KYDEX® THERMOPLASTICS

Determining Wall Thickness for KYDEX® Thermoplastic Sheet

For information applicable to KYDEX® FST please refer to 300 series technical briefs.

TB - 140-F

Draw Ratio

Under all thermoforming conditions where pieces are formed from flat sheet, the surface area will become larger and the gauge thickness thinner. One of the decisive factors of thinning is the draw ratio, generally defined as the ratio of part depth to part width.

$$\text{Draw Ratio} = \frac{\text{Depth of Part}}{\text{Width of Part}}$$

The part is formed from a sheet of KYDEX sheet that is stretched over a male mold, or stretched into a female mold. As the sheet is stretched, thin and thick spots will develop. Maintaining a low draw ratio is important to maintaining a somewhat uniform wall thickness, and avoids excessively thin areas. In general, draw ratio is more crucial for female molds than male. A draw ratio of 2:1 is recommended for female molds. If plug assist thermoforming is used, the draw ratio can be greatly increased.

Area Ratio

To estimate the thinning which occurs, one should first determine the area ratio. Area ratio is the ratio of the sheet area before thermoforming to the area of the part after forming:

$$\text{Area Ratio} = \frac{\text{Area of Sheet Before Forming}}{\text{Area of Part After Forming}}$$

The area ratio will give some indication to the amount of wall thinning the sheet will see. This calculation is also commonly used to determine the thickness of the sheet that is needed to achieve the desired wall thickness.

$$\text{Area Ratio} = \frac{\text{Area of Sheet Before Forming}}{\text{Area of Part After Forming}} = \frac{A \times B}{A \times B + E\,(2C + 2D)} = \frac{3 \times 4}{3 \times 4 + 1\,(4 + 2)} = \frac{12}{18} = 67\%$$

Example: A rectangular cavity with side flanges has been chosen, see Figure 3.1

A sheet that was originally 3.18mm (0.125”) will now have a thickness of 2.13mm (0.084”) (0.125” x 0.67 = 0.084”)

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Male Mold: (Figure 3.1)

If the part were made using simple drape forming over a male mold, the sheet would first contact area C x D, which would maintain its original thickness. The remaining available sheet, area A x B - C x D is now used to form the remainder of the part. The thinning that will occur is calculated as follows:

$$\frac{\text{Available Sheet Area}}{\text{Area of Part Remaining}} = \frac{(A \times B) - (C \times D)}{(A \times B) - (C \times D) + E\,(2C + 2D)} = \frac{(3 \times 4) - (2 \times 1)}{(3 \times 4) - (2 \times 1) + 1\,(4 + 2)} = \frac{10}{16} = 63\%$$

A sheet that was originally 3.18mm (0.125") will now have a wall thickness of 2.01mm (0.079") (0.125" x 0.63 = 0.079")

Female Mold: (Figure 3.2)

If the same part was to be formed using a female mold, the sheet would first contact area A x B - C x D, resulting

in a flange with a heavy wall thickness and leaving only area C x D for forming the total cavity area, E(2C + 2D) + C x D.

$$\frac{\text{Available Sheet Area}}{\text{Area of Part Remaining}} = \frac{C \times D}{C \times D + E\,(2C + 2D)} = \frac{2 \times 1}{2 \times 1 + 1\,(4 + 2)} = \frac{2}{8} = 25\%$$

A sheet cavity that was originally 3.18mm (0.125") will now have a thickness of 0.79mm (0.031") (0.125" x 0.25 = 0.031")

Note: In reality none of the flat areas will have the calculated thickness uniformly distributed because the walls are not formed at the same time but in sequence. As the sheet is drawn into the cavity, further stretching and thinning continues until finally the inside corners fill. The last formed edges will have the thinnest wall thickness.

Figure 3.1

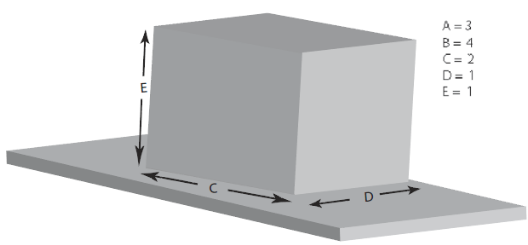
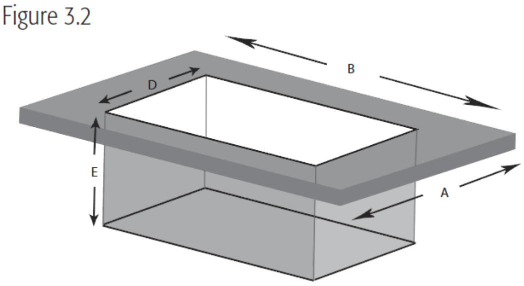


Figure 3.2



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