

A general overview of the thermoforming process, including common verbiage and procedures for the forming market.

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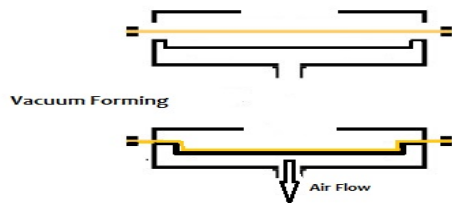
Thermoforming Defined

Thermoforming is the process of heating a plastic material to make it pliable, placing it in a mold and cooling to create a finished part. Heating temperatures can range from 250°F to 425°F depending on material and thickness.

The three most common types of thermoforming in the printing industry are vacuum forming, pressure forming and drape forming.

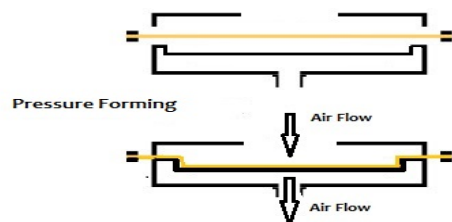
Vacuum forming is the process of heating a substrate to pliability and placing it into or around a mold. Air is vacuumed out, forcing the plastic around the mold to create the finished part.

Vacuum forming, because it is not a closed system like pressure forming, allows customers to add textures to the part.



Pressure forming is the same process, except compressed air is used above the part forcing the material down while vacuuming out the air inside the mold.

Pressure forming is more precise if a tight tolerance is required. This type of forming is typically used in the medical and scientific device field.



Drape forming or drape molding is the process of heating the substrate to pliability and placing it over a mold and letting the material fall over the mold without the use of air or vacuum. Drape

forming is economical, but it is a very slow process. Textures can also be added in this process.



Heat bending is sometimes categorized with thermoforming. Heat bending uses the same materials or substrates. However, in heat bending only a small section of the material is heated and not the entire sheet. Inks listed as thermoforming or forming can be used in the heat bending process with the exception of the 1500 Series, which needs the heat of the forming process to fully cure. When heat bending, only the print area exposed to heat provides the immediate harder surface with 1500 Series. Areas not exposed to high heat may retain a soft ink surface and require special handling.

Draw Lengths

The draw in thermoforming refers to how far the plastic is stretched around a mold. Draw lengths are defined as shallow and deep.

Nazdar defines a shallow draw as 2 to 4 inches in any direction. For instance, if a mold stretches the material 2 inches vertically and 2 inches horizontally, that would equal a 4 inch draw. Anything over 4 inches would be classified by Nazdar as a deep draw.

Any ink that Nazdar determines as formable is only formable to a shallow draw unless otherwise stated in the Technical Data Sheet.

There are many factors that affect draw lengths of a formed piece. The thickness, pliability, sharpness of the mold angles and ink thickness all play a part. The 2- to 4-inch draw measurement is the simplest form of measuring a draw.

In all cases the end user must test the ink and material to determine if it fits their needs.

Inks

A list of Nazdar inks that have been successfully tested in thermoforming applications are listed below.

UV Screen Inks:

- 1500 Series
- 4000 Series

Solvent and Water Base Screen Inks:

- 9700 Series
- GV Series
- 2700 Series

9600 and S2 Series Inks have also been used in vacuum forming, although this is not listed on the TDS. The customer would need to test these inks thoroughly to determine if they are suitable for the intended use.

Substrates

The most common substrates in the thermoforming market are ABS, polycarbonate, PMMA or acrylic, styrene, polypropylene and PVC.

Substrates for thermoforming come in many different thicknesses and strengths. Because of this, Nazdar inks may not work on all materials even though the ink exhibits good adhesion. If a substrate's pliability heat range exceeds the heat threshold of an ink, the ink may change colors, crack prematurely and/or lose adhesion to the material.

Terms

A positive, or male mold is a form that material is fabricated over to create the part.

Female, or negative molds are concave or open molds that material is forced into.

Negative pressure is the same as vacuum forming and positive pressure is another term for pressure forming.

Elongation is the process pulling a plastic part along a surface to create a long finished part. In the forming world this is often associated with metal forming. With plastic it is often called extrusion. Most of the time there is a process called roll forming the metal or plastic will go through before elongation or extrusion.

Embossing is the process of adding a raised area to a part. Embossing can be done with or without heat. Embossing is different from forming in two ways. First it is usually a small area of the part being embossed and second, embossing often uses force or an impact to create the image in the part.

In mold decorating inks are created differently than the typical formable ink because it must withstand high temperature liquid resin injected with force directly to the ink. Our formable inks will withstand most of the forming associated with in mold decorating, however, they will fail the resin injection process.

Trimming is the process of cutting away the excess material left from the finished part. This can include router, knives and saws for hand trimming to punch and die sets or lasers for automatic trimmers.

Twin sheet forming uses two pieces of material formed at the same time to create an enclosed part such as a gas tank. Before the parts have time to cool, the two parts are welded together to create the solid hollow part.

Plug assisted thermoforming is the process of having a positive mold that goes in a negative mold to force the material into place. This is most often used when sharp angles are needed.

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