Packaging of Dairy Products

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Lesson-1

History of Package Development

1.1 INTRODUCTION AND HISTORY OF PACKAGE DEVELOPMENT

1.1.1 Changes in packaging to meet society's needs

1. Packaging is not a recent phenomenon.
2. Packaging is an activity closely associated with the evolution of society and, can be traced back to human beginnings.
3. The nature, degree, and amount of packaging at any stage of a society's growth reflect the needs, cultural patterns, material availability and technology of that society.
4. A study of changing roles of packaging and forms over the centuries is a study of the growth of civilization.
5. Social changes are inevitably reflected in the way we package, deliver and consume goods.

1.1.2 The origins of packaging

1. We don't know what the first package was, but we can certainly speculate.
2. Primitive humans: nomadic hunter / gatherers lived off the land. Social groupings restricted to family units.
3. They would have been subject to the geographical migrations of animals and the seasonal availability of plant food.
4. Primitive people needed containment and carrying devices and out of this need came the First "package" which might be

a) A wrap of leaves

5. In 768, the oldest existing printed
the oldest existing book (the *Diamo*
6. Iron and tin plated steel were used
7. Packaging advancements in the ea
on bottles, transparent cellophane
processing efficiency and improved
8. As additional materials such as a
developed, they were incorporated
functionality.

1.1.3 The Industrial Revolution and Mo

The Industrial Revolution started in Eng
the change that transformed people with
an industrial society with world-wide con
use of machinery and manufactured good

1.2 DEFINITIONS OF PACKAGING

1. Packaging is described / defined i
2. Packaging is best described as a
transport, distribution, storage, re
3. Packaging is a complex, dynamic,
function.
4. Packaging is science, art and tech
distribution, storage, sale, and
design, evaluation and production
5. Packaging is an act of providing o
the product in container or enclos
6. Packaging is a technique of
components so as to protect, carr

13. Packaging is an all-embracing term and covers the operation of cleaning, giving protective coating, weighing and filling, closing, labeling, surface designing, printing, cartooning and bracing, containerizing, marketing and may also include material handling.
14. Packaging is defined as "the enclosure of products, items, or packages in a wrapped pouch, bag, box, cup, tray, can, tube, bottle, or other container to perform the following functions: containment; protection or preservation; communication; and utility or performance." If the device or container performs one or more of these functions, it is considered a package. This definition implies that packaging serves more than one function; i.e., it is multifunctional.

Packaging functions range from technical ones to marketing oriented ones as shown in the following Table-1.1:

Table 1.1: Functions of Packaging

Technical Functions		**Marketing Functions**	
contain	measure	communicate	promote
protect	dispense	display	sell
preserve	store	inform	motivate

Technical packaging professionals need science and engineering skills, while marketing professionals need artistic and motivational understanding.

1.3 CHANGING NEEDS AND NEW ROLES

1. All historical changes have had an impact on the way products are bought, consumed and packaged
2. Packaging is important to food supply because food is organic in nature (an

9. Humankind's global progress i
development of society, packaging

1.3.1 The United Nations and packagi

a. The less-developed countries do

b. Food goes beyond its natural
insects or eaten by rodents, ge
for numerous reasons, and is
packaging principles.

c. No industry can recover secon
economy can not afford wastag

d. Packaging is perceived to be a v

1.4 STATUS OF PACKAGING IN INDIA

1.4.1 Indian Packaging Industry

1. Early 1950's showed slow pace
witnessed.
2. The market volume of the India
77,570 crore and has constantly
year.
3. It is expected that the pace of gr
per year.
4. The highest demand for packagin
food processing industry at 50 pe
25 percent.
5. The Indian packaging industry c

13. Indian companies are now placing increasing emphasis on attractive and hygienic packaging. This promises enormous potential for the future
14. Today consumer is showing greater awareness towards food packaging for assurance on quality, quantity and hygiene of foods.
15. Potential benefits offered by unit packaging in retailing are also well realized.
16. Self service groceries, super markets (especially in urban sector) increased the demand for retail packs.
17. Changes in purchasing power, family sizes, frequency of shopping, inflation, changed food habits lead to changes in packaging material and pack sizes.
18. Every sector of user industry has become package conscious and the need for scientific, functional and aesthetic packaging is being realized.
19. Nationwide marketing becoming common trend for processed foods.
20. Expanding electronic media unprecedented audience reach (Paper, radio, TV) widen market of packaged food.
21. Thus dramatic change is observed bringing overall revolution in packaging concept, style and forms.
22. New concepts like aseptic packaging, system packaging, thermoforming, in-pack sterilization of foods have taken industrial footing in Indian market.

1.4.2 The Modern Packaging Industry

1.4.2.1 The broad industry divisions

1. "Converters": to take various raw materials and convert them into useful packaging materials or physical packages (cans, bottles, wraps). To this point, packaging becomes a materials application science. The company forming the physical package will also print or decorate the package.
2. Package "users": the firms that package products are also regarded as part of the packaging industry and are divided into a number of categories and each of these can be further subdivided.
3. The "suppliers": manufacturers of machines for the user sector and the suppliers

4. ISTA : International Safe Transi
5. FSSAI: Food Safety and Standa

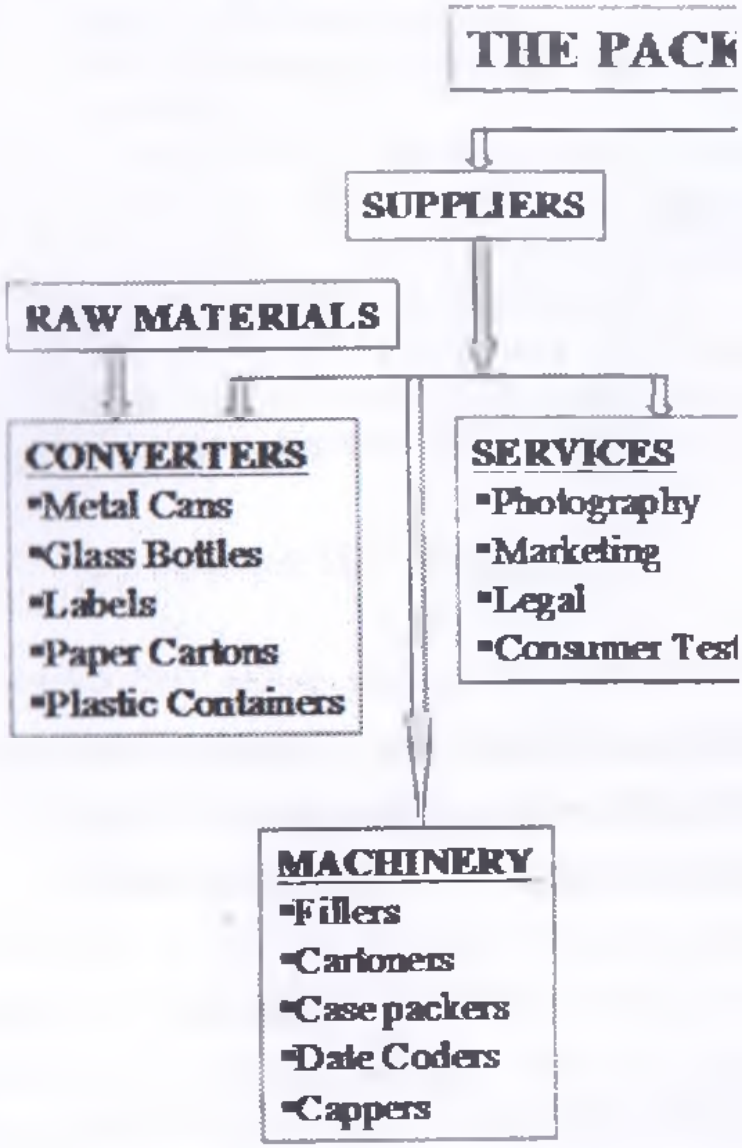


Fig-1.1: The packaging industry can be

Lesson-2

Importance of packaging

2.1 INTRODUCTION

This lesson deals with basic functions of packaging and importance of packaging in food industry.

2.2 FUNCTIONS OF PACKAGING

The functions of a package are "to preserve the quality and freshness of food, to add appeal to the food to attract consumers, and to facilitate its storage and distribution." The basic functions required of a package can be grouped under five major categories.

2.2.1 To Contain the Product

The primary function of any package is to contain the food and facilitate handling, storage, and distribution all the way from the manufacturer to the ultimate user or even the time the rest portion is utilized by the consumer. However, there are usually various levels of packaging. A primary package is one that comes into direct contact

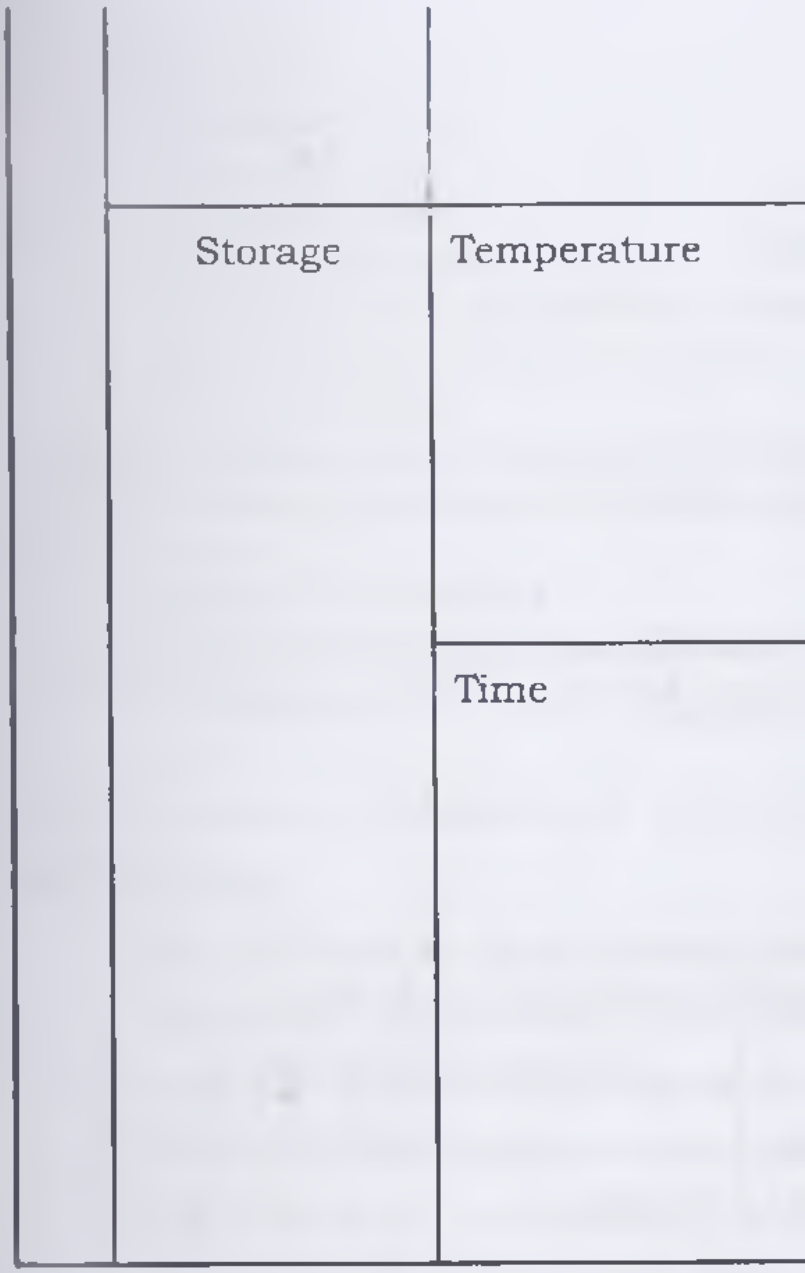
2. Proper constructional features
prevention.
3. Package: Must contain the comm
pack, prevent damage)
4. No subsequent damage after p
storage.
5. Thus package must be strong en
6. Optimum compatibility (nontox
chemical or biochemical changes
7. Containment or agglomeration -
one package for reasons of efficie
requires less physical handling t
granules need containment.

2.2.2 To Protect the Product

One of the most important function
contained against any form of loss, da
that might be encountered throughout
physical damage, e.g., bruising caused
stacking in a warehouse. Proper pa
potatoes from a weak sack or juice f
products against moisture loss or gai
causes deterioration of some light-sen
contents against temperature fluctuat
Packaging can also be used to con

Table 2.1: Hazard, damage and protection of packaging materials

SN	Storage	Hazard	Damage	Protection
I	Handling and transportation	Drop, shunting, shocks, vibrations, stack load, compression etc.	Breakage, loss of shape, dusting, seepage	Cushioning, blocking.
II	Storage	Stack load, compression, Attack by rodents and insects	Crushing, distortion sticking, spillage, contamination, spoilage	Adequate compression strength of package. resistance and repulsiveness to insects
III	Environment during storage transportation and distribution	Biological or otherwise	Contamination	Toughness of packaging material (to resist penetration).
		High/low humidity moisture/water.	Physical, chemical and biological deterioration due to loss/gain of moisture	Efficiency of closure providing. Water vapour barrier properties.Package desiccant etc.



Barrier protection - A barrier from oxy
Permeation is a critical factor in desig
absorbers to help extend shelf life. M

1. Product manufacturing and best buy dates
2. Proper storage conditions
3. Cooking instructions
4. Size and number of servings or portions per pack
5. Nutritional information per serving
6. Manufacturer's name and address
7. Cost
8. Suggested recipes
9. Country of origin
10. Information transmission - Packages and labels communicate how to use, transport recycle, or dispose of the package or product.

2.2.4 Means of minimizing costs:

An important factor often overlooked is that packaging actually reduces costs for the consumer. Packaging reduces food costs by reducing the cost of processing. Foods can be processed where they are grown, waste is treated at the processing plant, and shipping weights are reduced, thereby lowering the cost of transportation. The handling of packages in quantity is important for the economics of bulk storage, warehousing, transport, and distribution. Proper packaging facilitates efficient and mechanized handling, distribution, and marketing of products, thus reducing the high labour costs that would have to be absorbed into the price of the product. Thus, packaging not merely contains the product, but it is a process of bringing goods from

1. Sanitary
2. Non toxic
3. Transparent
4. Lightweight
5. Tamper evident
6. Easy to pick up and handle
7. Easy to fit into cupboards, shelve
8. Easy to open and dispense from
9. Easy to reclose
10. Returnable, recyclable, or reusab
11. Safe and presents no hazards in edges
12. Display the product
13. Glamorize: Create an illusion embossing techniques and exotic

The desirable polyfunctional properti in Table 2.2.

Table 2.2: Functional Req

No.	Functional Property	
1	Gas permeability	
2	Protection against environmental factors	
3	Mechanical properties	
4		

2.3 OTHER FUNCTIONS OF A PACKAGE:

1. **Dispensing:** Consumers: Product not used all at once, remove a portion...without destroying/damaging the remaining product/container.
2. **Preserve:** Remaining product in container-Protection and preserve it for extended/desired period.
3. **Measuring / Portion control:** Single serving or single dosage package has a precise amount of contents to control usage. Bulk commodities (such as salt) can be divided into packages that are a more suitable size for individual households. It also aids the control of inventory: selling sealed one-liter-bottles of milk, rather than having people bring their own bottles to fill themselves.
4. **Security** - Packaging can play an important role in reducing the security risks of transport. Packages can be made with improved tamper resistance to deter tampering and also can have tamper-evident features to help indicate tampering. Packages can be engineered to help reduce the risks of package pilferage: Some package constructions are more resistant to pilferage and some have pilfer indicating seals. Packages may include authentication seals to help indicate that the package and contents are not counterfeit. Packages also can include anti-theft devices, such as dye-packs, RFID tags, or electronic article surveillance tags, that can be activated or detected by devices at exit points and require specialized tools to deactivate. Using packaging in this way is a means of loss prevention.

2.4 PACKAGING TYPES:

1. **Primary packaging** is the mater
   This usually is the smallest unit
   is in direct contact with the conte
2. **Secondary packaging** is outsid
   group primary packages togeth
   wrapped in veg. parchment pape
3. **Tertiary packaging** is used
   and transport shipping. The mos
   packs tightly into containers (vi
   are put together).

These broad categories can be somew
use, a shrink wrap can be primary pa
secondary packaging when combining
some distribution packs.

Table 2.2: Differences between packagi

No.	Packaging
1	Comes in direct contact with product
2	Called primary packaging materia
3	Should be food grade, non-tasteless, odourless, lowest po migration
4	Packaging- a must e.g. Ice cream

8	Recycled material never used.	Much preferred.
9	Selection of packaging material: Physico-chemical properties of product are considered.	Generally stress / strength properties, puncture resistance / burst strength, folding endurance, environmental factors considered.
10	Keeping quality is determined by packaging material.	Generally not so.
11	Single unit packaging.	Generally multi unit packaging. Sometimes single unit also. Butter carton, Bag in box...Here packing materials should be more attractive / effective than packaging material.

Reasons for selecting a particular style/type of packaging are vast and varied, numerous and changing. Product and packaging are becoming so interdependent that one cannot separate/consider one without another. Greatest part of food is spent in some form of package.

2.5 REQUIREMENTS FOR PRODUCING SUCCESSFUL PACKAGE:

Four sets of facts are necessary to be known for producing a successful package:

2.5.1 Facts about the product:

1. The nature of the product, the material from which it is made and the manner

2.5.2 Facts about the transport haz

1. The type of transport-road, rail,
2. The degree of control over the tra
3. The form of transport- bulk, fre
train, etc.
4. The mechanical conditions a
Distributor District Distributor
or handling more strength is req
to higher cost).
5. The nature and intensity of m
storage, retailing and use. Packa
range of temperatures and relati
6. Whether handling aids are ava
between maker and user. (Viz. Li
7. The importance of minimum
packaging must be prevented.

2.5.2.1 Hazards may be:

1. Mechanical: Impact (vertical,
another, vibration, compression,
tearing etc.
2. Climatic hazard: (High / low tem
polluted), dust, and water vapou
3. Biological: (Microorganisms, fun
termites, mites, rodents (rats an

2.5.2.2 Contamination by other good

1. By materials of adjacent packs

Lesson-3

Selection of Packaging Materials

3.1 INTRODUCTION

The food processor has a variety of packaging materials to choose from for food packaging, specifically, paper, glass, metal, and plastics. The choice of the proper packaging material will be made by the food processor based on the requirements:

1. Composition of the food (solid or liquid)
2. Physical, chemical, and microbiological and deteriorative reactions that might occur
3. Storage conditions and time of storage
4. Socioeconomic situation of the anticipated customer or market
5. Desired package attractiveness
6. Cost of the packaging material
7. Packaging technology selected
8. Specific functional properties of the packaging material

There are several reasons for selecting or rejecting a particular packaging material over another, as summarized in the following Table: 3.1

Table 3.1: Reasons for Selection and Rejection of Specific Packaging Materials

Paperboard	Glass	Steel	Plastics

Chances of water absorption	Shatters, S
Penetrable	High strength ra
Image	Limited sha
Tears, punctures	Large sizes

3.2 TYPES OF PACKAGING MATE

A variety of packaging material commercially available for packagi glass, metal, and plastic (Table 3.2)

Table 3.2: Comm

No.	Materials	%
1	Paper and paper board	
2	Glass	

3.3 CHARACTERISTIC OF AN IDEAL PACKAGE

1. Compatible with product.
2. Protection from Mechanical hazards especially transportation. climatic hazards, microorganisms : Packaging do not harbour bacteria, restrict their growth....Flavour gain/loss/salts/difference in temperature.
3. Fit into a production line.
4. Advertising potential.
5. Attractive appearance.
6. Easy to handle during...Production, storage and Distribution
7. Moisture proof/resistance.
8. Sufficient mechanical strength to withstand drop, vibration, compression etc.
9. Acid, alkali resistance.
10. Grease & oil resistance.
11. Resistance to photo-chemical changes in product.
12. Resistance to insects and rodents.
13. Fire proof resistant to smoke, fume and water.
14. Pilfer proof (malpractice).
15. Inert: No effect on flavour/aroma.
16. Not injurious to health.
17. Economic.
18. Easy availability.
19. Protect against climatic hazards.
20. Protect against microorganisms. It should not harbour microbes rather restrict their growth by controlling growth factor like.

4.1 INTRODUCTION

This chapter deals with characteristic
and allied products.

4.2 PAPER AND PAPER BOARD

4.2.1 Characteristics

1. Paper and board are very popu
   mainly used for writing upon, p
   pressing together moist fibers,
   or grasses, and drying them int
2. Paper is a versatile material wit
   writing and printing upon, it is
   many cleaning products, in a n
3. Paper pulp is produced from w
   pulp is suspended in water and
   split the cellulose fibers longitu
   passed through heated rollers
   finishing rollers to give the fina
   hydrolysis produces sulphate p

is most often used in packaging and graphic printing. It is sturdier than paper but is thinner than corrugated board. Paperboard is widely used in today's society and is used to package many popular items, most notably food products and cigarette, ice-cream packaging. It can be easily cut and formed, is lightweight, and is strong; paperboard is popular in many industries as a packaging option.

4.3.2 Production:

Pulp (virgin or recycled) is used to create one or more layers of board which can be coated for a better surface and/or improved visual appearance.

4.3.2.1 General Steps of Paper Making Process

1. **Pulping**
2. **Washing**
3. **Settling**
4. **Squeezing of slurry**
5. **Pressing**
6. **Drying, Calendaring and Sizing**

4.3.2.2. Raw Materials:

1. **Hard wood:** 0.05 inches (length) e.g. Birch which has short fibres. It is

different processes like Soda
Semi chemical or Combinatio

4.3.2.4. Bleaching

Pulp used in the manufacture of p
purity. Virgin pulp is naturally br
Recycled paperboard may contain
which causes a grey colouration. Al
it is vital for many graphical and pa

4.3.2.5. Plies

Multi ply paperboard generally ha
single ply as a result of layering di
where the same kind of pulp is be
treated and shaped individually in
benefits of multi ply paperboard
performance.

4.3.2.6 Coating

In order to improve whiteness, sn
layers of coating are applied. Coatin
be china clay, calcium carbonate or

often combined with wax, plastic film, metal foil, or a combination of foil and plastic film.

5. Paperboard is made in a similar way to paper but is thicker in order to protect foods from mechanical damage. The main characteristics of board are thickness, stiffness, the ability to crease without cracking, the degree of whiteness, surface properties, and suitability for printing. White board is suitable for contact with food and is often coated with polyethylene, polyvinyl chloride, or wax for heat-sealability. It is commonly used to prevent freezer burn in stored frozen products. Pulp containers are made from paper pulp compressed in molds to remove moisture. Pulp containers are used for egg cartons, low-cost food trays, and cushioning of food products.

4.4. CORRUGATED PAPER, FIBRE BOARD, CBX ETC

4.4.1 Corrugated fiberboard

Corrugated fiberboard, also known as corrugated cardboard, is a paper-based construction material consisting of a fluted corrugated sheet and one or two flat linerboards. Corrugated board is the most common form of secondary food packaging and is used by virtually every industry in the manufacture of corrugated boxes and shipping containers.

1. Corrugated board has an outer and inner lining of kraft paper with a central corrugating (or fluting) material. This is made by softening kraft paperboard with steam and passing it over corrugating rollers. The liners are then applied to each side using a suitable adhesive. The board is formed into *cutouts*, which are then assembled into cases at the filling line.
2. The corrugated medium and linerboard are made of paperboard, a paper-like material usually over ten mils (0.010 inch, or 0.25 mm) thick. Paperboard and corrugated fiberboard are sometimes called *cardboard* by non-specialists;

4.4.1.1. Standard US Corrugated Fl

Table: 4.3: Standards of corrugated

Flute Designation	Flutes per lineal foot	th
A flute	33 +/- 3	
B flute	47 +/- 3	
C flute	39 +/- 3	
E flute	90 +/- 4	
F flute	128 +/- 4	

4.4.2 Chip Board / Bogus:

1. Old news papers, other scrap p converted in to paper/ board k to three layers of coating on th of its recycled content it will be packaging of shoes, toys etc.
2. Bogus is a paper product whic pulp to imitate higher quality g in colour due to the raw materi fill, wipes, bedding & cushionin

4.5 WOOD

4.5.1 Advantages and Disadvantage

Lesson-5

Characteristics of Glass

5.1 INTRODUCTION

Glass generally refers to hard, brittle, transparent material, such as those used for windows, many bottles, or eyewear. Glass is one of the most important packaging materials because of its high barrier and see-through properties. In the technical sense, glass is an inorganic substance formed from a mixture of sand (73%), sodium oxide (13%), and calcium oxide (12%), with a proportion of broken glass or *culler* (15 to 30% of total weight). Many glasses contain silica as their main component and glass former.

5.1.1 What is Glass?

Glass is a mixture in which all the constituent atoms have been persuaded by heating to line up in to a random but rigid net wall in which each silica atom is linked to '4' oxygen atoms and then to other silica atoms, both atoms of sodium and calcium distributed in holes in the network.

5.1.2 Approximate composition of Glass:

- Natural White Glass:
  - Silica (SiO_2) – 73%

The principal raw materials required fo
soda ash. Screen printing, ceramic spr
printing on the glass.

5.2. CHARACTERISTICS OF GLASS C

Glass containers have several chara
beverage packaging:

1. They are impervious to moisture
2. They are inert and do not react
3. They have filling speeds compar
4. They are suitable for heat proces
5. They are transparent to microwa
6. They are reusable and recyclable
7. They are resealable.
8. They are transparent and displa
9. They can be molded into a variet
10. They are perceived by the custor
11. They are rigid and allow stackin
12. They can be printed on directly

The main disadvantages of glass as a p

1. Higher weight and hence high
packaging containers.
2. Lower resistance than other m
shock.
3. More variable dimensions than c

cork plugs. Fruit juices and drinks like flavoured/sterilized flavoured milk, milk beverages etc. are often packaged in bottles The glass bottles used in Dairy industry are heat resistant bottles. But, they can withstand 50°C temperature difference during heating and only 30°C temperature difference during cooling, which is important during in-bottle sterilization of milk.

2. **Jars** are wide mouthed bottles with no neck, and this affords easy access to the product. They are used for liquid, viscous, solid, and semisolid products such as fruit pieces, sauces, and tomato pastes. They are closed in a similar manner to bottles, but with larger closures.
3. **Tumblers** are similar to jars but without a neck and a "finish" for the end closure. They are shaped like a drinking glass and are used for such products as jams and jellies.
4. **Jugs** are large sized bottles with carrying handles. They are used to package wine and institutional, industrial, and household products.
5. **Carboys** are large globular wicker-covered glass bottles for holding acids or other corrosive liquids.
6. **Vials and ampoules** are small, thin-walled glass containers. They are mainly used in the pharmaceutical industry for drugs and in the food industry for small quantities of very expensive ingredients, such as flavors.
7. Food products packed in glass: Baby foods, malted milk foods, sterilized flavoured milk, beer, soft drinks, meat/fish products, fruits and vegetable products.

5.4 GLASS CONTAINER PRODUCTION

Broadly, modern glass container factories are three-part operations: the **batch house**, the **hot end**, and the **cold end**. The batch house handles the raw materials; the hot end handles the manufacture, the furnaces, annealing ovens, and forming machines; and the cold end handles the product-inspection and packaging equipment.

5.4.1 Glass container forming process:

4. The glass is then annealed at
carefully controlled conditions
5. In all cases a stream of molten
is cut with a shearing blade to
6. Both processes start with th
troughs and chutes, into the bl

5.5 CONSIDERATIONS FOR SELEC

1. When selecting a glass conta
choosing dimensions and finis
product can be easily filled
selected. 'Finish' refers to the
containers, i.e. thread, lug, f
standard finishes.
2. Other important factors in se
which can influence the type
thermal shock. Some glasses c
i.e. filling a hot product into a
Special glasses are available fo
3. Though total quantity of glass
packaging has been diminis
materials like plastics.
4. Of late, the rediscovered virt
resistant glass is likely to bring
5. Recent developments in West
glass bottles and researches ar
6. Novel features like vacuum r
increasingly used.
7. In India, though

Lesson-6

Characteristics of Metals and Metallic Containers

6.1 INTRODUCTION

Metal packaging materials are appropriate for packaging of light, moisture and oxygen sensitive products and carbonated beverages such as soft drinks, flavoured milk etc.

1. Mainly aluminum is used as packaging material in the form of cans.
2. Also tin plates are now a day used as metal packaging material.
3. Tin plate is solid, heavy steel covered with tin to protect it against rust. It is used to package canned foods. It can be recycled and again can be used as an outer packing material.
4. The earliest metals used by man were those found in native state, which were soft and easily workable. These include copper, silver and gold.
5. The commercial packaging of food stuffs in metal containers began in the early 19th century.
6. Metal cans, made from steel or aluminum, are widely used by the food industry to pack a wide range of foods.

There are two basic types of metal cans:

1. Those that are sealed using a 'double seam' and are used to make canned foods: Double-seamed cans are made from tinplated steel or aluminum and are lined with specific lacquers for different types of food

Constituent
Carbon
Manganese
Phosphorus
Sulphur
Silica
Copper

- For the fabrication of containers e.g. carbonated beverage ends, ti steel is used. The chemical comp steel except with the addition of (

- To make the tin plate corrosion r Tin is applied either by

- Hot dipping process
- Electrolytic deposition

- Tin plate in addition to the corro protected by two surface treatme

(A) *Passivation:* The passivation using sodium dichromate sol controlling the growth of natu

containers cannot be soldered with Lead or tin. They are welded or organic adhesives are used.

6.1.3 Advantages of using Metal Cans:

1. They have a high strength-to-weight ratio.
2. They can be heat processed.
3. They have excellent barrier and protective properties.
4. They produce shelf-stable products that are safe and nutritious to eat and can be stored at ambient temperature.
5. They are tamperproof.
6. When sealed with a double-seam they provide total protection of the contents,
7. They can be made in a wide range of shapes and sizes.
8. Ease of fabrication.

6.1.4 Limitations of Metal Cans:

1. High cost of metal and relatively high manufacturing costs make cans expensive.
2. They are heavier than other materials, except glass, resulting in increased transportation costs for the finished product.

6.2 STEEL CANS

6.2.1 Three-piece cans:

- One of the most commonly used primary packaging containers for a wide variety of processed fruits and vegetables are the three-piece can or *sanitary* can.
- It is made from steel that is electrolytically coated on both sides with either a

1. Be nontoxic
2. Not affect the flavor or color of th
3. Provide a good barrier between t
4. Be easy to apply to the tin plate
5. Not peel off during sterilization o
6. Have mechanical resistance to ca
7. Be economical

Common types of enamels used by the

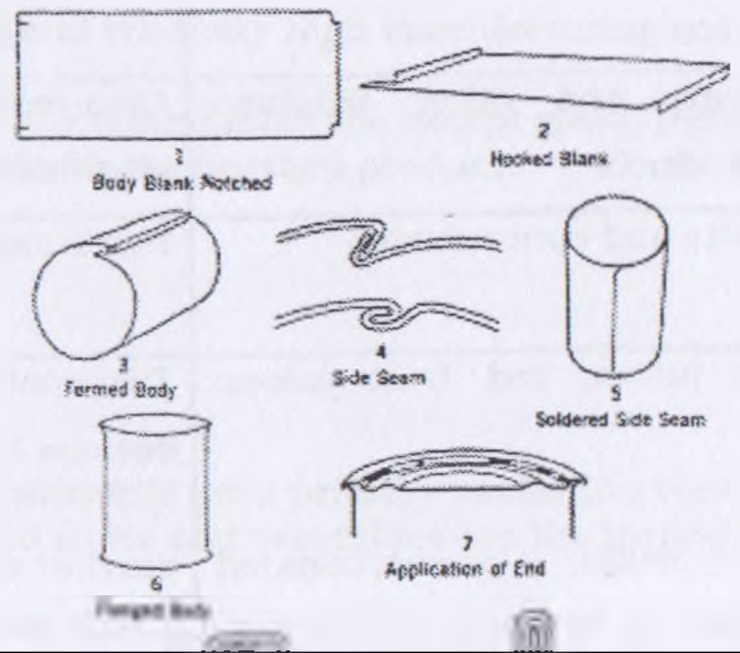
Table 6.1: General Types of Coati

No.	**Coating**	**Typic**
1	R-Fruit enamel	Dark colored berri requiring protect salts
2	C-Corn enamel	Corn, peas, and bearing products
3	Citrus enamel	Citrus fruits and c
4	Beverage can enamel	Vegetable juices; highly corrosive fruits beverages

not impart flavor to the food but have poor resistance to high temperatures. They are well suited for acidic products that do not need to be heat-sterilized and can be processed at temperatures below 100 °C.

- Outer coatings can also be applied to the outer can surfaces to prevent corrosion. Outside coatings of acrylics, phenolics, oleoresins, and vinyls are usually **pigmented**. They must be able to survive the heat-processing treatment and be receptive to decorative coatings and inks.

Three-piece cans are fabricated as shown in Figure 6.1. Sheets of tin plate or tin-free plate, with or without enamel coating, are cut into pieces to form the body of the can. Each *body blank* is hooked at the corners, flattened, and then seamed by soldering, cementing, or welding (Figure 6.1). The body blank is flanged, and the can bottom (manufacturer's) is double seamed onto the body. The can top is seamed on at the production line after the can is filled with product.



and bottom sealing steps, resulting in i
problems; however, their production rate

6.3 ALUMINUM CANS

- Aluminum is attractive, light, and
  materials to produce the packagir
  lids, foils etc are made from alum
  commonly used for packaging fru
- Aluminum cans were first used fo
- Aluminum can be used
- For making rigid containers/cans
- For making Aluminum foil
- For making collapsible metal tube
- Aluminum is obtained from Alum

6.3.1 Properties of Aluminum:

1. It is lightest of the commonly used
2. Melting point is 660°C.
3. High electrical and thermal condu
4. Soft, ductile and low tensile stren

6.3.2 Advantages of aluminum:

1. In comparison to tin plate & TFS,
2. Lower transportation costs, thus
3. It has a good weight-strength ratio
4. It has a high quality surface for de
5. Easier to recover or recycle

Pure or commercially pure aluminum (Type 1100 and 1050) is used for the manufacture of foil and extruded containers.

Hardest grade (5182) alloy containing 4-5 % Magnesium and 0.35% Manganese is used for manufacture of carbonated beverage can ends.

Two-piece aluminum cans are made by the draw-and-wall-iron (DWI) or the draw-and-redrawn (DRD) process. The DWI process results in cans with thinner walls than the DRD process and is used to produce cans for carbonated drinks where the gas pressure supports the container. Thicker-walled DRD cans are able to withstand the head-space vacuum required in heat sterilization.

Lacquers are applied internally to prevent interactions between the metal and the product. The type of lacquer used depends on the type of product packed. Epoxy-phenolic or vinyl-based lacquers are commonly used.

6.3.4 Aluminum Foil:

"Aluminum foil is usually defined as pure aluminum (not less than 99.4% purity) which has been rolled to a thickness not more than 0.152 mm"

Commercial foils generally range in thickness of 30-70 gauge. In thinner gauges pinholes are problems in aluminum foils.

L

Character

7.1 INTRODUCTION

Plastic is the general term for a v
polymerization products derived from e
Webster dictionary include any of a l
weight that usually contain as the esse
organic substance made by polymerizat
material or any chemical treatment,
laminated under various conditions into
and filaments.

They are composed of organic condens
other substances to improve performa
polymers generally considered to be "pl
films or fibers. Their name is derived fro
property of plasticity.

Plastics are polymers where long cha
A **polymer** is a substance composed of m
of repeating structural units, or monor
The word is derived from the Greek. πολ

- The first plastic based on a synthetic polymer was made from phenol and formaldehyde, with the first viable and cheap synthesis methods, the product being known as Bakelite.
- Subsequently poly vinyl chloride, polystyrene, polyethylene (polyethene), polypropylene (polypropene), polyamides (nylons), polyesters, acrylics, silicones, polyurethanes were amongst the many varieties of plastics developed and used commercially.
- The development of plastics has come from the use of natural materials (e.g., chewing gum, shellac) to the use of chemically modified natural materials (e.g., natural rubber, nitrocellulose, collagen) and finally to completely synthetic molecules (e.g., epoxy, polyvinyl chloride, polyethylene).
- Recently, corn has been used to make biodegradable containers. Corn can be used to create non-petroleum plastic, which is often compostable.

7.2.1 Types of Plastics:

1. Thermosets: Thermosets soften and flow when heated but at the same time an irreversible chemical reaction takes place so that once hardening has occurred the material again can not again be softened by heating. If strong heat is applied to thermoset, it will char and decompose bu will not soften and melt. Eg. Urea formaldehyde, Phenol formaldehyde.

2. Thermoplastics: Thermoplastics soften on heating and harden again on cooling, a process which can be repeated any number of times. Eg. Polyethylene, Nylon

Common thermoplastics range from 20,000 to 500,000 in molecular weight, while thermosets are assumed to have infinite molecular weight. These chains are made up of many repeating molecular units, known as "repeat units", derived from "monomers"; each polymer chain will have several 1000's of repeat units. The vast majority of plastics are composed of polymers of carbon and hydrogen alone or with oxygen, nitrogen, chlorine or sulfur in the backbone

7.2.1.2 Polyacetals:

The name polyacetals covers polym
compounds such as ethylene oxide. Th
have been used in engineering applica
acids and alkalis but are attacked l
resistance.

Polyacetal container is used for hair lac

7.3 ADVANTAGES OF PLASTICS OVE

1. ***Versatility:*** Glass/paper/board/
is possible in narrow limits c
properties. Their modification is
(cloth + PVC+PVDC) Nomex (a
(bulletproof jacket -5 x stronger
/insulator (PET electric tube ligh
2. ***Energy requirements*** for conve
than that of Glass and 30-40 tim
3. ***Plastic containers*** are light
breaking in handling. Attractive
decoration at competitive price a
4. ***Multilayers used:*** Multilayers c
/ EVA foil / EVA / LDPE. C
Collapsible tube has additiona
printing, light weight.
5. ***Cost:*** Cost of plastics is compa
containers.
6. ***Consumer's convenience*** at lo
for shampoo pouches, Foil-LDP
LDPE / metallized PET/HD or
foil/LDPE for coffee packaging a

b. Plastics have less weight and add little weight to the product so more amount can be loaded and thus less cost. Plastic crates are light in weight than wooden crates so easy to stack.
c. Shrink wrapping can act as intermediate of bulk packaging and cause less loss during handling / transportation / distribution.
d. Plastic packaging fit closely to the shape of the food, thereby wasting little space during storage and distribution.

11. Plastics have good barrier properties against moisture and gases.
12. Plastics are non-corrosive.
13. Heat-sealable to prevent leakage of contents.
14. Suitable for high-speed filling.
15. Good wet and dry strength.
16. Suitable for printing and even sandwiched printing layer can be provided.
17. Plastics can be recycled.

Plastics may be made as flexible films or as semi-rigid and rigid containers to meet the varied packaging and processing requirements of food. Plastic films are made with a wide range of mechanical, optical, heat-seal, and barrier properties. Furthermore, they can be coated with another polymer or metallized to give a laminated structure with superior properties. Examples of some of the common flexible films and their properties are discussed here.

Table 7.1: Examples of Basic Plastics Used as Packaging Material

No.	Materials	Structural Unit	Important Properties
1	Cellulose	Glucose	Good strength, poor H_2O and gas barrier,

6	Polystyrene	Styrene
7	Poly vinyl-chloride (PVC)	Vinyl chloride
8	Polyvinylidene-chloride (PVDC)	Vinyl alcoho Vinylidene chloride
9	Ethylene vinyl acetate (EVA)	Vinyl acetate ethylene
10	Ethylene vinyl alcohol	Vinyl alcoho ethylene
11	Ionomer	Methacrylic acid + Ethylene

7.4 DISADVANTAGES OF PLASTICS

7.4.1 Negative health effects:

Following plastics have been associated

PVC (polyvinyl chloride) contains nu

Other (usually polycarbonate - PC) group that consists mainly of polycarbonates, whose primary building block is bisphenol A (BPA), a hormone disrupter that releases into food and liquid and acts like estrogen. Research in Environmental Health Perspectives found that BPA (leached from the lining of tin cans, dental sealants and polycarbonate bottles) can increase body weight of lab animals' offspring, as well as impact hormone levels. A more recent animal study suggests that even low-level exposure to BPA results in insulin resistance, which can lead to inflammation and heart disease.

7.4.2 Negative effects on environment

1. Plastics are durable and degrade very slowly.
2. In some cases, burning plastic can release toxic fumes (Eg. PVC/PVDC).
3. The manufacturing of plastics often creates large quantities of chemical pollutants.
4. Unfortunately, recycling plastics has proven difficult. The biggest problem with plastic recycling is that it is difficult to automate the sorting of plastic waste, and so it is labor intensive.

Recycling certain types of plastics can be unprofitable, as well, e.g. polystyrene is rarely recycled because it is usually not cost effective.

Sources of different plastic n

8.1 INTRODUCTION

This lesson covers the topics related to manufacture of different plastic materia

8.2 DEVELOPMENTS IN PLASTICS

- By 1936, American, British, and methacrylate (PMMA), better kno well known for their use in pai their bulk form they are actuall and are sold as glass replacem and it is also now used as a mar
- Another important plastic, poly was discovered in 1933 by Regin
- PEs are cheap, flexible, durabl make films and packaging ma plumbing, and automotive fittin attack, it was found later that a by exposing it to fluorine gas, w into the much tougher polyfluor
- Polypropylene (PP) is similar t cost, but it is much more robust carpets to plastic furniture, and

- New manufacturing methods were developed, using various forming, molding, casting, and extrusion processes, to make plastic products in large quantities. Consumers enthusiastically accepted the endless range of colorful, cheap, and durable plastic containers/materials being produced.
- One of the most visible parts of this plastics invasion was a complete line of sealable polyethylene food containers which are highly effective and greatly reduce the spoilage of foods in storage. Thin-film plastic wrap that could be purchased in rolls also helped in keeping food fresh
- Formica, a plastic laminate is used to surface furniture and cabinetry. Formica was durable and attractive. It was particularly useful in kitchens, as it did not absorb, and could be easily cleaned of stains from food preparation, such as blood or grease.
- Polyurethane foam was used to fill mattresses, and Styrofoam was used to line ice coolers and make float toys
- Plastics are continuously subject to improvement. General Electric introduced Lexan, a high-impact polycarbonate plastic. Du Pont developed Kevlar®, an extremely strong synthetic fiber that is best known for its use in ballistic rated clothing and combat helmets

In the recent years, there has been a tremendous increase in the use of plastics replacing traditional packaging materials such as glass, metal, and paper. The raw materials for plastics are petroleum, natural gas, and coal. They are formed by a polymerization method that creates linkages between many small repeating chemical units (monomers) to form large molecules or polymers.Monomers are subjected to specific temperature and pressure conditions due to which chemical bonding takes place between them resulting in a chain structure. It is known as polymer and process is known as Polymerization *(Poly = many, meros = part)*. The types of plastics are made by either of the following methods which decide their properties also:

8.3. CLASSIFICATION OF PLASTICS

- Plastics can be classified in ma
backbone (polyvinyl chloride, p
acrylics, silicones, polyurethane
- Other classifications include th
plastic, addition or condensatic
method used), and glass transit
- Some plastics are partially cry
structure, giving them both a
attractive intermolecular forces
(temperatures above which the
increased)
- Many plastics are completely
copolymers, poly (methyl metha
- So-called semi-crystalline plas
(vinyl chloride), polyamides (nyl

8.3.1 Major Groups of Plastics:

8.3.1.1 Thermoplastics:

- A **thermoplastic** is a plastic tha
brittle, very glassy state when
heating and cooling cycles dur
and films. Thus the reaction is

Reduction

Molten Mass

Increase i

Some examples of Thermoplastics are:

- Acrylonitrile butadiene styrene (ABS)
- Acrylic
- Cellulose acetate
- Ethylene-Vinyl Acetate (EVA)
- Ethylene vinyl alcohol (EVAL)
- Fluoroplastics (PTFEs, including FEP, PFA, CTFE, ECTFE, ETFE)
- Ionomers
- Kydex, a trademarked acrylic/PVC alloy
- Polyacrylates (Acrylic)
- Polyamide (PA or Nylon)
- Polyethylene terephthalate (PET)
- Polycarbonate (PC)
- Polyester
- Polyethylene (PE)
- Polylactic acid (PLA)
- Polypropylene (PP)
- Polystyrene (PS)
- Polyvinyl chloride (PVC)
- Polyvinylidene chloride (PVDC)

8.3.1.2 Thermoset Plastics:

Thermosetting plastics (thermosets) are polymer materials that irreversibly cure, to a stronger form. The cure may be done through heat (generally above 200°C), through a chemical reaction (e.g. two-part epoxy), or irradiation such as electron beam processing. It is possible to burn but re-melting is not possible in such plastic.

- Thermoset materials are usually liquid or malleable prior to curing, and

- Thermoset materials are gener
  this 3-D network of bonds,
  applications up to the decompo
- Generally it is not used for
  high dimensional accuracy is
  caps, lids of bottle, transparen

Some examples of thermosets are:

- Vulcanized rubber
- Bakelite, a phenol-formaldehy
  wear)
- Urea-formaldehyde foam (use
  fibreboard)
- Melamine resin (used on workt
- Epoxy resin (used as an adhes
  reinforced plastic and graphite
- Polyimides (used in printed
  airplanes)

8.4 Methods of manufacture of pla

8.4.1 Molding Process:

Molding is the process of manufactu
frame or model called a mold

A **mold** or **mould** is a hollowed-out b
metal, or ceramic raw materials. The

- Rotational molding
- Thermoforming

  - Vacuum forming, a simplified version of thermoforming

- Reaction Injection Molding
- Laminating
- Expandable bead molding
- Foam molding
- Rotomolding
- Vacuum plug assist molding
- Pressure plug assist molding
- Matched mold

8.4.1.1 Flexible mold

A mold is a hollow shape which exactly encloses the shape of a desired object. The object is usually created by pouring a liquid into the mold and allowing it to solidify: typical liquids include molten metal or plastic, plaster of Paris, epoxy resin

Molds generally divide into two classes: solid or flexible

There are five different types of flexible mold compounds in significant use today:

- Hot-Melt
- Latex
- Silicone rubbers
- Polysulfide rubbers

common method of production, with
and outdoor furniture

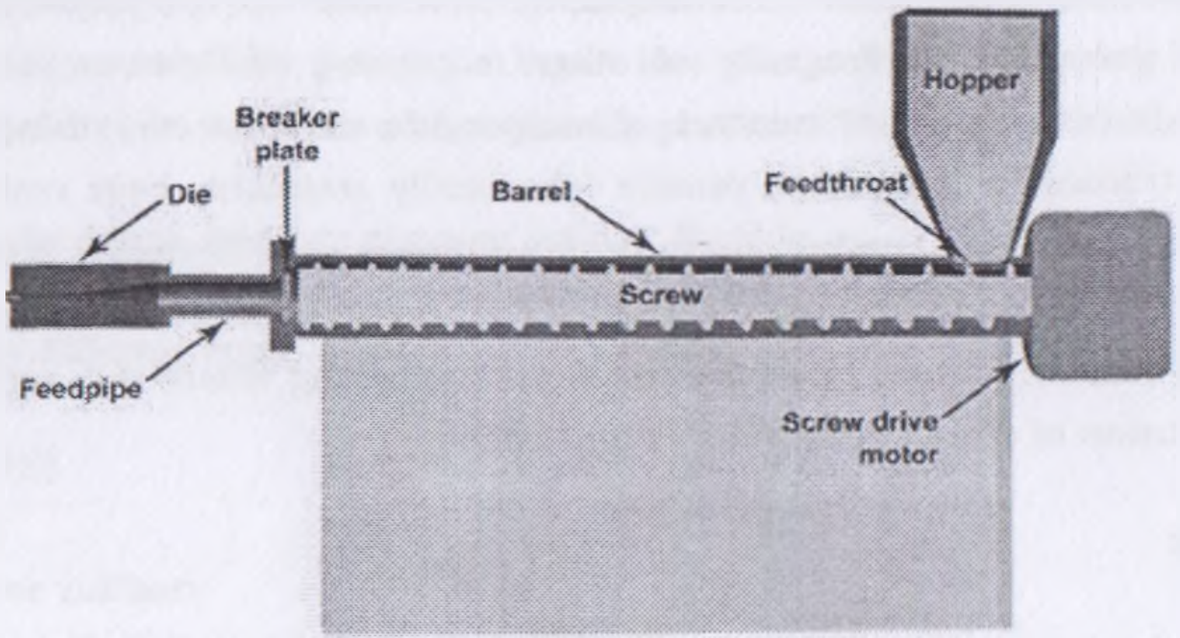
Figure 8.1: Standard two plates t

Materials: The most commonly us
cost, lacking the strength and lor
butadiene styrene (a ter-polymer or
Lego parts to electronics housings),
tough and flexible - used for comb
containers), polyethylene, and polyvi
as used for pipes, window frames, o
flexible by the inclusion of a high pro

Injection Process:

3. The screw is rotated by a motor, feeding pellets up the screw's grooves. The depth of the screw flights decreases towards the end of the screw nearest the mold, compressing the heated plastic
4. As the screw rotates, the pellets are moved forward in the screw and they undergo extreme pressure and friction which generates most of the heat needed to melt the pellets
5. Heaters on either side of the screw assist in the heating and temperature control during the melting process.
6. The channels through which the plastic flows toward the chamber will also solidify, forming an attached frame
7. This frame is composed of the *sprue*, which is the main channel from the reservoir of molten resin, parallel with the direction of draw, and *runners*, which are perpendicular to the direction of draw, and are used to convey molten resin to the*gate(s)*, or point(s) of injection

8.4.2 Plastics extrusion:



- The material enters through the
  barrel) and comes into contact w
  plastic beads forward into the
  temperature of the molten plasti
  profile is set for the barrel in w
  heaters gradually increase the te
  the plastic enters) to the front. Tl
  as they are pushed through the b
  may cause degradation in the poly
  pressure and friction taking place
  is running a certain material fast
  melt temperature maintained by
  In most extruders, cooling fans ar
  value if too much heat is generate
- At the front of the barrel, the
  through a screen pack to remove a
  reinforced by a breaker plate (a
  through it) since the pressure at
  screen pack/breaker plate assem
  barrel. Back pressure is required
  polymer. This breaker plate also
  memory" of the molten plastic into
- After passing through the breake
  die is the component that gives
  designed so that the molten plasti
  product's profile shape. Uneven fl
  unwanted stresses at certain poi
  warping upon cooling.
- The product must now be cooled
  extrudate through a water bath.
  are therefore difficult to cool quic
  heat away 2000 times more slow
  water bath is acted upon by a ca

- A common post-extrusion process for plastic sheet stock is thermoforming, where the sheet is heated till soft (plastic), and formed on a mold into a new shape. When vacuum is used, this is often described as vacuum forming. Thermoforming can go from line bended pieces (e.g. displays) to complex shapes (computer housings), which often look like being injection moulded, because of the various possibilities in thermoforming, such as inserts, undercuts, divided moulds

8.4.2.1.2 Blown Film extrusion:

The manufacture of plastic film for products such as shopping bags is achieved using a blown film line

- This process is the same as a regular extrusion process up until the die
- The die is an upright cylinder with a circular opening similar to a pipe die
- The diameter can be a few centimeters to more than three metres across
- The molten plastic is pulled upwards from the die by a pair of nip rolls high above the die (4 metres to 20 metres or more depending on the amount of cooling required)
- Changing the speed of these nip rollers will change the gauge (thickness) of the film
- Around the die sits an air-ring. The air-ring cools the film as it travels upwards. In the centre of the die is an air outlet from which compressed air can be forced into the centre of the extruded circular profile, creating a bubble
- This expands the extruded circular cross section by some ratio (a multiple of the die diameter). This ratio, called the "blow-up ratio" can be just a few percent to more than 200 percent of the original diameter
- The nip rolls flatten the bubble into a double layer of film whose width (called the "layflat") is equal to ½ the circumference of the bubble
- This film can then be spooled or printed on, cut into shapes, and heat sealed into bags or other items

the die and in most cases positive pressure
the pin.

4.2.1.5 Coextrusion:

Coextrusion refers to the extrusion of multi
type of extrusion utilizes two or more extruc
throughput of different molten plastics to a
materials in the desired shape. This tech
described above (Blown Film, Overjacket
controlled by the relative speeds and sizes
materials.

4.2.1.6 Extrusion coating:

Extrusion coating is using a blown or cast f
an existing rollstock of paper, foil or film.
characteristics of paper by coating it with
water. The extruded layer can also be used
together. A famous product that uses thi
UHT milk).

Lesson-9

Forms of different plastic materials - 1

9.1 INTRODUCTION

In this lesson the topics related to different plastic materials like cellulose, polyethylene, polypropylene, polyester, polyamide etc are discussed.

9.2 CELLULOSE

Cellophane is produced from wood pulp, treated chemically, and cast into a film on heated rollers. Glycerol is added as a softener, and the film is dried on heated rollers. Higher quantities of softener produce more flexible films.

Art silk, technically known as Cellulose Acetate is well known under the trade name "rayon". It is cheap and feels smooth on the skin, though it is weak when wet and creases easily. It could also be produced in a transparent sheet form known as "cellophane".

9.2.1 Characteristics of Cellulose:

9.2.2 Modified Celluloses:- Thermoplast

- Cellulose acetate
- Cellulose acetate-butyrate
- Cellulose acetate-propionate

Application – Thermoformed blisters, cartons.

9.2.2.1 Cellulose Acetate:-

This is a cellulose plastic made from bark of acetic and sulphuric acids. It has goo very similar in properties to PS. The hig utilized for wrapping fresh produce like to

Cellulose acetate is resistant to aromatic esters and is decomposed by strong acid moisture and is not dimensionally stable.

9.2.2.2 Cellophane:-

It is derived from natural cellulose which cellulose glucose units may vary from 3 by which cellulose could be obtained in a

9.2.3.1 Carboxy Methyl Cellulose(CMC):

This film is available as Sodium EMC. It is hydrophilic and is insoluble in cold water.

Methyl Cellulose: It is obtained by treating cellulose with NaOH and then by alkylation. It is highly resistant to oils and greases. It can be formed in to small pouches.

9.2.3.2 Polyvinyl Alcohol:

The film is obtained by hydrolysis of polymerized vinyl acetate. It is insoluble in hydrocarbons. These are used for wrapping candies, single application for coffee, tea, derived milk, cold drinks, detergents and insecticides. It is soluble in water. It is utilized for manufacture of film, sachets used to give controlled dosage in water.

9.3 POLYETHYLENE:

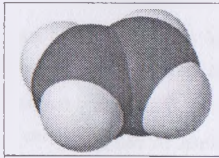
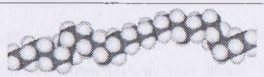
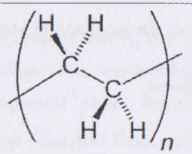
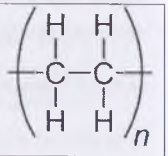
			
Two CH_2 groups connected by a	Space-filling model of a polyethylene chain	The repeating unit of polyethylene	A simpler way of representing the

FIGURE 9.1 basic structure and charact

Polyethylene or **polythene** (IUPAC name heavily used in consumer products and fo polymerization of ethylene.

Polyethylene is a polymer consisting of lo name ethene). In the polymer industry th commonly called **polythene** in UK. The et ethylene), C_2H_4 is $CH_2{=}CH_2$. Polyethylene i It can be produced through radical polyr ion coordination polymerization or catio methods results in a different type of polye

9.3.1 Characteristics of Polyethylene:

1) Polyethylene was first synthesized by t 1898. It contained long -CH_2- chain industrially practical polyethylene syn The types of catalyst that promot temperatures and pressures are:

- Chromium trioxide based

- Most Low Density Polyethylene (LDPE) , Medium Density Polyethylene (MDPE), and High Density Polyethylene (HDPE) grades have excellent chemical resistance and do not dissolve at room temperature because of the crystallinity.
- Polyethylene is classified into several different categories based mostly on its density and branching. The mechanical properties of PE depend significantly on variables such as the extent and type of branching, the crystal structure, and the molecular weight
- Polyethylene (other than cross-linked polyethylene) usually can be dissolved at elevated temperatures in aromatic hydrocarbons, such as toluene or xylene, or chlorinated solvents, such as trichloroethane or trichlorobenzene

9.3.3 Classification of Polyethylene:

9.3.3.1 High-density polyethylene (HDPE):

- HDPE is defined by a density of greater or equal to 0.941 g/cm^3
- It also has a higher softening temperature (121^{0}C) and can therefore be heat-sterilized.
- It has a low degree of branching and thus stronger intermolecular forces and tensile strength.
- It is stronger, thicker, less flexible, less transparent, and more brittle and has lower permeability to gases and moisture than LDPE.
- It is used in products and packaging such as milk jugs, detergent bottles, margarine tubs, garbage containers and water pipes. It is commonly used in the production of bags, as liners, and as an over wrap.

9.3.3.2 Medium-density polyethylene (MDPE):

- MDPE is defined by a density range of 0.926–0.940 g/cm^3
- It can be produced by chromium/silica catalysts, Ziegler-Natta catalysts or **metallocene** catalysts

LDPE, with better environmental stre
but is not as easy to process.
- It is used in packaging, particularly f
(gauge) may be used compared to LD
containers, pipees etc.
- While other applications are available
applications due to its toughness, fle

9.3.3.4 Low-density polyethylene (LDPE):

- LDPE is defined by a density range o
- It has a high degree of short and long
chains do not pack into the crystal st
intermolecular forces.
- This results in a lower tensile strengt
- It is created by free radical polymeriz
- The high degree of branches with lon
desirable flow properties.
- It is used for both rigid containers an
bags and film wrap.
- It is heat-sealable at low temperature
- It is chemically inert, odor-free, and s
- It is a good moisture barrier but a po
makes it a good choice of packaging f
fruits, and vegetables.
- It is less expensive than most films a
packaging applications, including app
products.

9.3.3.5 High Molecular High Density Poly

Table. 9.1 Properties of LDPE & HDPE

SN	Property	LDPE	HDPE
1	Yield Stress	1250 – 2000 psi	3000 – 4100 psi
2	Yield Elongation	16 – 20%	11 – 16%
3	Ultimate Elongation	200 – 600%	50 – 400%
4	Impact Strength (200 gauge film)	4.5	1.5
5	Hardness	41 – 43	60 – 70
6	Softening Point	85 - 87°C	137°C
7	Tearing Strength (gm / mil)	150	75
8	WVTR (gm / m^2 / day)	18	5 – 6
9	Oxygen Transmission Rate (cc/cm^2/day)	15	3
10	CO_2 Transmission Rate (cc/cm^2/day)	55	13
11	Nitrogen Transmission Rate (cc/cm^2/day)	5	1
12	Turpentine Grease Proof Test	2 hours	168 hours

Ethylene copolymers:

In addition to copolymerization with alpha-olefins, ethylene can also be copolymerized with a wide range of other monomers and ionic composition that creates ionized free radicals. Common examples include vinyl acetate (resulting product is ethylene-vinyl acetate copolymer, widely used in athletic shoe sole foams), and a variety of acrylates

- Polyester may be produced in numerous
  thermoplastic may be heated and proces
  sheets, and three-dimensional shapes.
- While combustible at high temperatures
  flames and self-extinguishes.

9.4.1 Characteristics of Polyester:

1. The main characteristics of PET are its s
   pressures of 50-60 psi used for soft drin
   properties to moisture and gases, and it
2. These characteristics make it an ideal p
   drink bottles and as a component of boi
   pouches (max. used temp. 150°C)
3. A more crystalline PET (CPET) is used tc
   enable precooked food and entrees to be
   without deformation of the packaging tr
4. It has good chemical resistance, soluble
   alkalis.

9.4.2 Uses of Polyester:

1. Polyester is the most widely used manu
2. Polyesters are also used to make bottles
   displays, holograms, filters, dielectric fil
   and insulating tapes. In general they ha
   properties and are extremely heat resist
3. Thermosetting polyester resins are gene
   polyesters with styrene. Another import
4. Unsaturated polyesters are commonly u
   laminating resins, and non-metallic aut

Subsequently polyamides 6, 10, 11, and 12 have been developed based on monomers which are ring compounds, e.g. caprolactam. Nylon 66 is a material manufactured by condensation polymerization. Nylon 6, 66 and 11 are most widely used as packaging films.

(A) Nylon 6:- It is prepared from phenol. It is more flexible than Nylon 66 and has better grease resistance than Nylon 11. It can withstand dry heat up to 250°C and hence, it is used for roast-in-bags. It has high mechanical strength, high elongation, excellent abrasion and bursting resistance. Unsupported film is used for containing frozen foods, aromatic flavourings, fats & oils.

(B) Nylon 66:- This has higher softening point i.e 265°C.

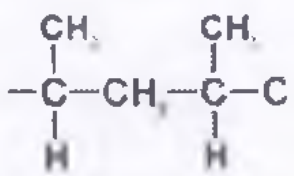
(C) Nylon 11:- It is manufactured from castor oil, undeconoic acid and ammonia. It softens at 125°C and is resistant to fats, oils and even concentrated alkalis and organic acids, but does not resist phenol and strong mineral acids.

9.5.1 Characteristics of Polyamide:

1. Nylon is a clear, tough film with good mechanical properties over a wide

10. They have good grease resistance and

9.6 POLYPROPYLENE



Polypropylene was first polymerized in 1
polypropene (**PP**) (IUPAC- Poly (1-methyleth
by the chemical industry by an addition p
other names are: Polypropylene; Polypr
polymers; Propylene polymers; 1-Propene
$(C_3H_6)_x$

9.6.1 Characteristics of Polypropylene:

1. **Polypropylene (PP)** is one of the light
2. It has a melting point of ~ 165°C and
   Crystalline: (0.95 g/cm^3).
3. There are three general types of PP: h
   impact or block copolymer.
4. Two main types are made: Non-orient
   polypropylene (OPP).
5. Melt processing of polypropylene can
   extrusion and 2) molding.
6. **Biaxially oriented polypropylene (O**

13. However, it is more brittle than polyethylene at low temperatures.
14. Its resistance to oils & grease is better than polyethylene.
15. One outstanding property of PP is its resistance to fatigue when fleshed.

Table. 9.2 Properties of Polypropylene

Sr. No.	Property	Cast PP	Oriented PP
1	Tensile Strength	5000 units	8000 units
2	WVTR (gm/m²/day)	11.8	5.4
3	Oxygen Permeability (cc/cm²/day)	100	60
4	Behaviour at 0°C	Brittle (It can not be used for freeze dehydration)	Unaltered

9.6.2 Applications of Polypropylene:

1. A common application for polypropylene is as Biaxially Oriented polypropylene (BOPP). These BOPP sheets are used to make a wide variety of materials including clear bags. When polypropylene is biaxially oriented, it becomes crystal clear and serves as an excellent packaging material for artistic and retail products.
2. It is used in a wide variety of applications, including packaging, textiles, stationery, plastic parts and reusable containers of various types.
3. It is most commonly used for plastic moldings where it is injected into a mold while molten, forming complex shapes at relatively low cost and high

6. Rugged, translucent, reusable plastic c
shapes and sizes for consumers are co
the lids are often made of somewhat m
the container to close it.
7. Polypropylene can also be made into di
powdered or similar consumer product
terephthalate are commonly used to m
8. PP can also be used to package soft ba
it is flexible enough to fit around irregu
9. PP has been produced in sheet form ar
production of stationary folders, packa
range, durability and resistance to dirt
papers and other materials. It is used i
characteristics.

Lesson-10

Forms of different plastic material-2

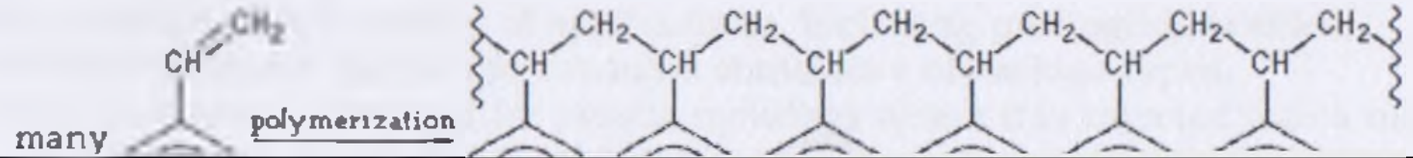
10.1. INTRODUCTION

In this lesson the topics related to different plastic materials like polystyrene, PVC, PVDC, EVA, EVOH etc are discussed in detail.

10.2. POLYSTYRENE (PS)

Polystyrene (IUPAC Polyphenylethene) is an aromatic polymer made from the aromatic monomer styrene, a liquid hydrocarbon via the double bond in the ethylene group attached to the benzene ring of the monomer unit that is commercially manufactured from petroleum. **Polystyrene foam (Thermocole) or expanded polystyrene (EPS)** is made by adding hexane during polymerization.

10.2.1. Characteristics



- Polystyrene may be oriented to impro
  strength.
- It can be used as Expanded Polystyr
- Expanded polystyrene is produced fr
  and 5-10% gaseous blowing agent, n
  The solid plastic is expanded into foa
- Extruded polystyrene (XPS) is comm
  The voids filled with trapped air give
- The density of expanded polystyrene
  200 kg/m³ depending on how much

10.2.2. Copolymers:

- **High-impact polystyrene** or **HIPS:**
  that a fairly high-performance produ
  properties of a stretchier material, su
  materials can never normally be mix
  intermolecular forces on polymer ins
  during polymerization it can become
  forming a graft copolymer which hel
  the final mix, resulting in **high-impa**
  impact plastic". HIPS are usually inj
  polystyrene can compress and harde
- Acrylonitrile butadiene styrene or AB
  acrylonitrile and styrene, toughened
  are made of this form of polystyrene,
  become brittle over time. ABS is use
- Styrene can be copolymerized with o
  divinylbenzene for cross-linking the
- It has got shining surface, good prin

10.2.3. Uses of Polystyrene

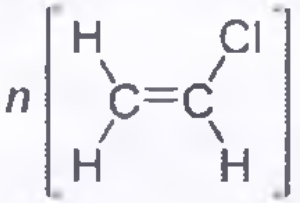
4. The voids in Extruded polystyrene (XPS) are filled with trapped air which give it low thermal conductivity. This makes it ideal as a construction material and it is therefore sometimes used in structural insulated panel building systems. It is also used as insulation in building structures, as molded packing material for cushioning fragile equipment inside boxes, as packing "peanuts", as non-weight-bearing architectural structures (such as pillars), and also in crafts and model building, particularly architectural models. Foamed between two sheets of paper, it makes a more-uniform substitute for corrugated cardboard, trade named Foamcore.
5. Polystyrene is economical and is used for producing plastic model assembly kits, license plate frames, plastic cutlery, CD "jewel" cases, and many other objects where a fairly rigid, economical plastic is desired.
6. Polystyrene can be dish washed at 70 °C without deformation since it has a glass transition temperature of 95 °C.
7. Petri dishes and other containers such as test tubes, made of polystyrene are used in biomedical research and science. For these uses, articles are almost always made by injection molding, and often sterilized post molding, either by irradiation or treatment with ethylene oxide.
8. Polystyrene is also used in preparing breath-in boxes type packaging for fruits, which keeps fruits fresh for longer time.

- Polystyrene, though is an efficient insu
from being used in any exposed install
retarded e.g. with hexabromocyclodode
- Polystyrene is used in some polymer-b
also a component of Napalm and a con
bombs.

10.2.5. Environmental concerns and bans

- Expanded polystyrene is not easily rec
low scrap value
- Expanded polystyrene foam takes a ve
environment

10.3. POLYVINYL CHLORIDE (PVC)



Polyvinyl chloride, (as per IUPAC called as
PVC, is a widely used thermoplastic polymer
of the most valuable products of the chem
made by the low-pressure polymerization
incorporating chlorine atoms, which form str

10.3.1. Characteristics of PVC

- PVC has excellent oil and grease resistance.
- Heat sealing is good but gives off corrosive HCl vapours.
- PVC is unsuitable for sterilization. It decomposes at about 60°C

10.3.2. Health and safety

- Plasticizers used to make soft PVC for toys can leach out into the mouths of the children chewing on the toys. In 2006, the EU placed a ban on six types of phthalate softeners, including DEHP (diethylhexyl phthalate), used in toys. An alternative plasticizer, DINP (diisononyl phthalate) is also found to be risky
- PVC plastic has been used safely for more than 70 years in a variety of medical and commercial applications and humans. No reports of adverse human health effects have been reported from intravenous (IV) bags and medical tubing made with PVC
- **Vinyl chloride monomer:** The carcinogenicity of vinyl chloride monomer to humans who were exposed to very high VCM levels, routinely, for many years have been linked. Vinyl chloride is a known human carcinogen that causes a rare cancer of the liver
- **Dioxins:** The dioxin is produced as a byproduct of vinyl chloride manufacture and from incineration of waste PVC in domestic garbage
- Dioxins are a global health threat because they persist in the environment and can travel long distances
- At very low levels, dioxins have been linked to immune system suppression, reproductive disorders, a variety of cancers, and endometriosis

10.3.3. Recycling

- Post-consumer PVC is not typically recycled due to the prohibitive cost of regrinding and recompounding the resin compared to the cost of virgin (unrecycled) resin
- The thermal depolymerization process can safely and efficiently convert PVC into fuel and minerals, according to the company that developed it. It is not yet

5. PVC can also be softened with chem
used for shrink-wrap, food packagi
6. UPVC (Unplasticized PVC) can some
cars window as it is very hard and t
7. Food grade PVC can be used for pac
items.
8. PVC bottles are used for edible oils,
9. PVC jars are used for chocolate drir

10.4. POLYVINYLIDENE CHLORIDE

Polyvinylidene chloride (PVDC) is made
chloride and vinyl chloride.

- Ralph Wiley, a Dow Chemical lab w
chloride in 1933. Dow researchers
film, first called "Eonite" and then "
- The most well known use of polyvin
Wrap, a plastic food wrap was intro
- Saran fiber is manufactured by mel
Saran is pigment dyed before fiber s

10.4.1. Characteristics of PVDC

- PVDC is a clear, heavy, very strong
commonly used for packaging chees

(PET). This coating increases the barrier properties of the film, reducing the permeability of the film to oxygen and flavours and thus extending the shelf life of the food inside the package. So used when high barrier characteristics are required, e.g., gas packaging

2. **Household:** Cleaning cloths, filters, screens, tape, shower curtains, garden furniture
3. **Industry:** Screens, artificial turf, waste-water treatment materials, underground materials and industrial applications

10.4.3. Limitations of PVDC:

- While extremely useful as a food packaging material, the major disadvantage of Saran is that it will undergo thermally induced dehydrochlorination at temperatures very near to processing temperatures
- This degradation easily propagates, leaving polyene sequences long enough to absorb visible light, and change the color of the material from colorless to an undesirable transparent brown (unacceptable as food packaging)
- Therefore, there is a significant amount of product loss in the manufacturing process, which increases production and consumer costs

10.5. ETHYLENE VINYL ACETATE

Ethylene vinyl acetate (EVA) is comprised of low-density polyethylene copolymerized with vinyl acetate.

10.5.1 Characteristics of EVA

2. The major disadvantage of EVOH fi
hygroscopic.

3. When they absorb moisture at high re
acts as a plasticizer and the gas barrier
be overcome by

   a. Increasing the ethylene content of

   b. Laminating it between two films t

   c. Adding a desiccant to the tie layer

4. EVOH is commonly used in laminated
barrier characteristics are desired,
applications.

*****

Lesson-11

Forms of different plastic materials - 3

11.1 INTRODUCTION

In this lesson the topics related to different plastic materials like PET, Polyurethane, Acrylonitrile Butadiene Styrene, Polycarbonate and Ionomers are discussed in detail.

11.2 POLYETHYLENE TEREPHTHALATE (PET)

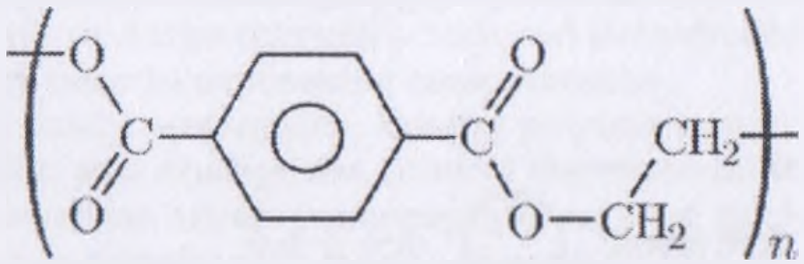


Fig. 11.1: Polyethylene terephthalate

- **Polyethylene terephthalate** (**PET**, **PETE** or the obsolete PETP or PET-P) is a thermoplastic polymer resin of the polyester family
- It is used in synthetic fibers; beverage, food and other liquid containers; thermoforming applications; and engineering resins often in combination with glass fiber. It is one of the most important raw materials used in man-made fibers. Depending on its processing and thermal history, it may exist both as an

11.4.1 Processing:

There are two basic molding methods, one-step

In two-step molding, two separate machines
molds the preform. The preform looks like a
already molded into place, and the body of the t
inflated into its final shape in the second step u

In the second process, the preforms are heate
two-part mold to form them into the final sha
bottles) are now also used as containers for can

In one-step machines, the entire process from
conducted within one machine, making it espec
shapes (custom molding), including jars, flat o
is the reduction in space, product handling an
than can be achieved by the two-step system.

11.4.2 Copolymers:

- In some cases, the modified properties of
  particular application
- Such copolymers are advantageous for ce

11.2.4 Charateristics of PET:

- PET can be semi-rigid to rigid, depending on its thickness.
- It makes a good gas and fair moisture barrier, as well as a good barrier to alcohol and solvents.
- It is strong and impact-resistant.
- It is naturally colorless with high transparency.
- When produced as a thin film (trade name Mylar), PET is often metalized with aluminum to reduce its permeability, and to make it reflective and opaque.
- PET bottles are excellent barrier materials and are widely used for soft drinks.
- PET or Dacron is also used as a thermal insulation layer.
- For certain specialty bottles, PET sandwiches an additional polyvinyl alcohol to further reduce its oxygen permeability.
- When filled with glass particles or fibers, it becomes significantly stiffer and more durable.
- While all thermoplastics are technically recyclable, PET bottle recycling is more practical than many other plastic applications. The primary reason is that plastic carbonated soft drink bottles and water bottles are almost exclusively PET which makes them more easily identifiable in a recycle stream
- PET is also an excellent candidate for thermal recycling (incineration) as it is composed of carbon, hydrogen and oxygen with only trace amounts of catalyst elements (no sulphur) and has the energy content of soft coal.
- PET can withstand temperature upto 150°C and hence it is heat sterilizable and used for boil-in-bags.

11.3 POLYURETHANE

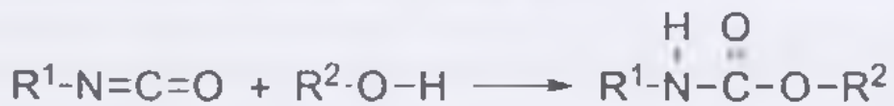


FIGURE 11.2: Generalized polyurethane reaction

In addition, additive such as catalysts, surfact
flame retardants, light stabilizers, and fillers a
reaction.

Polyurethane formulations cover an extremely w
densities. These materials include:

- Low density flexible foam used in upholste
- Low density rigid foam used for thermal in
  dashboards
- Soft solid elastomers used for gel pads and
- Hard solid plastics used as electronic instr

Commercial production of flexible polyurethane fo
diisocyanate (TDI) and polyester polyols. These foa
swiss cheese by the inventors

11.8.1 Health and safety aspects:

- Fully reacted polyurethane polymer is chem
- It is not regulated for carcinogenicity.
- Polyurethane polymer is a combustible soli
  open flame for a sufficient period of time.
- Decomposition products include carbon mo
  hydrogen cyanide.
- Polyurethane polymer dust can cause mech
  lungs.
- Liquid resin blends and isocyanates may co

Table 11.1 Characteristics and Uses of polyurethane materials

Density	Stiffness	Flexible	Semi-Rigid	Rigid
6 kg/m³	**Low Density Foams**	High resiliency foam for bedding & upholstery	Packaging Foam	Insulation Foam
400 kg/m³	**High Density Foams**	Footwear mid soles & Footwear cut soles	Integral skin foam for vehicle interior	Simulated wood
800 kg/m³	**Microcellular Foams & Elastomers**	Fabric coatings and synthetic fibers, Vehicle external parts		Structural Foam
1200 kg/m³	**Solid Elastomers**	Coatings, adhesives, sealants and elastomers		
		Print Rollers	Cast Elastomers	RIM Solid plastics

11.4 ACRYLONITRILE BUTADIENE STYRENE (ABS):

11.4.1 Characteristics of ABS:

1. **Acrylonitrile butadiene styrene,** or **ABS** $(C_8H_8 \cdot C_4H_6 \cdot C_3H_3N)_n$ is a common thermoplastic
2. ABS is derived from acrylonitrile, butadiene, and styrene
3. Acrylonitrile is a synthetic monomer produced from propylene and ammonia; butadiene is a petroleum hydrocarbon obtained from butane and styrene monomers, derived from coal, are commercially obtained from benzene and ethylene from coal
4. ABS polymers are resistant to aqueous acids, alkalis, concentrated hydrochloric

11.4.2 Uses of ABS:

ABS can be used between −25 and 60 °C. It is products such as piping, musical instruments, shock absorbance), automotive body parts, wheel gear and toys.

It is used for manufacture of inside liner of refriger

11.5 POLYCARBONATE

Polycarbonates are a particular group of therm worked, moulded, and thermoformed; as such, th the modern chemical industry. Their interestin impact resistance and optical properties) position and engineering plastics

11.5.1 Moulding / Extrusion techniques

- Injection moulding into ready articles: lighti safety glasses, automotive headlamp lenses, equipment, research animal enclosures, dri cases
- Extrusion into tubes, rods and other profile
- Extrusion into sheets (0.5-15 mm) and films

6. Metallized polyester laminates saves 15-20% in material costs besides saving an extra laminating process as compared with other laminated packaging material.
7. Metallized polyester film is used for packaging WMP, Pan masala, nut powder, fruit drinks, coffee etc.

12.2.2 Coated Cellophane Films:

About 80% of the total film manufactured is coated because plain cellophane is hygroscopic, not moisture proof and not heat sealable.

Nomenclature:

P = Plain uncoated film

T = Transparent

C = Coloured

M = Moisture proof

A = Anchored (Coated more firmly secured to the base film) hence more resistance to water under wet and humid conditions.

D = Darning (one side coated)

L = Low moisture vapour proof ness

easily. It is a barrier against non-boring
and permeable to water vapour but, impe
soluble gases like CO_2. It is used as a
some interchange of moisture with the s
even desired. Used for wrapping bread, s

(h) **MST:** Moisture proof & heat sealable. It
and heat sealability are required. It is us
over wrap for cigarettes, cartons of tea ba

(i) **MSAT:** Anchored grade of MST film us
particularly hygroscopic frozen food.

(j) **MSC:** Moisture proof, heat sealable and
Amber, yellow or orange film is used
rancidity in foods products that have a hi

(k) **LMAT:** Low moisture, heat sealable. Th
products that are sensitive to deteriorat
package. It is used to pack certain bacons

(l) **MSAIDT:** This film has a sealable moistu
The importance of this film is due to i

wrinkling and shrinkage caused by changing humidity conditions.) It is used for packing desiccated coconut, potato chips, dried foods, biscuits and some type of cheese.

(i) **MSAQ:** opaque grade used for light sensitive foods like cheese, butter etc.

(j) **MTTW:** A non heat sealable Nitrocellulose coated type of cellophane used for twist packaging of sweets.

12.3 CO-POLYMER

At the time of polymerization we can polymerize more than one monomer to form polymers. The resultant polymer is called co-polymer. It has modified/superior properties those are not available in homopolymers.

Advantages of co-polymers:

1. No problems of exudation, migration and leaking associated with plasticizers.
2. Controlling co-polymerization and selecting right type basic monomer combination can produce tailor made Plastic materials.

12.3.1 Other Additives

Many plastics contain very small amounts of additives such as plasticizers, antioxidants, lubricants, antistatic agents, heat stabilizers, and UV stabilizers. These

Lamination are used for:

1. Good water vapour barrier properties
2. Good gas barrier properties
3. Good grease resistance
4. Heat sealing facility
5. To provide strength to the base film
6. To improve toughness
7. To improve tear resistance
8. To improve abrasion resistance
9. To improve machinability
10. To improve printability

Lamination of two or more films improves the mechanical strength of a package. Materials th include

- Plastic to plastic,
- Paper to plastic,
- Paper to aluminum foil, and
- Paper to aluminum foil and then to plastic.

Several methods can be used to laminate material

(A) **Adhesive Lamination:** The webs are bon which may be (i) Aqueous, (ii) Lacquer or (to the web which is subsequently brought i through two rollers.

12.4.1 Characteristics of Laminated films:

1. Laminated materials are used when high gas and moisture characteristics are required for a long shelf life.
2. Laminated structures usually consist of an outer protective tougher layer, e.g., nylon or polypropylene, a middle high gas barrier layer, e.g., EVOH or PVDC, and an inner heat sealant layer.
3. LDPE is commonly used as a heat-sealant layer because of its low melting temperature; however, it sometimes does not give a good seal with starchy or greasy food products.
4. The choice of sealant layer for these food products is either EVA or Surlyn.

12.4.2 Laminated packaging material:

A laminated packaging material suitable for use in flexible containers for potato chips, corn chips, and the like, have an excellent moisture resistance and sealing properties. It can comprise:

1. As an outer surface: a transparent sheet of nylon, polyester, cellophane, or polypropylene,
2. A coextruded laminate: A pigmented polyethylene and ethylene acrylic acid copolymer,
3. A metallic foil: Preferably aluminum, and
4. An inner surface: A heat-sealable polyolefin.

12.5 ALUMINUM FOILS:

Foil thicknesses used:

Use
Confectionary wrapping
Cheese wrapping
Strip packaging, milk bottle caps
Semi - rigid containers
Fat Products
Household Foil
Plated food stuff & pie dish contain

19.6 CURRENT TRENDS IN USE OF PACKAGIN

Presentation (graphics and material), cost, consum
use) and effect on environment are the four most i
industry today. They are fulfilled by the following

1. To cut down the **cost**, the preformed container
such as cream and yogurt, curd, shrikhand et

2. fill machines are being replaced by form-fill-se
polystyrene (or polypropylene) containers.

5. High barrier structures/laminate based on polyester / EVOH / polythene and polypropylene / EVOH polythene are being developed for products like yoghurts and milk based desserts.

6. EVOH (Ethylene Vinyl Alcohol) has excellent **gas barrier** properties in dry conditions, and such materials would be particularly suitable for aseptic packaging.

7. EVOH is also more **environment-friendly** than saran, the alternate high barrier material.

8. PVDC however continues to dominate in foods that come in **retorted** pouches. A typical laminate structure for such use might consist of polyester / polypropylene / PVDC / polypropylene.

9. The developments in **laminate** (paper/polyethylene/aluminium/polyethylene) used for milk have been restricted to improvement in print quality, better glass lacquers, more rapid sealing characteristics, using different and thinner polymer films reduce costs mainly by down gauging.

10. Until now, **permeability** in plastic food packaging was provided only by polyvinylidene chlorides (PVDC) and ethylene vinyl alcohol (EVOH) co-polymers. Recently, a third, complementary polymer, metaxylenediamine and adipic acid

13. Depending on ethylene content and humi
cost / performance, followed closely by P

14. EVOH and $NMXD_6$ are very **sensitive to**
a multi layer system of blends, as a sandv

15. PVDC is not moisture sensitive but is diff
an issue, PVDC is, therefore, predominan
and coating.

12.7 COMMON PLASTICS AND THEIR USE

Table 12.1: Common plastics and their us

No.	Plastic	
1	Polypropylene (PP)	Food conta
2	Polystyrene (PS)	Packaging disposable
3	High impact polystyrene (HIPS)	Fridge line buttermilk
4	Acrylonitrile butadiene styrene (ABS)	Electronic printers, k
5	Polyethylene	Carbonate

11	Polyvinylidene chloride (PVDC) (Saran)	Laminates of Food packaging viz. retortable pouches
12	Polyethylene (PE)	Wide range of inexpensive uses including supermarket bags, plastic bottles, milk pouch film and as heat sealing layer in laminates/coated films
13	Polytetrafluoroethylene (PTFE) (trade name Teflon)	Heat-resistant, low-friction coatings, used in things like non-stick surfaces for frying pans, plumber's tape and water slides, Heat sealing per covering.

Table 12.2: Desirable attributes of commonly used flexible materials

No.	Flexible substrate	Primary function	Other characteristics
1	Paper	Stiffness, Printability	Low cost, rigidity, strength, machine performance. Deficient in: clarity, sealability and barrier properties (Parchment, Glassine)
2	Foil	Barrier properties, Strength, Aesthetic appeal	Lacks clarity, poor printability, Difficulty to seal
3	Cellophane	Clarity, printability, stiffness, machinability	Susceptible to moisture, poor tear strength, not heat sealable.

Lesson-13

Foils and Laminates – Characteristics and Importance in Food Industry

13.1 INTRODUCTION

This lesson covers topics related to foils and laminates, composite cans and barrier properties of different packaging materials in detail.

13.2 ALUMINUM FOIL

Aluminum foil is sheet metal of a very thin gauge. It is produced by the cold reduction process through which pure aluminum is pressed to reduce its thickness to less than 0.152 mm and annealed to give folding properties. Aluminum foil is used in the form of cups and trays, laminated foil pouches as alternatives to cans or jars, collapsible aluminum tubes for pastes, and aluminum barrels.

13.2.1 The advantages of foil as a packaging material are:

1. Good appearance
2. Excellent dead-folding properties

To overcome these problems, the foil is often la
increase its strength) and with low-density
resistance to high-acid products and to
Aluminum is also used to metallize flexible films

10.3 COMPOSITE CONTAINERS

- Recently due to development of laminates
similar properties of a metal container wi
containers is decreasing.
- Therefore, cans made from a combinatio
now used in place of metal cans.
- Kraft paper is the main component in th
plastic (low-density polyethylene, polypr
foil for added barrier properties. End clos
paper, or a combination of these materia
- Composite cans are manufactured by a s
spiral cans dominating the market due t
- Composite cans are widely used to packa
dehydrated baby foods, aseptically packa
frozen dough.

10.4 BARRIER PROPERTIES OF PACKAGING

Many materials can be selected for packagi
appropriate packaging material, the following fa

1. Gas barrier properties

- However, the barrier properties to oxygen and moisture may be different and may also vary as a function of the relative humidity and temperature of the storage conditions. E.g. EVOH, a hygroscopic film that is an excellent oxygen barrier at low relative humidity. At higher relative humidity, it absorbs moisture that has a plasticizing effect and reduces the barrier characteristics to oxygen.
- Some films have mixed barrier properties, i.e., low oxygen barrier characteristics and high-moisture vapor barriers. E.g. LDPE, which explains why this film is selected for packaging fresh meat and produce and for frozen stored products to prevent freezer burn.

	Table 13.1		Table 13.2		Table 13.3
No.	**Oxygen Transmission Rate (OTR) of Selected Packaging Materials**		**Moisture Vapor Transmission Rate (MVTR) of Selected Packaging Materials**		**Laminated Packaging Materials**
	Materials	**CC/m²/d[a]**	**Materials**	**CC/mil/m²/d[b]**	
1	**High Barrier Materials**				**High Barrier (Flexible)**
	Glass	0	Glass	0	Nylon/Saran/EVA
	Aluminum	0.1	Aluminum	0	Nylon/Saran/Surlyn
	EVOH (0% RH)	0.2	HDPE	3.8	Nylon/EVOH/Surlyn
	PVDC	2.5	PVDC	4.0	PET/Saran/EVA
			PP	6-10	PET/Saran/Surlyn
			LDPE	18-23	Nylon/Saran/LDPE
			Oriented PET	19	PET/Foil/LDPE
2	**Medium Barrier Materials**				**High Barrier (Semi-rigid)**
	Polystyrene	1500	Polystyrene		Polystyrene/EVOH/Polystyrene
	HDPE	1705	Oriented nylon		Polystyrene/Saran/Polystyrene
	PP	2320	Polycarbonate		Polystyrene/Nylon/Polystyrene
	Polycarbonate	3500	Nonoriented nylon		
	Surlyn	5500			
	LDPE	7500			

[a] Measured @23°C and 0% RH.; [b] Measured @37

1 mil = 25 μ = 0.001 in

Table 13.4: Multilayer films used for dairy pro

No.	Product	Structure
1	Milk	LDPE/LDPE
		LD/LLDPE

		PP/Tie/EVOH/Tie/PP PET/Met PET/PE	Gas and moisture barrier, sealability
5	Yoghurt	HIPS/HIPS, PP	Thermoformable
		HIPS/GPPS	2 colour, gloss, strength, Rigidity
6	Cream	PP/PP	Thermoformable, moisture barrier, strength, Rigidity
7	Butter	PA/TIE/LLDPE or LDPE/PA/TLE/Ionomer or EVA LDPE/TIE/EVOH/ TIE/LDPE(Surlyn)	Good gas, moisture barrier, sealability
		PS/TIE/EVOH/TIE/LDPE(Surlyn)	Thermoformable, good gas and moisture and odour barrier.

***** ☺ *****

Lesson-14

Characteristics of Reto

14.1 INTRODUCTION

Retort is a cooking process that uses heat and package. Retort Pouches conditions are quite den ranging from 120°C to 130°C.

14.2 RETORT POUCH PROCESSING OF FOODS

- Retort processing of foods in rigid, semi-rigi the most acceptable form of food preservatic
- It represents unique combination of packag with potential economic benefits.
- Traditionally, tin containers have contribute confidence in processed foods.
- The increasing public awareness and aversi preservation like chemical preservation, irra scope for retort processing of foods.
- Different retort grade films are **laminated** to toughness, puncture and burst resistance th withstand the strenuous retort process.

14.2.1 Characteristics of Retort Pouches:

- Because Retort pouches have thinner dimensions, it takes less time to cook food in a flexible retort pouch than in other forms of rigid packaging such as cans and jars.This reducd retort time results in foods that have superior taste in retort pouches.
- Retort Pouch packaging has superior barrier and printing qualities and can be supplied as stand-up, flat or in roll form.
- Retort pouches are suitable to pack a variety of food products.
- The laminated material has a high puncture resistance.
- It offers a variety of styles of retort packaging such as foil based or completely transparent.
- Flexible retort pouches offer a variety of additional benefits over rigid packaging to both retailers and consumers that include:

1. Superior taste due to reduced retort time
2. Extended shelf life in **retort pouches**
3. Reduced storage space, both in warehouse and pantries
4. Reduced transportation costs
5. Easier and safer tear-open/disposal consumer experience
6. Microwave convenience

14.2.2 Common Structures used for retort processing:

1. **Retortable pouch and packaging material for the retortable pouch comprises**

- A laminated base film formed by laminating together a polyester film and an inelastic polypropylene film,
- A laminated cover film formed by laminating together a polyester film and an aluminum foil, and

- High temperature sterilization, Excellent s
  colors gravure printing, Lower OTR, WTR a
  laminated layers for better barriers agains
  the major characteristics.

4. **Alu-PET / NY / Retortable CPP:** High Retc
   MVTR) Microwaveable.

- Microwavable pouch is advanced version c
- It is very convenient to use and microwava
  pouch lately.
- Microwavable pouch does not contain alu
  special polyester film.
- It can be used in seafood, stew, meat, cur
- Normally, microwavable pouch is standup
  put pouch in to the microwave and eat rig

11.1 RETORTABLE POUCHES

Lesson-15

Forms of packages used for packaging of food and dairy products

15.1 INTRODUCTION

In this lesson the topics related to different forms of package like foils, containers, jars, blister packs, pouches etc are discussed in detail.

15.2 DEVELOPMENTS IN PACKAGE FORMS:

1. In Paleolithic times, food was consumed where found and when needed, man used natural containers such as hollow tree trunks, gourds, hollow rocks, shells, leaves and pieces of bark.
2. In later times man learned to fashion containers from natural materials. He deliberately hollowed out logs of stones, and animal parts used such as bladders, skins, horns, bones, sinews and hair.
3. Mesolithic man stored food surpluses in baskets made of rushes and grasses.
4. Neolithic man fashioned metal containers and discovered pottery.
5. From prehistoric times until about 1200 AD the status of packaging could be summed up as follows:

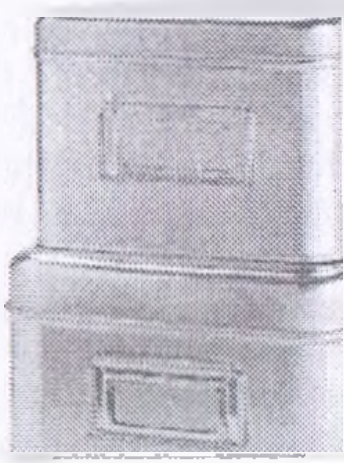
Material	Package Forms & Uses

18.2.1. Common Package Forms:

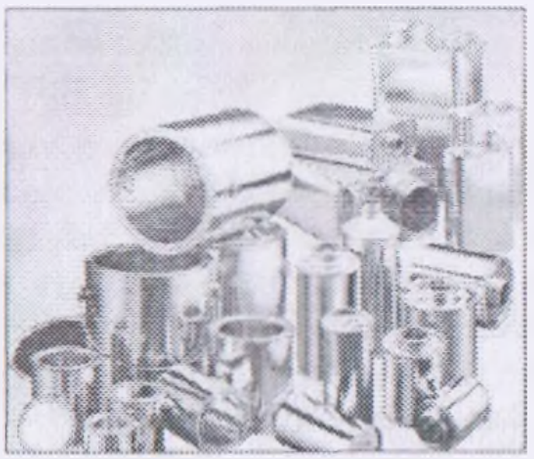
- (A) **Rigid Packages:** They are formed in to
strong materials, so that they retain their
are not deformed unless subjected to suff
damage the total structure. Eg. Metal, gla
- (B) **Semi-rigid Packages:** They are formed
massive or weaker materials, so that altho
distorted substantially when filled with pr
without severely damaging the total struc
force. Eg. Collapsible tubes, Bag-in-box s
- (C) **Flexible Packages:** They are formed t
made from sufficiently flexible materials t
to the product they contain and may be d
supported by the rigidity of the product. E

Some of the important package forms are discus

18.3 METAL BOXES/CANS/TINS:



15.3.1 Metal cans:



1. Traditionally, cans have been made from soldered triplet steel. More recently aluminum can has been introduced. Today there are several more choices available: standard tinplate, light weight double reduced tinplate, tin free steel (coated), vacuum - deposited aluminum on steel and aluminum.
2. Can bodies can be soldered, welded or cemented. Steel bodies can be combined with aluminum ends. Many new easy open devices are available for cans ranging from pop-tabs for beverages to complete removal of lids or panels for frozen or meat products.
3. Can coatings are now regarded as vital components - especially for foods and beverages. Coatings must be non-toxic and free from odour or taste. They must not deteriorate or come loose from the can wall during food processing and storage. Interior coating are made from acrylics, alkyls, butadienes, epoxy amines, epoxy - esters, epoxy - phenolics, oleoresins, phenoics and vinyls depending upon the type of food and process. Outside coatings include acrylics, alkyds, oleoresins, phenolics and vinyls and are usually pigmented. They are less exposed to food contact but must survive processing and be receptive to further decorative coatings and inks.
4. The tinplate is made of thin sheets (0.025mm thick) of mild steel coated on both sides with a layer of pure tin. The steel sheet is made by

apply a thin coating to the sheet. The coat
oven, which causes the lacquer to dry and
then be made into cans exactly as plain s

Types of metal cans used for Dairy Products are:

A	Open Top	D	Valv
B	Vent hole	E	San
C	Drawn		

18.1.2 Tin packaging:

1. It is one of the earliest food packages and
supply of conveniently packaged food ever
preservation was understood.
2. As for the developments in the tin can, th
contamination of canned foods have led to
can by the welded one.
3. Continuous efforts are on to improve and
polyester lacquer, and to reduce tin coatin
4. Tin - free steel (TFS) can, an economic alt
can is also being used extensively.
5. With respect to developments in India, sol
A significant development is the partial re
the indigenous one.
6. For carbonated beverages, aluminum can
thin walls can be used taking advantage o
to obtain structural rigidity and strength.
7. With aluminum becoming costlier now, th

15.5.1 Bottles:

1. Bottles are the most extensively used type of glass container.
2. They may be many different shapes but the neck is always round and much narrower than the body. The neck facilitates pouring and reduces the size of the closures required.
3. Principal uses are for liquids or small sized solids.
4. Until recently, almost all milk was packaged in glass bottles.
5. The increase in supermarket shopping and the decrease in home delivered milk has decreased the usage of glass milk bottles.
6. Glass milk bottles originally were round, tapering to a rather wide mouth with a thick flange. The move to a squared body saved considerable space in the home refrigerator.
7. Glass bottles average about 50 trips and are packed at rates up to 24000 per hour.
8. Brown glass is used sometimes to filter out harmful light (UV light).
9. Bottle closures are formed from aluminum foil, high density polyethylene, polypropylene and paper board.
10. Most closures are applied by automatic machinery at high speeds.

15.5.3 Jars:

10.5.4 Tumblers:

1. These are like jars but they are open-end
2. They have no neck and no 'finish'.
3. They are shaped like a drinking glass and
   jellies.

10.5.5 Jugs:

1. These are large-sized bottles with carryin
2. Necks are usually short and narrow.
3. They are usually used for liquids in large

10.5.6 Carboys:

1. These are very heavy shipping containers
   having 10 liters or more capacity.
2. Typically they have been used with a woo
   protective frames are now finding use.

10.5.7 Vials and Ampoules:

1. These are small glass containers.

2. Molded paper and picnic plates both rectangular and round with and without compartmentation have been made for several decades.
3. Pulp board trays are also used to package meats and produce in supermarkets.
4. Aluminum foil containers are available in many shapes.
5. Convolute and spiral wound canisters made from paper are used extensively, with asphalt providing moisture barrier.
6. Aluminum foil liner is used to provide superior moisture barrier.
7. Foil is also incorporated as an inner liner, thereby marking it possible to package liquids.
8. With the introduction of plastic that could be thermoformed, a wide variety of molded plastic boxes, trays, pans and the like became possible.

15.7 WOODEN AND CARDBOARD BOXES:

1. One of the earliest packaging materials, and one that is still very useful, is wood in its various forms.
2. Although it is used less frequently as other more sophisticated materials are substituted, it has still an important place in industrial packaging for heavy and or fragile items that require rigidity and strength.
3. The different types of packaging made from wood include baskets and hampers, tight and slack barrels, nailed wood boxes and crates, wire bound boxes pallets and skids, and containerization units.
4. They are made from lumber, veneer, or plywood.
5. Veneer is defined as wood that is less than 3/8" thick, regardless of whether it is sawed, sliced, or rotary-cut.

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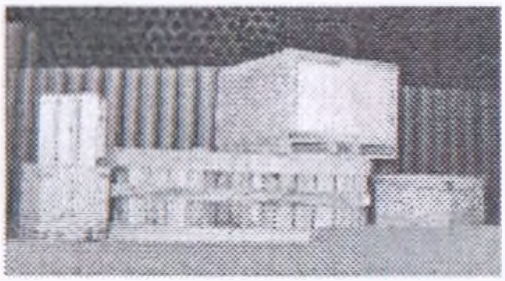
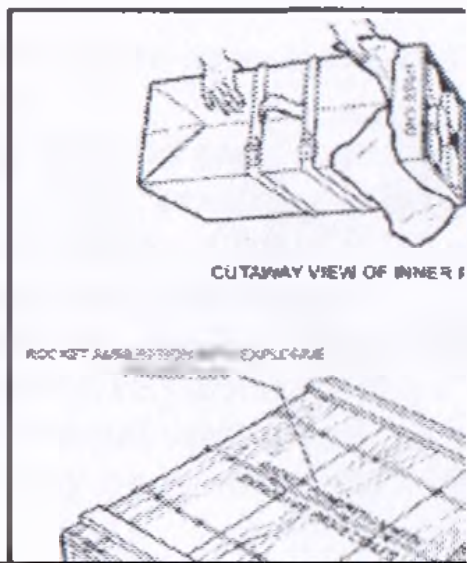
6. But if protection from moisture, rapid ass
attractive appearance is more important,
the best choice.

18.7.2 Nailed Boxes:



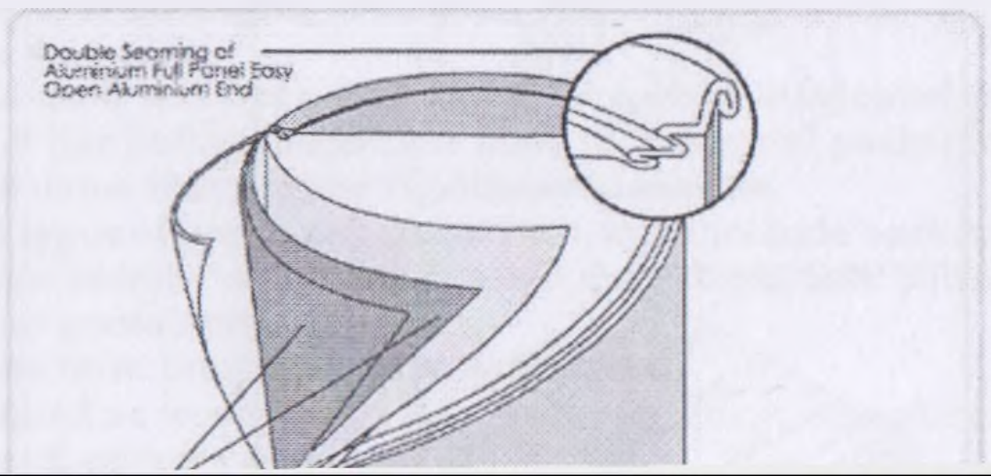
There are various methods of constructing a
type of service required.

18.7.3 Wire bound boxes:



5. **Boxes** are usually solidly walled, rectangular shaped, nailed wooden containers and will very in construction and in extra cleats and braces as may be required by the load. The top, bottom, and sides of a box provide the main structural strength.
6. **Crates** are similar to boxes but may be of lighter weight and more open construction - that is spaces may be left between boards or the crack may be fully enclosed or sheathed.
7. A crate differs from a box in that the frame members carry the load. The sheath merely encloses, hence sheathing may be corrugated fiber board or thin plywood or light weight lumber.
8. Other joining methods may be used for boxes and crates. These include metal fasteners, glues, and wires or wire tapes. When using wires, thinner side, top and bottom sheathing can be utilized as the wires add strength. Cleated ends and stiffeners provide the structured strength required.
9. Advantage of wooden boxes and crates depend on the relative cost, strength, and weight ratios involved.
10. In most food uses today, wooden containers are being phased out and solid or corrugated fiberboard containers are replacing them. Some wood is still used for reinforcing cleats and bottoms.

15.8 COMPOSITE CONTAINERS:

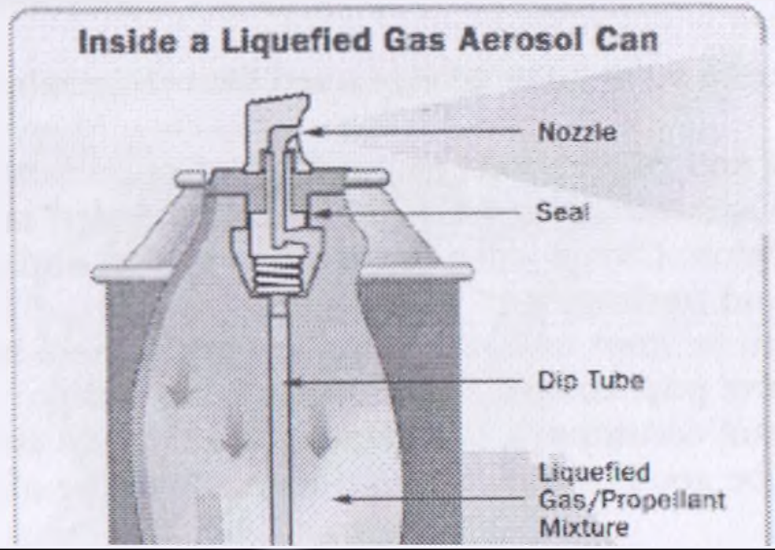


1. Three basic types are available:
    1. **Spiral-wound** containers: They are m
    or more plies of board are glued toget
    2. **Convolute-wound** composites: They
    and is used for squares, oblongs and
    type.
    3. **Lap-wound:** Lap-seam bodies are ma
    blanks and joined at the side with ad
2. The convolute method Spiral winding does r
convolute winding and for larger packages f
shipping and storage is of paramount impor
will outperform spiral winding.
3. Body materials used are chipboard and Kra
4. Linings used are vegetable parchment, wax
and polyethylene coated paper. Other lining
product to be packaged.
5. Composite cans are closed by either a snap-
6. In the non-detachable type of closure, perfo
devices are used as well as double seamed e
7. Specific advantages in using composite cans
economics.
8. In recent years, composite cans have widely
other food products.
9. Combinations of metal and paperboard or p
incorporating films, foils, coatings or adhesi
applications in many fields. Citrus juice can
are examples among food packages.
10. Expensive materials can be kept to a minim
supported by inexpensive paperboard for st
11. In comparison with metal containers, a fabr
insulation, which may be good or bad, depe
contains.

1. A large version of the fibre can is the fibre drum that is used for shipping bulk chemicals and other industrial products.
2. Fibre drums are generally used for dry products, although with suitable plastic liners they can be used for pastes and certain types of liquids.
3. A wide range of sizes is available from stock, with end pieces of metal, wood or fiberboard, and body constructions that include a variety of laminations and coatings.
4. Fiber drums are light in weight and they have exceptional strength in proportion to their weight.
5. Although a fibre drum is essentially a single trip container, it is sometimes reconditioned and used for several trips.

15.10 AEROSOL CONTAINERS:

The aerosol can generally a 3 piece or 2 piece tin plate or aluminum container that has been specially designed to hold a product under high internal pressure and to dispense the product through an aerosol valve.



- The basic components of the package are protective cap.
- The container must be gas-tight and may aluminum cans, glass, plastic, or a comb related to safety (ability to hold pressure compatibility.
- There are several types of aerosols which sprays, dusts or foams depending upon t product/propellant arrangement.
- A Single phase aerosol contains a liquid propellant layer.
- A two phase aerosol contains a liquid pro plus a compressed gas propellant layer.
- A three phase aerosol contains a layer of and a layer of propellant vapor. Removal to boil and replenish the vapour phase.
- Piston aerosols contain a flexible plastic propellant gas.
- Co-dispensing aerosols disperse two prod
- **Use**: Aerosol containers have been used f mixes, cake icings, pan cake mixes, syru whipped cream, pan release spray and ch

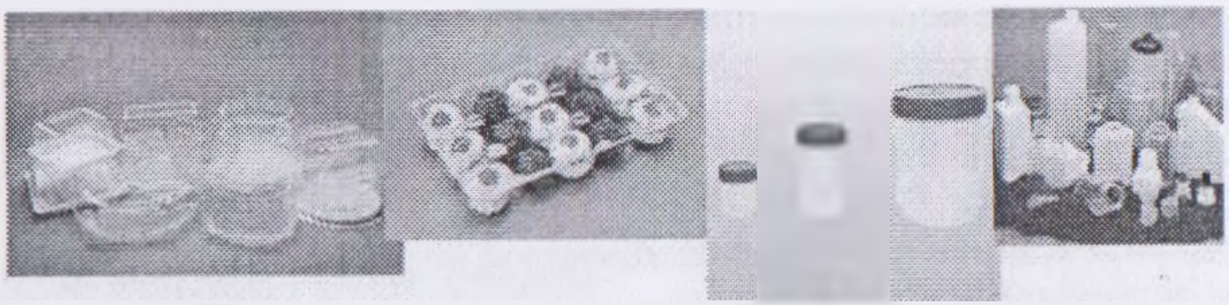
18.10.1 Advantages and disadvantages of aer

- The convenience of dispensing materials is an outstanding feature of this type of p
- The other advantages are premixing, lack even when partly used.

Disadvantages:

15.11 RIGID PLASTIC PACKAGES

A wide variety of rigid plastic can be used in the form of thermoformed, injection molded or blow molded containers.



Rigid Plastic Packages | Thermoformed | Injection Molded | Blow Molded

15.12 BLISTER PACKS

- A colorful graphic design on the blister card a
distance and puts his eyes on the product th

18.13 TRANSPORT / SHIPPING PACKAGES

18.13.1 Master Packages:

- Normally they are outer containers in which
units is placed to give protection against tran
- These master packs also could be unitized in
kgs or loaded into containers of 5, 10 or 20 t
minimum handling of unit packages.
- The unitization either in pallets or containers
since the cost of the master pack will be cons
designed for transport on its own.
- The transport packages could be broadly clas

I	**Rigid**	
	Wooden cases	Plywo
	Wooden crates	Plast
	Wooden barrels	Plast
	Metallic crates	Tin c
	Composite containers	Metal
II	**Collapsible (Rigid when erected) containers**	
	Wooden crates (wire bound)	Plywo
	Hardboard	Corr

- **Solid and corrugated fiberboard materials** are used to fabricate shipping cartons and cases used extensively in wholesale and Industrial shipping.
- They are not usually used as direct containers for foods but are extensively employed as after shippers for food packages i.e. cans and bottles.
- Both are made from heavy fibrous craft paperboards.
- Solid fiberboard is made by gluing several plies of paperboard together. By using asphalt or special resin adhesives, such as urea formaldehyde, enhanced moisture resistance may be built in. Selection of weight, fibrous construction and number of plies is related to the desired burst, tear, puncture and bend resistance.
- Corrugated fiber board is made from similar base materials but is generally thinner, as it is then constructed by combining facing (flat sheet) and liners (corrugated or fluted sheets) by means of adhesives.
- There are four major types of corrugated paperboard:

- Unlined single faced,
- Double faced,
- Double walled, and
- Triple walled.

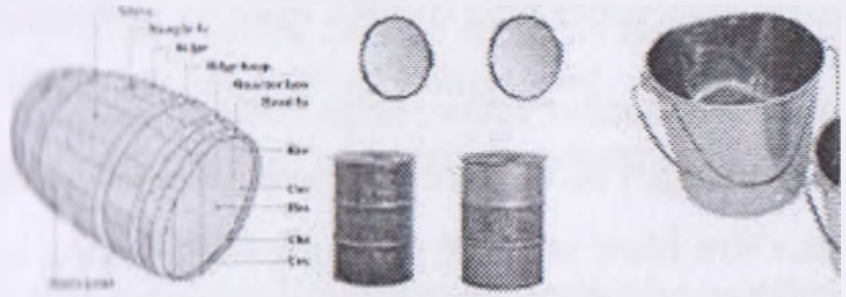
- The first two types are used for wrappings of fragile objects or as interior padding of boxes.
- The latter two types are used where exceptional strength and rigidity are essential.
- Double - faced corrugated is the most commonly used type for boxes liners and partitions.
- Each flute has particular properties with respect to load support in each of the three possible directions.
- In double wall construction different flutes can be combined.
- Corrugated containers are now available with easy open tear strips, self locking assembly and smooth white liners permitting flexographic printing on the exterior. Special reinforcements can be employed. Where strength is less important molded pulp has been used for liner material

Disadvantages:

1. Low wet strength - newer techniques of manufac eliminating this disadvantage.

10.10.3 Cylindrical shipping containers:

1. Cylindrical containers have high stacking streng handling.
2. They may be made from fiberboard, glass, metal
3. A **barrel** is a cylindrical container of greater leng flat ends of equal diameter and bulging at the wa



Barrel **Drum**

4. A **drum** has straight sides and flat or bumped en
5. A **pail** is a cylindrical or tapered (truncated cone without a wire handle or bail.
6. Small pails may be called **cans**.

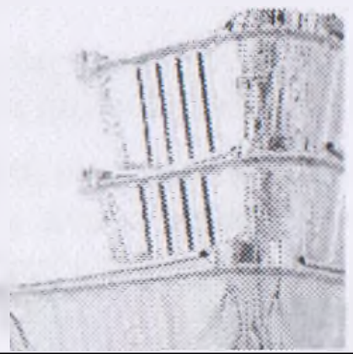
interior facings of special papers, foils, or plastics such as glassine, parchment, aluminium foil, polyethylene, or pliofilm, they may be used successfully for bulk shipment of foods as the linings prevent contamination of the food or weakening of the container. Other barrier components can be built into the side wall at time of lamination. These may be asphalt, foil, or polyethylene to achieve a moisture barrier.

- **Steel drums** are used as single trip or returnable containers. Drum heads may be removable or fixed. Fixed heads may be fastened to the body by brazing, welding or double seaming. Some drums are formed in two halves and joined circumferentially at the waist.
- Drums may be fitted with removable covers which are of the friction lid type or which may be held in place by locking rings or lugs.

- Tight head drums or pails are furnished with small capped or screw plug openings for easy of pouring. Additional vents and drains may be specified.

- Aluminum drums are designed to have similar features to steel drums. Stainless steel drums are used where corrosion resistance or high levels of sanitation are required.
- Latest types of drum constructions are blow molded polyethylene drums as the primary container and a steel shell for added protection and rigidity.

15.14 SEMI - RIGID CONTAINERS



10.10 SET UP PAPERBOARD BOXES

- Four basic components are used to make set u
  board, adhesive, corner stays, and covering.
- Paperboard is selected to give the right weight
  required.
- Blanks of the boxboard are cut and scored, the
  tray, and the corner stays are adhered.
- This is repeated for the cover.
- Finally the covering material is glued on.
- Coverings may be coloured papers, foil laminat
  and printed litho papers.
- Boxes can be made in almost any shape and w
  arrangements - separate or hinged.
- Bend - rigid plastics can be used as lids for bet
  windows can be similarly employed.

10.10.1 Advantages & Disadvantages of Paperboar

- Convenience, individuality, strength, reusabilit
  protection and display are the main advantage
- Equipment required is minimum and low cost.
- Boxes are shipped set up - hence no set up tim
- Small quantities are no more expensive than la
  inventories unnecessary.

Disadvantages of Paperboard Boxes:

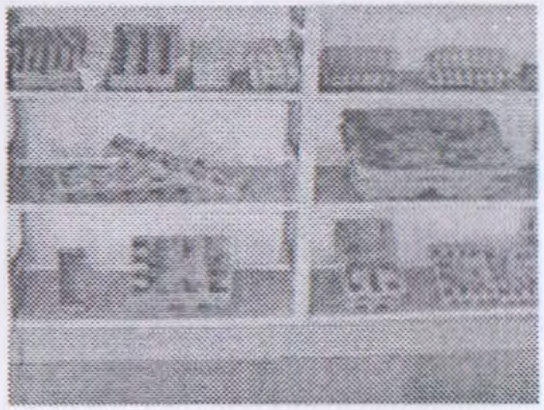
- Generally higher cost in comparison to folding
  quantities.

- There are two common styles of folding cartons and a large number of special constructions.

- **Tube types** are one piece cartons that are bent into a tube (generally square) with a longitudinal glued body seam. End flaps are glued shut, tucked or self-locking.
- **Tray types** may be one or two piece with or without a lid. They are shipped flat and are set up and glued to form the tray and / or lid in the packager's plant. Some tray types are glued by the box manufacturer and folded flat along diagonal score lines. They can be snapped open to set up.

- Carriers for cans or bottles are special types of folding cartons.
- Cartons may be printed, embossed or die cut prior to blanking. Printing may be by letter press, offset lithography or rotogravure.
- Folding cartons are widely used for both solid and liquid foods.
- **Advantages** are low cost, ease of automatic high speed set up, filling and closing, good stack ability, easy opening and reclosure and excellent graphics.

15.17 MOLDED PULP CONTAINERS

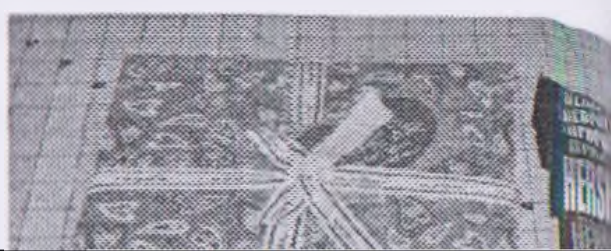


- When a fibrous material is mixed with water and molded, a molded pulp

10.18 FLEXIBLE PACKAGES

- Flexible packages are made from combination of
- These include the basic substrate, laminating ad
  decorative coatings, and decorative inks.
- There are literally millions of possible combina
- By selecting appropriate components and tailor
  possible to meet the packaging needs of a partic

10.19 WRAPPERS



- The simplest wrappers are sheets of paper, metal foil or plastic film with or without decoration.
- Many films can be heat sealed but paper and foil require coatings in order to make them heat sealable.
- Early types of paper wrappers were glued shut.
- The earliest types of heat - seal coating were waxes.
- Many advances have been made in wax formulations and hot melt so that today some wrappers can be sealed with pressure alone (cold tack adhesives).
- The advent of plastic resin coatings such as the vinyls, nitrocelluloses, sarans and polyolefins made it possible not only to add heat seal properties but also to substantially improve strength and barrier properties of laminates of paper and plastics.
- Metal foil is in itself an excellent barrier. Coating and other substrates serve only to add strength, decoration and heat sealability.
- A wrapper that comes in direct contact with a food such as candy or a loaf of bread is called an **intimate wrap** whereas if it wraps an inner package such as a carton it is called an **overwrap**.
- Wraps may be purchased as roll stock or as precut sheets. The latter are usually used for hand or semi automatic production.
- Other variations of wrappers include **labels** which wrap only part of a rigid package and serve primarily to identify the contents. Some completely wrapped around labels on paper containers contribute barrier protection also.
- Another variation of a wrapper is a **bundling overwrap** which combines several smaller packages into one larger unit. Plastic film **shrink wraps** serve this function. The ultimate is extremely large pallet overwraps where a plastic film stabilizes an entire pallet load of smaller packages.
- There are at least 13 distinct types of twists and folds by which wrapper may be closed neatly before sealing. Over wrapping machinery has been developed for each type of wrap and fold and for specific products.

15.20 PREFORMED BAGS OR ENVELOPES

- Multiwall sacks are either 'sewn' across the construction.
- The side seams in either case are glued.
- If only one of the ends is closed, the contair
- In other cases both ends are closed except f which may have an extended 'sleeve' that is on the check valve action of an internal slee sleeve in a pasted bag will give the least am

15.20.2 Bags:

- Plastic bags and paper bags require comple both for manufacturing and for sealing.
- Plastic bags may be made from plastic tubi and joined in 'back-seam' construction.
- Either of these can be 'flat' or they can be 'g -sealed to complete the closure.
- In some cases a web of film is folded and he
- The folded edge forms the bottom and can b gusset is desired.
- The top edge usually has a lip for easy open advantage of a side seam bag over the other

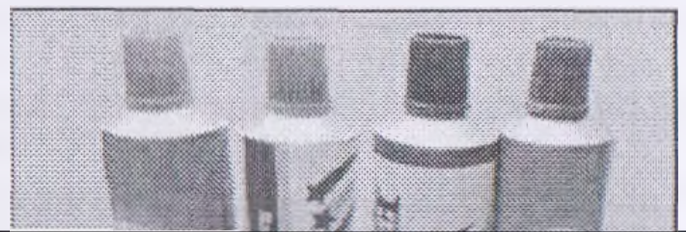
15.20.2.1 Advantages & Disadvantages of Bags:

1. The paper bag is lowest in unit cost,
2. It keep shipping costs to a minimum since t ratio.
3. They are essentially dust - tight and protect contaminations.
4. They can be tailored to fit snugly around the

15.21 RETORTABLE POUCHES

- A typical laminate for retortable pouch is 0.0005 polyester / 0.00035 foil / 0.003 polypropylene, with the outer ply designated first as is customary for pouch material.
- Filled pouches are sterilized at 115-121^{0}C, with overriding air pressure of ~ 2 kg/cm^2 to prevent bursting.
- Pouch material that will not delaminate at these temperatures must be selected, and the seals should withstand a tensile test of 0.08 kg/m of width, internal pressure of 1 kg/cm^2 for 30 s, pinhole strength of 0.6 kg and a drop test of 1.22 m.

15.22 MULTILAYER COLLAPSIBLE TUBES (MLCT)



- The entire tube is formed by impact extrusio
  is trimmed, threaded and annealed.
- Exteriors are decorated by roller coating and
- Interiors may be lined by dipping, flushing o
  coatings.
- Linings may be waxes or vinlys, phenolic or
- Product is filled through the open bottom wh
- In use, the closure is removed, the interior s
  product is dispensed through the nozzle by s
- Tubes are marketed on cards, in blister pack
- Blow-molded **plastic tubes** are now being us
  disadvantage is lack of dead - fold. They tend
  making total dispensing of the product diffic
- Tubes are best for packaging thick liquids or
- It is used for packaging of process cheese sp
  ketch-ups.

*****  **

Lesson-16

Safety requirements of packaging materials and product information

16.1 INTRODUCTION

Most of the packaging related regulatory initiatives are concerned to the Product quality, Public Health and Hygiene, Safety, Export Promotion, Transportation and Consumer protection.

Packaging needs to communicate clearly all the mandatory information about the product to the consumer. Wrong information given on the package could mislead the consumer. Moreover, the packaging must communicate the way to handle the package or the product. This helps in protecting the consumers from accidents that could occur while opening the pack or during disposal, as in the case of glass bottles.

The international markets are governed by various packaging rules and regulations that make it mandatory for an exporting country to abide by them. Therefore, packaging for exports should comply with global norms to match with international standards. Government of India has instituted various laws and regulations. All these

16.2 NEGATIVE EFFECTS OF PLASTICS AS PA

16.2.1 Negative health effects:

Following plastics have been associated with nega

PVC (polyvinyl chloride) contains numerous to
Phthalates ("plasticizers"), which are used to sof
form.

The World Health Organization's International Ag
has recognized the chemical used to make PVC,
carcinogen.

- Plasticizers used to make soft PVC for toys
  children chewing on the toys. In 2006, the
  phthalate softeners, including DEHP (diethy
  alternative plasticizer, DINP (diisononyl pht
- PVC plastic has been used safely for more t
  and commercial applications and humans.
  effects have been reported from intravenous
  with PVC
- **Vinyl chloride monomer:** The carcinogeni
  humans who were exposed to very high VCl
  have been linked. Vinyl chloride is a known
  rare cancer of the liver
- **Dioxins:** The dioxin is produced as a bypro
  and from incineration of waste PVC in dom

into food and liquid and acts like estrogen. Research in Environmental Health Perspectives finds that BPA (leached from the lining of tin cans, dental sealants and polycarbonate bottles) can increase body weight of lab animals' offspring, as well as impact hormone levels. A more recent animal study suggests that even low-level exposure to BPA results in insulin resistance, which can lead to inflammation and heart disease.

16.2.2 Negative effects on environment

1. Plastics are durable and degrade very slowly.
2. In some cases, burning plastic can release toxic fumes.
3. The manufacturing of plastics often creates large quantities of chemical pollutants.
4. Thermoplastics can be remelted and reused, and thermoset plastics can be ground up and used as filler, though the purity of the material tends to degrade with each reuse cycle.
5. To assist recycling of disposable items, the Plastic Bottle Institute of the Society of the Plastics Industry devised a now-familiar scheme to mark plastic bottles by plastic type. A recyclable plastic container using this scheme is marked with a triangle of three "chasing arrows", which encloses a number giving the plastic type i.e. Resin identification code.
6. Unfortunately, recycling plastics has proven difficult. The biggest problem with plastic recycling is that it is difficult to automate the sorting of plastic waste, and so it is labor intensive.

Recycling certain types of plastics can be unprofitable, as well, e.g. polystyrene is rarely recycled because it is usually not cost effective. These unrecyclable wastes can

food/pharmaceutical are absorbed into plastic ar
product leads to spoilage.

In case of PE bottles, the milk fat gets into pla
rancidity of the product and therefore such bott
packaging material reacts with each other. Hun
consumption of such product which increases th
blood. Therefore, for food grade plastics, two type

1. **Global migration:** Includes all substances
   sum of all mobile packaging component
   toxic/non-toxic, even substances physiol
   also.

2. **Specific migration:** Includes one or two
   only. For these reasons Toxicological subs
   used.

Overall migration units are fixed at 10 mg/cr
material or articles in the following cases as per E

- Containers or articles which are similar to
  be filled to a capacity of less than 250 ml p
  surface area of contact with the food stuff

packaging, Bombay) have built up infrastructural facilities to assess the compatibility of plastics and also to estimate the migration.

16.3.1 Residual toxic compounds likely to be transferred to food through plastics:

1. **Monomers and oligomers**: Polymers have very high molecular weight and hence not assimilated by the body. Monomers being small may be assimilated by the body and therefore may pose health problems.

2. **Polymerization residues**: There may be presence of catalysts, solvents, emulsifiers and wetting agents having low molecular weight. During film container manufacturing a variety of processing aids are added which are

    a. **Antioxidants:** To prevent fading of colour and prevent cracking, viz. BHA/BHT etc.

    b. **Antiblock agents**: To avoid blocking of film i.e. when it is drawn rolled the film surfaces should not adhere to each other.

    c. **Antistatic agents**: They are important in packaging industries, when two materials/surfaces are in contact, the electrons on the surface atoms intermingle and may move from one material to another.

d. **Plasticizers**: At lower processing ter
of polymer and modify processing c
these functions by acting as lubr
plastic to slide over one another free
the resin. Plasticizers tend to ooze
and they may migrate from one plas
they are in contact). They may als
product. Even some plastic becomes
use of plasticizers is in PVC – PV
therefore PVC has poor resistance t
oil products.

c. **Lubricants**: Internal lubricants suc
friction between plastic molecules, a
acid reduce friction with processing

f. **Slip agents** like Silicon components h

Many additives used, may migrate to food. Ther
with list of safe components.

However, in case of recycled materials, it is almost
the prescribed unit, hence should never be used fo

DEHA- BIS-2-Ethyl Hexyl Adipate BBP: Butyl Phenyl Methyl or Butyl Benzyl Phthalate

DEHP: Bis-2- Ethyl Myxyl or Di-Ethyl Hexyl Phthalate

16.3.3 Factors involved in migration:

1. Composition and properties of packaging materials
2. Composition and properties of food stuffs
3. Surface (plastic) to volume (food) ratio
4. Temperature conditions
5. Duration of contact
6. Influence of light

16.4 (43-A). RESTRICTION ON ADVERTISEMENT-

There shall be no advertisement of any food which is misleading or contravening the provisions of Prevention of Food Adulteration Act, 1954 (37 of 1954) or the rules made thereunder.

Explanation: The term 'Advertisement' means any visible representation or announcement made by means of any light, sound, smoke gas, print, electronic media, internet or website"

Test procedures that are applicable for general classes of materials or packages are available and published in standardized form. The institutions

6	FEFCO	Federation Europeanne des Methods
7	PIFA	Packaging and Industrial Film
8	ABA	American Box Board Associati
9	BPBMA	British Paper and Board Manu
10	NFPA	National Flexible Packaging As
11	PFMA	Packaging Film Manufacturers
12	FPA	Flexible Packaging Association
13		Federation of Corrugated Box

(K) LIST OF APPROVED INDIAN STANDARD RECOGNITION SCHEME

A. PAPER & PAPER BOARD		
SR.NO.	STANDARD	DETAILS
1	1397	Kraft Paper Specification Re
2	1848	Writing and Printing Specifi
3	6956	Cover paper specification Y
B. STEEL / METAL		

		1992 Reaffirmed 2003
2	6312	Polyethylene Containers for the Transport of Material - specification Year 1994 Reaffirmed 1999
3	8069	High Density Polyethylene (HDPE) Woven Sacks for Packing Pesticides - Specification (Second Revision) Year 1989 Part (1 & 2) Reaffirmed 1997
4	2508	Low Density Polyethylene Specification Year 1984 Reprint Dec 1996
D. PLASTIC FEEDING BOTTLE		
1	14625	Plastic Feeding Bottle Year 1999 Reaffirmed 2004
E. PACKAGED MINERAL WATER		
1	15410	Containers for packaging of Natural Mineral Water and Packaged Drinking Water Specification Year 2003
2	15609	Specification for polyethylene Flexible pouches for the packaging of Natural Mineral Water and Packaged Drinking Water Reprint August 2005
F. JUTE FABRIC		
1	1943	Textile - A - Twill Jute Bags Year 1995 Reprint 1999
2	2566	Textile - B - Twill Jute Sacking Bags for packing Food Grains
3	7407	Specifications for Jute Tarpaulin Fabric Year 1980 1st Reprint September 1996

Lesson-1

Pasteurized

17.1 INTRODUCTION

The appropriate packaging of milk is of utmo
nutritive value and saving of wastage, but also
better returns. The challenge to the packagin
milk to the consumer in most economical, hygi
package.

There are two main types of packaging systems
system in which container is to be returned a
container is disposable and does not travel ba
distribution system there are several alternati
materials, shapes, sizes, forms and machines a

For selection of a suitable package mat
characteristics of milk/ milk products is essenti

17.5.2 Returnable Plastic Bottles:

Plastic bottles reduce the weight and the chances of breakage are rare but most other characteristics of packaging milk in glass bottles remain same.

17.5.3 Non-Returnable Plastic Bottles:

This system reduces transport charges through light weight and one way of delivery of bottles in a convenient way in comparison to any other system.

Ex: HDPE with PP lid, car buoy.

17.5.3.1 Plastic Films:

Plastic pouches are generally made of low-density polyethylene (LDPE) film. Co-extruded LDPE-LLDPE film is also used because of its advantage of eliminating pin-hole problems. The films are of 45-75μ thick. The pouches are formed and filled on form-fill-seal (FFS) machines in capacities of 200, 500ml and 1000 ml. The film should confirm to IS: 11805 – 1999. The plastic pouches are clean, hygienic and safe for this application and since these are not reused, the cleaning operation is eliminated and energy loss is avoided. Moreover, these pouches are easily recyclable for other purpose.

17.5.3.1.1: Developments in milk packaging in plastic pouches: The milk pouch

17.3.1.2 Aseptic Packaging of Milk:

Aseptic or long-life milk was originally introduc
originally called the "Tetra-pack" system. It utili
filling environment heater. Aluminium foil is an in
order to provide a barrier against light and gas. I
to 75– 85°C then rapidly raised to 135 °C for fra
cooled by flashing into a vacuum chamber. It mus
conditions. No refrigeration is necessary for at
refrigeration a self life of up to 1 year is possible.

In the distribution system, the pouches are pl
crates. The crates are made of HDPE or PP and pa
plastic crates shall confirm to specifications laid d

Lesson-18

UHT-Sterilized milk

18.1 INTRODUCTION

High heat treatment of milk is not enough to give long shelf life of UHT milks if packaging is not proper. So packaging plays an important role in UHT products.

UHT milks, like pasteurized and sterilized milks, can be packed in plastic bottles and pouches. The bottles may be blow-moulded at the point of packing, or pre-moulded on either unsterilized or sterilized form. Because of the shelf-life requirements of UHT milks, multiple laminates, for example a triple layer of high density polyethylene are used. An intermediate light barrier may be incorporated, according to the manufacturer's preference. Oxygen penetration during storage is not usually a problem. Whatever the source of bottles, aseptic techniques are used in filling and sealing to prevent contamination, and milk can be expected to have a shelf-life of 6 months at ambient temperatures.

For short shelf-life (10-15 days) products, pouches are usually made of white polyethylene and paper.

18.1.1 Cans

The lids are applied and seamed in a chamber k
flue gas.

18.1.2 Paper Board Cartons:

This kind of packaging materials are common
milk, cream, fruit juices, soups etc. The filling s
two types: those in which the carton is formed
of material; and those in which the cartons are
flat, which are assembled into cartons in the fi
composed of printed-

paper coated with aluminium foil and several pl
polyethylene-aluminium foil polyethylene). The
package is coated with a special layer facilitatin
specific function:

1.Pol
2. Pa
3. Pol

18.2 FLAVOURED MILK:

Flavoured milk drinks are generally skimmed or partly-skimmed and contain less than 1.5% fat. The package should be leak and tamper proof, should have sufficient wet strength and should not pass on any odour or taint to the product packed inside. The plastic based material used for sachets is octane LLDPE (O-LLDPE). OLLDPE when blended with 50% LDPE provides excellent puncture resistance, excellent seal strength. Co-extended multiple layers low-density films with an outer opaque film and an inner black film for reducing the transmission of light are also used.

In India, flavoured milk drinks are available in sterilizable crown cork glass bottles, glass bottles with aluminium foil lid or snap-on plastic lid, plastic sachets and aseptic packs (Tetra bricks). Recently 200ml, translucent bottles of HDPE with an aluminium foil cap have also been introduced. Poly carbonate bottles with the leak proof screw cap are also used in place of glass bottles as these are unbreakable and are much lower in weight (1/6th the weight of glass bottle). PET containers are in use as they are light in weight, have good sales appeal and are strong.

Lesson-1

Aseptic packa

9.1 INTRODUCTION

Aseptic packaging is a packaging concept wh
conditions.The history of aseptic packaging go
patent was filed for a process, termed as asep
prior to 1913 by J. Nielson-following Orla Jense
another major advancement in aseptic packagi
plant was commercialised in the market by D
210 °C for sterilization. The most significa
development of a commercially viable packagi
system, following the development of UHT proc
today the most widely used aseptic processing c

The production of a commercially sterile pro
requires a means of packing which will ensure
attainment of expected shelf-life. Such a requi

1. Low water-vapour transmission rate.
2. Low gas transmission rates, especially to oxygen. This is important to preserve the colour, flavour and nutritional constituents in the products.
3. Good physical or mechanical strength, sufficient to resist any physical damage during manufacture, handling and distribution.
4. Good sealing characteristics to prevent entrance of external contaminants.
5. Capability to fit into automatic fabricating and filling equipment.
6. Resistance to withstand the temperatures encountered during filling of the product as well as during storage and distribution.
7. Chemically resistant to the product packed and ability to withstand sterilisation packing material with gas, liquid radiation.
8. Resistance to microbes, insects and other types of biological hazards.
9. Compatibility with the milk packed. The constituents and additives etc. of the package material should be inert with low migration levels in accordance with the appropriate codes of practice and standards of the country.
10. Economical in cost in comparison to the packaged product and readily available in the market.

19.2 PACKAGING MATERIALS USED IN ASEPTIC PACKAGING

1. 1st generation material: Paper board/plastic /foil/plastic laminates.
2. 2nd generation: plastic containers.

19.2.1 Properties sought in laminate for aseptic packaging

No.	Properties	Example of suitable material
1	Tear resistance	PVC, PVDC/PVC, PE, PP
2	Stiffness	Paper, PS
3	Puncture resistance	Ionomer, PET
4	Printability	Paper, Al-foil, PS, PE, PET
5	Folding	Al-foil, paper
6	[illegible]	LDPE/LDPE

Between the polyethylene layers is a paper lay
printability and the aluminium foil layer serves

The general principle of a common aseptic
formed from a roll of packaging material wh
containing a 35% solution of hydrogen perox
material then passes through rollers and a cu
the solution and also serves to increase the rat
a continuous tube sealed along the longitudin
formed by a transverse seal. Milk from asepti
under aseptic conditions maintained by a heat
transverse seal which also forms the base of th
the transverse seal separates the cartons.

The complete carton forming, filling and seali
room, sterilized prior to use. This Aseptic packa
and supplied with a positive pressure sterilized

Figure 19.1 shows the principle of aseptically
Pre-formed cartons may be used for UHT milk,
pre-sterilized, for example with ethylene oxide g
of H_2O_2 and sterile air at around 180°C, just pri

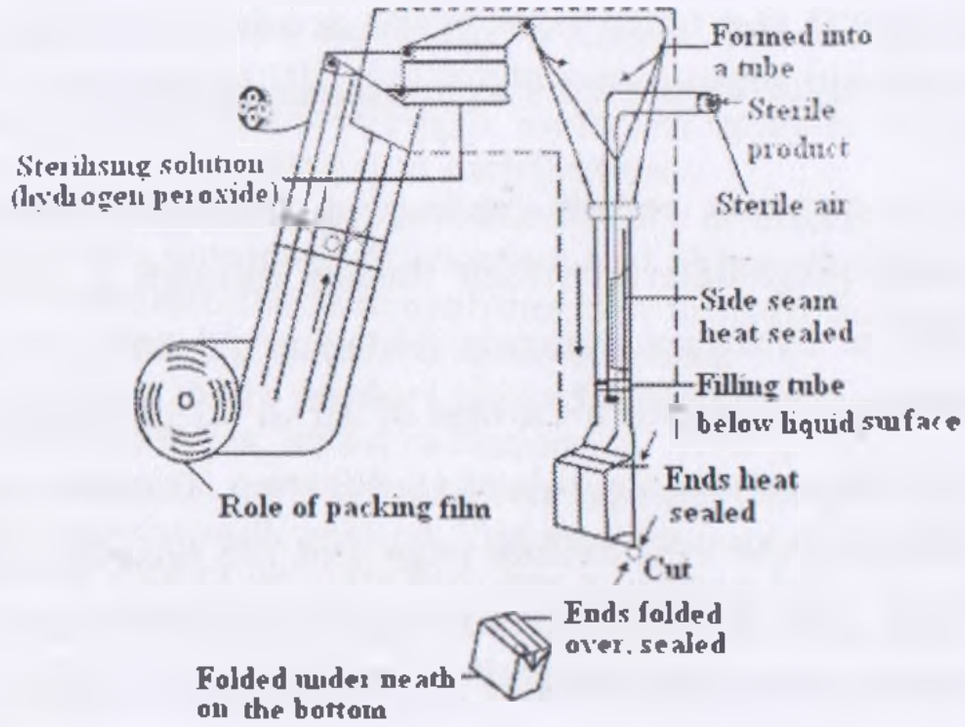


Fig. 19.1 Aseptic Packaging of UHT Milk

There are various packaging forms in which the UHT milk is packed.

19.2.2 Tetra pack cartons: Tetra Pak group of Sweden had launched various types of cartons and 'Tetra Hedron' cartons were the first type introduced in fifties, which required the development of heavy weight paper board/aluminium/polyethylene and have proved to be quite successful for UHT milk packaging. The Tetra Pak Company had gradually replaced these Tetra Hedron cartons with Tetra Brick cartons as the former posed problems of collating and stacking and short shelf life

protection. PE extruded or wax coated paperboard tubs are used to pack single portion cream. Sterilized/ UHT cream is packed in similar lines to that of UHT milk.

20.3 BUTTER

It consists primarily' of about 80% milk fat, 15% moisture and in table butter upto 3% common salt. Because of high moisture content butter is susceptible to mould growth and lypolytic rancidity

20.3.1 Characteristics of Butter

1. Due to high moisture content butter unlike solid fats is susceptible to mold growth.
2. Flavour and odour are easily absorbed by butter from its environment.
3. Deterioration of the butter may take place due to rancidity.
4. Butter has tendency to lose Moisture.

20.3.2 Requirement of Packaging

1. Non toxic, not harmful to consumer's health.
2. It should be grease/moisture proof.
3. Shall be barrier for Oxygen.
4. Low metallic content as metals favour oxidation of fat.
5. Shall not transmit light.

20.3.3 Packaging Material Used: In India, butter is packed in bulk as well as in retail packages. For bulk packaging there is no standard method, and generally polyethylene

proof paper, aluminium foil, and paper board ca protection to the product are more commonly used.

Indian Standard 7161 - 1973 gives specifications Grease Proof paper/ Aluminium foil laminate fo parchment paper has good wet strength, generally aluminium foil above 0.009 mm thickness are used foreign odour, care must be exercised while choosin in the manufacture of the laminates.

There is also another IS: 8113-1976 standard for pr g, 200 g and 250 g. butter slabs. Cartons pro packaging in primary Wrapper, in the distribution sy refrigerator, cartons may be waxed with about 10 g not mandatory. Paperboard can be extrusion coate and tubs of PP can also be used for packaging of the

High-impact polystyrene or HIPS is also used in variety of other polymers, like PE, PP, PET, PVDC an

Large packs of 10, 20 and 50 kg butter are packed or parchment paper lined corrugated boxes. For bet efficient use of storage space and economy Fibre boa

Wet strength: 0.8 ± 0.2 kg/cm²

Grease resistance: Should pass the turpentine oil test

Acidity: 0.02% as H_2SO_4

pH of H_2O extract: not less than 5.0

Brightness: 79.

20.4 GHEE

It is usually 100 per cent fat with little moisture (< 0.3 %), obtained by boiling butter at 110°C till all water is evaporated with a grainy texture and a characteristic flavour.

The product needs to be protected from chemical spoilage and rancidity caused by oxygen, light, heat, moisture and metal ions.

20.4.1 Characteristics of Ghee:

1. Easy to absorb flavour from its environment
2. Easily prone for oxidation
3. Prone for adulteration.

20.4.2 Packaging Material Should Have

IS: 11352-1985 specifications for flexible packs
vanaspati have been recommended for this purpose

For long – term storage, stainless steel containers
is also marketed in lined cartons with flexible
materials and in tetrapaks. In both these packs lo
pouches of metallised polyester based films are als
are filled on automatic FFS machines. However, if
with the product, sealing of the pouch becomes diffi

Recently it is packed in certain laminates and
comprises of a pre-sealed bag made of polyethyle
with a spout and cap housed in a CFB / Duplex b
plies which is sealed together on all four sides and t
sealed onto it. The bag is vacuum filled and inser
layer Nylon containing self standing pouch with c
HDPE / LDPE is used for packing ghee.

Another form is consisting of a multi-ply collapsi
housed in a rigid outer container. The container can
capacity varies between 3 and 200 liters. The bags a

Nylon/ Styrene-based laminates, EVOH and

Lesson-21

Coagulated and Desiccated Indigenous Dairy Products and their Sweetmeats

21.1 INTRODUCTION

Traditionally, Indian dairy products have been manufactured by individual sweet makers-"halwais" and small entrepreneurs. Very little attention is paid to sanitary handling and packaging of these products.

Traditionally, indigenous products have been packed in leaves, paper cartons or paper-board boxes. These materials do not provide sufficient protection to the product from atmospheric contamination and manual handling. Consequently, the sweets soon lose their typical body and texture, absorb foreign odours, lose their aroma characteristics and show mold growth. Moreover, the products are stored in open metal trays.

21.2 PACKAGING OF COAGULATED INDIGENOUS AND FERMENTED DAIRY PRODUCTS

Cultured milk products have various textures and viscosities, i.e. when liquid they are considered as beverages (Butter milk) and when semisolid they are spoonable

of unlacqurered aluminium lids. A polystyrene
It is economical, practical and widely used. Y
polystyrene foam tubs. Each tray holds 20 tul
serve not only as display holders and light
fermentation of yoghurt. This saves extra handl

21.2.2 Packaging of fermented milks (Bu
sachets, polystyrene cups, polypropylene cups
used. Recently buttermilk, lassi and sour crea
HIPS for stored products must never be emp
cracking of the material.

21.2.2.1 Packaging of dahi/lassi: The traditi
pot with a loose cover of glassine or greaseproo
heavy, easily breakable and because of oozing
inside develops shrinkage cracks. Recently,
Polypropylene/ HIPS cups have been introduce
lids. These cups are available in capacities of 20
shelf-life of about 10 days under refrigeration.
easy to handle and are hygienic. Some private
pouches of 200ml capacity.

LDPE made by injection moulding are also in use. PP or PE bags, Glassine paper lined containers are also used.

21.2.3 Packaging of cheese: Packaging requirements for natural cheese: Any material to be used for packaging natural cheese must give general protection, prevent moisture loss, improve appearance, protect against micro organisms and prevent oxygen transmission.

Cheese is essentially a product with high fat and moisture content. Therefore, package used for cheese should prevent oxidation and mould growth. It should also have fat and grease resistance and be able to protect against micro organisms. Oxygen is eliminated by packing cheese in hermetically sealed containers in vacuum or inert gas atmosphere. Processed cheese is usually packed in aluminium foil in cubes with different shapes. Tinplate cans are used for 200 gms and above quantity. PVDC coated plastic films are suitable for cheese packaging as they provide good oxygen and moisture barrier properties.

Cream cheese is packed in foil lined card board boxes of heat stable plastic packs. Saran is used as wrapping material for Neufchatel cheese. Air evacuation and gas flushing is used for cottage cheese, green cheese is packed by waxing and paraffining or alternatively vacuum packed in polyethylene or chyovac. Ripened cheese is packed in laminated cellophane film or pliofilm. Cheese consumer packs are generally consists of Lacquered metal cans of laminated consisting of Nylon / PVDC / Copolymer or

21.2.4.1Package forms: Most bulk ice cream sulphate board carton, coated with wax or polye moisture and oxygen. Once the carton is opene board tends to wrap. Although economic consid paper board carton, improved packaging often price differential may be offset by higher through

1. Aluminium foil cartons
2. Cylindrical containers
3. Plastic containers.

21.2.5 Packaging of chhana: Chhana requi microbial contamination, moisture loss, odour grease resistance. Therefore the package should for heat sealing.

21.2.5.1 Packaging materials used for packing

- Vegetable parchment: chhana can keep we refrigerated storage.
- Vegetable paper parchment treated with N quality of chhana.
- Wax/plastic coated paper: 55-60 gsm / 0.
- Poster paper/Al-foil/LDPE - 150 gauze
- MST Cellulose (300)/LDPE – 150 gauze
- Poster paper/Al-foil (0.02 mm)/LDPE

life. Paneer is also packed in EVA/EVA/PVDC/EVA film under vacuum which may have a shelf life of 3 months under refrigeration

21.2.7 Rasogolla: Tin cans with resistant lacquer + SO_2 (100 ppm maximum) are generally used which gives highest shelf life to the product. Earthen pots which may be lined with leaves are also used in some areas of the country. HIPS or PP cups are also used along with heat sealable caps. Retailers use HIPS / polypropylene cups with press on lids.

21.3 PACKAGING OF DESICCATED INDIGENOUS DAIRY PRODUCTS

21.3.1 Packaging of khoa: Under existing trade practice, producers and traders do not employ any packaging for khoa. By employing proper packaging the shelf life of khoa can be enhanced. Hot packaging of khoa in pre-sterilized cans can improve the shelf life up to 14 days at room temperature and 75 days under refrigerated temperatures. Three times increase in shelf life was claimed by packing khoa in rigid polypropylene containers with lid and khoa packed in pre-sterilized laminate pouches (paper, Polyethylene and aluminium foil). Vacuum packaging and packing in Cryovac Shrink wrap pouches will prevent growth of aerobic micro organisms. However, these two packaging methods do not offer protection against bacteria growing inside khoa. Bulk packaging of khoa is done in PP buckets.

21.3.2 Packaging of peda: Peda is generally packed in paper board containers lined

21.3.4 Packaging of burfi: Burfi is packed in pap
parchment paper in sizes of 500 gm, 1 kgs and 2 k

Materials used are:

- LDPE, MSAT, HDPE, MSAT+HDPE,
- Glassine
- PE lamination: Saran/Cellophane/Saran/P

The shelf life of burfi is about 10-15 days at room

21.3.5 Packaging of Sandesh: Traditional st
pouches. The packaging material used is similar
board cartons. 079, 0.08, 0.008 cm with Parch
Nylon-6 and Tin cans 0.041 cm are used.

Tin cans, Nylon-6 and recent material CXA 148/
PS/ HDPE/ Nylon-6, Tin. Earthen Pots are also us

Leaves of Banana, etc. heat pressed to give shape
our country.

21.3.6 Packaging of Kulfi: Traditional Kulfi is pa
which are partially thawed by dipping in fresh
serving. Kulfi is frozen as a cylindrical block, whi

nal container properties through storage,

rketability of the product.
pproved for use in contact with foods.

LS

groscopic in nature and even slightest
e the shelf life considerably. Hence, the
ards water vapour and such property is
roducts. When retention of low moisture
of the product, the tests required to be
ination of

duct
which the product becomes

nding atmosphere at which the
ned in the product. Initial level to the
om this data along with requirement for
ublished data for different packaging
s selected.

cohesion increases very fast.

3. **O_2 Sensitivity**: Preheating releases the -SH groups which protect against oxidization. However still there are chances of oxidation. Therefore for Fat containing products prevent the gas diffusion by employing either Vacuum or N_2 flushing.

4. **Light sensitivity**: Powder exposed to light for long period bleaches the surface and thereafter it accelerate Fat oxidization.

5. **Heat sensitivity**: Affect Flavour and Solubility. Ideal storage conditions are 18-19°C temperature and dry atmosphere.

6. **Bulk Density** is very important because Packaging size is affected. The Free flowing properties improves with increased Bulk Density.

7. **Odour pick up**: Product containing Fat is prone to pick up odour. High Fat powders pick up odour from packaging materials, surrounding atmosphere, stores, water and houses. The off flavour problem is encountered from kraft paper, PE film, CFB, fiber board cases and even from rubber sealing compositions.

8. **Static electricity**: The problem is difficult to resolve. The plastic packaging materials are also important where antistatic agents are added e.g. Glycol alkyl esters (prevent electrical charge accumulated on the film surface).

9. **Bacterial aspects**: Powders of normal moisture and RH do not give rise to bacterial problem.

22.4 REQUIREMENTS OF PACKAGE FOR DRIED MILKS

1. **Adequate mechanical strength** to withstand damage during packaging, handling, transportation and storage is necessary.
2. **Resistance to climatic hazards**: The material should be resistant to damage by exposure to high / low temperature and humid atmosphere. This is more important in tropical countries.
3. **Convenient closure:** Sealing is of supreme importance. Simple, effective re-closure is also desirable.
4. Bulk packages should be **light in weight, easy to handle and stack** during transport and storage. Empty packages should occupy minimum storage space before use.
5. **Very low Water vapour and gas permeability:** Dried milk absorbs moisture very easily. Powder with > 5 % moisture gets deteriorated during storage. The stale and gluey flavours result from Maillard reaction. It results in losses of solubility, colour change; lumping and free flowing properties are affected. For long storage, vacuum and N_2 flushing is essential especially in hot climate. An impervious container is needed which should also be odour-proof.
6. Impermeability to light: To avoid surface bleaching and fat oxidation.
7. Inertness, durable, safe, utilizing minimum space, identification of product and directions for use, easy availability at reasonable cost are the other requirements.

12.4.2 Flexibles for powder:

1. Cartons lined with Al-foil-PE:

   a. Bag-in-box: Coated Al-PE bag or pl

   b. Modified Atmosphere Packaging -8
      is reduced to 3.0%.

2. Long storage: Lacquer/print/print pre-lac
   paper (40 gsm)/PE (30 gsm).

3. Shorter Keeping quality: Al-foil may be om
   gum and coated with PVDC (30 gsm).

4. Bulk Packaging: Sacks made of craft pap
   Al, Cellophane, bitumen, wax or paraffin.
   Most common types:

- WMP: Laminates of paper, PE, Foil, Metal
- SMP: HDPE or LDPE or Laminates of HD,
  PE coating or wrinkling- Bag-in-box pape
  Metallized/PE

5. Powder packaging materials:

8. **Static electricity**: The problem is difficult to resolve. The plastic packaging materials are also important where antistatic agents are added e.g. Glycol and esters (prevent electrical charge accumulated on the film surface).

9. **Bacterial aspects**: Powders of normal moisture and RH do not give rise to bacterial problem.

22.4 REQUIREMENTS OF PACKAGE FOR DRIED MILKS

1. **Adequate mechanical strength** to withstand damage during packaging, handling, transportation and storage is necessary.
2. **Resistance to climatic hazards**: The material should be resistant to damage by exposure to high / low temperature and humid atmosphere. This is more important in tropical countries.
3. **Convenient closure:** Sealing is of supreme importance. Simple, effective re-closure is also desirable.
4. Bulk packages should be **light in weight, easy to handle and stack** during transport and storage. Empty packages should occupy minimum storage space before use.
5. **Very low Water vapour and gas permeability:** Dried milk absorbs moisture very easily. Powder with > 5 % moisture gets deteriorated during storage. The stale and gluey flavours result from Maillard reaction. It results in losses of solubility, colour change; lumping and free flowing properties are affected. For long storage, vacuum and N_2 flushing is essential especially in hot climate. An impervious container is needed which should also be odour-proof.
6. Impermeability to light: To avoid surface bleaching and fat oxidation.
7. Inertness, durable, safe, utilizing minimum space, identification of product and directions for use, easy availability at reasonable cost are the other

Finishes for powder:

with Al-foil-PE:

Coated Al-PE bag or

Modified Atmosphere Packaging

is reduced to 3.0%.

Lacquer/print/print pre-la

(30 gsm).

quality: Al-foil may be o

with PVDC (30 gsm).

Sacks made of craft pa

bitumen, wax or paraffi

types:

Laminates of paper, PE, Foil, Met

or LDPE or Laminates of H

or wrinkling- Bag-in-box pa

/PE

materials:

- Form – Fill – Seal: 17 μ PET / 9 μ PE – 9 μ foil – 70 μ PE
- Metallized film is also used. Lined cardboard – Adhesive / Coating of PVDC or RHC – Metallized PET / Al-foil / PE.
- Metal/Plastic laminate – Retain O_2 content of 0.5 % even after 13 numbers. Bulk: Heavy gauge PE used mainly for sea voyage (passing through tropics).

3. PE is used to much lesser extent as a separate bag within or as a liner for (a) Card board cartons, (b) Calico bags, (c) Jute bags with paper, (d) Liner between jute and PE.

4. Alternative material to PE:

- Multi walled paper sack may incorporate one layer of waxed paper which is more satisfactory than paper alone but is inadequate for long storage.
- Multi wall sack may include a layer of bituminized paper, often the outer layer with 4-5 inner kraft layers. This is a good packaging material used even for export but is slightly inferior to PE.

5. Perfect closure is required:

- Metal is completely impervious but closure is a weak point.
- Sack is sealed by sewing threads which makes holes and therefore it is covered by H_2O proof tape.
- Gas packaging by mixture of N_2 + H_2 + Palladium as a catalyst and if kept impervious can have up to 10 years of storage life.

22.5 WHOLE MILK POWDER AND BABY FOOD

Generally packed in Lacquered tins under N₂ gas packaging. With [illegible]

22.7 MALTED MILK FOOD

The malted food beverage industry is popula
Historically, malted beverage has a strong a
beverages market is divided into white and
contribute about 65% of the market.

Malted milk foods are highly sensitive to moi
in the presence of light, heat and oxygen
prevention of moisture and oxygen ingress ar
in protecting the product, and in selection of

Malted milk foods are packed in quantities c
packages. The types of packages used
containers, which are now slowly being rep
laminated pouches. Though glass containe
advantage of a long shelf-life, it has the disad
Tinplate containers though provide good prot
to rust at body welding or at top and bot
expensive.

The plastic containers used are blow mould
moulded PET containers / jars, for brown

2. 500 grams

    a. 12µ PET/20µ metallised BOPP/50µ LDPE

    b. 12µ PET/12µ metallised PET/50µ LDPE

3. 1000 grams

    a. 12µ PET/12µ metallised PET/65µ LDPE

22.8 PRECAUTIONS BEFORE PACKAGING

Protection against moisture pick up: The low moisture products must be packaged as soon as possible after removal from the dehydrator. Each product has its individual need with regard to moisture uptake.

22.8.1 In-package desiccation: In-package desiccation has been used successfully for many dried products, particularly powders. The desiccant compound is placed in the container inside a small envelop made out of a moisture permeable material which does not allow the contamination of the product with desiccant, Calcium oxide or silica gel are usually used for this purpose. When in package desiccant is used, the dried product can be stored at higher moisture content without caking than in the absence of a desiccant. However, this is not used for milk powders.

22.8.2 Anticaking agents: Anticaking agents are mixed with the low moisture

as less space remains in the head space. The t
around 16° C. the tins and lids should be steri
U.V radiation before use.
Aluminium cans filled with condensed milk wi
sanitary conditions should be observed during

Evaporated milk is packed in cans before s

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Lesson-23

Vacuum and Modified Atmosphere Packaging (MAP)

23.1 INTRODUCTION

Modified Atmosphere packaging (MAP) is a technique that is being used to extend the shelf life of fresh foods such as meat, fish and cut fruit, as well as of various bakery products, snack foods and other dried foods. In this method of packaging air in a package is replaced with a gas composition that will retard microbial growth and slow down chemical deterioration of the food.

Modified atmosphere packaging (MAP) is defined as 'the packaging of a perishable product in an atmosphere which has been modified so that its composition is other than that of air.

MAP is the alteration of the gaseous environment produced as a result of respiration (passive MAP) or by the addition and removal of gases from food packages (active MAP) to manipulate the levels of O_2 and CO_2.

23.2 HISTORICAL DEVELOPMENT

The three main gases used in MAP are O
dependent upon the food product being pa
gases are commonly used to balance exter
properties of the food. Experimental use of
(SO_2) has also been reported. The exact
entirely on the type of food being packaged

Modified atmosphere packaging is general
extend the shelf life of fresh, perishable foo
can reduce respiration, delay ripening, de
softening, slow down compositional ch
resulting in extension of shelf life. C
recommended for fruits and vegetables for

Gaseous atmosphere is modified by

1. Direct injection of gases (often CO_2 o
2. Evacuating air from the package and

Modified atmosphere packages have an a
that atmosphere can change over time. In
affected by the transmission rates of the
temperatures. Higher temperatures lead to
levels in the package atmosphere and

- Polyvinyl chloride (PVC)
- Polyvinylidene chloride (PVDC)

Selection of these plastic packaging materials are based on the following attributes

1. Food contact approval
2. Gas and vapour barrier properties
3. Optical properties
4. Antifogging properties
5. Mechanical properties
6. Heat sealing properties

23.2.1 Advantages of MAP

1. Fresh appearance
2. Potential shelf life increase by 50-400%
3. Product can be distributed to long distances
4. High quality product
5. User friendly

23.2.2 Disadvantages of MAP

1. Added cost
2. Temperature control is necessary during storage.
3. Special equipment is required

23.3 DAIRY PRODUCTS PACKED BY MAP

MAP has the potential to increase the shelf life of a number of dairy products like fat-filled milk powders, fat spreads and cheeses

of spoilage organisms including *Pseudomo* showed significant extension of the shelf containing CO_2:N_2 in the proportion of 40: cheese significantly.

23.4 VACUUM PACKAGING

An alternative to controlling or modifying the all of the gas in the package is removed. Thi chemical changes such as development of o taken to prevent the growth of the patho unaerobic conditions. A specific pasteu *psychrotrophic botulinum* process, is applie numbers to commercially acceptable levels. storage, greatly extended shelf-lives have be *vide* cooking, which originated in France as meals for restaurant use with up to 42 day thermal process has evolved since the origina °C for 40min, and the target process is no packaging materials is a key requirement to a

Table 23.1 Shelf life of vacuum packaged food

Lesson-24

Eco Friendly Packaging

24.1 INTRODUCTION

Packaging is an essential component in the complex distribution system. The main aim of packaging is to safeguard the food material from microbial attack and other contaminants and prevent damage during the distribution. There is huge demand for the packaging material, which will be causing huge environmental concerns as they are majorly plastics which will degrade very slowly. In order to overcome this problem "**Biodegradable Packaging**" has emerged.

24.2 DEFINITION OF BIO-PACKAGING MATERIALS

"Biobased food packaging materials are materials derived from renewable sources. These materials can be used for food applications". The renewable sources are from plants, marine life and animals.

24.3 DEGRADABLE PLASTIC

Plastic designed to undergo significant change in its chemical structure under specific environmental conditions, resulting in loss of some properties that may be

known compostable materials and leaves residues.

24.6 POLYMERS DIRECTLY EXTRACTED

These are the material, which find their animals and plants. They are having ve materials are hydrophilic, by nature and ar problems to certain extent, mainly in the Pa

24.6.1 Polysaccharides: The polysacchar point of view are cellulose, starch, gu polysaccharides produced by fungi and bact hyaluronic acid are of greater interest in the

24.6.2 Starch and its Derivatives: The Potatoes. The starch is a very competitive n As a packaging material, starch alone does properties unless it is first treated by e materials, genetic or chemical modification o

24.6.3 Cellulose and its derivatives: Ce polymer on the earth. Because of its regular

24.7.2 Nitrocellulose, wax or PVC or PVDC (Poly Vinylidene chloride)

Cellulose acetate (C.A), is the most commonly used Packaging material in food industry.

24.7.2.1 Uses of packaging material in foods

- Baked Goods.
- Processed Meat.
- Cheese and its products.
- Candies.

24.7.3 Chitin: Chitin is chemically composed of repeating units of 1,4-linked deoxy-2-acetoamido-D-glucose, and chitosan refers to a family of partially N-acetylated 2-deoxy-2-amino-.-glucan polymers derived from chitin. It is the second most abundant polysaccharide material available after cellulose.

24.7.4 Chitosan: Chitosan also readily forms films and, in general, produces materials with very high gas barrier properties. It is widely used for the production of edible coating. The cationic properties of chitosan offer good opportunities to take advantage of electron interactions with numerous compounds during processing and incorporating specific properties into the material. The advantages of this material include antimicrobial property and their ability to absorb the heavy metals. The application of laminates made of chitosan, cellulose, and polycaprolactone in Modified

the major drawback of these protein polymer

II. I. a Animal Origin:

II. I. a. i Casein: Casein is a milk-derived p
random coil structure. Upon processing with
III. [illegible], materials can be made with mech
brittle to flexible and tough performance. Ca
films suitable for film blowing. In general, c
Casein materials do not dissolve directly in w
relatively high price. Casein was used as a th
and [illegible].

II. I. a. ii Whey: Whey proteins are by-produc
relatively high nutritional value, are availab
been extensively investigated as edible coati
processable and have some potential as exte
modification strategies can be developed to re

II. I. a. i Collagen: Collagen is a fibrous
particularly skin, bones and tendons. Collage
of its complex helical and fibrous structure,
process. Collagen is the basic raw material

24.7.7 Plant Origin:

24.7.7.1 Gluten: Gluten is the main storage protein in wheat and corn. Gluten plastics exhibit high gloss (polypropylene like) and show good resistance to water under certain conditions. They do not dissolve in water, but they do absorb water during immersion. Due to its abundance and low price, research on the use of gluten in edible films, adhesives, or for thermoplastic applications is currently being carried out.

24.7.7.2 Soy Protein: Soy proteins are commercially available as soy flour, soy concentrate and soy isolate, all differing in protein content. Soy protein consists of two major protein fractions referred to as the 7S (conglycinin, 35%) and 11S (glycinin, 52%) fraction. Both 7S and 11S contain cysteine residues leading to disulphide bridge formation and processing is, therefore, similar to gluten with similar mechanical properties. The best results are obtained with soy isolate (approx.90% protein). This behaviour in water is similar to that of gluten plastics. The most successful applications of soy proteins are paper coatings.

24.7.7.3 Potato: Potato starch produces a more translucent plastic. The potato starch plastic display significantly greater water absorption than those made from other sources.

24.7.7.4 Zein: Zein comprises a group of alcohol soluble proteins (prolamines) found

materials. However, a wide range of other bi
the conventional packaging materials derived
be produced from renewable monomers gainec

24.8.1 Polylactic Acid (PLA): Lactic acid, th
easily be produced by fermentation of carl
feedstock may be agricultural products such
consist of waste products from agriculture o
whey, green juice, etc.

PLA is polyester with a high potential for pack
PLA material are highly related to the ratio bet
lactic acid monomer. Using 100% L-PLA result
point and high crystallinity. If a mixture of D-
isomer, an amorphous polymer is obtained wi
which will be too low for some packaging purp
material which can be polymerized in the m
processable showing very high potential of
packaging. Furthermore, PLA may be plasticiz
oligomeric lactic acid and the presence of plasti

24.9 POLYMERS PRODUCED DIRECTLY

have a much lower melting point and Tg than their PHBS. The major application of medium chain length PHAS are biodegradable cheese coatings and biodegradable rubbers.

24.9.1 PHAS from bacteria:

The major packaging compounds of the bacteria are "Bacterial Cellulose". Strains of *Acetobacter xylinum, Acetobacter pasteurianus* are capable of producing cellulose (*homo a 1-4 glucane*). The cellulose thus produced from bacteria is processed at ambient conditions where the degree of *polymerization is* 15000, crystalline in nature. This technique is not that successful on the economic terms as its production cost is very high.

24.10 BIO PACKAGING OF FOODS

Most commonly used food packages clearly fall into primary, secondary or tertiary packaging categories. For a variety of food products, however, conventional packaging does not provide optimal conditions for product storage and a number of approaches are used to design packages for specific products. Such product-specific packaging includes applying of edible films and coatings, active packaging, modified atmosphere packaging (MAP), and using combinations of packaging materials. Of these packaging techniques specified above bio films or *edible films* are of importance.

films and coatings may provide barriers towar
(CO2), aromas, lipids, etc., carry food ingredie
flavour components).Edible films and coatir
components in multi-component foods thereb

They may be used to reduce the amount of pr
in a product or allow conversion from a r
material to a single component material. Edi
quality by preventing moisture and aroma t
primary packaging.

Biobased packaging materials must meet t
packaging materials associated with foods. T
gases, light, aroma, optical properties, stre
marking and printing properties, migration r
resistance, disposal requirements, antistatic
and cheap.

Biobased packaging materials must also com
and interactions between the food and packa
quality or safety.

11.11 APPLICATION OF BIODEGRADABLE

24.12 RECENT TECHNOLOGIES FOR PRODUCING BIODEGRADABLE PLASTICS

Bio – degradable plastics are being produced from plants by Fermentation, Recombinant DNA engineering etc.

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Lesso

Active Pa

25.1 INTRODUCTION

Active packaging refers to the incorporation
within packaging containers with the aim o
life (Day, 1989). Packaging may be termed a
food preservation other than providing an in
1995; Hotchkiss, 1994).

Active packaging includes additives or *fi*
scavenging oxygen; adsorbing carbon
flavour/odour taints; releasing ethanol,
preservatives; and/or maintaining temperat

Packaging material itself plays an active ro
holding the growth of spoilage microorganis
"smart", "functional", and "freshness prese
substances can be incorporated into t
functionality and give it an extra function

25.2 ACTIVE PACKAGING SYSTEMS

There are many varieties of active packaging techniques that are being followed. A list of techniques followed is being enlisted in the table 25.1 and are discussed in this chapter.

Table 25.1 Selected examples of active packaging systems

Active packaging system	Mechanisms	Food applications
Oxygen Scavengers	1. Iron based 2. Metal/acid 3. Metal (e.g. platinum) catalyst 4. Ascorbate/Metallic salts 5. Enzyme based	Bread, Cakes, Cooked rice, Biscuits, Pizza, Pasta, Cheese, Coffee, Snack foods, Dried foods and Beverages
Carbon Dioxide Scavengers/Emitters	1. Iron oxide/calcium hydroxide 2. Ferrous carbonate/metal halide 3. Calcium oxide/activated charcoal 4. Ascorbate/sodium bicarbonate	Coffee, Nuts and other Snack food products and Sponge cakes
Ethylene Scavengers	1. Potassium permanganate	Fruit, Vegetables and Other horticultural

	2. Encapsulated ethar
Moisture Absorbers	1. PVA blanket 2. Activated clays and 3. Silica gel
Flavour/Odour Adsorbers	1. Cellulose triacetate 2. Acetylated paper 3. Citric acid 4. Ferrous salt/ascorb 5. Activated carbon/ c
Temperature Control Packaging	1. Non-woven plastics 2. Double walled cont 3. Hydrofluorocarbon 4. LIME/water 5. Ammonium nitrate

25.2.1 Oxygen scavengers: Oxygen scaven by the Mitsubishi Gas Chemical Co. Ltd scavengers are the most commercially i

3. Light activated oxygen scavenger plastic packaging materials for Beverage industry

25.2.2 Carbon dioxide scavengers/emitters: There are many commercial sachet and label devices which can be used to scavenge or to emit carbon dioxide.

The use of carbon dioxide scavengers is particularly used in packing fresh roasted or ground coffees that produce significant volumes of carbon dioxide. A mixture of calcium oxide and activated charcoal has been used in polyethylene coffee pouches to scavenge carbon dioxide. Dual-action oxygen and carbon dioxide scavenger sachets and labels are more common and are commercially used for canned and foil pouched coffees in Japan and USA.

Carbon dioxide emitting sachet and label devices can either be used alone or combined with an oxygen scavenger.

Dual action oxygen scavenger/carbon dioxide emitter sachets and labels are also developed, which absorb oxygen and generate an equal volume of carbon dioxide.

The main food applications for these dual-action oxygen scavenger/carbon dioxide emitter sachets and labels have been with snack food products, e.g. nuts and sponge cakes.

25.2.3 Ethylene scavengers: Ethylene (C_2H_4) is a plant growth regulator which

25.2.4 Ethanol emitters: Ethanol is an ant
against mould but can also inhibit the growth
sprayed directly onto food products just prio
method of generating ethanol is through the us
All of these films and sachets contain absorbe
material which allows the controlled release of e

25.2.5 Preservative releasers: There is a
antioxidant packaging films which have preser
life of a wide range of food products. Some
materials have been introduced, primarily in J
synthetic silver zeolite which is in contact w
antimicrobial silver ions into the surface of food

The anti microbial agents generally used on pac
e.g. propionate, benzoate and sorbate, bacterio
e.g. from rosemary, cloves, horse radish, musta
peroxidase, lysozyme and glucose oxidase, c
acids, e.g. sulphur dioxide and chlorine dioxi
and benomyl. The major potential food appli
bread, cheese, fruits and vegetables.

Moisture drip absorber pads are commonly placed under packaged fresh meats, fish and poultry to absorb unsightly tissue drip exudate. Larger sheets and blankets are used for absorption of melted ice from chilled seafood during air freight transportation, or for controlling transpiration of horticultural produce.

Microporous sachets of desiccant inorganic salts such as sodium chloride have been used for the distribution of tomatoes in USA. Another example is an innovative fibreboard box which functions as a humidity buffer on its own without relying on a desiccant insert which is used for fruits or vegetables

25.2.7 Flavour/odour adsorbers: The interaction of packaging with food flavours and aromas has long been recognised. Commercially, very few active packaging techniques have been used to selectively remove undesirable flavours and taints, but many potential opportunities exist.

Debittering of pasteurised orange juices by using cellulose triacetate or acetylated paper into orange juice packaging material. is one of the example for such methods.

BMH™ powder can be incorporated into packaging Removal of aldehydes such as hexanal and heptanal from package headspaces has its applications in foods such as snack foods, cereals, dairy products, poultry and fish.

Another packaging material which is paper-based, which absorbs odorous aldehydes

25.2.9 Quality indicators: Time / temp
package which monitors the product ten
chain. They will indicate how long the fo
temperature. They provide a non reversi
accurate and easy to interpret.

Uses: 1. Time / temperature indicators
temperature ranges and may be used to
products.

2. To monitor the temperature exposure
transportation and storage.

*****

Lesson-26

Different Methods of Package Sterilization, Importance of such methods and Principles

26.1 INTRODUCTION

Sterilization of packaging material is a very important operation to free the surface from microorganisms before filling the product.

26.2 CHARACTERISTICS OF GOOD STERILANT /STERILIZING AGENT

1. Rapid sporicidal activity
2. Ease of application and compatibility with packaging machinery.
3. Compatibility with packaging material
4. Ease of removal of residues
5. No detrimental effects of residues on the package/ product
6. Should be economical
7. Easy to Handle.

26.3 METHODS OF PACKAGE STERILIZATION

Many methods are presently in use. They are briefly discussed here in this chapter.

26.3.1 Dry Heat: The packaging material is heated in a hot air oven for a specified minimum temperature for a stated time. Various combinations of temperature and time are recommended depending on the type of the material being sterilized; for example, the usual recommended minimum holding times and temperatures are 180

packaging material is not metal and it
containers. The rolls are continuously fe
forms, fills, and seals the package. Steriliz
hydrogen peroxide and heat.

A second system is similar to the one jus
the heat is applied to the package surfac
for sterilization by means of a heated stai
applied to the product contact surface. T
drum. Contact with the drum heats the pe

A third system also uses packaging mat
continuously fed into the machine whi
Sterilization is accomplished with a combi
packaging material travels through a bath
material for forming. Cups are then form
travels through a hydrogen peroxide bath.

A fourth system utilizes preformed cups t
The cups are fed into the machine where
peroxide followed by heating. The lid mat
bath of hydrogen peroxide

oxide. The method can be carried out at low temperatures and damages relatively few materials. It is however difficult to control and use of ethylene oxide. Compared to other methods of sterilization, the bactericidal efficiency of ethylene oxide is low.

26.3.6 Sterilization by chemicals:

26.3.6.1Per-acetic acid: Per-acetic acid is a liquid sterilant which is effective against spores of aerobic and anaerobic bacteria and is effective at low temperatures than hydrogen Peroxide. But it is toxic. Hence this is used in pre-sterilization of packaging materials.

26.3.6.2 Ethyl alcohol: At 80% concentration, ethyl alcohol is effective in sterilization of packaging materials. However, it is ineffective against spores. Hence it is not generally used.

26.3.7Sterilization by irradiation: Sterilization may be effected by exposure to high energy electrons from a particle accelerator or to gamma radiation from sources such as cobalt^{60} or caesium^{137} employing energies below 10 Mev. In irradiation sterilization, radiations of energies well below 10 Mev are usually employed and hence no radioactivity is induced in the material so sterilized.

Advantages:

- Irradiation sterilization is a single process.
- Irradiation sterilization is a clean process – No residual chemicals

UV rays are produced by mercury dischar
transmission of UV rays with minimum
inexpensive. UV radiation is harmful to man
to UV rays must be avoided.

26.3.7.2 Irradiation with gamma rays: Ga
form of ionizing radiation sterilization and in
industry standard for high-energy sterilizati
good sterilization results. Gamma irradiatio
from a ^{60}Co source. Because of the excellent
range of packaging materials may be gamm
multiple resins. Pre-packaged articles may
materials such as cellophane, polyethylene,
rays. Gamma rays have five times the pe
radiation. Gamma radiation sterilization u
source with a dosage of generally 2.5 megara
used, and maximum temperatures usually a

26.3.7.3 Electron beam (E-beam): Electron
high-energy electrons. Sterilization is quick
known about the e-beam sterilization effects
stability of thermoplastics compared with ga
irradiation for the sterilization of medical dis
range. Doses for packaging where the contai

Lesson-27

Different Methods of Coding and Standards of Labeling of food packages

27.1 INTRODUCTION

Most of the packaging related regulatory initiatives are concerned to the Product quality, Public Health and Hygiene, Safety, Export Promotion, Transportation and Consumer protection.

The international markets are governed by various packaging rules and regulations that make it mandatory for an exporting country to abide by them. Therefore, packaging for exports should comply with global norms to match with international standards. Government of India has instituted various laws and regulations. All these legislations are classified into two types i.e. Compulsory and Voluntary Standards.

To ensure product quality and provide safety to the consumer, it is important to regulate manufacturing, distribution, marketing and retailing of packaged products. This can be achieved by mandating rules and regulations. Food laws in India have been enforced in the country since, 1899. The Food Safety and Standards Act, 2006

shall be packed for sale, distribution or del specified in that schedule.

Declaration to be made on every package:

1. The name and address of the manufactu
2. The common generic names of the comm
3. The net quantity in terms of standard un commodity
4. The month and year in which the commc
5. The retail sale price of the package
6. Such other matter as are specified in the

Maximum permissible errors on net quantity de

(1) The maximum permissible error, in excess weight or volume of any commodity shall be as

S.No	Declared quantity	Maximum permis deficiency
		As percentage of declared quantity
1	Upto 50	9
2	50 to 100	-
3	100 to 200	4.5

	900 gms, 1 kg, 2kg, 5kg and 10 kg.
Uncanned packages of butter and margarine	25 gms, 50 gms, 100 gms, 200gms, 500gms, 1kg, 2kg, 5kg and thereafter in multiples of 5 kg
Ghee & butteroil	50 gms, 100 gms, 200gms, 500gms , 1 kg, 2kg, 3 kg, 5 kg.
Milk powder	Below 50 gms no restriction, 50 gms, 100gms, 200gms,500gms, 1 kg and thereafter in multiples of 500 gm.

27.3 Package of Food to Carry a Label: Every package of food shall carry a label and unless otherwise provided in these rules, there shall be specified on every label:

(a) The name, trade name or description of food contained in the package;

(b) The names of ingredients used in the product in descending order of their composition by weight or volume as the case may be;

Provided that in the case of artificial flavouring substances, the label may not declare the chemical names of the flavours, but in the case of natural flavouring substances or nature-identical flavouring substances, the common name of flavours shall be mentioned on the label. Provided also that whenever Gelatine is used as an ingredient, a declaration to this effect shall be made on the label by inserting the word "Gelatine-Animal Origin."

Provided also that when any article of food co
including birds, fresh water or marine animals or
but not including milk or milk products, as ingre

(a) A declaration to this effect shall be mac
stipulated for this purpose to indicate that
The symbol shall consist of a brown colo
less than the minimum size specified ir
square with brown outline having side d
indicated in clause (16) of sub-rule(ZZZ) of

Table 27.1 Area and Diameter of Non-vegetaria

S. No.	Area of principal display panel
1	Upto 100 cms square
2	Above 100 cms square upto 500 cm square
3	Above 500 cms square upto 2500 cm square
4	Above 2500 cms square

(b) The symbol shall be prominently displayed

1. On the package having contrast backgroun
2. Just close in proximity to the name or bran

(a) A declaration to this effect shall be made by a symbol and colour code so stipulated for this purpose to indicate that the product is Vegetarian Food. The symbol shall consist of a green colour filled circle, having a diameter not less than the minimum size specified in the Table given below, inside the square with green outline having size double the diameter of the circle, as indicated in clause (17) of sub-rule (ZZZ) of rule 42;

Table27.2 Area and Diameter of Vegetarian symbol to be printed on package

S. No.	Area of principal display panel	Minimum size of diameter in mm
1	Upto 100 cms square	3
2	Above 100 cms square upto 500 cms square	4
3	Above 500 cms square upto 2500 cms square	6
4	Above 2500 cms square	8

(b) The symbol shall be prominently displayed,

1. On the package having contrast background on principal display panel,
2. Just close in proximity to the name or brand name of the product, and
3. On the labels, containers, pamphlets, leaflets, advertisements in any media;

Provided further that the provisions of these rules shall not apply in respect of any Vegetarian Food which is manufactured and packed without the symbol before the commencement of the Prevention of Food Adulteration (9th Amendment) Rules, 2001.

(I) CONTAINS PERMITTED NATURAL C

OR

(II) CONTAINS PERMITTED SYNTHET
FLAV

OR

(III) CONTAINS PERMITTED NATURAL AN
ADDED F

OR

(IV) CONTAINS PERMITTED NATURAL*/AN
FLAVOURS (For the period up to a

NOTE: A specific name shall be used for

Provided that for ingredients falling in the fall
class titles may be used, namely in dairy indu

Table 27.3 Declaration of Additives like fa

Name of the Classes
Animal fat/oil, other than milk fat

Agent, Humectants, Preservative, Propellant, Raising Agent, Stabilizer, Sweetener, Thickener.

Provided also that for declaration of flavours on the label the class of flavours namely, Natural Flavours and Natural Flavouring Substances or Natural-Identical Flavouring Substances or Artificial Flavouring Substances as the case may be, shall be declared on the label.

(c)

(i) The name and complete address of the manufacturer and the manufacturing unit, if these are located at different places and in case the manufacturer is not the packer or bottler, the name and complete address of the packing or bottling unit as the case may be;

(ii) Where an article of food is manufactured or packed or bottled by a person or a company under the written authority of some other manufacturer or company, under this or its brand name, the label shall carry the name and complete address of the manufacturing or packing or bottling unit as the case may be, and also the name and complete address of the manufacturer or the company, for and on whose behalf it is manufactured or packed or bottled;

Note: In declaring the net quantity of the commod
weight of the wrappers and materials other than con

Provided that where a package contains a la
confectionery, each of which is separately wrapped a
to exclude from the net weight of the commodity
wrappers of all the items of the confectionery contai
declared on the package, containing such confectic
include the weight of such immediate wrapper if, a
immediate wrapper does not exceed:

(i) 8 per cent where such immediate wrapper is
with wax or aluminium foil under strip; **or**

(ii) 6 per cent in the case of any other paper, of t
of confectionery contained in the packag
wrapper.

(e) A distinctive batch number or lot number or
or alphabets or in combination, representing
or code number being preceded by the words
or, Lot or any distinguishing prefix.

package in such a manner that the same is readable even without opening the package.

Provided further that in case of carbonated water containers and the packages of biscuits, confectionery and sweets, containing more than 60g, but not more than 120g, and food packages weighing not more than 60g. Particulars under clauses (d) and (e) need not be specified.

Provided also that in case of packages containing bread and milk including sterilised milk, particulars under clause (e) need not be specified.

"Provided also that in case of any package containing bread or liquid milk, sterilized or Ultra High Temperature treated milk, Soya milk, flavoured milk, any package containing dhokla, bhelpuri, pizza, doughnuts, khoa, paneer or any uncanned package of fruits, vegetables, meat, fish or any other like commodity which has a short shelf life, the date, month and year in which the commodity is manufactured or prepared or prepacked shall be mentioned, on the label:

Provided that in case of wholesale packages the particulars under clauses (b), (f), (g), and this clause need not be specified.

Provided further that in case of package or bottle containing sterilised or Ultra High Temperature treated milk, soya milk, flavoured milk, any package containing bread,

"BEST BEFORE UPTO.... DATE/MONTH/YEAR

OR

"BEST BEFORE WITHIN .....DAYS FROM T

PACKAGING/MANUFACTURE"

Note: (i) Blank be filled up

(ii) Month and Year may be used in numerals.

(iii) Year may be given in two digits.

Provided also that in case of a package contai
the particulars under clause (i) may not be spe

Provided also that the above declaration of
applicable to the Packages of Aspartame and I

"Provided also that in case of any bottle co
having milk as an ingredient, soft drink, ca
beverages, the declarations with regard to add
as the "dated of manufacture" and "best befo
body of the bottle.

package in such a manner that the same is readable even without opening the package.

Provided further that in case of carbonated water containers and the packages of biscuits, confectionery and sweets, containing more than 60g, but not more than 120g, and food packages weighing not more than 60g. Particulars under clauses (d) and (e) need not be specified.

Provided also that in case of packages containing bread and milk including sterilised milk, particulars under clause (e) need not be specified.

"Provided also that in case of any package containing bread or liquid milk, sterilized or Ultra High Temperature treated milk, Soya milk, flavoured milk, any package containing dhokla, bhelpuri, pizza, doughnuts, khoa, paneer or any uncanned package of fruits, vegetables, meat, fish or any other like commodity which has a short shelf life, the date, month and year in which the commodity is manufactured or prepared or prepacked shall be mentioned, on the label:

Provided that in case of wholesale packages the particulars under clauses (b), (f), (g), and this clause need not be specified.

Provided further that in case of package or bottle containing sterilised or Ultra High Temperature treated milk, soya milk, flavoured milk,

[illegible] Agri.Water Cess

[illegible] BEFORE UPTO.... DATE/MONTH/YE

OR

[illegible] BEFORE WITHIN .....DAYS FROM

PACKAGING/MANUFACTURE"

Note: (i) Blank be filled up

(ii) Month and Year may be used in numeral

(iii) Year may be given in two digits.

Provided also that in case of a package cont
the particulars under clause (i) may not be sp

Provided also that the above declaration o
applicable to the Packages of Aspartame and

Provided also that in case of any bottle c
having milk as an ingredient, soft drink, c
beverages, the declarations with regard to ad
as the "date of manufacture" and "best be
body of the bottle.

Table 27.4 Schedule

S.No.	Year of manufacture	Date of enforcement of the declarations referred to in the first proviso by replacing old bottles with new bottles
1	2002 and beyond but before the commencement of the Prevention of Food Adulteration (8th Amendment) Rules 2002	1.4.2008
2	2001	1.4.2007
3	2000	1.4.2006
4	1999	1.4.2005
5	1998	1.4.2004
6	1997 and before	From the date of commencement of the Prevention of Food Adulteration (8th Amendment) Rules, 2002

Provided also that the returnable new glass bottle manufactures and used for packing of such beverages on the date of commencement of the Prevention of Food Adulteration (8th Amendment) Rules 2002 shall carry these declarations on its body"

Provided also that the above provisions except date of manufacture and "best before date" shall not apply in respect of carbonated water (plain soda) potable water impregnated with carbon dioxide under pressure) packed in returnable glass bottles.

Explanation- I: The term 'label' means a display of written, marked, graphic, printed,

Explanation-V: 'Multipiece package' mean
individually packaged or labelled pieces of t
intended for retail either in individual pieces

Explanation-VI: "Wholesale package" means

a) A number of retail packages, where such
sale, distribution or delivery to an in
direct to a single consumer; or

b) A commodity of food sold to an intermed
to sell, distribute or deliver such comm
quantities.

Explanation VII- Prepacked commodity witl
expressions means a commodity of food with
is placed in a package of whatever nature
contained therein has predetermined value a
the package or its lid or cap, as the case
perceptible modification.

Explanation VIII-

Explanation IX- Non-Vegetarian Food' means an article of food which contains whole or part of any animal including birds, fresh water or marine animals or eggs or products of any animal origin, but not including milk or milk products, as an ingredient.",

Explanation X- "Vegetarian Food" means any article of Food other than the Non-Vegetarian Food as defined in Explanation IX of this rule;

32-A. Nutritional Food: The food claimed to be enriched with nutrients such as minerals; proteins or vitamins shall give quantities of such added nutrients on the label.

33. **Languages of the Particulars or Declaration on the Label:** The particulars of declaration required under these rules to be specified on the label shall be in English or Hindi in Devnagri script:-

Provided that nothing herein contained shall prevent the use of any other language in addition to the language required under this rule.

34. **Declaration to be Surrounded by Line:** There shall be a surrounding line enclosing the declaration and where the words ["unsuitable for babies"] are required to be used there shall be another such line enclosing these words.

(a) in the case of a rectangular containe
and width of the panel of such contai

(b) in case of cylindrical or nearly cylin
nearly oval container, twenty perc
average circumference of such contai

(c) in the case of a container of any ot
surface area of the container except
the container such label shall hav
percent of the total surface area of th

(3) In computing the area of the principal
at top and bottoms of cans, and shoulc
excluded.

(4) In the case of package having a capac
principal display panel may be card
container and bearing the required info

(5) The height of any numeral in the de
principal display panel shall not be les

TABLE -27.5 Height and Size of Letters to be printed for net quantity declared in terms of weight or volume on label

Sr. No.	Net quantity in weight/volume	Minimum height of numeral in mm	
		Normal case	When blown, formed, moulded or perforated on container
1	Up to 50g/ml	1	2
2	Above 50g/ml up to 200g/ml	2	4
3	Above 200g/ml up to 1kg/litre	4	6
4	Above 1kg/litre	6	8

(ii) As shown in Table-27.6 below if the net quantity is declared in terms of length, area or number.

TABLE-27.6 Height and Size of Letters to be printed for net quantity declared in terms of length, area or number on label

Sr. No.	Net quantity in length, area or number, Area of Principal display panel	Minimum height in mm	
		Normal case	When blown, formed, moulded or perforated on container
1	Up to 100 cm^2	1	2

(7) Every declaration which is required
shall be-

- Legible, prominent, definite, plain an
- Conspicuous as to size number and
- As far as practicable, in such style o
and conspicuously present in distinc
graphic material used on the packag
package in a colour that contrasts c
label.

Provided that -

- Where any label information is blow
surface or where such information is
that information shall not be require
- Where any declaration on a package
handwriting or hand script, such de
legible.

(8) No declaration shall be made so a
commodity contained in the package

(9) Where a package is provided wit
container or wrapper shall also cont
to appear on the package except
transparent and the declarations o

37-A. Manufacture of Proprietary Foods and Infant Foods:

1. An article of infant milk substitutes/ infant foods whose standards are not prescribed in Appendix 'B' shall be manufactured for sale, exhibited for sale or stored for sale only after obtaining the approval of such article of food and its label from Government of India.
2. In case of proprietary foods the name of the food or category under which it falls in these rules shall be mentioned on the label.

37-B. Labelling of Infant Milk Substitute and Infant Food:

(1) Without prejudice to any other provisions relating to labelling requirements contained in these rules, every container of infant milk substitute or infant food or any label affixed thereto shall indicate in a clear, conspicuous and in an easily readable manner, the words, "IMPORTANT NOTICE" in capital letters and indicating there under the following particulars, namely:

(a) A statement "MOTHER'S MILK IS BEST FOR YOUR BABY" in capital letters. The types of letters used shall not be less than five millimetres and the text of such statement shall be in the Central Panel of every container of infant milk substitute or infant food or any label affixed thereto. The colour of the text printed or used shall be different from that of the background of the label, container or the advertisement, as the case may be. In case of infant food, a statement indicating "infant food shall be introduced only after six months and up to the age of two years" shall also be given.

"Warning/caution-Careful and hygienic pr
substitutes is most essential for health. Do
diluted feeding will not provide adequate nut
more scoops than directed since concentrate
by your infant"

(e) The approximate composition of
including its energy value in Kilo

(f) The storage condition specifically st
air tight container" or the like;

(g) The feeding chart and directions
instruction for discarding left over

Instruction for use of measuring sc
scoop (scoop to be given with pack

(i) Indicating the Batch No. Month and
year before which it is to be consu

(j) The protein efficiency ratio (PER) wh
other than infant milk substitute i

(3) The containers of infant milk substitute meant for low birth weight infant (less than 2500gm) or labels affixed thereto shall indicate the following additional information, namely:

(a) The words "**Low Birth weight** (Less Than 2.5 kg)" in capital letters along with the product name in central panel;

(b) A statement "the low birth weight infant milk substitute shall be withdrawn under medical advice as soon as the mother's milk is sufficiently available", and

(c) A statement "TO BE TAKEN UNDER MEDICAL ADVICE" in capital letters.

(4) The product which contains neither milk nor any milk derivatives shall be labelled "Contains no milk or milk product" in conspicuous manner.

(5) The container of infant milk substitute for lactose intolerant infants or label affixed thereto shall indicate conspicuously "LACTOSE FREE" in capital letters and statement "TO BE TAKEN UNDER MEDICAL ADVICE".

38. **Labels not to Contain Reference to Act or Rules Contradictory to Required Particulars:**

40. Unauthorized Use of Words Showing

(1) There shall not be written in the sta
containing any article of food the
implying that the article is a substitu
words is specifically permitted under

(2) Any fruit syrup, fruit juice, fruit squ
does not contain the prescribed amount
fruit juice, fruit squash, fruit beverage or
shall be described as a synthetic produc
and conspicuously marked on the la
containing such product shall have a lab
the wrapper of such container or other
believing that it is a fruit product. Nei
describing such a product nor shall it
carries picture of any fruit..... Carbonate
shall not have a label which leads the
product.

(3) Any fruit and vegetable product alle
contain not less than 40 mg of ascorb

(a) In the case of condensed milk (unsweetened);

CONDENSED MILK UNSWEETENED (Evaporated milk)

This tin contains the equivalent of (x).....litres of toned milk

(b) In the case of condensed milk (sweetened);

CONDENSED MILK SWEETENED

This tin contains the equivalent of (x).....litres of toned milk with sugar added

(c) In the case of condensed skimmed milk (unsweetened):

CONDENSED SKIMMED MILK UNSWEETENED

(Evaporated Skimmed Milk)

This tin contains the equivalent of (x).... litres of skimmed milk

(d) In the case of condensed skimmed milk(SWEETENED)

CONDENSED SKIMMED MILK SWEETENED

This tin contains the equivalent of (x)..... litres of skimmed milk with sugar added

MILK PC

This tin contains the equivalent

(ee) In the case of milk powder which contai

MILK POWDER IN

CONTAINS

(f) In the case of partly skimmed milk pov

PARTLY SKIMMEI

This tin contains the equivalent of (x) ....lit
cent m

(g) In the case of skimmed milk powder:

"To make a fluid not below the composition of toned milk or skimmed milk [***] (as the case may be) with the contents of this package, add (here insert the number of parts) of water by volume to one part by volume of this condensed milk or desiccated (dried) milk.

Sweetened condensed milk and other similar products which are not suitable for infant feeding shall not contain any instructions for modifying them for infant formula.

(iv) Wherever the word "milk" appears on the label of a package of condensed skimmed milk or of (dried) skimmed milk as the description or part of the description of the contents, it shall be immediately preceded or followed by the word "machine skimmed" or "partly skimmed", as the case may be.

(C) **Fluid Milk:** The caps of the milk bottles shall clearly indicate the nature of the milk contained in them. The indication may be either in full or abbreviation shown below:

1. Buffalo milk may be denoted by the letter 'B'.
2. Cow milk may be denoted by the letter 'C'.
3. Goat milk may be denoted by the letter 'G'.
4. Standardized milk may be denoted by the letter 'S'
5. Toned milk may be denoted by the letter 'T'.
6. Double toned milk may be denoted by the letters 'DT'.
7. Skimmed milk may be denoted by the letter 'K'

name and address along with the
any, legibly and conspicuously dis
the case may be.

Every package of synthetic food co
label upon which is printed a dec
content.

Unless otherwise provided in these
which contains added natural colo
following label:

MALTED MILK FOOD IN THIS PACKA
COLOURI

(ZZZ)(1) Every package of food which is
mentioned in table given in rule
carry the following label, namely:

(i) This..... (Name of food) contair

CONTAINS ARTIFICIAL SWEETENER AND FOR CALORIE CONSCIOUS

(ZZZ)(1)(B) The declaration under sub-rule (ZZZ)(1)(A) shall be provided along with name or trade name of product and shall be of the half of the size of the name/trade name. The declaration may be given in two sentences, but in the same box:

Provided that the provision of these rules shall not apply in respect of any food which is manufactured and packed before the commencement of Prevention of Food Adulteration (Ist Amendment) Rules, 2004.

(ZZZ) (5) Every package containing Fat-Spread shall carry the following labels, namely

(i) **Milk Fat Spread** Total Milk Fat Content..... percent by weight Date of Packing..... Use before.....	(i) **Mixed Fat Spread** Total Fat Content..... percent by weight Milk Fat Content..... percent by weight Date of packing..... Use before.....
(i) **Vegetable Fat Spread**	

ZZZ) (16) Every package of Non-Vegetarian
principal display panel just close
food namely:

(ZZZ) (17) Every package of Vegetarian Foo
colour on the principal display
brand name of the Food, namely

Provided if caffeine is added in the produc
container/bottle.

Provided also that in case of returnable gla
the declaration of caffeine, may be given on

43. Notice of Addition, Admixture or De

(1) Every advertisement and every price
which contains an addition, admixtu
containing such addition, admixture
nature and quantity of such addi
advertisement or label attached to th

[DECLARATION]

THIS (a).....CONTAINS AN

ADMIXTURE/ADDITION OF NOT MORE

THAN (b).....PER CENT OF 3[***] (c)

(a) Here insert the name of food.

(b) Here insert the quantity of admixture which may be present.

(c) Here insert the name of the admixture or the name of the ingredient which is deficient.

Where the context demands it, the words' contains an admixture of' shall be replaced by the words 'contains an addition of or is deficient in;

(3) Unless the vendor of a food containing an addition, admixture or deficiency, has reason to believe that the purchaser is able to read and understand the declaratory label, he shall give the purchaser, if asked, the information contained in the declaratory label by word of mouth at the time of sale.

(4) Nothing contained in this rule shall be deemed to authorize any person to sell

Explanation: The term 'Advertisement' announcement made by means of any l media, internet or website"

Bar Code Definition: A bar code is a serie the encodation rules of a particular specific

Benefits of the codes: The main purpose is machine-readable, and work can be spee entry, capturing data automatically by rea second. Generally the error rate is extreme readings.

Advantages:

Computer Aided Checkout.

Avoidance of over and under charging.

Self-service.

Instant inventory control.

Market survey – products sold and rate.

EAN/UPC: European Article Numbering (EAN) system and Universal Products Code (UPC) system is a continuous symbology encoding fixed length number digits. Several variants exist, known as EAN-8, EAN-13, UPC-A and UPC-E. In addition, the symbology enables to encode 2 small symbols encoding 2 and 5 digits. These are called add-ons.

Two-Dimensional Symbology: PDF 417: As distinct from the linear symbology, a system such as PDF 417 is a two-dimensional stacked bar-code symbology. In this, the basic data unit or minimum segment containing interpretable data is called a codeword.

Printing and Reading of Bar Codes: Any printing technology can be of use in printing bar codes, provided it achieves enough accuracy with required quality at the right level.

There are many types of bar code readers available. They all illuminate the symbol and analyse the resulting reflectance. High reflectance areas are interpreted as spaces while areas of low-reflectance are represented as bars.

The decoder assigns binary values to the signal and forms a complete message. This is checked by the decoder and transformed into data.

Applications

processed by the receiver, the original messa
and delivered can be checked. Inventories ca

*****

Lesson-28

Scope of Aseptic Packaging and Pre-Requisite Conditions for Aseptic Packaging. Description of Equipments (Including Aseptic Tank) and Machines

28.1 INTRODUCTION

Aseptic packaging can be defined as the filling of a commercially sterile product into a sterile container under aseptic conditions and hermetically sealing the containers so that re-infection is prevented. This results in a product, which is shelf-stable at ambient temperature conditions.

28.2 SCOPE OF ASEPTIC PACKAGING

There are number of limitations and disadvantages during actual application of this technology. However, we can't ignore the advantages over various lacunas of the process. Thus, it can be concluded that aseptic packaging of sterile/non sterile food and food products is the most significant innovation in the field of food science and technology and there is a big scope in this area.

28.3 MAJOR CATEGORIES OF ASEPTIC PACKAGING SYSTEMS

- *Can system*: It includes hermetically sealed cans
- *Bottle systems*: Glass containers and plastics bottles fall into this category. The bottles can further be divided into; a) Non-sterile bottles; b) Sterile blown bottles; c) Single station blowing, filling & sealing
- *Sachet and pouch systems*: This system is classified into Form-fill-seal systems and Lay flat tubing
- *Cup systems*: The aseptic packaging of food into cups can be into; Pre-formed plastic cups and Form-fill and seal cups
- *Carton systems*: This type of aseptic packaging system includes Form-fill-seal cartons and Prefabricated cartons
- *Bulk packaging systems*: This type of [illegible]

28.4 PRE-REQUISITE CONDITIONS FOR ASE

- It should contain the product.
- It should prevent physical damage to pac
- It should run smoothly on filling lines.
- It should withstand packaging processes
- It should be easy to handle throughout d
- It should prevent dirt and other contamir
- It should be able to protect the product fr
- It should be resistant to rodent attack.
- It should be able to stop insect infestatio
- It should be biologically safe i.e. non toxic
- It should be compatible to foodstuff.
- It should provide sterility to product.
- It should prevent ingress of microorganis
- It should show evidence of tampering.
- It should control moisture loss or gain.
- It should offer a barrier to oxygen.
- It should be protective against the light.
- It should maintain gas atmospheres, i.e.C
- It should communicate all the information manufacturer.
- It should have good sales appeal.
- It should be easy to open
- It should be cost effective.

The above given pack criteria are separated into s

- **Product Containment**: The need that liquids or powders do not leak
- **Physical Protection**: This is require

weight, list of ingredients, batch number, use-by date, nutritional information etc.

- **Sale-Appeal**: The package must look attractive and 'catch the eye' of prospective purchasers, and it should also be easy to open and dispense the product.
- **Cost-Effectiveness**: Value for money in packaging is more important than looking for the lowest price. A cheap but dimensionally variable container could cause more damage during production or an increase of 'leakers' in the market place, thereby effects the sale of the product.

28.5 ASEPTIC TANK

The aseptic tank is used for intermediate storage of UHT treated dairy products. It can be used in different ways in UHT lines, depending on plant design and the capacities of the various units in the process and packaging lines.

- If one of the packaging machines incidentally stops, the aseptic tank can take care of the surplus product during the stoppage.
- Simultaneous packaging of two products.

The aseptic tank is first filled with one product, sufficient to last for a full shift of packaging. Then the UHT plant is switched over to another product which is packed directly in the line of packaging machines. One or more aseptic tanks included in the production line offer flexibility in production planning.
Direct packaging from a UHT plant requires recirculation of a minimum extra volume of 300 litres per hour to maintain a constant pressure to the filling machines. Products which are sensitive to overtreatment cannot tolerate this and the required overcapacity must then be fed from an aseptic tank.
The optimum arrangement must thus be decided for each individual process with UHT plants, aseptic tanks and aseptic packaging machines.

Lesso

Micro-processor Controlled Systems Em

Conditions and Quality Assuranc

29.1 INTRODUCTION

Microprocessors & microcomputers are first
time in 1973. Microprocessor-based equip
Microprocessor-controlled packaging machi
Microprocessor-based aseptic packaging h
process variables simultaneously.

Main operations that are taken care by micr

- Feeding of film to the machine
- Converting of film into required shape
- Filling the product with specific volum
- Heat sealing
- Collecting up of specific no of packs a
  pack.

All these operations are taken care by Micro

shutdown, product changeovers and, for carton systems, reel splices and paper splices.

- Pipes, storage tank, and surfaces of the packaging machine come into contact with the sterilized product have to be sterilized.
- Sterilization procedures should be verified.
- The seal integrity of the package should be monitored as well as the overall microbial quality of packaging material itself.
- Care should be taken to minimize contamination during subsequent handling. All these could result in an increase in spoilage rate.
- Rinsing, cleaning and disinfecting procedures are also very important, especially the removal of fouling deposits, which may provide a breeding ground for the growth of micro-organisms, especially thermofiles.

29.3 QUALITY ASSURANCE ASPECTS OF ASEPTIC PACKAGING

- Aseptic packaging has to be meticulously checked.
- Not only must the packaged product be examined, but so must all preceding steps, as well as the operators, which are potential carriers of pathogens.
- If just one bacterium reaches the product, and that bacterium is pathogenic and can proliferate (for example, *Staphylococcus aureus*), the result could be disastrous.
- In addition to regular sampling during production, further samples should be taken at the times or in situations known to be associated with an increased risk of contamination. It is advisable to incubate these samples long enough, in most cases from 5 to 7 days at 30°C to allow sub-lethally damaged bacteria also to grow to detectable counts. The products should only be delivered if the result of the shelf-life test is Satisfactory

Le

Microbial Standards, Packaging

30.1 INTRODUCTION

Modern packaging can be defined as a me
consumer in sound condition at minima
product and protect it from environment
consumers and enables convenient disp
packaging materials are containment,
convenience.

30.2 MICROBIAL STANDARDS

Microbial characteristics of food that influ
can be divided into 3 types:

- Perishable: Milk
- Semi perishable: Dried Milk
- Non perishable canned, sterilized

Important factors in choosing a packaging unit may depend on:

- Degree of protection needed against light, humidity, temperature, micro-organisms /insects, protection for Protein, Fat, Characteristic Flavour and Water in products. The Price, Sales appeal, Ease in handling, Mechanical hazard and handling by consumers are also the determining factors.

The two important factors that control the influence of packaging materials on milk products are

1. Exposure to high temperature during the fabrication of packaging materials to keep them sterile.
2. Care during subsequent handling and storage of these materials and avoiding the contamination.

30.2.1Proposed Microbiological Standards

- SPC : 10 / 100 cm^2 or 10 per 100 ml capacity among which about 3% are spores.

  o Laminated paper has been shown to contain, say, 10 organisms per 100 cm^2, The inner surface of a 1-liter carton is about 800 cm^2 and will thus on average be contaminated by about 2.5 spores. These spores are the most heat resistant, and hence their number must be reduced to less than 10^{-5} per package. Furthermore, the packages should be aseptically

containers. An ideal pack should be virtu
moisture proof.

Testing of packaging materials for microbial

- A specified area of the packaging mate
  medium in a Petri dish and over laid v
- Incubate the plates and count the col
- This technique is for the non absorbe
  plastics and aluminium foil

The packaging materials for the presence
suspension of *Bacillus polymyxa*. The packa
Bacillus polymyxa under slightly induced va
the pin holes and cause spoilage on incubati

Lesson-31

Disposal Methods of Waste Packages

31.1 INTRODUCTION

After product usage, the empty packages have to be discarded, and these constitute a fair proportion of the solid waste produced by the community. In developed countries 4 lb of municipal waste is created by each person in one day. Out of this, packaging accounts for nearly 1/3rd of the volume. The collection and proper disposal of the waste is done by ministerial or public health authorities. Glass, paper, plastics and tin cans are the main packaging materials which get mixed with the city refuse and present problem of their proper disposal. The non - disposable nature of many packaging materials make it much more complicated problem.

31.2 THE HIERARCHY OF WASTE DISPOSAL

- **Reuse** – The reuse of a package or c
encouraged. Returnable packaging l
viable.
- **Recycling** – Recycling is the reproc
into new products. Emphasis is focu
components of a package. i.e. Steel,
components can be chosen which a
contaminate recycling operations.
- **Energy recovery** – Waste-to-energy
facilities are able to make use of the
components.
- **Disposal** – Incineration and placem
some materials. Material content sh
emissions and ash from incineratio
should not be littered.

31.3 METHODS OF WASTE DISPOSAL

There are various methods of waste dispos

31.3.1 Open dumping: By this method on
not be expected to contribute to public hea
Discarded food packages may contain resi
harbour insects and bacteria that may cau

31.3.2 Sanitary landfill method: The mos
waste is the landfill method. Here the troul
after compressing and piling. The waste is
covered by earth. Degradability due to bio-
common feature in sanitary landfill. Disad
polluting ground water and production of

c. Very little lead and cadmium are found in ash on incineration

d. Most hygienic way of waste disposal.

31.3.4.2 Disadvantages:

a. Large investment is required to construct plants.

b. High operational cost is involved.

c. Air pollution - Ex: release of hydrogen chloride during burning of PVC.

d. Glass, steel and other metals are not combustible and they should be removed before incineration.

e. Glass and plastics if not removed, create problems in incinerator due to melting and solidifying inside the equipment.

31.3.5 Recycling: Recycling means use of waste material as raw material for preparation of new products.

31.3.5.1 Two methods of recycling:

a) Primary Re-cycling: It means the use of recycled material to produce the same material. Ex: Aluminum cans, Glass bottles.

b) Secondary Re-Cycling: Use of recycled material to form new materials with lower specifications.

Ex: Use of food grade plastics in production of plastics for industrial use.

4) Recycling of coloured glasses / fil

5) Difficulty in collection and segreg

31.4 THE MATERIALS THAT CAN BE RE

(A) Steel cans

(B) Aluminum cans

(C) Glass bottles/containers

(D) Plastics

(E) Paper

31.5 RECENT DEVELOPMENTS

Recent developments in packaging waste di filling, more sophisticated combustion tec plastics. Bio-degradable, solar-degradable PP etc can be added to coal tar while me resistance for the road laid. The laminates ply boards which are used for industry lami

Lesson-32

Description of Equipments and Machines of Different Packaging Systems

32.1 INTRODUCTION

Packaging is the science, art, and technology of enclosing or protecting products for distribution, storage, sale, and use.

32.2 PACKAGING MACHINE

Choice of packaging machinery depends as

- technical capabilities, labor requirements
- worker safety
- maintainability
- serviceability
- reliability

- throughput
- efficiency
- productivity
- Ergonomics, etc.

Packaging machines may be of the followin

1. Blister packs, skin packs and Vacuun
2. Bottle capping equipment, Over-Capp Machines
3. Cartoning Machines
4. Box, Case and Tray Forming, Pa Machines
5. Cleaning, Sterilizing, Cooling and Dryi
6. Conveyors, Accumulating and Related
7. Feeding, Orienting, Placing and Relate
8. Filling Machines: handling liquid and

32.3 PACKAGING MACHINERY

32.3.1 Filling Machine

There are two Types (a) Filling by gravitation (b) Mechanical filling.

32.3.1 Filling by Gravitation: Filling by gravity is used for filling thin liquids like milk into glass bottles/plastic bottles. In gravitational filling, the filling process is stopped when the pre-calibrated filling height has been reached. This system is suitable for filling milk in glass bottles. However, packaging milk in bottles is outdated in India. In volumetric filling process, fixed volume of milk is filled.

32.3.2 Mechanical Filling: In this type milk powders are metered filled by using screw conveyors. The conveyors are used as metering and dosing devices. However, due to variation in bulk densities of milk powder, care must be exercised to ensure even delivery of the product and which shall be equal in weight from package to package.

32.3.3 Over Wrapping Machines: Over wrapping the product with a film or foil is commonly employed for cheese and butter. Generally these machines work as the push – through principle i.e. the portion to be wrapped is pushed onto the film. In these machines, a measured amount of foil or film is pressed by a piston through a folding channel into a mould. The product shape that is

pressure of air. The remaining stage
lid takes place in the sterile tunnel.

32.3.5 Form Fill and Sealing Machine: Fc
automated assembly-line product packagin
of milk, buttermilk, ghee etc.. The machine
plastic film, while simultaneously filling th
bags.

- The typical machine is loaded with a
has had labeling and artwork applied
LDPE or
LLDPE is the most commonly used pa
- For some products the film may first
and dryer prior to use in the packagin
- The film approaches the back of a lon
center of the plastic is near the tube,
wrap around the conical tube. The filn
of the tube and a vertical heat-sealing
bonding the film by melting the seam
- To start the bagging process, a horizor
edge of the tube, bonding the film toge
sealed tube end is then lowered onto a
to be bagged is dispensed through the
- When the tare weight of the product-fil
horizontal sealing bar seals the top of
bottom of the next bag above. This bag
a sealed package, ready to advance an

32.3.7 Shrink wrapping machines: Shrink wrapping cannotes packing of one or several articles with a thermoplastic film which when subjected to heat shrinks and form a tight wrap around the object. Shrink wrap, also shrink-wrap or shrink film, is a material made up of polymer plastic film. When heat is applied to this material it shrinks tightly over whatever it is covering. Heat can be applied with a hand held heat gun (electric or gas) or the package can pass through a heat tunnel on a conveyor. Shrink wrap is commonly used as an overwrap on many types of packaging, including cartons, boxes, beverage cans and pallet loads. A variety of products may be enclosed in shrink wrap to stabilize the products, unitize them, keep them clean, add a degree of tamper resistance, etc. It can be the primary covering for some foods such as cheese and Paneer.

The most commonly used shrink wrap is polyolefin. It is available in a variety of thicknesses, clarities, strengths and shrink ratios. The two primary films are either crosslinked, or non crosslinked. Other shrink films include PVC and several other compositions like LDPE, LLDPE, PP, EVA etc. Coextrusions and laminations are available for specific mechanical and barrier properties for shrink wrapping food.

In shrink-wrap machine a loose plastic film pouch is made on a wrapping machine. The product is placed in this pack which passes through a heated tunnel in which the film shrinks and adheres closely to the product. The film is generally heated by hot air, infrared rays or hot water. Shrink wrapping is also used to hold together several singly wrapped products/ packages in a multiple unit package.

Advantages of shrink wrap packaging:

1. All types of items of regular / irregular shapes and sizes can be shrink wrapped.

32.3.8 Stretch wrapping: Stretch wrap or stretch film that is wrapped around items. The elastic rec In contrast, shrink wrap is applied loosely aroun heat. It is frequently used to unitize pallet loads smaller items. Types of stretch film include bund extended core stretch film, machine stretch film an

32.3.8.1 Materials: The most common stretch polyethylene or LLDPE, which is produced by copo olefins, the most common of which are butene, polyethylene and PVC can also be used. Many film but are only stretched to about 100 – 300% i recovery is used to keep the load tight. Other prop clarity, tear resistance, static discharge, etc. are al

32.3.8.2 Functions

In pallet unitizing, stretch wrap can have severa

- improved stability of products or packages,
- more efficient handling and storage of unit l
- some degree of dust and moisture protectio
- some degree of tamper resistance and resist
- Stretch wrapping is the most cost-effective pallet.
- Stretch wrapping can be applied manually w wide) of film. Dispensers are also available f

32.3.9 Insert gas packing: Inert gas packing using nitrogen, carbon dioxide or a mixture of the two is done by passing the gasses around the product prior to sealing ex: Cheese. Whole milk powder packed in tins with a pin hole is evacuated under vacuum. The vacuum is then broken by the inert gas (usually N_2) and the pin hole is sealed immediately.

32.3.10.Vacuum Packaging: Vacuum packaging is done for products like cheese blocks, panner etc, where there is problem of microorganisms growing on the surface. The product is placed in a plastic pouch and placed in the vacuum packaging machine for the creation of vacuum in the pack and subsequent sealing takes place in the machine itself.