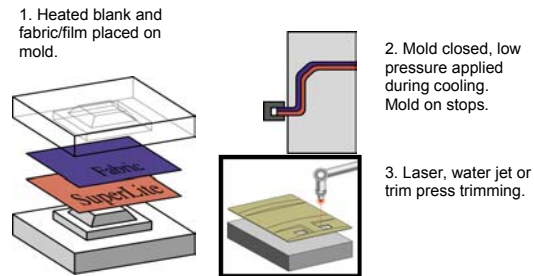
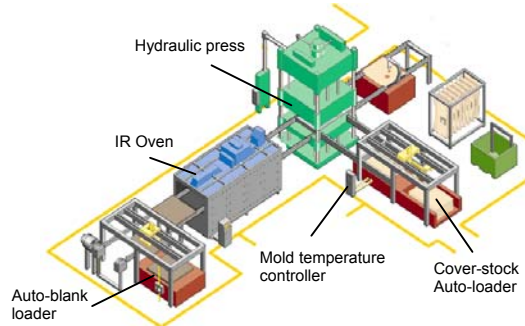


AZDEL SuperLite Thermoplastic Composites

Processing Overview

- SuperLite forming process is characterized as “Thermo-stamping” or “Matched-mold Thermoforming”.
- Typical forming pressures are around 0.33 bar (10 psi) and are unlikely to exceed 2 bar (30 psi).
- Thickness of formed part is set by stops external to the mold.
- SuperLite can be molded to different thickness’ due to lofting behavior.
- For optimal structural performance, lofted material should not be fully compressed during molding.
- Thermoforming equipment is ideal for forming SuperLite, however, it can be formed on standard compression molding presses with the use of a frame to hold the sheet.
- Either single zone or multi-zone heating profiles can be used, although single zone is usually sufficient. Multi-zone ovens may help reduce cycle times.
- Infrared type ceramic or quartz electric heating elements are most commonly used.



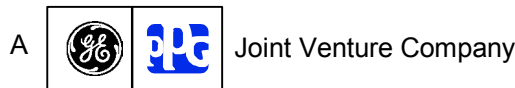
Typical Processing Conditions

- | | |
|---|--------------------------------------|
| • Sheet forming temperature: | 375°F - 400°F (190°C - 205°C) |
| • Mold temperature: | 75°F - 150°F (23°C - 65°C) |
| • Typical cycle times ^{1, 2, 3)} : | |
| – 600 to 1200 GSM: | 40 - 60 seconds |
| – 1400 to 2000 GSM: | 60 - 80 seconds |
| • Cooling time in press ²⁾ : | 20 - 40 seconds |
| • Typical forming pressure ²⁾ : | 30 - 45 psi (2-3 bar) |

Notes

- 1) Based on single-zone Infrared heating oven.
- 2) Depending on mass-per-unit-area (GSM), filler content and part complexity.
- 3) Cycle time is normally dependant upon the heating time in the oven. However, use of multi-zone oven systems can change the emphasis from the oven to the press when considering cycle time influence.

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AZDEL SuperLite[®] Thermoplastic Composites

Problem Troubleshooting

Before proceeding to the action steps, please check the following;

- Verify that material meets specifications, I.e.; GSM, glass percentage, sheet dimensions, and film/scrim combination. Also, visual inspection to determine if material has been contaminated (oil, water, etc.) during shipment or storage.
- Determine if press is functioning properly and verify that oven does not have a broken heating element.
- Verify proper heat distribution in the oven and mold.
- Verify that molding parameters are within engineering specification.
- Verify SPC and process master set-up.

The following actions should be followed for correcting problems;

- Determine frequency and location of problem.
- Determine and record the current oven and mold temperatures and press set-up.
- Determine material temperature at oven exit.
- Implement interim containment or temporary corrective action plan.
- Determine root cause and implement permanent corrective action plan.
- Record new process set-up.

Problem	Comments	Possible cause	Suggested action
Wrinkling	Most problems with wrinkling are related to the framing of the SuperLite sheet in the oven and through the molding cycle.	Insufficient clamping/pinning of SuperLite in frame.	Increase clamping pressure or number of pins in local area of wrinkling.
		Insufficient material in clamp/pin frame.	Increase distance of pins from edge of sheet.
		Insufficient distance from edge of clamp frame to edge of mold.	Increase distance between clamp frame and mold.
Scrim tearing		Depth of draw too high.	Use alternative scrim.
		Oven bank nearest scrim too hot.	Reduce oven bank temperature. May need to increase opposite oven bank temperature to compensate for overall sheet temperature.
Adhesion problems between SuperLite and scrim	Usually caused by differences in shrinkage between SuperLite and PET scrim.	Mold too cold.	Increase mold temperature.
Adhesion problems between SuperLite and cover stock		Incompatible adhesive.	Use alternative adhesive film.
		Oven temperature too low	Increase oven temperatures to recommended levels.
		Incompatible cover stock.	Use alternative cover stock.
Read through of adhesive for counter-measures	Sometimes visible as worm-tracks on cover stock. May disappear over time.	Thickness of SuperLite too low.	Increase mold gap.
		Temperature of adhesive too high.	Use alternative adhesive with lower application temperature.
		Temperature resistance of cover stock too low.	Use alternative cover stock.
SuperLite not lofting during heating		Material not hot enough.	Increase oven temperatures to recommended levels.
Warpage	Usually caused by differences in shrinkage between SuperLite and cover stock.	Insufficient temperature differential between mold halves.	Increase temperature differential between mold halves.
		Incompatible cover stock.	Use alternative cover stock.
Residue in oven	Can be either SuperLite or just adhesive layer.	Adhesive layer sticking to transfer mechanism.	Clean transfer mechanism regularly
		SuperLite sheet tearing on pins (usually on pin chain.)	Add stripper mechanism to remove excess material from chains.

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