White Paper

Tube Fillers

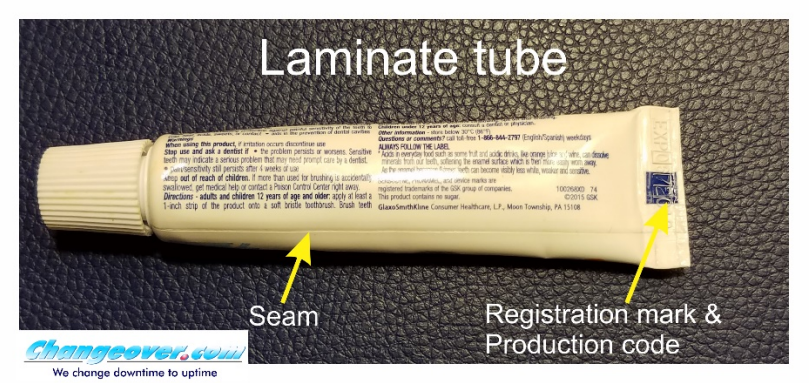
By John R Henry

When we think of collapsible tubes we most likely think of toothpaste since we all use it every day. Tubes are also used for packaging many other products such as foods, pharmaceuticals, cosmetics, candy and more. Tubes can be used for any liquid from very thick like silicone caulk to as thin as water. Occasionally tubes are even filled with powder. Tube filling/sealing speeds run from 20-30ppm to 500+ppm.

The first thing to know about tubes is that there are 3 major types. All are handled the same way except for closure and sealing.

- Laminate tubes are probably the most common type. Most toothpaste is packaged in laminate tubes. Laminate tubes are made from multi-layer film. The flat film is formed into a tube, sealed longitudinally and cut to length. One end of

the tube is closed with a plastic tip and cap or other fitment which is sealed to the laminate. The tubes come to the tube filling machine closed on one end, open on the other and ready for filling. Most laminate tubes are susceptible to denting and must be handled carefully during filling and packaging to maintain the pristine appearance. Most laminate tubes are formed offline and brought to the filler ready to run. In high speed, high volume, operations, the tube making machine is sometimes run in close conjunction with the tube filling machine.



- Metal tubes are stamped from aluminum or other metal blanks. The entire tube is a single monolithic component. Metal tubes are crimped closed. They dent easily so gentle handling during transport, filling and packaging is a must.
- Plastic tubes are made from various single or multi-layer plastic, injection molded to form monolithic tube, closed with fitment on one end and open for filling on the other. Plastic tubes are usually fairly rigid and do not collapse in use. This renders them very durable on the filling and packaging lines and much less sensitive to denting than laminate or metal tubes. While the rigidity makes them easy to run, it makes them harder for the consumer to use since they do not collapse. After squeezing the product out, the tube returns to its original shape, sucking air into the tube.

Empty tubes generally come to the filling machine in single-layer partitioned cartons, packed open side up. At the tube filler, the cover of the box is opened by the operator or automatically by machine, exposing the open end of the tubes.

The tubes are then loaded into the filler infeed bopper individually or by dumping the entire box. Loading method depends on filler design, speeds and box style. Either type of loading may be manual or automated.

If tubes are removed individually, as opposed to dumping, they are usually removed 1-2 rows at a time from the box. In low speed lines an operator may use a device that looks like a series of bottle brushes mounted side by side. These are spaced on the tube centers in the box and the diameter is slightly larger than the inside diameter of the tube. The operator shoves the brushes into the tube and friction between bristle and tube allows them to lift the tubes out. They group of tubes is laid in the hopper and the brushes pulled out.

A similar method is used on higher speed machines, sometimes with a robot or a pick and place system. Instead of the brushes, a more positive system uses either an expanding mandrel or vacuum. This also allows simpler release of the tubes in the filler hopper.

Higher speed machines may automate tube loading with a robot. This robot has grippers as above but they will be articulated. When picked from the box, the tubes and picking fingers will be close together. After clearing the box, the fingers will separate to match the centers of the filler's tubeholding pucks.

These pucks hold the tube by the closed end, with the open up, through the filling and sealing process. The pucks are commonly of plastic or plastic and aluminum. Internal springs hold the tube tightly to prevent rotation. Serrations on the bottom of the puck match serrations on the carrier base to prevent it rotating.

The carrier base may be a rotating turret for lower speed machines or chain in rounded rectangle or “racetrack” layout in higher speed machines. Pucks may index one at a time or in multiples of two, four, eight or more for high speeds. Either turret or chain are intermittent motion, indexing the tube through the various stages.

Once loaded in the puck, the first step is usually an air cleaning. The tube indexes under a nozzle which lowers to near the bottom of the tube. A blast of ionized air blows any dust or debris that might be present. Ionized air is used because, especially with plastic or laminated tubes, static electricity can cause the dust to adhere to the tube walls. A vacuum collar at the top of the tube captures the dust.

After cleaning, the tube indexes to the filling station. If the product is relatively low viscosity, the filling nozzle may only enter the tube deeply enough to assure that no product splashes on the seal area. Any air bubbles that may occur due to turbulence will will rise and dissipate naturally. Thicker products will require the nozzle to dive all the way to the bottom. As product is filled, the nozzle is gradually retracted so that it is always just above the product surface.

At the end of the fill, thick products may have a tendency to form a tail. This tail, if it enters the seal area can prevent a good seal. The filling nozzle must be properly designed to eliminate this tail.

Tubes are sometimes used to dispense a 2 part product such as a toothpaste with stripes. This is done using a coaxial filling nozzle. The bulk of the product is filled through the center nozzle. Simultaneously, the “stripe” product is filled through a coaxial nozzle around the main nozzle.

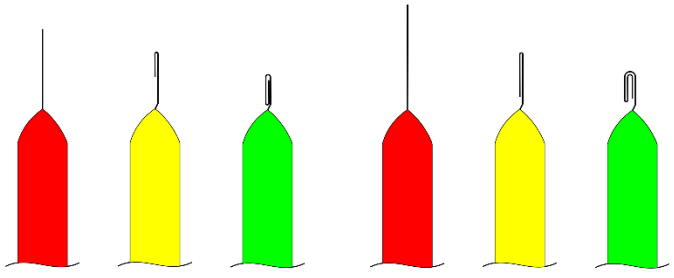
The tube dispensing tip has grooves or slots so that as the end user squeezes the tube, the secondary product is dispensed as a stripe.

Most tubes are printed and it is important that the graphics align properly with the seal. The next stage after filling is aligning. In the aligning station the puck and tube are lifted slightly to disengage the serrations. They are then rotated until a photoeye or camera detects a registration mark on the tube. Once aligned, the puck is lowered into the serrations. In some machines alignment takes place before filling.

The tube is now ready for sealing. Depending on the tube material, there are three sealing methods:

Crimping – This is used on metal tubes and is a multi-step process. First the tube end is pinched closed. The tube has a band of elastomer sealent at the crimp point applied when the tube is made. This assures a leakproof seal since the crimp seal is purely mechanical.

The flattened end of the tube is then folded in successive stations. Shown are a single and a double fold crimp. Other crimping configurations may sometimes be used.



SINGLE FOLD CRIMP DOUBLE FOLD CRIMP

Laminate tube – Laminate tubes cannot be crimped closed due to the memory of the tube material. If crimped, they would immediately open. Laminate tubes are sealed with a pair of heated serrated jaws. These melt the inner layers of the laminate together, sealing the tube.

Plastic tube – Plastic tubes are usually a single material layer and cannot be sealed directly by heated jaws. The tubes are passed through a box where the open end is heated to soften the plastic. A pair of jaws then presses the end closed.

In both laminate and plastic sealing an additional set of jaws may be used after sealing to cool the seal and set it in place.

Sealing of plastic and laminate tubes is a function of the combination of time, temperature and pressure. Although these can sometimes compensate for each other eg; higher temperature and less pressure, there will always be one optimal combination of the three. Finding and always using that optimal setpoint is the key to consistently achieving good seals.

Ultrasonic welding is sometimes used as an alternative to heated jaws to seal laminate and plastic tubes.

The edges of both laminate and plastic seals will generally not be perfectly even. Another set of jaws will cut a slight amount of excess material from the end to make it square. Shaped sealing and trimming blades are sometimes used to give a special effect such as this rounded seal on a plastic tube.

After closing, some machines may incorporate vision systems to inspect the seal for alignment, appearance and functionality. Defective tubes will be discarded to a reject chute.

Good tubes will discharge to a conveyor, cartoner or some other downstream packaging process.