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Technical Article

Understanding Draft in Thermoforming

Draft is an angle that designers apply to the vertical walls of thermoformed parts. If you don't add enough draft, your parts may not eject cleanly from the mold, or tool, that's used to produce them. There are two basic types of thermoforming tools: positive and negative. This article provides draft guidelines for each type of tool, but you'll also need to account for the plastic you plan to use.

Positive Tools and Draft

Positive tools are convex. A thermoplastic sheet is placed over the raised area of the tool, and the sheet shrinks as it cools. To release the part, draft is required. At a minimum, apply 1° of draft to all vertical surfaces. ***As shown in Figure #1, the ideal draft for vertical surfaces would be 5° to assist in obtaining a closer to nominal material thickness when the sheet is stretched over the thermoform tool.*** Note that the texture of the part will vary based on the corner radii and the sidewall draft. The more draft you apply to sidewalls, the more consistent the resulting part texture.

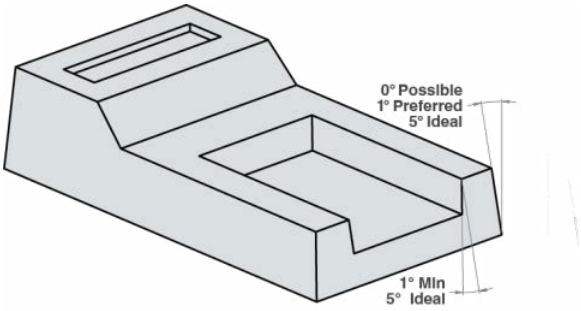

Figure 1

With positive tools, it's possible to apply 0° degrees of draft to certain areas of your part. By tilting the tool accordingly, a skilled thermoformer can form the part and eject it cleanly. ***As shown in Figure #2, to achieve the 90° vertical wall the tool is tilted 5° to allow this geometry to eject from the tool properly.*** Corner radii are used to distribute the stresses that accumulate in corners over a broader area. Sharp corners are possible in thermoforming, but a corner with an angle of greater than 90° is ideal.

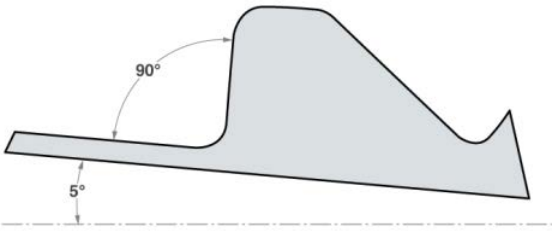

Figure 2

Negative Tools and Draft

Negative tools are concave. A thermoplastic sheet is placed within the recessed areas of the tool, and this sheet shrinks as it cools. As with positive molds, draft is needed for part release. As a rule, apply 1° of draft for negative tools with smooth or untextured vertical walls. However, if your negative tool requires texture, the depth of texture may require added degrees of draft. In many cases, the depth of the texture will dictate the required draft will be required on vertical walls. It's best to consult an experienced thermoformer to understand what draft is required for your desired texture.

If negative draft angles/undercuts are a part geometry requirement, additional tooling design (i.e. slides, flippers, part layout/configuration may be necessary. As we shared in Figure #2 some techniques may be used to achieve 0° negative draft by adjusting the tool layout.

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Depending on depth of draw and degree of draft, a negative tool may need a plug-assist to help move the material closer to the end-location and reduce thinning. ***To help showcase material thinning, see Figure #3 where we showcase how the material will stretch around certain geometry. The sharp corner geometry will reduce the material's capability to stretch and, therefore, the material will likely thin in this area during processing.*** It's also important to avoid designing part features that will require male features on a female mold. Without adequate draft, a male section at the bottom of a female tool may prevent the part from shrinking away from the sidewall.

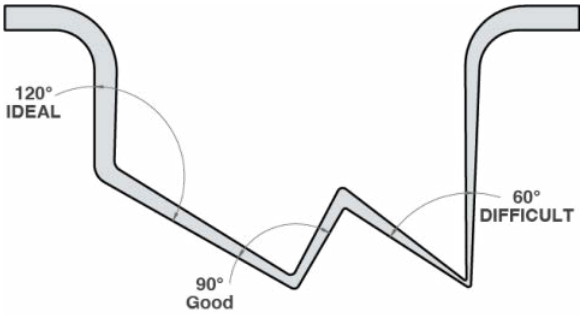

Figure 3

Material Selection and Draft

Any draft is better than no draft, but designers need to consider more than just the type of tool that a thermoformer will use. Each plastic material has its own design requirements. Tough, self-lubricating plastics with high shrinkage factors are easier to remove from negative molds than from positive molds. Examples of these materials include nylon and polyethylene.

Brittle materials that are not self-lubricating and that have low shrinkage factors are also challenging because it's difficult to eject them from tools with minimum draft angles. Examples of these materials include acrylic and styrene. By partnering with a skilled thermoformer, however, designers can apply the proper amount of draft and use the materials they need with either type of tool.

Contact Profile Plastics to discuss your application

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