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Thermoforming

Thermoforming is a plastic forming process that forms pockets or “blisters” in plastic film or sheet. PVC is one common material but other materials are used as well. Thermoforms are used to package everything from small pharmaceutical tablets, to syringes, food products, electronics, tools and more. It has many advantages over other forms of packaging:

- It displays the product while protecting it
- It allows the customer to examine it from all sides.
- Multiple products can be packaged for individual dispensing without exposing other products. Eg: blister packs of tablets
- The package can be hermetically sealed
- A modified atmosphere for better preservation can be provided.
- The package can be physically sealed to provide a high level of tamper evidency
- The material is compact taking up much less space than bottles or cans
- Thermoform packaging can be produced semi-automatically at low speeds or fully automatically at high speeds with all options in between.
- They can be hung for POP

The thermoforming process can be done offline or inline. In both cases the forming process is the same.

Offline thermoforming

Offline thermoforming makes the thermoforms at another location, often at a converter specializing in thermoforming. The formed plastic shells are brought to the packaging line and the product is loaded. Once loaded, the package is closed or lidded.

“Clamshells” are single piece thermoforms which incorporate both top and bottom in a single piece. Product is placed in the clamshell which is folded closed. Some clamshells incorporate buttons and recesses that allow the lid to be snapped closed. This gives the customer the ability to open and reclose the form as it is used. If additional security is desired, or a hermetic seal is desired, the two halves can be sealed closed by heat or sonic welding.

A variation of this is to provide separate top and bottom pieces which are assembled and snapped or welded together. This allows different materials or different colors, for example a black bottom and clear top, to be used. As they are two separate components it increases the number of SKUs and thus complexity of inventory.

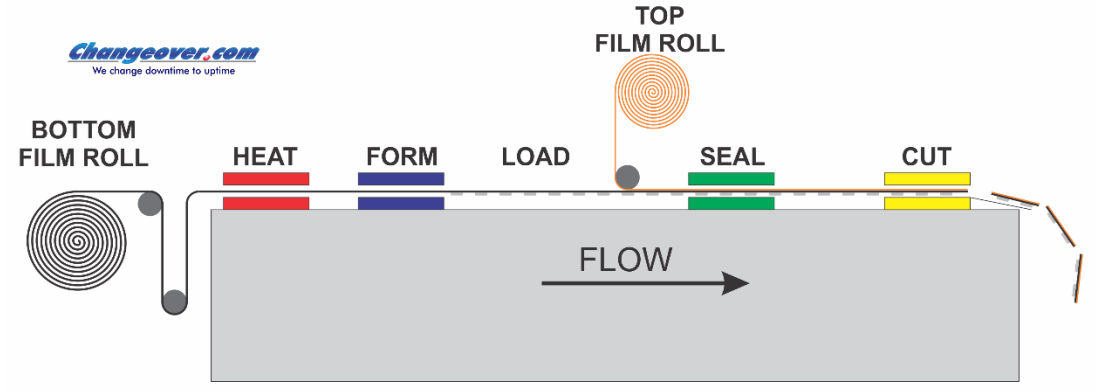
Many thermoform packages have a paper, board, foil or plastic film lid or closure. These can also be produced offline. On the packaging line product is placed in the individual form, the closure placed on top and welded closed

Semi-automated machines such as this Alloyd rotary sealer are available that can pull the thermoform from a magazine, place it in a fixture, position it for loading either manually or automatically then place and seal the top seal.

Inline thermoforming

Packaging thermoforms made offline is great when speed and volume requirements are fairly low or there is a high variety of different packages or products. When higher volumes/speeds are needed, making the thermoforms at the time of packaging is the way to go. Generally, inline thermoforming machines can run at a maximum of 50-60 cycles per minute. This sounds slow but a larger machine, with a smaller package such as a 6 cavity tablet blisterpack can run as many as 4-6 blisters across and 3-4 long allowing as many as 24 blisters per cycle. A 4X6 pattern at 50 cycles per minute would produce 1200 finished packages per minute.

There are several styles of thermoforming machines available for varying purposes but all function similarly. This schematic shows the main functions of all automatic inline thermoformers:



INLINE THERMOFORMER SCHEMATIC

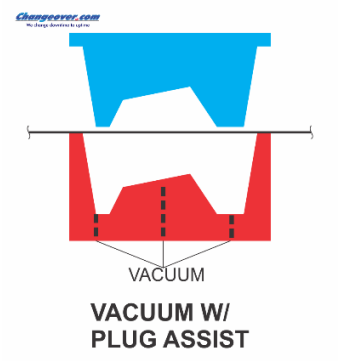
Film is supplied to the machine in rolls. The film is unwound, fed through dancer rolls to control tension and indexed between two (red) heating platens. These heat the film, softening it for forming. Normally uniform heat is applied to the top and bottom of the film. Some applications may use a multi-layer film with each layer having different thermal characteristics. In these cases, it may be necessary to set the heat of the top and bottom platens differently to avoid film warping. Heating platens may be fixed or may open and close to provide better heat transfer.

After softening, the film moves to the forming (blue) dies.

The sealing dies are closed clamping the film tightly between them. The blister or product pocket is formed by introducing compressed air into the upper die, forcing the film conformally into the lower cavity. Pinhole vents in the lower cavity permit air to escape as the film conforms to the cavity. In some cases, vacuum may be used in addition to, or instead of, compressed air to help pull the film into the lower cavity.

The blister shown here is simple and fairly shallow.

When deeper or more complex blisters are required, compressed air alone may not give good results. In a deep cavity, air alone can cause the sidewalls of the blister to be thicker than the bottom. In extreme cases, the bottom may thin to the extent that it blows out.



A male “plug” conforming to the shape of the female bottom die may be used to assure better material distribution. The plug pushes the film down into the bottom cavity. The plug may be fixed, moving with the upper die or it may be articulated, forced down after the dies have clamped the film. Vacuum and/or compressed air are also used to force the film to the shape of the lower die.

For simplicity, the machine schematic assumes an intermittent motion machine with the film being indexed forward one complete pattern per cycle. Some machines are continuous motion. This is usually achieved by reciprocating the forming, sealing and cutting stations linearly with the film.

Over time the dies will heat up from contact with the film. Cooling will generally be required to prevent the film stretching, shrinking or deforming when released from the dies. Cooling can be via compressed air or water

After forming, the thermoformer has an open area where the blisters can be loaded. The length of this area can vary depending on the product and loading method. Loading can be by hand or can be fully automated. There are many ways to automate loading and these are beyond the scope of this paper.

The loading area will often include cameras for automated inspection. These inspection systems can be simple, merely detecting the presence of a product in each blister. More sophisticated systems will inspect to make sure it is the proper product, proper color and undamaged. 3D vision systems are available that will check not only the top of the product but the sides and bottom as well.

Generally, an empty blister or defective product will be allowed to continue rather than stopping the machine. Software tracks the position of the defect and physically rejects it at the machine discharge.

Now a lid needs to be placed. This lid can be plastic, board, paper, or foil. Board and heavy plastic may come to the line individually pre-cut. It will be placed in a magazine a pick and place arm will put it on top of the package for sealing.

The lid also commonly comes as rollstock as shown in the schematic. The material can be blank or pre-printed. If blank or pre-printed with a continuous graphic there will be no need to register the material. If pattern printed, the machine will need a registration system to assure that it is properly aligned.

Another option is to use blank rollstock and print it as applied. Inkjet, laser, flexo, rubber mat are a few of the printing technologies that may be mounted on the thermoformer to print the lidstock as it is unrolled.

After applying the lid, the film goes into the sealing section. Shown on the schematic and in the picture below and left is a pair of flat platens. These open and close applying heat and pressure to the film and lid welding them together. The lower sealing section has recesses for the blisters. The upper section has slight recesses to reduce the amount of heat applied over the product. If continuous motion is desired, the jaws can reciprocate linearly while sealing. Another alternative is to use a rotary sealing wheel shown below to the right. This will provide a good seal but the contact area is limited. There can also be issues with insufficient dwell time.

The final step is cutting the film into individual packages. If the package is a simple square or rectangle, this can be done with slitting wheels that cut the film into longitudinal strips. After cutting in strips, a crosscut blade cuts the strips to final package length.

Many customers do not like the square corners and prefer a more shaped final package. In this case, and as shown in the schematic, formed dies are used to cut the individual packages from the film web. These dies can include perforating blades to allow individual blisters to be removed.

The sealing jaws may include provision for mounting metal type that deboss date and manufacturing codes into the blister as seen below.

One sealed and cut, the packages are discharged into a bulk bin or randomly onto a conveyor for hand packing. They can also be stacked and deposited for synchronized feeding into a cartoner or other machine.