KYDEX® THERMOPLASTICS

Ideal Conditions for Forming KYDEX® Sheet

TB - 140-C

Temperature Profile for Thermoforming KYDEX® Sheet Products

- KYDEX® sheet forms differently than an ABS and Polycarbonate.
- KYDEX® sheet is denser than ABS and Polycarbonate, results in heating the material differently than ABS and PC.
- The recommended temperature profile for heating KYDEX® sheet is, normally achieved by setting the bottom heaters higher then the top heaters.

  1) The distance between the bottom heaters and the sheet is greater than the distance between the top heaters and the sheet.
  2) Running the bottom heaters higher in temperature allows the heat to rise and be trapped under the sheet, allowing the heat to be absorbed into the KYDEX® sheet faster, reducing the heating time.
  3) Running the top heaters lower, reduces the amount of heat being applied to the sheet surface, hence, reducing the gloss level of the part.

- A good starting temperature profile for forming KYDEX® sheet is:
  - 30% top heaters and 70% bottom heaters.

- A good rule of thumb (starting point) on the dwell time (heating) for heating KYDEX® sheet is:
  - For sheet thickness up to 0.125" -1 second per mil
    (ex.: 0.125" = 125 seconds)
  - For thicknesses over 0.125" - 1 ¼ seconds per mil
    (ex.: 0.200" = 250 seconds)

- It is always good to run the perimeter of the ovens 5% to 10% higher than the rest of the settings (depending on ambient temperature).
  - Purpose for doing this, is to help compensate for any air flow across front of the oven.

Example of Top and Bottom Oven Settings for Ceramic, Quartz and Halogen Heaters:

Top Oven

35%			35%			
	35%	30%	30%	30%	35%	
040%	30%	30%	30%	30%	30%	40%
	35%	30%	30%	30%	35%	
40%			40%			

Front

Bottom Oven

70%			70%			
	70%	70%	70%	70%	70%	
75%	70%	70%	70%	70%	70%	75%
	75%	70%	70%	70%	75%	
75%			75%			

Front

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Thermoforming and Mold Shrinkage

Example of Top Oven Settings for Gas Catalytic Heaters:

Top Oven

1.2 (left half)				1.2 (right half)		
1.5	1.2	1.0	1.0	1.0	1.2	1.5
	1.0	1.0	1.0	1.0	1.0	
	1.2	1.2	1.2	1.2	1.2	
1.5 (left half)				1.5 (right half)		

Front

Bottom Oven

2.0 (left half)				2.0 (right half)		
2.1	2.0	2.0	2.0	2.0	2.0	2.1
	2.0	2.0	2.0	2.0	2.0	
	2.1	2.0	2.0	2.0	2.1	
2.1 (left half)				2.1 (right half)		

Front

Gas Catalytic Heats operate on CWI (Column of Water Inches)

Important Thermoforming Information

Thermoforming Molds:

Male Molds
Min. draft angle: 2 - 4°
Min. radius: 2.30mm (0.094")
Mold shrinkage: 0.40 – 0.60%

Female Molds
Min. draft angle: 1 – 2°
Min. radius: 1.60mm (0.063")
Mold shrinkage: 0.50% – 0.70%

Pressure Forming - Female Molds
Min. draft angle 1 - 2°
Min. radius 1.6mm (0.063")
Mold Shrinkage: 0.40% - 0.50%

Drying of KYDEX® Sheet:

KYDEX® sheet is less hygroscopic then most thermoplastics and does not require drying. But, if the material has been stored for a period of time in a humid environment, drying may need to be performed.

Recommended Drying Temperatures and Times:

(at 68°C (155°F) in an air-circulated oven)

Sheet Thickness	Minimum Time (hrs)
2.00mm (0.080")	10
3.20mm (0.125")	16
6.40mm (0.250")	24

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Thermoforming Temperature Guidelines

Forming Surface Temperatures Guidelines:

- Sheet should not exceed 400°F (204°C).
  - 165 - 177°C(330 - 350°F) for 0.71mm - 1.50mm (0.028" to 0.060").
  - 182 - 196°C (360 - 385°F) for 1.50mm - 3.20mm (0.060" to 0.125").
  - 196 - 204°C (385 - 400°F) for 3.20mm and greater (0.125" and greater).
- The recommended temperature ranges are to give you the optima temperature of the KYDEX sheet to achieve good detail and uniform wall thickness.
- To avoid warpage and/or distortion in the formed part, allow the surface temperature of the part to cool below 65.5ºC (150ºF) before removing the part from the mold.
- If you are using a temperature controlled mold, maintain a mold temperature of 65.5ºC (150ºF) in the cooling cycle
- Do Not exceed 71.1ºC (160ºF). This is close to the HDT (Heat Deflection Temperature) of the material.

Forming Technique for KYDEX® Sheet

Note: Using FR/ABS or ABS temperature profiles, which are more of an even top and bottom temperature profile (50/50, 60/60, etc), KYDEX sheet would very likely be formed with a glossy primary surface, due to the more concentrated heat on top. By using the recommended temperature profile above, the heating cycle times will be comparable to FR/ABS and other thermoplastics.

By having a higher tear strength, KYDEX® sheet will not sag like FR/ABS, ABS and other thermoplastics. So, the use of a sag sensor would need to be adjusted to accommodate the difference in sag rate between KYDEX® sheet and other thermoplastics.

Due to constant changes in forming conditions, relating to ambient temperature changes, drafts on the shop floor, age and condition of the equipment, you can not always rely on fixed cycle times.

Although there are ways of measuring surface temperature to achieve the proper forming temperature (Infrared temperature sensors, paper thermometers, etc.), the most difficult aspect is achieving the proper core temperature as well. By achieving the proper core temperature, internal stresses in the material are reduced, improving part quality and consistency.

Therefore, we suggest that you rely on visual methods as well in determining the correct time to form, rather than relying strictly on cycle time.

The method below relies on sheet appearance. Most likely, your operators are already using this method to some extent. The method is a four-stage sequence that will tell the operator when the sheet is to come out of the oven and will signal when to adjust the oven conditions. By using this four-step method you will achieve higher quality, get greater consistency and have fewer rejects. The bottom line: This method saves you money.

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Benefits of Using KYDEX® Sheet

KYDEX® sheet:

- Is a monolithic sheet (colour throughout), where competitors are mostly capped product
- Exhibits higher impact resistance
- Is easy to thermoform
- Is a great material for pressure forming
- Allows downgrading, reducing cost and weight
- Has excellent extensibility in deep draw thermoformed parts
- Retains its pattern texture after thermoforming
- Provides very good uniform wall thickness in thermoformed parts
- Cycle times are similar in all products
- Produces less rejects in thermoforming due to its quality
- Has short lead times (usually 3 weeks or less)
- Has technical and field support

What to Look for During the Heating of KYDEX® Sheet

Stage 1: As the material starts to heat, it will begin to soften and bulge up slightly from the heat below it.

Stage 2: As the material begins to approach thermoforming temperature, the material will start to form ripples. Ripples are a result of inherit stresses from the extrusion process. They are common in any extruded plastic.

Stage 3: As the sheet approaches the thermoforming temperature, the ripples will start to smooth out. If the material is formed at this point, your part would have a lower quality or have higher internal stresses in them than desired. Possibly creating poor part definition and thinning in the side walls. If the surface temperature is already at the proper thermoforming temperature, you may be heating too quickly. You should lower the oven settings and adjust the dwell time.

Stage 4: The material is now smooth, free of ripples along the clamping frame and sagging slightly (KYDEX® sheet does not sag as much as ABS). This tells the operator that the core temperature is at the proper temperature. It is now ready to form. The combination of the proper surface temperature and core temperature is the key to achieving better parts, less rejects, and cost savings.

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