



## PHARMACEUTICAL PACKAGING TECHNOLOGY: A COMPLETE REVIEW

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### ABSTRACT

Packaging is the science, art, and technology of enclosing or protecting products for distribution, storage, sale and use. Packaging is system or mean by which the product will reach from production center to the consumer in a safe and sound condition & with minimum over loss. So many issues regarding the pharmaceutical product like stability, sell, patient compliance, etc are related with the packaging and in regard to this review is done on the various advancements in the packaging techniques and selection of packaging material, machinery & labeling. The present article reviews the various packaging materials, types of packaging in pharmaceutical industry.

**KEYWORDS:** Introduction, Types Of Packaging, Components Of Packaging, Packaging Materials, Types Of Packaging Materials, Machinery For Packaging, labeling, Types Of Labeling, Conclusion, Reference.

### INTRODUCTION

A pharmaceutical package container is an article or device which contains the pharmaceutical product and the container may or May not in direct contact with the product. The container which is designed for pharmaceutical purpose must be stable.

#### Ideal Qualities of a Pharmaceutical Packaging:

1. It should have sufficient mechanical strength so as to withstand handling, filling, closing and transportation.
2. It should not react with the contents stored in it
3. It should be of such shape that can be elegant and also the contents can be easily drawn from it.
4. It should not leach alkali in the contents.
5. The container should not support mould growth.
6. The container must bear the heat when it is to be sterilized.
7. The contents of container should not be absorbed by the container.
8. Any part of the container or closure should not react with each other.
9. The material used for making the container should be neutral or inert.
10. Closure should be of non toxic nature and chemically stable with container contents.

#### Types of Package

1. **Primary Packaging:** Primary packaging is that package which is in direct contact with the pharmaceutical formulation. The main aim of

primary package is to protect the formulation from the environmental, chemical, mechanical and other hazards.

2. **Secondary Packaging:** The package external to primary package is known as secondary package. This package provides additional protection during warehousing and also provides information about drug product for e.g. Leaflets.
3. **Functions**
  - a) Protect the flexible containers
  - b) Protection from tough handling during transportation.
4. **Tertiary Packaging:** It is outer package of secondary packaging and prevents damage to the products. It is used for bulk handling and shipping Examples: Barrel, crate, container, pallets, slip sheet.

#### Components of Packaging

1. **Container:** The containers refer in which the product/medicine is placed & enclosed .It is direct contact with drug.
2. **Closure:** It is tightly packs the container to exclude oxygen, carbon dioxide, moisture & prevents the loss of water and volatile substances from the products.
3. **Carton/outer:** Which give the secondary protection against mechanical and other environmental hazards. It is outer covering .Cartons are made up of cardboard, wood pulp etc.
4. **Box:** In this multiples of products are packed. It provides primary defense against external hazards.

The boxes are made up of thick cardboard and wood.

### Packaging Materials

The materials selected for packaging must have the following characteristics:

1. Mechanical properties.
2. Physico-chemical properties.
3. Biological properties
4. Pharmaceutical properties.
5. Economical aspects.
6. They must be non-toxic.

### Types of Packaging Materials

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

#### 1. Glass

- a) Type-1 borosilicate glass.
- b) Type-2 treated soda lime glass.
- c) Type-3 regular soda lime glass.
- d) Type-4 NP general purpose soda lime glass.
- e) Colored glass.

**Preparation of glass:** Glass is composed of principally of sand, soda ash and lime stone. Glass made from pure silica consists of a three dimensional network of silicon atoms each of which is surrounded by 4 oxygen atoms in tetrahedral way to produce the network.

#### Properties

- a) It is very hard.
- b) Chemically resistant.
- c) Structure is less rigid so low melting point.
- d) Glass made of pure silica.

#### Types of glass

##### A. Type-1 Borosilicate glass.

E.g. Pyrex, Borosil.

*Main Constituents:* SiO<sub>2</sub> 2-80%, Al<sub>2</sub>O<sub>3</sub> 3-2%, Na<sub>2</sub>O, CaO-6%

*Properties:* Resistant to chemical substances reduced leaching action.

*Uses:* Laboratory glass apparatus, for water for injection.

##### B. Type-2: Treated soda lime glass.

*Main Constituents:* Made of soda lime glass. The surface of which is treated with acidic glass like SO<sub>2</sub> at elevated temperature and moisture.

*Uses:* For alkali sensitive products, infusion fluids, blood & plasma, large volume container.

*Properties:* The surface of glass is resistant to attack by water for a period of time.

##### C. Type-3 Regular soda lime glass.

*Main Constituents:* SiO<sub>2</sub>, Na<sub>2</sub>O, CaO.

*Properties:* Flakes separate easily, many crack due to sudden change of temperature.

*Uses:* Topical use, for oral use, not for ampoules.

##### D. Type-4 NP (Non Parenteral glass or general

#### purpose soda lime glass).

*Uses:* Topical use, for oral use, not for ampoules.

#### Neutral glass

*Main Constituents:* SiO<sub>2</sub>-72 to 75%, B<sub>2</sub>O<sub>3</sub>-7 to 10%, Na<sub>2</sub>O-6 to 8%, K<sub>2</sub>O-0.5 to 2%, BaO-2 to 4%.

*Properties:* Lower cost than borosilicate, they are softer & can easily be molded.

*Uses:* Small vials (25ml), large transfusion bottles.

#### Colored bottles

*Main Constituents:* Glass+ iron oxide.

*Properties:* Produce amber color glass, can resist UV visible radiation from 290-400-450nm.

*Uses:* For photosensitive products.

#### 2. Metals

##### Advantages

- a) Metal containers are strong, relatively unbreakable opaque.
- b) Resistance to chemical attack.
- c) Impervious to water vapour, bacteria.
- d) Readily coats a number of metals.

##### Disadvantages

1. This is the most expensive metal among tin, lead, aluminum, & iron.
2. Currently some eye ointments still package in pure tin ointment tubes.

##### i. Aluminum

###### Advantages

1. Aluminum is a light metal hence the shipment cost of the product is less.
2. They provide attractiveness of tin at somewhat lower cost.

###### Disadvantages

1. As a result of corrosion process H<sub>2</sub> may evolve.
2. Any substance that reacts with the oxide coating can cause corrosion.

*Uses:* Aluminum ointment tubes, screw caps.

##### ii. Iron

###### Advantage:

Iron as such is not used for pharmaceutical packaging, large quantities of tin combines the strength of steel with corrosion resistance of tin.

*Use:* Fabrication of milk container, screw caps and aerosol cans.

##### iii. Lead

###### Advantages

Lowest cost of all metals used in pharmaceutical containers, 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 product such as fluoride tooth paste.

### 3. Plastics

General properties of plastics:

- Robust, strong, light, aesthetic.
- Plastics are synthetic polymers of high molecular weight.
- Easy to handle
- They are poor conductor of heat, a disadvantage, if the content is to be autoclaved.
- Very few types of plastics completely prevent the entry of water vapor and some are permeable to gases like O<sub>2</sub>, CO<sub>2</sub>.

#### Types of plastics

Plastics are classified in to two groups according to their behavior when heated.

- Thermoplastic type:** On heating, they soften to viscous fluids which harden again on cooling. E.g. Polyethylene, polypropylene, PVC, polystyrene, nylon etc.
- Thermosetting type:** When heated, they may become flexible but they do not become liquid, usually hard and brittle at room temperature. E.g.: Phenol,

formaldehyde, urea etc.

### 4. Rubber

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

- Butyl rubber.
- Nitrile rubber.
- Chloroprene rubber.
- Silicon rubber.

#### Machinery For Packaging

The machinery is an important technique for packing any medicines or other materials.

##### 1. Strip packing machine

###### *Application:*

This model is applied for the packing of tablets, candy and pills in medicine, healthcare, chemical, and foodstuff industry etc with automatic double-aluminum foil hot sealing. Meeting the requirement of sealing for avoiding light, and also it is for double plastic hot sealing packing



**Fig. 1: Strip packing machine**

##### 2. Blister packing machine

It is high quality machine, which are suitable for handling automatic loading, filling or none stop feeding. Blister packaging machines are used by pharmaceutical industry to pack capsule and tablets. The packing process initiates with the capsules or tablets being loaded in to a hopper and then in to feeder which in turn can either be

linear feeder or a brush box feeder depending on the shape of the product and also the terminal to be used.

###### *Applications:*

- Unit dose hospital packs.
- Ampoules & vial tray packs.
- Multi product and child resistant blister packs.



**Fig. 2: Blister packing machine.**

##### 3. Cartoning machine

This machine is applied to automatically box packing for medicine board, medicine bottle, soft box with palletized

granule and ointment. Such as automatically boxing package of medicine, cosmetics. This machine features stable performance, compact structure and beautiful

appearance. And it can automatically print stainless steel stamp. It has multi-function identification system. Automatically stopping or elimination when no tablets or vials are available. Cartoners have an output ranging 30

to 300 cartons per minute depending on whether the machine is vertical loading, intermittent cartooning or a continuous motion model. These machines can handle blister stripes & other pharmaceutical packing.



**Fig. 3: Cartoning machine**

#### 4. Ampoule filling machine

These high precision machines completely encase the product in the inert glass & do not have a rubber stopper or any other material in direct contact with the drug. The line can be applied to fill 1-20ml ampoule with automatic procedures as follows: Ultrasonic washing, three times

water washing (twice circulating water washing, plus one time fresh water washing), three time air spraying, drying and sterilizing cooling, liquid filling and protection gaseous filling (compressed air filling and nitrogen filling).



**Fig. 4: Ampoule filling machine.**

#### 5. Liquid filling machine

##### Description

It features advanced control system, accurate filling, stable performance, excellence appearance.

1. Ideal equipment for filling liquid injection and lyophilization injection.

2. Imported peristaltic pump system has high filling accuracy.
3. Completely 100% purifying laminar flow protection.
4. With function of stop filling without vial.
5. It can automatic count the filled vials.



**Fig. 5: Liquid filling machine.**

#### 6. Syringe filling machine

These machines are high precision & reliable machines

used to fill syringes, cartridges and other related containers. Filling is done with the help of rotary piston pumps. The machines format spectrum can range from 0.2 to 29ml.

1. *Semi automatic syringe filling machine:* These machines require manual operators for loading the syringes in to the machine which are then filled &

capped automatically. Applications include oral dosage syringe & dental gels.

2. *Fully automatic syringe filling machine:* These high speed and compact machines automatically fill and are used for saline flush syringes, dental gels and oral dosesyringe.



**Fig. 6: Syringe filling machine.**

#### 7. Automatic labeling/ gumming/ stickering machine

##### *Description*

1. Fully automatic labeling machine is useful to place label accurately on round shape of product.

2. Full/ partial wrap labeling can be possible. A unique feature of machine is if the body diameters changes, and then also machine operates without change part.

3. Labeling speed is automatically synchronized with conveyor speed to ensure quality.



**Fig. 7: Automatic labeling/ gumming/ stickering machine**

#### 8. Pharmaceutical printing machine

##### *Description:*

This machine is suitable for printing labels, batch number, validity time and series numbers on the surface

of cartons, tissue paper, non-ferrous plastic film and aluminum film. No matter with the dry-ink roller or instant liquid ink, it has the features of instant printing and instant drying, and strong adhesion.



**Fig. 8: Pharmaceutical printing machine.**

### Labeling

*Defination:* Labeling is the term used in the pharmaceutical industry. It is the information that appears on a bottle or package. It gives the best information about a drugs quality, efficacy and safety. The term labeling designates all labels and other written, printed or graphic matter upon or in any package or wrapper in which it is enclosed. The label states that a name of the preparation, percentage content of drug of a liquid preparation, the volume of liquid to be added to prepare an injection or suspension from a dry preparation, the route of administration, a statement of storage condition and expiry date . Also indicate the name of manufacturer or distribution.

### Types of Labels

Various materials are used for labeling such as paper, foil and fabric. It is also possible to print directly on a bottle or other containers by means of silk screen or hot transfer process .Choice will depend on need and economy.

1. *Paper labeling:* Most labels are printed on paper, since it is the most economical method, whether the quantities are large or small. There is limit to the colors and techniques that can be used in case of paper label.
  2. *Foil labels:* It is nearly always necessary to laminate foil with paper so that the label will work properly in the labeling machines. The foil and paper together should measure 0.0025 to 0.003 inch for best results.
  3. *Transfer labels:* These are several processes for transferring heat sensitive inks from a pre-printed strip to the container that is to be decorated .These are known by the trade names of.
    - Therimage
    - Electoral.
- a) *Sleeve labels:* These are two types of sleeve labels
- i. Stretch band and
  - ii. Shrink tubing

### Method of Applying A Label

1. *Hot melts:* A simple method of applying a label to a package is with a pasting out board. Glue is put on the board with a brush and the labels are laid face upon the glue. They are manually removed and

placed on the containers.

2. *Semi automatic labeling:* With this method the operator places the container in position and the machine applies the label. The speed of the operation is usually dependent upon how fast the operator can remove the container and put a new one in its place. About 3600 per hour is the maximum ideal condition.
3. *Fully automatic labeling:* Glue is applied to the bottle by a rubber pad, often which the label paper of labeling. Bottle and back again leaving a label adhering to the bottle, pressure station complete the operation of labeling.

### CONCLUSION

In recent decades pharmaceutical packaging technology is an important technique in pharmaceutical industry. After formulation, the next step is packaging. It is an important process in pharmaceuticals because it provides the protection for products, identification & protection against the physical damage and also gives the attractiveness for the products & improves the patient compliances. Some researcher are going on the packaging for better results and pharmaceutical companies increasingly are working to improve productivity and reduce costs in their manufacturing and packaging operations, it gives the good quality of packs & good sales & also economical results. Expanding markets and innovative marketing strategies have led to an increased demand in packaging products.

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