PHB

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2.0 PACKAGING MATERIALS

Definition: Packing is the art and science which involves preparing the articles for transport, storage, display and use.

TYPE OF PACKAGING MATERIALS

The following materials are used for the construction of containers and closures

1. Glass: -	(i) Type-I	Borosilicate glass		
	(ii) Type-II	Treated sodalime glass		
	(iii) Type-III	Regular soda-lime glass		
	(iv) Type-NP	General purpose soda lime glass		
	(v) Coloured glass			
2. Metals	(i) Tin	(ii) Iron	(iii) Aluminium	(iv) Lead.
3. Plastics	(a) Thermosetting resins:		(i) Phenolics	
			(ii) Urea	
	(b) Thermoplastic resins:		(i) Polyethylene	
			(ii) Polypropylene	
			(iii) Polyvinylchloride (PVC)	
			(iv) Polystyrene	
			(v) Polycarbonate	
			(vi) Polyamide (Nylon)	
			(vii) Acrylic multipolymers	
			(viii) Polyethylene terephthalate (PET)	
4. Rubber	(i) Natural rubber			
	(ii)Neoprene rubber			
	(iii)Butyl rubber.			

PHARMACEUTICAL PACKAGES

CONTAINERS

The container is the device that holds the drug. The immediate container is that which is in direct contact with the drug at all times.

According to the method of closure and use, the containers are of following types;-

(a) Well closed containers:

A well closed container is used to protect the preparation from contamination by extraneous solids, to prevent the loss of contents during transport, storage and handling.

(b) Air tight container:

Air tight containers are used to protect the container from atmospheric contamination of liquids, solids or vapors. They prevent loss of drugs due to efflorescence, deliquescence or evaporation or oxidation.

(c) Hermetically sealed containers:

Hermetically sealed containers is that which does not allow the air and other gases to pass through it. e.g. glass ampoules are sealed by fusion.

(d) Light resistant containers:

They are used to protect the drugs which undergo decomposition in the presence of light. Such drugs may be enclosed in amber coloured bottle or opaque container.

(e) Single dose container:

They are used to supply only one dose of the medicament. e.g. ampoules.

(f) Multi dose container:

A multidose container holds a number of doses e.g. multidose vials.

(g) Aerosol containers

Containers for aerosol must be strong enough to withstand the pressure evolved inside the container at the time of use of the preparation.

SELECTION OF PACKAGING MATERIAL

The materials selected for packaging must have the following characteristics:

1. They must be non-toxic.
2. They must protect the preparation from environmental conditions.
3. They must not be reactive with the product.
4. They must not impart tastes or odours to the products.
5. They must be FDA (Food & Drug Administration) approved.
6. They must meet applicable tamper-resistance requirements.

GLASS

Preparation of glass:

Glass is composed principally of sand (silica - SiO_2), soda-ash (Na_2CO_3 - sodium carbonate) and lime-stone (Ca CO_3-calcium carbonate).

Advantages of glass container

Physical aspect

1. They are quite strong and rigid.
2. They are transparent which allows the visual inspection of the contents; especially in ampoules and vials.
3. They are available in various shapes and sizes. Visually elegant containers attracts the patients.
4. Borosilicate (Type-I) and Neutral glasses are resistant to heat so they can be readily sterilised by heat.
5. Glass containers can be easily cleaned without any damage to its surface e.g. scratching or bruising.

Chemical aspect

6. Borosilicate type of glass is chemically inert. Treated soda lime glass has a chemically inert surface.
7. As the composition of glass may be varied by changing the ratio of various glass constituents the proper container according to desired qualities can be produced.
8. They do not deteriorate with age, if provided with proper closures
9. Photosensitive drugs may be saved from UV-rays by using amber colour glass.

Economical aspect

10. They are cheaper than other packaging materials.

Disadvantages:

1. They are brittle and break easily.
2. They may crack when subject to sudden changes of temperatures.
3. They are heavier in comparison to plastic containers.
4. Transparent glasses gives passage to UV-light which may damage the photosensitive drugs inside the container.

Type of glass	Main Constituents	Properties	Uses
Type-1 Borosilicate glass e.g. Pyrex, Borosil	SiO_2 – 80% B_2O_3 – 12 Al_2O_3 - 2% Na_2O+CaO - 6%	• Has high melting point so can withstand high temperature • Resistant to chemical substances • Reduced leaching action	• Laboratory glass apparatus • For injections and • for water for injection.
Type-II Treated soda-lime glass	Made of soda lime glass. The surface of which is treated with acidic gas like SO_2 (i.e. dealkalised) at elevated temperature (500^0C) and moisture.	• The surface of the glass is fairly resistant to attack by water for a period of time. • Sulfur treatment neutralizes the alkaline oxides on the surface, thereby rendering the glass more chemically resistant.	• Used for alkali sensitive products • Infusion fluids, blood & plasma. • large volume container
Type-III Regular soda-lime glass	SiO_2 Na_2O CaO	• It contains high concentration of alkaline oxides and imparts alkalinity to aqueous substances • Flakes separate easily. • May crack due to sudden change of temperature.	• For all solid dosage forms (e.g. tablets, powders) • For oily injections • Not to be used for aqueous injection • Not to be used for alkali-sensitive drugs.
Type NP Non-parenteral glass or General purpose soda-lime glass.			• For oral and • Topical purpose • Not for ampoules.
Neutral Glass	SiO_2 – 72-75% B_2O_3 – 7-10% Al_2O_3 – 6% Na_2O – 6-8% K_2O – 0.5 – 2% BaO – 2-4%	• They are softer and can easily be moulded • Good resistance to autoclaving • Resistant to alkali-preparations (with pH upto 8) • Lower cost than borosilicate	• Small vials (<25 ml) • Large transfusion bottles
Neutral Tubing for Ampoules	SiO_2 – 67% B_2O_3 – 7.5% Al_2O_3 – 8.5% Na_2O – 8.7% K_2O – 4% CaO – 4% MgO – 0.3%	• In comparison to neutral glass its melting point is less. After filling the glass ampoules are sealed by fusion and therefore the glass must be easy to melt.	• Ampoules for injection.
Coloured glass	Glass + iron oxide	• Produce amber colour glass • Can resist radiation from 290 ⟷ 400 ⟷ 450nm UV Visible	• For photosensitive products.

PLASTIC MATERIALS

Properties of Plastic Materials:

MATERIAL	ADVANTAGES	DISADVANTAGES	TYPICAL USES
High density polyethylene (HDPE) ρ = 0.955 g/cc	Inert, low cost, low water vapour transmission, tough.	Semi-opaque, transfer of taste ingredients, absorb dilute solutions.	Detergents, bleaches, milk, foods, cleansing powders, drugs & cosmetics.
Low density polyethylene (LDPE) ρ = 0.920 g/cc.	Squeeze property, inertness, low cost.	Relatively poor barrier to non-polar molecules and high water vapour transmission.	Cosmetics, personal products, foods.
Polystyrene ρ = 1.05 g/cc.	Clarity, stiffness, low cost.	High water vapor transmission, susceptibility to cracking, poor impact.	Dry drugs, petroleum jelly.
Rigid polyvinylchloride (PVC) ρ = 1.35 g/cc.	Clarity, stiffness, O_2-barrier, retention of non-polar molecules.	10-12 additives may be present, difficult to process, susceptible to organic solvent.	Shampoo, bath oil, detergent.
Polypropylene ρ = 0.90 g/cc.	Inert, low cost.	Low temperature brittleness, high concentration of stabilizer is present.	Drugs, cosmetics, syrups, juices.
Polyamide (Nylon6,10) ρ= = 1.10 g/cc.	Good barrier for non-polar molecules, tough, good O_2-barrier, sterilizable.	High cost, water absorption	Foods, drugs, cosmetics, aerosols
Polycarbonate ρ = 1.20 g/cc.	Very tough, clear, sterilizable	Cost, susceptibility to solvent cracking, poor barrier for water and O_2.	Drugs, cosmetics.
Acrylic polymers (PMMA =Polymethyl methacrylate) ρ = 1.10 g/cc.	Clarity, good for oils	Poor water vapor transmission, poor barrier for O_2.	Drug cosmetics.
Polyethylene terephthlate (PET)	Excellent strength, good barrier for gas and aroma.		Bottle for carbonated waters, mineral waters, mouth washes, cosmetics.

METALS

TIN

Advantages:

(i) This metal is very resistant to chemical attack.

(ii) Readily coats a number of the metals e.g. tin-coated lead tubes combine the softness of lead with the inertness of tin and for this reason it was formerly used for packaging fluoride toothpaste.

Disadvantages:

Tin is the most expensive metal among tin, lead, aluminium and iron.

Uses:

(i) Tin containers are preferred for foods, like milk powder containers are coated with tin.

(ii) Currently, some eye ointment still packaged in pure tin ointment tubes.

ALUMINIUM

Advantages:

(i) Aluminium is a light metal – hence the shipment cost of the product is less.

(ii) They provide attractiveness of tin at some what lower cost.

(iii) The surface of aluminium reacts with atmospheric oxygen to form a thin, tough, coherent, transparent coating of oxide, of atomic thickness, which protects the metal from further oxidation.

Disadvantages:

(i) Any substance that reacts with the oxide coating can cause corrosion e.g. products with the oxide coating can cause corrosion e.g. products of high or low pH, some complexing agents etc.

(ii) As a result of corrosion process H_2 may evolve.

Use:

(i) Aluminium ointment tubes.

(ii) Screw caps

(iii) Aluminium strips for strip-packaging of tablet, capsules etc. Some times internally lacquered aluminium containers are used to stop the reaction with the content.

IRON

Advantages:

Iron as such is not used for pharmaceutical packaging, large qualities of tin-coated steel, popularly called ‘tin’, combines the strength of steel with the corrosion resistance of tin.

Disadvantages:

If an aqueous liquid can penetrate a pinhole or other fault in the layer of tin, which is virtually a short-circuited galvanic cell is set up and the intense chemical reaction which results brings about rapid corrosion of underlying steel. As a further measure the tin surface is lacquered.

Uses:

Fabrication of milk containers, screw caps and aerosol cans.

LEAD

Advantages:

(i) Lowest cost of all the metals used in pharmaceutical containers.

(ii) Soft metal.

Disadvantages:

Lead when taken internally there is risk of lead poisoning. So lead containers and tubes should always have internal lining of inert metal or polymer.

Uses:

With lining lead tubes are used for such product as fluoride tooth paste.

RUBBER

Natural rubber consists of long chain polymers of isoprene units linked together in the *cis*-position. Its most important source is the tree *Hevea braziliensis* from which a latex, containing 30 to 40% of rubber in colloidal suspension, exudes when shallow cuts are made in the bark.

Composition of rubbers:

1. Raw rubber
2. Vulcanizing agent
3. Accelerators
4. Activators
5. Fillers
6. Softeners
7. Antioxidants
8. Pigments
9. Lubricants

1. BUTYL RUBBER

These are copolymers of isobutylene with 1-3% of isoprene or butadiene.

Advantages:-

(i) Water absorption is very low.

(ii) After vulcanization butyl rubber possesses virtually no double bond, consequently they are most resistant to aging and chemical attack.

(iii) Permeability to water vapour and air is very low.

Disadvantages

(i) Oil and solvent resistance is not very good.

(ii) Slow decomposition takes place above 130^0C.

2. NITRILE RUBBER

Advantages:

(i) Heat resistant.

(ii) Oil resistant due to polar nitrile group.

Disadvantage

Absorption of bactericide and leaching of extractives are considerable.

3. CHLOROPRENE RUBBERS (NEOPRENE)

these are polymers of 1:4 chloprene.

Advantages

(i) Heat stability is good (upto 150^0C).

(ii) This rubber is more polar hence oil resistant.

(iii) Due to the presence of –Cl group close to the double bond so the bond is resistant to oxidation hence these rubbers age well.

(iv) Water absorption and permeability are less than for natural rubbers.

4. SILICONE RUBBERS

Advantages

(i) Poor tensile strength.

(ii) Heat resistance (upto 2500C).

(iii) Extremely low absorption and permeability of water.

(iv) Excellent aging characteristics due to their saturated chemical structures.

Disadvantages

They are very expensive.