen peroxide, steam, or UV)

Fill of sterilized food product in sterilized package in a sterile environment

Sealing of the package

(immediately to maintain sterility)

Storage

(Shelf life of 6-12 months at ambient temperatures)

Materials Used

Features of Tetra Pak

Six layers:

Polyethylene for moisture seal,

Paperboard for strength (80%),

Aluminum foil (5%) for oxygen/light barrier, and

Adhesives

Advantages

A. As the food material is exposed to heat for shorter period aseptically packaged food retains nutrients, taste, and texture.
B. Eliminate the presence of pathogens like bacteria.
C. Package is lightweight and shatterproof.
D. Reduces refrigeration needs,
E. Eco-friendly.
F. Ensures food safety.

Lecture 7 Glass in food Packaging

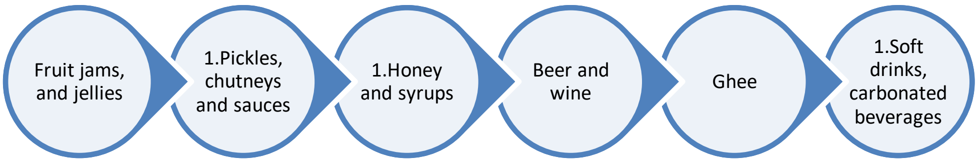
Glass is one of the oldest and most reliable packaging materials for food and beverages.

Advantages	Description
Chemical Inertness	Glass does not react with food or beverage contents, No leaching of chemicals in the packaged food.
Superior Barrier Properties	Glass is 100% barrier to gases (oxygen, CO_2), moisture, aromas, and microorganisms
Long shelf life	Enhances shelf life of the packaged food
Maintains original color, taste, and flavor	Preserves original taste flavour and colour of the packaged food.
Transparent	Allows consumers to see the product at the time of purchase and thus build consumer confidence.
Reusability and Recyclability	Glass can be reused multiple times with our any degradation in quality.
Heat Resistance	High temperature resistance makes it safe for high temperature processing operations like pasteurization/sterilization and retort processing.
Premium perception	Glass is regarded as a high-quality packaging material, making it suitable for premium and luxury products.

Disadvantages	Description
Fragile and Breakable	Glass is prone to cracking or shatter during handling and transportation leading to loss of food product.
Heavy Weight	Significantly heavier than to plastics and metals, which increases transportation

	cost.
Energy intensive manufacturing process	Melting of raw materials requires high temperatures (up to 1500°C)
Limited Design Flexibility	Difficult to mold into complex shapes. Thick walls needed for structural strength

Foods Commonly Packed in Glass



Composition of Soda–Lime Glass

Glass is primarily composed of silica (SiO_2), which makes up about 70–75%. To lower the melting temperature and improve workability, soda (Na_2O) is added in the range of 12–15%. Lime (CaO), present at 8–12%, enhances chemical durability and mechanical strength.

Minor additives such as alumina (Al_2O_3) at 1–2% and magnesium oxide (MgO) further stabilize the glass matrix and improve resistance to weathering. Additionally, colorants like iron oxides, chromium oxides, and selenium are incorporated in small amounts to impart specific hues and optical properties, making the glass suitable for diverse applications ranging from containers to architectural and decorative uses.

Role of Raw Materials

Component	Function

Silica (sand)	Forms glass structure
Soda ash	Lowers melting temperature
Limestone	Increases chemical durability
Alumina	Improves toughness
Colorants	Produce amber, green, blue glass

Manufacturing Process of Glass Containers

Unit Operations in bottle and jar manufacturing

Preparation of Batch

Weighed and mixing of Raw materials (silica, soda ash, limestone, cullet)

↓

Melting at 1400–1500°C

↓

Refining & Conditioning

↓

Forming

Glass gob dropped into mold to form bottle/jar (blow-and-blow or press-and-blow methods)

↓

Annealing

↓

Surface Coating

↓

Inspection

↓

Packaging

Types of Glass Used for Food Packaging

Soda Lime Glass

- Most common (90% of glass containers)
- Clear, amber, blue, green variants

Borosilicate Glass

- Higher thermal shock resistance
- Oven-safe cookware Some premium food jars

Colored Glass

- Amber Glass: Blocks 95–99% UV lightIdeal for beer, pharma, light-sensitive foods

Exercise

1. Discuss the importance of glass as a food packaging material. Explain main advantages and limitations with the use of glass for packaging food.

2. Describe the composition of glass used for food packaging.

3. Describe the step-by-step manufacturing process of glass containers, from raw material preparation to final inspection.

4. Compare glass packaging with other common packaging materials such as plastics, metals, and paper.

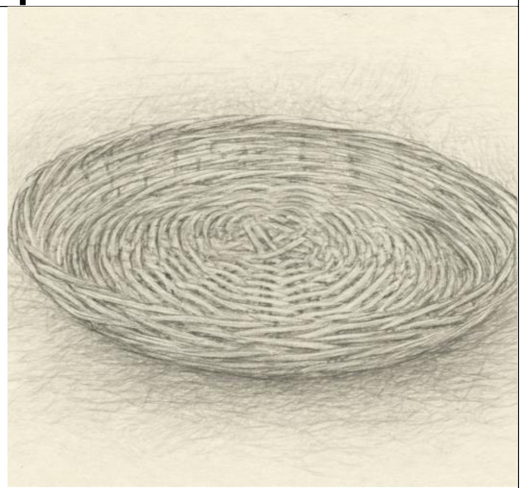
Lecture 8 Packaging systems

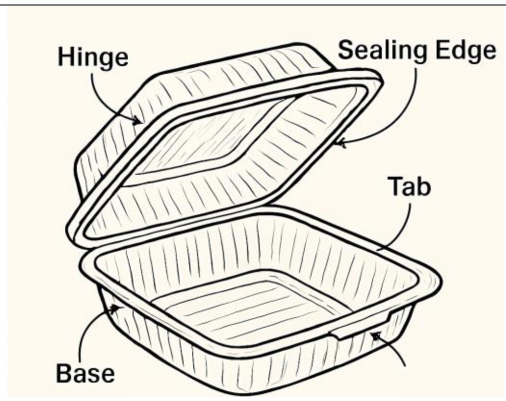
Classification of Packaging

Types of Packages used for the packaging of food materials

Flexible and Rigid; Retail and Bulk

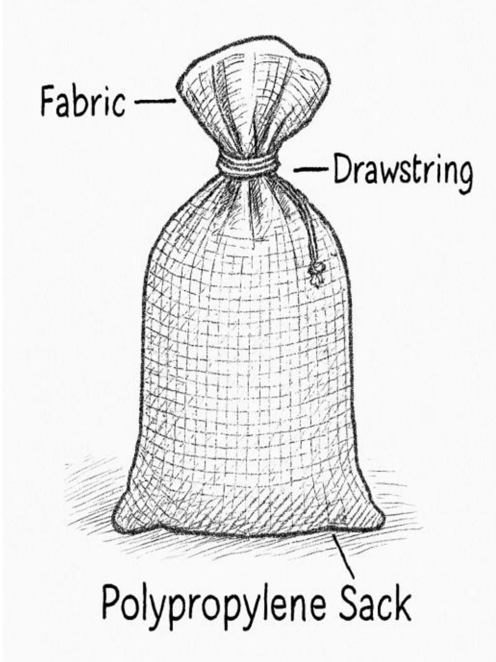
Rigid Packaging	Flexible Packaging
• Wooden Crates • Plastic Crates • Wooden Baskets and Hampers	• Jute Sacks • Plastic Sacks • Paper Bags • Plastic Bags • Mesh Bags

Rigid Packages	
Wooden crates	
Wooden crates are boxes made of wood that farmers use to carry fruits and vegetables. Strong wire-bound crates are used for hard produce like oranges and potatoes, while softer fruits like tomatoes are kept in field crates. These crates are strong, can face rain and sun. They also have spaces that let air pass through, which keeps food fresh. But rough wood and splinters can hurt the fruits, and the wood can catch mould easily.	
Wooden Baskets and Hampers	
Earlier, farmers used wire-reinforced wooden baskets and hampers of different sizes to carry many crops like strawberries and sweet potatoes. These baskets are strong and can be placed one inside another when empty, which makes transport easy. But now, they are not used much because they cost more, are hard to throw away, and don't fit well on pallets for transport. So, they are mostly used by local farmers who can reuse them many times.	
Printed Corrugated Fiberboard	
Post Printed	**Pre-Printed**
Printing done after the corrugated fibreboard is formed is called **post printing**. • **Economical**: It is cost-effective and suitable for **small press runs**. • **Common Use**: Most widely used method for printing on **corrugated fibreboard containers**. • **Limited Graphics**: Produces **less detailed graphics**, usually in **one or two colours**.	**High-Quality Graphics**: Produces sharp, eye-catching visuals ideal for branding and display. • **Enhanced Product Appeal**: Attractive packaging improves buyer's first impression and product perception. • **Preferred for Displays**: Popular with produce managers for **supermarket floor displays**. • **Higher Cost**: About 15% more expensive than standard two-color containers. • Done Before Assembly: Printing

<table>
<tr><td></td><td>is completed before the linerboard is attached to the corrugated board</td></tr>
<tr><td colspan="2">Waxed Fiberboard cartons</td></tr>
<tr><td>Suitable for produce that needs hydrocooling or icing.
• Composition: Wax makes up about 20% of fiber weight.
• Disposal Problem: Cannot be recycled.
• Landfill Issue: Often refused at landfills after use.</td><td>
</td></tr>
<tr><td colspan="2">Clamshell</td></tr>
<tr><td>Structure:
o Made from one or two pieces of plastic.
o Heat-formed with a top and bottom that close together like a shell.
Cost:
o Inexpensive compared to many other packaging types.
• Versatility:
o Can be used for different kinds of produce and products.
• Protection:
o Provides strong protection against crushing and damage.
• Appearance:
o Looks attractive and pleasing to consumers.
• Usage:
• Commonly used for high-value produce items.
• Examples: small fruits, berries, mushrooms, and other delicate items.</td><td>

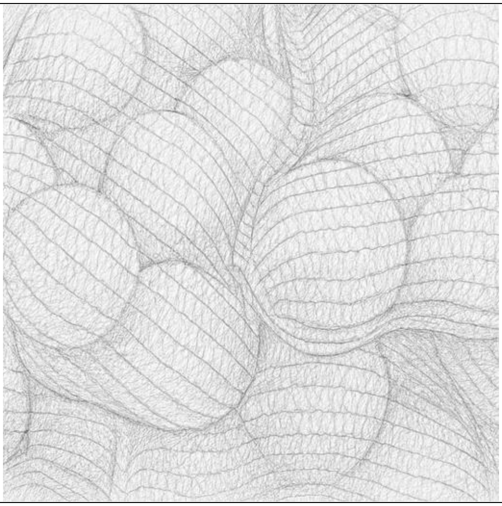
Lid – the top half that closes over the base
Base – the bottom half that holds the food
Hinge – flexible joint connecting lid and base
Tab – locking mechanism for secure closure
Sealing Edge – rim that ensures tight fit between lid and base</td></tr>
</table>

<table>
<tr><th colspan="2">Flexible Packages</th></tr>
<tr><td colspan="2">Sacks</td></tr>
<tr><td>Traditionally made from jute fiber or similar natural materials.
Most jute sacks are manufactured in a plain weave structure.
Widely used for packaging of:
Cereals (rice, wheat, maize, paddy, lentils)
Nuts (cashew, groundnut, peanut)
Cash crops (cotton, copra, palm kernels)
Commercial goods (gum arabic, coffee beans, cocoa beans)
Common Sizes of Jute Sacks
44 × 26.5 inches / 2.25 lbs
44 × 26.5 inches / 2.00 lbs
48 × 28 inches / 2.25 lbs
43 × 29 inches / 2.50 lbs
43 × 29 inches / 2.25 lbs
37.5 × 22 inches / 2.00 lbs</td><td>
</td></tr>
<tr><td colspan="2">Polypropylene Sacks</td></tr>
</table>

<table>
<tr><td>Earlier, sacks were made from natural fibres like jute or cotton. But now, many of these have been replaced by synthetic materials (like plastic) or paper.
This change happened because synthetic and paper sacks are usually cheaper, look better, are stronger, and help reduce the risk of insect attacks.
For storing and transporting root vegetables (like potatoes, onions, carrots), sacks made from polypropylene (a type of plastic) with plain weave are commonly used.
These sacks usually have a fabric weight of 70 to 80 grams per square meter, which makes them strong enough for handling vegetables.</td><td>
</td></tr>
<tr><td colspan="2">Paper Bags</td></tr>
<tr><td>Consumer packs of potatoes and onions are about the only produce items now packed in paper bags.
The sturdy mesh bag has much wider use.</td><td></td></tr>
<tr><td colspan="2">Mesh bags</td></tr>
</table>

<table>
<tr><td>

- Mesh bags are widely used for packaging produce such as potatoes, onions, cabbage, turnips, citrus, and certain specialty items.
- Their popularity stems from low cost and excellent ventilation, which is especially beneficial for onions.
- Small mesh bags are favoured by supermarket managers because they create appealing displays that encourage customer purchases.

</td><td></td></tr>
<tr><td colspan="2">Plastic bags</td></tr>
<tr><td>

- Plastic bags made from polyethylene film dominate consumer packaging for fruits and vegetables due to their low material cost and compatibility with automated bagging systems, which further reduce labour expenses.
- Their transparency allows shoppers to inspect produce easily, while the surface supports vibrant, high-quality graphics for branding.

</td><td></td></tr>
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Lecture 6 Plastics in food Packaging

- The adjective Plastic is derived from the Greek *plstikos* meaning easily shaped or deformed. The word plastic is used to describe the easily deformable state of the material.
- The term plastics refers to a broad group of materials that have a common property of being composed of very large long-chain molecules.
- These molecules may have molecular weight of 10,000 or more.
- Plastics are made by connecting small repeating molecules called monomers together in a head to tail fashion.

Importance of Plastics in Food Packaging

In modern food packaging plastics are the most popular choice. Plastics are chosen for their remarkable versatility and superior performance. As the plastics can take the desired shape, these can be adapted to different product needs essential in modern food packaging system. Plastics help in preserve freshness and extending the shelf life of packaged food.

Advantages and disadvantages of using plastics for food packaging

Advantages	Disadvantages
Lightweight	Environmental Pollution
Significantly reduces weight of package and transportation cost.	Non-biodegradable plastics lead to solid waste accumulation and ocean pollution.
Highly Versatile	Recycling Challenges
Can be used for bottles, pouches, trays, films, caps, and laminates.	Many multilayer laminates and mixed plastics are difficult to recycle.
Good Barrier Properties	Potential Chemical Migration
Protects food from moisture, dust, microbes, odours and, in many cases,	Poor-quality plastics may leach additives if

gases.	heated, reused, or stored improperly.
Flexible and Tough	Poor High-Temperature Resistance
Unbreakable compared to glass **Good Resistant to impact.**	Can deform, melt, or release harmful compounds when heated (microwave, hot filling).
Suitable for Heat Sealing	Variable Barrier Properties
Simple and fast sealing for airtight packaging.	Basic plastics allow gases to permeate; need multilayers for long shelf life.
Low Cost	Flammability
Raw materials and processing are cheaper than metals or glass.	Most plastics burn easily and produce toxic fumes if ignited.
Chemical Resistance	Increasing consumer concern about plastics and safety issues.
Safe against acidic, salty and fatty foods (food-grade types).	Dependence on petrochemicals (non-renewable sources).
Transparency & Printability	
Provides product visibility and attractive branding.	
Extended Shelf Life	
Used in MAP, vacuum packs, multilayer films to retain freshness.	
Energy Efficient Processing	
Requires lower heat and energy in manufacturing than metals and glass.	

Comparison of Plastics with Other Food Packaging Materials

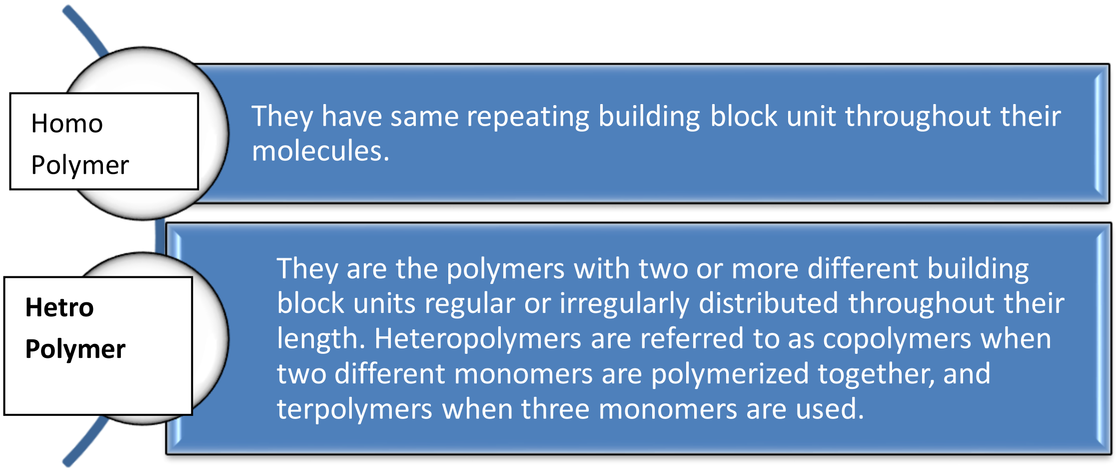
Parameter	Plastics	Glass	Metals (Steel/Aluminium)
Weight	Very lightweight	Heavy	Moderate–heavy (steel), light (aluminium)
Breakability	Flexible, non-breakable	Easily breakable on impact	Denting possible, but not breakable
Barrier Properties	Good barrier to moisture, variable to gases	Excellent barrier to gases, moisture & odours	Excellent barrier to gases, light & moisture
Transparency	Can be transparent/opaque	Completely transparent	Opaque (light cannot enter)
Shape & Formability	Easily molded into many shapes	Difficult to reshape, needs mold	Requires high energy to form into cans
Heat Resistance	Moderate, may deform at high temperature	High thermal resistance	Excellent heat tolerance (can withstand retorting/sterilization)
Chemical Resistance	Good against acids, salts, oils	Excellent inertness	Very good, may need lacquering to prevent corrosion
Sealing	Easily heat-sealable for airtight packs	Needs capping or sealing systems	Seamed or crimped closures
Recyclability	Recyclable (varies by type), energy efficient	Highly recyclable with no loss in quality	Widely recyclable; metals retain properties

Cost	Low-cost material & processing	High manufacturing and transport cost	Moderate to high production cost
Energy Requirement for Production	Low	High (melting at high temp)	High (metal extraction & forming)
Environmental Impact	Light footprint if recycled; waste problem if littered	Reusable & recyclable; heavy energy footprint	Long life cycle, recycling reduces energy use
Shelf-life Influence	Good protection; multilayers improve barrier	Excellent for high-value foods	Ideal for long-term preservation (canned food)

Polymerization (Plastic manufacturing)

Polymerization is the process of joining small molecules (monomers) to form long-chain macromolecules (polymers).

Classification of polymers



Types of Polymerization

Polymerization Process	Mechanism	Products
Addition (Chain-Growth) Polymerization	Monomer units add one by one without loss of atoms. Reaction initiated by heat, light, or catalysts.	Polyethylene (PE) Polypropylene (PP) Polystyrene (PS) Polyvinyl Chloride (PVC)
Condensation (Step-Growth) Polymerization	Monomers join with elimination of small molecules (water, HCl, methanol).	Polyesters (PET) Polyamides (Nylons) Polycarbonates

Classification of Plastics

Basis of classification	Type	Properties
Thermal Behaviour	Thermoplastics	Soften on heating and harden on cooling (reversible)
		Recyclable
		Examples: PE, PP, PVC, PET, PS.
	Thermosetting Plastics	Harden when heated and cannot be remelted
		Highly rigid and heat resistant
		Examples: Epoxy, Melamine, Phenolic resins
Structure	Amorphous	random structure (PVC, PS)
	Crystalline/Semi-crystalline	ordered structure (PE, PP, nylon)
Use	Packaging films	LDPE, LLDPE
	Rigid containers	HDPE, PET
	Laminates & barrier films	EVOH, nylon
	Foams	PS foam (thermocol)

Common Plastics Used in Food Packaging

Plastic Material (Code)	Full Name	Key Properties	Common Packaging Forms	Examples of Foods Packed
PET / PETE	Polyethylene Terephthalate	Clear, strong, good gas barrier	Bottles, trays, jars	Water, juices, fizzy drinks, edible oils
HDPE	High Density Polyethylene	Strong, rigid, moisture-proof	Bottles, jugs, caps, bags	Milk bottles, yogurt tubs, ghee containers
PVC	Polyvinyl Chloride	Clear, tough, good barrier	Shrink wrap, blister packs, cling film	Fresh meat overwraps, fruits & vegetables trays
LDPE	Low Density Polyethylene	Flexible, good heat sealable	Films, bags, pouches	Bread bags, milk pouches (in India), frozen food bags
PP	Polypropylene	High heat resistance, rigid	Containers, microwave trays, closures	Ready-to-eat meal trays, biscuit trays, curd/dahi cups

PS	Polystyrene	Rigid or foamed, insulating	Cups, trays, cutlery, thermocol boxes	Ice-cream cups, disposable plates, egg trays
EVOH	Ethylene Vinyl Alcohol	Excellent oxygen barrier	Laminates with PE/PP	Ketchup pouches, baby food, meat packaging
PA (Nylon)	Polyamide	High strength, good puncture resistance	Vacuum bags, multilayer films	Vacuum-packed meat, cheese blocks, sausages
Bioplastics (PLA, PHA)	Polylactic Acid	Compostable, eco-friendly	Cups, trays, films	Salads, bakery items, fresh-cut produce

Exercise

1. Discuss in detail the major advantages and disadvantages of using plastics as packaging materials in the food industry. Support your answer with practical examples.
2. Explain why plastics are considered highly suitable for modern food packaging and identify the major environmental drawbacks associated with their use.
3. Evaluate the suitability of plastics for packaging perishable and processed foods in terms of protection, convenience, cost, and sustainability.
4. Describe the important physical, mechanical, thermal, and barrier properties required for plastics used in food packaging. Provide examples of plastics that exhibit these properties.
5. Explain how the structure and properties of plastics influence their performance in food packaging. Discuss flexibility, strength, permeability, and chemical resistance.