KYDEX THERMOPLASTICS

Ideal Conditions for Forming KYDEX® Thermoplastic Sheet

INTRODUCTION

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® Thermoplastic Sheet:
  - forms differently than an ABS and Polycarbonate
  - is more dense than ABS and PC, results in heating the material differently than ABS and PC
  - is more consistent than other thermoplastics, resulting in fewer rejects
  - allows better detail than other thermoplastics
  - can be vacuum, drape, and pressure formed. These methods result in increased levels of detail

TEMPERATURE OVEN PROFILES

Oven temperatures are different than the settings used for ABS or FR-ABS.

- The recommended temperature profile for heating KYDEX® sheet is normally achieved by setting the bottom heaters higher then the top heaters.
- A good starting temperature profile for forming KYDEX® sheet is:
  - 30% top heaters and 70% bottom heaters.
  - The distance between the bottom heaters and the sheet is greater than the distance between the top heaters and the sheet.
  - Running the bottom heaters at a higher temperature allows the heat to rise and be trapped, under the sheet, allowing heat to be absorbed into the KYDEX® sheet faster, reducing the heating time.
- Running the top heaters lower, reduces the amount of heat being applied to the sheet surface, hence reducing the gloss level of the part.
- 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).
  - The purpose 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%	
40%	35%	30%	30%	30%	35%	40%
	30%	30%	30%	30%	30%	
	35%	30%	30%	30%	35%	
40%					40%	

Front

Bottom Oven

70%					70%	
75%	70%	70%	70%	70%	70%	75%
	70%	70%	70%	70%	70%	
	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					1.2	
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					1.5	

Front

Bottom Oven

2.0					2.0	
2.1	2.0	2.0	2.0	2.0	2.0	2.1
	2.0	2.0	2.0	2.0	2.0	
	2.1	2.0	2.0	2.0	2.1	
2.1					2.1	

Front

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

Thermoforming Molds:

Male Molds

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

Female Molds

Min. draft angle: 1 – 2º
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 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 be required. Two sided (sandwich) heaters are recommended above 2.00mm (0.080") nominal thickness.

Recommended Drying Temperatures and Times:
(at 68ºC (155ºF) 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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FORMING TECHNIQUE FOR KYDEX® SHEET

Heating:

- Oven temperatures should be set differently than the settings used for ABS or FR-ABS.
- 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, sheet thickness, 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.
- A good rule of thumb (starting point) on the dwell time (heating) for heating KYDEX® sheet is based on initial sheet thickness:
  - ≤ 3.20mm (0.125") 40 seconds per millimeter (1 second per mil)
  - > 3.20mm (0.125") 50 seconds per millimeter (1.25 seconds per mil)

Below are the optimal parameters for forming KYDEX® sheet to achieve good detail and uniform wall thickness:

- Ideally the sheet core temperature should be within 5.6°C (10°F) of the sheet surface temperature.
- **Sheet temperature should not exceed 204°C (400°F).**

Sheet Thickness Range	Forming Temperature Range
0.71mm - 1.50mm (0.028" to 0.060")	165 - 177°C(330 - 350°F)
1.50mm - 3.20mm (0.060" to 0.125")	182 - 196°C (360 - 385°F)
3.20mm - 12.7mm (0.125" and 0.500")	196 - 204°C (385 - 400°F)

Sheet Thickness	Approximate Dwell Time (Seconds)
0.71mm (0.028")	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

Cooling/De-molding:

- 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.

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Sag:

- KYDEX® sheet has a higher tear strength, it will not sag like FR/ABS, ABS and other thermoplastics.
- Sag sensors will need to be adjusted to between KYDEX® sheet and other thermoplastics

Cycle Time:

- Ambient temperature changes, air drafts on the shop floor, age and condition of the equipment will have an impact on a part's cycle time.

Sheet Temperature:

- 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.
- Proper core temperature is nessessary to reduce the internal stresses in the material, improve part quality and part to part consistency.

Therefore, we suggest that you rely on a combination of visual and mechanical methods to determine the cycle time. The 4 stage method below relies on sheet appearance. The method is a four-stage sequence that will tell the operator when the sheet is ready to cycle out of the oven and will signal when to adjust the oven conditions. This method is suggested to acheive high quality asethetic finished parts, with greater consistency and have fewer rejects.

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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