KYDEX® THERMOPLASTIC SHEET

Thermoforming KYDEX® Thermoplastic Sheet

TB - 116

Intoduction

KYDEX sheet has excellent forming properties, which results in uniform wall thicknesses and crisp detail. KYDEX sheet forms to deep draws with low forces when heated to the upper end of the forming temperature range. Unlike many other thermoforming sheets, KYDEX sheet has unusually high resistance to hot tearing.

General Guidelines

- KYDEX sheet will form differently than other thermoplastic materials.
- KYDEX sheet is more consistent than other thermoplastics, resulting in fewer rejects.
- KYDEX sheet will give better detail than other thermoplastics.
- KYDEX sheet can be vacuum, drape, and pressure formed. These methods result in increased levels of detail.

Forming Guidelines

- Oven temperatures should be set differently than the settings used for ABS or FR-ABS.
- Typical heater settings (percentage timers) are 30% – 50% top heaters and 50% - 70% bottom heaters.
- The most frequent problem is trying to heat the sheet too quickly, particularly on the primary surface.
- Cycle times will vary depending on the oven conditions and grade of KYDEX sheet being formed.
- When forming KYDEX sheet, it is better to rely on the sheet appearance during heating than on fixed cycle times.
- Forming temperatures – Guidelines: (Sheet should not exceed 204°C (400°F).

165 - 177°C (330 - 350°F) for < 1.50mm (0.060").
182 - 196°C (360 - 385°F) for 1.50mm to 3.20mm (0.060" to 0.125").
196 - 204°C (385 - 400°F) for > 3.20mm (0.125")

- Ideally the core sheet temperature should be within 10°F of the surface temperature.

Additional Guidelines

Drying is generally not required except in high humidity conditions. If the material needs to be dried, it should be dried at 68°C (155°F) or about 15° below the products HDT for 16 hours for 3.20mm (0.125") thickness.

Two sided (sandwich) heaters are recommended above 2.00mm (0.080") nominal thickness.

Sheet Appearance During Heating

As KYDEX sheet is heated, the inherent stresses in the sheet will relax.

- **Stage I:** The heating is marked by wide undulations and softening
- **Stage II:** The material will start to form small ripples (known as oil canning).
- **Stage III:** The material will start to smooth out and sag (KYDEX sheet will generally sag less than other thermoplastics due to its high melt strength.
- **Stage IV:** The ripples will have smoothed out indicating that most stresses have been removed. 10 to 30 seconds afterwards the sheet is ready to form.

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Sheet Appearance During Heating

If you can NOT achieve Stage IV before the sheet blisters and /or smokes excessively, IT IS BEING HEATED TOO QUICKLY. Cut back on the heat and increase the dwell (cycle) time.

Thermolabels or Infrared (IR) pyrometer is ideal for determining sheet surface temperature. You should achieve (but not exceed) proper forming temperature at Stage IV.

In summary, the main thing to look for when thermoforming KYDEX sheet, is the uniform sag and lack of rippling. At this point, the KYDEX sheet is ready to form.

Design Criteria:

- Minimum radius (vacuum forming) is generally equal to the nominal thickness (i.e. 0.71mm (0.028")) thickness.
- Mold Shrinkage for male molds is 0.4% - 0.6% and female molds, 0.5% - 0.7%.

Thermoforming Machine Manufacturers

Brown Machine LLC
330 N Ross Street
Beaverton, MI 48612
Tel: +1.989.435.7741 or +1.877.702.4142
Fax: +1.989.435.2821
E-mail: sales@brown-machine.com
Online: http://www.brown-machine.com

Custom Manufacturing, Inc
330 N Ross Street, P.O. Box 434
Beaverton, MI 48612
Tel: 517.435.7741
Fax: 517.426.4049

Modern Machinery
3031 Guernsy Road, Box 423
Beaverton, MI 48612
Tel: 989.435.9071 or +1.888.649.9839
Fax: 989.435.3940
E-mail: info@modernmachineinc.com
Online: http://www.maodernmachineinc.com

Lamco Machine Tool, Inc
135 Industrial Drive, P.O. Box 2357
Moorehead City, NC 28557-2357
Tel: 252.247.4360
Fax: 252.247.4633
E-mail: lamco@mail.clis.com
Online: http://www.lamcomachine.com

MAAC Machinery Corp
801 Hilltop Drive
Itasca, IL 60143
Tel: 800.588.MAAC
Fax: 630.285.1506
E-mail: maac@maacmachinery.com
Online: http://www.maacsales.com

Plastimach, Inc
704 Executive Blvd.
Valley Cottage, NY 10989
Tel: 800.394.1128
Fax: 914.267.2825
E-mail: plastimach@plastimach.com
Online: http://www.plastimach.com/

Adolf Illig
Maschinenbau GmBH
Mauerstrasse 100
D-74081 Heilbronn
Germany
Tel: +49.7131.505.0
Fax: +49.7131.505.303
Online: http://www.illig.de/en/index_en.html

Geiss AG
Industriestße
2 D-96145 Seßlach
Germany
Tel: +49.9569.92.21.0
Fax: +49.9569.92.21.0
E-mail: mail@geiss-ttt.com
Online: http://www.geiss-ttt.com

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Troubleshooting Thermoforming Problems

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Intoduction

The most common problem in thermoforming KYDEX® thermoplastic sheet is one of trying to heat KYDEX sheet too quickly. See the chart below for recommended heating times when sandwich heaters are used. If a problem still exists, review the troubleshooting section of this brief.

Approximate Heating Times

Sheet Thickness	Time (Seconds)
1.00mm (0.040")	15-35
1.50mm (0.060")	50-70
2.00mm (0.080")	65-85
2.40mm (0.093")	80-100
3.20mm (0.125")	100-130
4.70mm (0.187")	180-200
6.40mm (0.250")	240-285

Heating will vary with the type of heaters being used and the percentages the heaters are set to.

Troubleshooting

Problems	Causes	Remedies
Blister or Bubbles	Heating too Quickly	1) Lower heater(s) temperatures 2) Use slower heating 3) Increase distance between heaters and sheet.
	Excessive Moisture	1) Pre-dry material. 2) Heat material from both sides. 3) Lower heater temperatures (more soak time).
	Uneven Heating	1) Hot spots (install screening to deflect heat from overheated areas). 2) Check heaters for proper operation. 3) Adjust heater zones to balance sheet surface temperature.
Poor Detail in Formed Part	Sheet too Cold	1) Increase dwell time to heat sheet longer. 2) Increase temperature of heaters. 3) Check heaters for proper operation. 4) Pre-heat clamping frame (cold frame can draw heat from sheet). 5) Check for air drafts across sheet (open doors, fans, etc.).
	Insufficient Vacuum	1) Check vacuum holes for blockages. 2) Increase the number of vacuum holes. 3) Increase size of vacuum holes. 4) Check for vacuum leaks.

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Troubleshooting

Problems	Causes	Remedies
Poor Detail in Formed Part	Vacuum not drawing Fast Enough	1) Check the vacuum gauge for minimum of in. /Hg pressure. 2) Check for vacuum leaks. 3) Use slots instead of vacuum holes. 4) Increase the size of the vacuum surge tank or vacuum capacity. 5) Check vacuum hose for leaks or collapse.
Poor Detail in Formed Part (when pressure forming)	Improper pressure	1) Use 20 - 50 psi (.137 - .345 Mpa) air pressure.
Sheet Scorched	Surface of the Sheet too Hot	1) Reduce heating cycle (dwell time). 2) Lower heater temperature (more soak time).
Blushing or Discoloration	Excessive Heat	1) Reduce cycle time (poor detail may occur due to material being too cold). 2) Reduce heater temperatures (increasing dwell time may be required). 3) If problems exist in one area only, check heaters.
Whitening of Part in Corners	Sheet too Cold	1) Increase the dwell time. 2) Reduce platen time delay. 3) reduce vacuum delay.
Webbing, Bridging or Wrinkling	Sheet too Hot	1) Reduce heating time. 2) Lower heater temperatures.
	Insufficient Vacuum	1) Check mold for proper vacuum. 2) Check vacuum lines for restrictions.
	Excessive Draw Ratio or Poor Mold Design	1) Redesign mold. 2) Increase the draft and radii of the mold design. 3) Use a plug assist. 4) Add take-up blocks (web catchers) to pull material away from the corners. 5) Use recessed pockets (web moats) in web areas. 6) If tooling is multiple mold design, increase the distance between molds.

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Problems	Causes	Remedies
Nipples on Mold Side of Formed Part	Sheet too Hot	1) Reduce dwell time. 2) Reduce heater temperatures.
	Vacuum Holes	1) Plug vacuum holes and re-drill with smaller bit.
Excessive Sag After Heating	Sheet too Hot	1) Reduce dwell time. 2) Reduce heater temperatures. 3) Balance sheet surface temperature (increase the perimeter heat and lower center heat).
Chill Marks or "Mark-Off Lines"	Mold Temperature too Cold	1) Increase the mold temperature (do not excess 165ºC) if the mold is water cooled. If the mold is not temperature controlled, pre-heat the mold with a torch. 2) Increase the pre-stretch to allow the mold to come in contact with the material later.
	Plug Assist Cold	1) Use a syntactic foam plug assist. 2) Cover plug assist with flannel or felt.
	Sheet too Hot	1) Reduce dwell time. 2) Reduce heater temperatures.
Surface imperfections	Pock Marks on Smooth MoldSurface	1) Air entrapment (sand blast mold texture with #30 shot grit).
	Dirt on Sheet or Mold	1) Clean sheet and/or mold surface prior to forming.
Shiny Streaks or Spots	Sheet Overheated in Areas	1) Adjust heaters in affected areas. 2) Hot spots (screen areas to deflect heat, if unable to do with zoning).
Distortion in Part after Removing Part from the Mold	Removing Part From Mold too Soon	1) Increasing the cooling cycle. 2) Use temperature controlled mold. 3) Use fans or water mist.
	Uneven Cooling	1) Cool part evenly by adding additional water coolings to mold and/or add fans. 2) Poor Material distribution (improve pre-stretch or plug assist).
	Mold Temperature	1) Lower mold temperature 10º below HDT of material.

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Problems	Causes	Remedies
Poor Wall Thickness Distribution	Improper Sag	1) Heat sheet uniformly to allow material to flow properly. 2) Mount mold on top platen. 3) Use Billow Vacuum Snap-Back method. 4) Use plug assist.
	Hot or Cold Spots in Sheet	1) Balance sheet heating. 2) Check heaters for proper operation. 3) Avoid air flow and drafts across sheet.
	Mold Too Cold	1) Increase mold temperature 10° below HDT of material.
Shrink Marks in Corners *What do shrink marks look like?*	Poor Vacuum	1) Check for vacuum leaks. 2) Check vacuum holes for blockages. 3) Add vacuum holes. 4) Increase the vacuum time to hold material tight to mold until material is cooled below HDT.
Thin Corners when Forming over a Female Tool	Improper Forming Techniques	1) Use a Billow Forming technique. This will help by pre-stretching the sheet before forming. 2) Use a plug assist.
	Variation in Sheet Temperature	1) Adjust the heating temperatures so the sheet is heated evenly. 2) Increase the perimeter (outer) heaters approximately 10% higher then the center.
Part Sticking to Mold	Mold Design	1) Increase the draft angle of the mold. 2) Sand blast the mold with #30 grit to roughen the surface of the mold. 3) Use breakaway mold for undercuts. 4) Increase the air ejection pressure. 5) Use a mold release agent (silicone, talc, etc.)
Tearing of the Sheet When Forming	Mold Design	1) Increase the radius in the corners.
	Sheet too Cold	1) Increase heating cycle and temperatures. 2) Balance temperature across sheet.
	Vacuum Too Rapid	1) Reduce the rate (speed) of the vacuum being pulled.