

## Collapsible Tube for Pharmaceutical Use

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### ABSTRACT

This article is based on collapsible tube requirement for pharmaceutical use. Since pharmaceutical product are very much sensitive towards degradation with respect to moisture and air. After product reaction with air (oxygen) and moisture their self life is reduced and may not be used as medication. The Aluminium collapsible tube are impervious for moisture and air (oxygen) also its collapsible or dead fold property does not allow to keep air inside tube, that again reduce the chance of reaction. Quality & uniformity of lacquer coating in collapsible tube, is very important for product compatibility and quality for long term study and use.

**Keywords:** Collapsible tube, Lacquer coating, Impact extrusion process, Printing.

### INTRODUCTION

Collapsible tubes made of tin, tin alloy or aluminium as they are commonly used for containing and delivering liquid, viscous or pasty products such as tooth pastes are generally fitted with a lid so as to be perfectly air tight. The majority of medical creams and ointments are marketed in collapsible tubes made from aluminium. Manufacturing the collapsible metal tube comprises: Spray coating a dispersion of fine spherical particles of a metal adhesive thermoplastic resin on the inside wall surface of a metal body portion open at one end of a collapsible tube comprising the metal body portion plastically deformed without difficulty, and a neck portion connected to the other end of the body portion, to form a coating of uniform thickness and heating the coating to fuse the fine spherical particles of the resin, thereby forming a metal-adhesive thermo-plastic resin layer<sup>9</sup>. When internally lined with the appropriate lacquer, collapsible aluminium tubes serve as a stable corrosion-free packaging<sup>10</sup>. Metal tubes are impermeable to moisture, gas, odour and light provided they are adequately closed<sup>1</sup>. Aluminum has superior "dead fold" characteristics, which give it the ability to remain bent or folded without rupturing. This quality is necessary for a container that is designed to be squeezed and folded as the dispensing method<sup>11</sup>. They are convenient for a customer or patient to use and as the contents are expelled by squeezing the tube, there is no tendency for the walls to recover their original shape when the pressure is released. Consequently the risk of air entering the pack and reacting with the product or

causing it to dry out is minimized. Internal coating may be necessary to prevent chemical reaction<sup>1</sup>.

The tube itself is absolutely scent-neutral and can be sterilized and coated with an inert internal lacquer. Aluminium permanently prevents the penetration of oxygen. This essential barrier property makes the aluminium tube a most appropriate and well established packaging in the food, cosmetic and pharmaceutical markets<sup>8</sup>.

The ductile metals used for collapsible tubes are tin (15%), aluminum (60%), and lead (25%). Tin is the more expensive than lead. Tin is the most ductile of these metals. Laminates of tin-coated lead provide better appearance and will be resistant to oxidation. They are also cheaper compared to tin alone. The tin that is used for this purpose is alloyed with about 0.5% copper for stiffening. When lead is used, about 3% antimony is added to increase hardness<sup>8</sup>.

### Products description<sup>7</sup>

Material Aluminium Slugs with or without holes Alloy AA1070, Purity 99.70% minimum, Grain Sizes Grain 5, and Hardness 16 to 19 HB

Thickness 3.00 mm. to 10.00 mm

Diameters: The following are the different diameters that can be readily available 20mm, 25 mm, 27mm, 40mm, 45 mm, 50 mm, 54 mm, 63.5 mm, 74 mm, 75 mm, 85 mm, 89 mm 90 mm and 116 mm.

### Chemical Composition (%maximum allowed by element)<sup>7</sup>

>% Si -0.1, >% Fe -0.2, >% Cu -0.04, >% Zn -0.04, >% Mg -0.03, >% Mn -0.03, >% Ti -0.03

>% Other -0.01

## METALS

### TIN

Tin containers are preferred for foods, pharmaceuticals, or any product for which purity is an important consideration.

#### Advantages

Metal is very resistant to chemical attack. 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.

### ALUMINIUM

Aluminum tubes offer significant savings in product shipping costs because of their light weight. They provide good appearance.

#### Advantages

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

They provide attractiveness of tin at somewhat lower cost.

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

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.

As a result of corrosion process  $H_2$  may evolve.

### LEAD

Lead has the lowest cost of all tube metals and is widely used for nonfood products such as adhesives, inks, paints, and lubricants

#### Advantages

Lowest cost of all the 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.

### Linings<sup>7</sup>

If the product is not compatible with bare metal, the interior can be flushed with wax-type formulations or with resin solutions, although the resins or lacquers are usually sprayed on. A tube with an epoxy lining costs about 25% more than the same tube uncoated. Wax linings are most often used with water-base products in tin tubes, and phenolics, epoxides, and vinyls are used with aluminum tubes, giving better protection than wax, but at a higher cost. When acidic products are packed, phenolics are used and for alkaline products, epoxides are used.

### MANUFACTURING PROCESS

The impact extrusion process is used to produce open-ended collapsible tubes from softer metals such as tin and lead. When aluminium is used, it work-hardens during the forming process and the resultant tubes must be annealed to regain flexibility. Alternatively aluminium tubes may be left in their work-hardened state as rigid containers. Impact extrusion is a particularly useful process to produce containers with a high length to diameter ratio, e.g. up to 7:1<sup>2</sup>.

The basic extrusion process used for metal collapsible tubes is identical with that used to produce rigid aluminium containers except that the slugs used are rings rather than discs and the female die which holds the slug is shaped so that the metal is forced downwards into the die to form the shoulder and nozzle as well as upwards around the plunger (Figure 1.0). The formed tubes then pass to a trimming machine where they are cut to length, a thread cut or rolled on the nozzle, and the face of the nozzle orifice cleaned. The shoulder, which is relatively rigid, may be decorated, e.g. with concentric rings, if required. The tubes are then ready for the finishing operations of internal coating, enamelling, printing and capping. Whereas rigid containers can only be produced from aluminium, collapsible tubes can be produced from any of the softer metals such as aluminium, tin, lead and tin/lead alloys. Aluminium tubes must be annealed after forming and finishing, otherwise they are too springy this process also serves to remove all traces of lubricant. Tin is the least reactive of the metals available, is very bright and is also non-toxic. However, it is inherently expensive and its usage is therefore restricted to pharmaceuticals such as antibiotic and some ophthalmic ointments where maximum protection is required. Lead-based tubes are now not recommended for pharmaceutical products, for toxicity reasons. The majority of collapsible tubes are made from aluminium,

which is relatively cheap but subject to attack by some acidic or alkaline products. The widespread use has been made possible by the development of internal coating systems which are sprayed into the tube immediately after forming it. A wide range of coatings are used including vinyl, epoxy and phenolic resins. The use of epoxy and phenolic resins is restricted to aluminium tubes due to the high curing temperatures required. Most internal lacquering systems involve two coatings, the first being partially dried before applying a second coat and drying completely. Needless to say, where lacquers are used it is essential that they be pinhole-free for the whole length of the inside of the tube, including the interior

of the nozzle. After the internal coating has been applied the tubes are enamelled externally, baked, printed and the print dried by heating again. It is essential that the enamel and print—as well as the internal coating—be flexible or the tube may become unsightly when the product is dispensed. The finished tubes are then capped automatically and packed into shipping outers for dispatch to the packers. Tubes are normally packed open end upwards, for ease of removal, in fully divisional slip lid fibreboard outers, sufficiently rigid to protect the tubes from denting in transit and impeding the filling and closing operation. It is also important to avoid contamination of the open tubes during transit and in storage<sup>1</sup>.

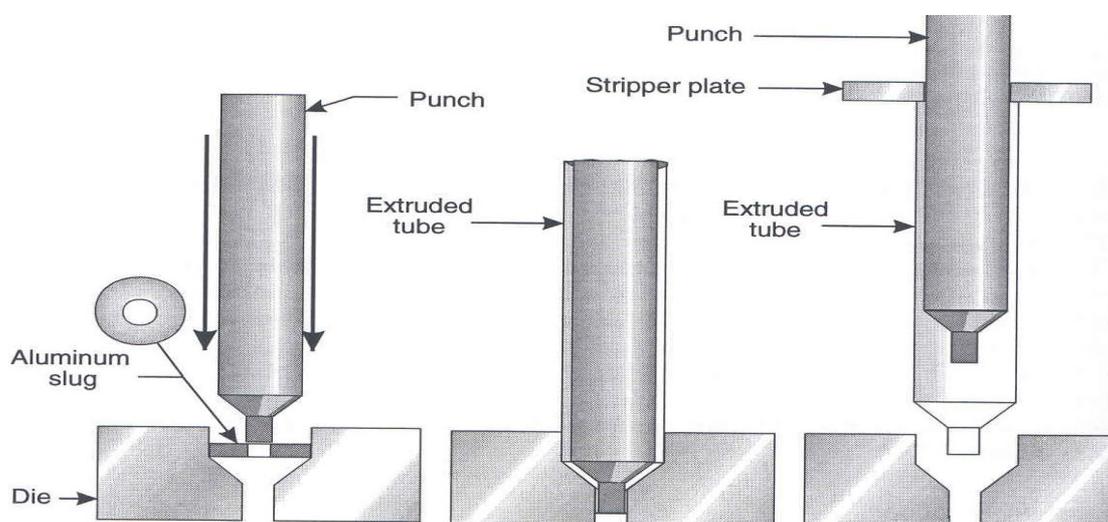


Fig. 1: Collapsible metal tubes produced by impact extrusion<sup>1</sup>

#### Use of coatings for collapsible packaging<sup>4</sup>

Collapsible tube packaging's are normally coated on one or both sides. The inside (product contact) coating is referred to as an internal coating, lacquer or enamel and the outside as external coating, enamel, ink or varnish<sup>4</sup>.

#### Collapsible tube packaging is coated for many reasons such as

##### Internal (product contact) coatings

- Provide protection of the contents from the metal.
- Provide protection of the tube from the contents of the tube – e.g. acidic, alkaline or sulphur product may cause problem.

##### External (non-food contact) coatings

- Provide protection of the metal from the environment – e.g. atmospheric corrosion
- Support decoration, labelling and consumer information

- Influence mobility (friction) of the article during filling operations
- By reducing tool wear for tin-free steel (TFS) substrates. Tin on the surface of steel (electrolytic tinplate – ETP) “lubricates” the metal during deformation, whereas steel without a tin layer is very abrasive and the presses used for forming would rapidly wear out.
- By assisting tooling for aluminium substrates.

Coatings are applied to metal and after thermal treatment (cure schedule or staving) form a dry (final) film on the metal. Most coatings are applied as a wet film. The major constituents in a coating as applied to the metal include:

- Resin(s)
- Cross-linking agents (almost always present)
- Additives
- Solvents (not always present).

The first three components are incorporated into the dry (final) film. In case a solvent is

used, it evaporates during the cure schedule. The film, which is in contact with food, must comply with relevant food regulations as discussed in the chapter on regulatory aspects. Unlike most plastics, the majority of coatings only attain their final properties after the wet (applied) film has undergone further chemical reactions, normally during the cure schedule. Typically the resin(s) would react with one or more cross-linking agents (or resins), which join individual resin molecules together to form a three-dimensional cross-linked network. It is this network and the density of crosslinks in combination with the different molecules used in the resins that give the corrosion resistance and flexibility, amongst other properties, of the final film<sup>4</sup>.

#### Applying and curing coatings<sup>4</sup>

Internal coatings for metal packaging are typically applied by either roller coating or spraying before undergoing a cure schedule (staving or baking). The metal to be coated can be shaped as a sheet, coil or preformed object. As in many cases the coatings are applied before deformation of the metal to form the container or cap, the coating has to withstand severe mechanical deformations (e.g. for lug closures, crowns, ends and some

shallow drawn cans). Because internal lacquers are primarily intended for protection, the cure schedules for internal lacquers tend to be more severe and longer than those used for external systems. Typically, industry defines the cure schedule necessary to ensure a specified performance as peak metal temperature (pmt). This is the minimum metal temperature at which a coating must be held for a specified time and is often given as a cure window, e.g. 195–205°C for 10–12 min for a sheet-fed product and perhaps 10–20 s at 270–230°C for a coil-coated product. Each coil line is different and requires different conditions. The amount of a coating applied to the metal packaging is quoted in weight per area (e.g. g/m<sup>2</sup>) or weight per can (e.g. mg/can). This weight refers to the coating remaining on the metal after curing. Weight per area is normally used for sheets, i.e. for food applications, whereas weight per can would be used for preformed objects such as beverage cans. For food, the range is typically 5–15 g/m<sup>2</sup> and for beverages weights in the range 110–180 mg/33cl can would be typical, depending on whether the can was aluminium or ETP and whether beer or soft drinks were to be packed<sup>4</sup>.

**Table 1: Types and properties of resins used in internal can coatings<sup>4</sup>**

Type	Nature	Flexibility	Pack resistance	Main end-uses
Epoxy-phenolic	High molecular weight epoxy resins cross-linked with phenolic resole resins	Good	Very good	Universal gold lacquer for three-piece cans Shallow drawn cans
Organosol	PVC dispersed in an appropriate varnish and conventionally stabilised with a low molecular weight epoxy resin or novolac epoxy resin. Epoxidised oils can also be used	Very good	Very good	Drawn cans Easy-open ends Often used over epoxy phenolic basecoat.
Epoxy-anhydride	High molecular weight epoxy resins cross-linked with anhydride hardeners	Good	Very good	Internal white for three-piece cans
Epoxy-amino	High molecular weight epoxy resins cross-linked with amino resins. Also Side seam stripes epoxy acrylic water- Some food systems based spray internals for B&B DWI	Good	Limited	Universal lacquer for beer and beverage cans (water reducible)
Polyester	Polyester resins cross-linked with Resins. May contain lower Molecular weight Epoxy resin	Very good	Pack - dependent	May not be suitable for very acidic and amino or phenolic aggressive foods
Phenolic	Phenolic resin(s) Which self-crosslink (Cure)	Very poor, but film quality is weight-dependent	Excellent particularly for aggressive foodstuffs	Drums and pails where flexibility is not a
Oleoresinous	Naturally occurring	Variable	Pack-dependent	Very limited uses

The single most widely used class of resin in use today for metal packaging, with epoxy phenolic coatings finding the largest application. Epoxy resins are cross-linked through both their hydroxyl and oxirane functionalities, using phenolic or amino resins and occasionally an anhydride oligomer. All of the roles currently met by epoxy-based systems. Polyester based coatings can be thermoplastic, as used in side seam stripes, or they can undergo cross-linking reactions (typically through their hydroxyl functionality) with a number of systems, such as phenolic resins, amino resins (particularly melamine formaldehyde resins) or poly-isocyanates. The higher the number of hydroxyl groups available for reaction, the greater the potential cross-linked density of the cured film. Increasing cross-link density typically decreases flexibility, but increases chemical resistance. Amino resins are based on the reaction products of urea, melamine or benzoguanamine with formaldehyde and frequently a low molecular weight aliphatic alcohol. Their prime use in coatings for metal packaging is as a cross-linking resin for either epoxy or polyester resins. Amino resins are normally complex mixtures, partly because they typically undergo some degree of self-condensation reaction during their manufacture. During the curing process, they react with functionalities in the other resins present in the coating, as well as undergoing some self-condensation reactions, which can give rise to "clusters" of amino resin moieties in the cured coating. Phenolic resins are based upon the reaction products of phenolic monomers such as phenol, cresols, xylenols or mixtures of these with formaldehyde and frequently a low molecular weight aliphatic alcohol. Their prime use in coatings for metal packaging is as a cross-linking resin or adjuvant; however, they can undergo self-condensation (cross-linking or curing) reactions without any other resins being present. Phenolic resins are complex mixtures, partly due to self-condensation reactions occurring during their manufacture. Whilst phenolic resins will self-condense to give a chemically resistant film, the resulting flexibility is very limited and for most applications phenolic resins are "plasticised" with epoxy resins, with which they react yielding a cured film. Epoxy phenolic coatings normally generate a "gold" colour when cured due to the chromophores in the phenolic resin. Indeed, epoxy phenolics are often referred to as "gold" lacquers and colour can be used as an indication of degree of cure for a given system. The white coatings are made by the

addition of titanium dioxide, often in an epoxy anhydride coating or sometimes an organosol. Aluminium is added to a coating to give a grey "aluminiumised" appearance to the final film<sup>4</sup>.

### 1.0 Lacquer damage<sup>5</sup>

Three main types of damage are common with impact extrusions, particularly with collapsible tubes, all of which substantially impair the corrosion resistance of the aluminium itself, and the lacquer films.

These are as follows:--

#### 1.1 Excessive extrusions Marks

Processing lines are inevitable but are to a large extent dependent on the condition of the tools used in extrusion, and should be shallow and smooth. Deep torn marks cut through the lacquer film when enamellings and printing pressures applied, and it is quite usual to see a lacquered tube or container which has corroded along the whole length of a deep extrusion line<sup>5</sup>.

#### 1.2 Cross scoring

These are a very potent source of trouble. Where these transverse scratches intersect extrusion lines, little "sore spots" of broken metal are formed which act as nucleic of corrosion on unlacquered metal, and which give weak area so fun supported film in the case of lacquered containers<sup>5</sup>.

#### 1.3 Knurl marks

These apply mainly to tubes, but can also occur it narrow necked rigid containers, and are caused by the use of steel knurled points or printing fingers, which grip the container internally in the nozzle or container neck, leaving deep cuts or torn metal. It is possible to obviate these by using alternative devices<sup>5</sup>. A second factor associated with knurl point damage is that fragment so if metal may be partially detached from the neck area and protrude through the lacquer film. Heavy areas of copper deposited on otherwise flawless films during electro-chemical sting, are nearly always located where small particles of swarf are trapped in the dry lacquer<sup>5</sup>.

The next factor to be considered is the adhesion of protective films to container walls. All the modern lacquers in use have excellent adhesion, but can fail drastically in this respect after contact with product under certain conditions and it is a fact that a film which gives adequate protection when adhering strongly to the metal substratum will afford little or no protection, even though its continuity and cohesion remain unaffected then it becomes detached. In other words, it is

possible for the lacquer film to become a loose membranous bag, and whilst still containing the product, it allows component so penetrate and attack the metal. One of the very early signs that this type of attack is starting, is a pronounced increased stiffness of the product<sup>5</sup>.

**2.0. There are three main causes of loss of adhesion in use, assuming at the coating material is not at fault in this respect, and that optimum staving conditions have been observed<sup>5</sup>**

### **2.1 Lubricant Residues remaining under the dried lacquer film**

It is very easy to be misled, as tests on newly applied coatings which have not been in contact with product invariably give equal results to those obtained with specimens free from lubricant residues. It is only after ageing contact with the product, that adhesion losses become apparent. Much controversy has raged about the part played by the lubricant itself, bearing in mind that the best lubricants for impact extrusion are, quite frequently, those which are the most difficult to remove, and in the case of collapsible tubes, no actual degreasing is used--the lubricant is intended to be removed by annealing. Further, that whatever lubricant is used is very strongly attached to the metal surface, and if any appreciable time elapses before annealing in the case of collapsible tubes or degreasing in the case of rigid containers, it become almost impossible to guarantee complete lubricant removal. Many instances are known of adhesion failures in service of containers which have been subjected to, and passed stringent coating tests when newly produced. There is little doubt that these are due to the fairly long term effects of lubricant residues<sup>5</sup>.

### **2.2 Film Penetrators in the product**

certain ingredient used in many products packed in tubes and containers are known to rapidly penetrate the lacquer films particularly epoxy based lacquers. These materials rapidly destroy the adhesive forces at the metal/lacquer interface. Chief among these are the following:--

Irish moss and associated gums.

Sodium alginate under certain conditions

Menthol

Methyl salicylate and similar esters

Usually this particular difficulty can be overcome by slight reformulation of the product. With the gums, by substituting tragacanth, karaya, locust bean, sodium carboxymethyl cellulose or methyl cellulose all of which are innocuous<sup>5</sup>.

### **2.3 Oxide Films on the metal**

The type of oxide film formed on aluminium containers is dependent on the annealing process in the case of collapsible tubes; the types of degreasing used, and on subsequent drying in the case of rigid containers and in both cases on the length of time the containers are exposed to atmosphere before application of the lacquer. All these conditions should be controlled to give the optimum oxide film for maximum adhesion. Rigid aluminium containers may be anodized to give maximum corrosion resistance and lacquer adhesion.

The point should also be made in connection with collapsible tubes concerning the difficulty in obtaining adequate coatings in the nozzle owing to the restricted diameter, and it should be noted in connection with very aggressive products that lacquer films in the nozzle area are invariably much weaker than on the remainder of the tube. From the foregoing general outlines, two main conclusions can be drawn.

1. It is possible to draw up a code of good practice for producing containers using a one lacquer system i e., one lacquer irrespective of the number of coats employed.
2. It is possible to develop further systems for dealing with corrosive products to overcome the defects inevitable with system

Dealing with system (1), the following simple rules should be observed:--

- a) The lacquer itself must be suitable chemically.
- b) Their minimum optimum film Weight must determine and the degree of cure of the film. These must be controlled to fine limits by a properly designed inspection scheme.
- c) The lubricant used for impact extrusion should be purely organic. Metallic soaps, such as zinc stearate should be avoided, and if water soluble compounds e, .g. ethoxylated lanolines can be used, so much the better, as subsequent degreasing is going to be more effective.
- d) There must be minimum delay between extruding and annealing or degreasing.
- e) With rigid containers solvent degreasing should be avoided. Aqueous treatments giving a chemically clean surface and slight etch should be used, and there should be no delay between final rinse and drying.

- f) The containers themselves should be free from deep extrusion lines and torn metal.
- g) Cross scoring should be absent.
- h) Knurl Marks should be absent from the nozzles of collapsible tubes.
- i) The containers should be processed on plastic covered spindles for Operations subsequent to lacquering.
- j) There should be minimum delay between annealing or decreasing and internal lacquering.
- k) The nozzle diameter of a collapsible tube should be as large as possible to permit effective lacquering, or alternatively, a plastic nozzle may be used.

In addition, with aluminium collapsible tubes the annealing conditions should be such that there is maximum lubricant removal as well as the formation of the optimum oxide film for lacquer adhesion. This involves something of a compromise, as cleaning of the surface is more efficient at higher temperatures whilst the type of oxide film formed at the set temperatures is not the one that gives maximum adhesion. Dealing with our second conclusion, it is very obvious that one of the main drawbacks to present one-lacquer systems is the fact that the lacquer is applied at an early stage of the container's production, i.e., following annealing or degreasing and that no matter how many coats are applied how good the film build, damage and possibly contamination must occur during subsequent operations. Secondly there is a limit to the film thickness which can be applied without brittleness. Finally, high speed automatic spraying leaves something to be desired in the way of continuity. Recent systems overcome these defects by utilizing two coats of dissimilar materials, the second coat being applied at the final stage of the container's production. This type of system gives very good protection, for apart from compensating for flaws in the first lacquer coat, the barrier provided by a laminate of dissimilar organic materials has very high resistance to penetration. Flush coated wax and spray coated vinyl-based lacquers are at present in production as final coats for use with corrosive products although wax itself, and spray coating in the case of the vinyls leave

much to be desired. Development work in this connection is mainly directed at substituting thermoplastic polymers for wax, and flush coating plastisols or organosols based on high molecular weight vinyl resins, in place of spray coated vinyl lacquers. In this way, very thick films of inert solids can be built up as a final coat<sup>5</sup>.

#### **Printing process of Collapsible tube: Rotary dry offset letterpress**

Metal containers produced by impact extrusion must be decorated as the last stage rather than the first stage. The process normally used is rotary dry offset letterpress<sup>2</sup>.

This is a relief printing process in which the image areas are raised above the level of the non-image areas and transferred from the inked printing plate to the metal surface by means of an intermediate resilient rubber surface<sup>1</sup>.

A dry offset process using either thermally or UV-cured inks. The tube is pushed on a mandrel and rolled past a curved printing blanket, which applies up to six colors simultaneously<sup>2</sup>.

A base coat of white enamel is first applied to the container by roller coating and set by partial baking, which aids keying of the inks at the printing stage. The base coat can also extend marginally around a corner radius, e.g. at the base of a rigid tube or over a bead or shoulder where present. However, the next operation of printing itself is restricted to the cylindrical surface as the actual (relief) printing plate is wrapped around a cylinder in a similar manner to a lithographic plate. Each tube is supported separately on a mandrel which can rotate freely on its axis. The inking stations apply their separate images to the same rubber-faced blanket cylinder and the composite image is transferred to the tube in a single revolution of the latter. The printed tubes are then dried again. The tubes are held on pins for both the initial base coat baking cycle and the print baking cycle. A period of 4 min at 170–230°C is normally adequate, depending on the nature of the enamel and the inks. Where there is a possibility of the product reacting with the decoration, an over-vernish is applied by roller coating, and set by baking<sup>2</sup>.

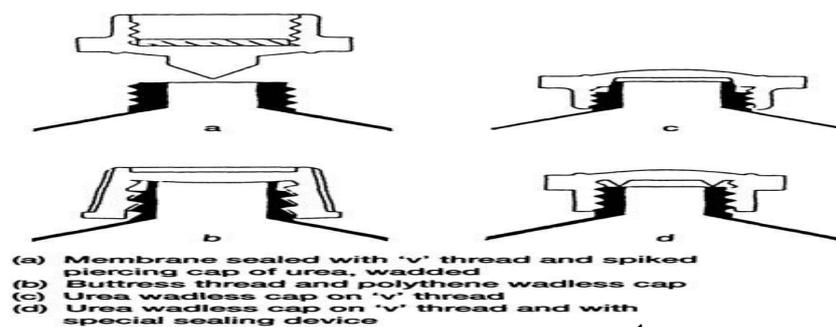


Fig. 2: Caps for collapsible tubes<sup>1</sup>

### Closures and closing

The majority of reclosable tubes are fitted with screw closures or flip-top variants on screw closures. The choice of liner facing depends on satisfying product compatibility requirements. Injection moulded polyethylene and polypropylene closures have gained ground. This is achieved by shaping the tube,

folding it over on itself and crimping it. In general the effectiveness of the closure increases with the number of folds. However, it should be borne in mind that the more complex folds require a greater length of tube. A saddle fold requires 10 mm more than a double fold (Figure 3.0)<sup>1</sup>.



Fig. 3: Metal tube-end closures: typical folds<sup>1</sup>

### Nozzles

Collapsible tubes are produced in a range of standard diameters, the length being selected to suit the required fill volume and method of closing. The nozzle and orifice size are governed by the viscosity of the product and the amount to be dispensed per application. Many pharmaceutical products require special applicator to dispense the products from nozzles<sup>1</sup>.

### CONCLUSION

The Aluminum collapsible tube very important application in the field of pharmaceutical industry. It provides best option for semi solid formulation that is very sensitive towards degradation due to small exposure of environmental stress. It provide best packaging for semi-solid because it is impermeable to moisture, gas, odour and light. It is mitigating the risk of air entering the pack and reacting with the product or causing it to dry out is minimized.

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