Thermoforming Troubleshooting Guide (Primarily Thin Gage)

Problem	Probable cause	Suggested course of action
Sheet breaks prior to thermoforming	Excess tension applied to the roll at unwind station when sheet indexes forward	Maintain some slack in sheet during indexing
		Power driven nip
		Manually assist unwinding, initially
	Sheet edges too cold when impinged by pin chain	Verify edge preheaters achieve the following:
		Edge is ~200°F or ~95°C
		Preheat is >1 index length long
	Sheet too cold to navigate the directional changes of a series of rollers	Warm sheet to 120-130°F (50-55°C)
		Bypass some rollers
		Increase roller diameter
	Rails spread too far apart	Measure width at start and end of pin chains (especially PP substitution) -- anticipate < 1 inch (25 mm) wider at end
	Dull / Bent Pin Chains	Inspect pin chains, replace or repair
		Use edge heating
White marks	Stress whitening	Warm sheet to 195-210°F (90-100°C)
		Consider gauge increase
		Initiate vacuum bleed sooner
		Reduce plug speed or delay initiation of plug travel
		Mold too cold, increase mold temp
	Contamination (uniform haze)	Verify sheet is not source of whiteness
	Scratches (white lines)	Walk line comparing appearance of sheet on roll to sheet after contact with rollers etc.
Poor wall thickness distribution	Modulus too high	Warm sheet to 195-210°F (90-100°C)
		Consider whether the temperature of the mold or clamp is changing the modulus --consider recessed molds, or process changes to reduce thickness at the clamp more rapidly
		Thin bottom/thick wall suggests too high forming temperature
		Thick bottom/thin wall suggests too low forming temperature
	Plug moving material inappropriately	Increase plug radius (especially HIPS substitution)
		Adjust forming process variables timing and rates (especially PET substitution)
		Verify plug alignment and plug depths
	Inappropriate TF cycle settings	Adjust forming process variables inlcuding plug travel timing and rate, timing of forming pressure and vacuum assist
	Non-uniform sheet temperature	Access thermal mapping instrumentation to assess temperature variations throughout each shot
		Record thickness measurements in specimens (four corners) representative of all cavities in shot and overlay heater profiles to determine whether the variability can be related to heater zones and their settings
	Non-uniform sheet thickness	Verify that there are no gauge bands in sheet
	Use of stationary plugs	Design tooling with non-stationary plugs
	Sheet not retained properly prior to forming	Verify that retaining system is timed properly
		Design tooling that utilizes retaining system
Poor forming, bad detail	Insufficient comformation or detail	Warm sheet to 195-210°F (90-100°C)
		Apply vacuum/pressure sooner or longer
		Apply vacuum bleed earlier
		Increase form pressure
	Overforming	Cool sheet to 195-210°F (90-100°C)
		Reduce mold temperature or increase mold time so not demolding too hot
		Vacuum holes need to be smaller for Ingeo than for PP

Thermoforming Troubleshooting Guide (Primarily Thin Gage)

Problem	Probable cause	Suggested course of action
Webbing, bridging or wrinkling	Sheet too hot	Cool sheet to 195-210°F (90-100°C)
	Mismatched sheet dimensions	Is edge pulling away from pin chains or folding? (see sheet breaks prior to thermoforming)
	Sheet retainers not used	Install sheet retaining system on mold
	Too much sheet sag	Cool sheet to 195-210°F (90-100°C)
		Increase rail spread
Chill marks	Viscosity change too rapid	Increase mold temperature, and cool sheet to 195-210°F (90-100°C)
		Delay forming vacuum/pressure and provide more time to billow/droop
		Allow plug enough time to reach steady state before making quality assessment on parts
	Plug depth not set correctly	Plug depth 3-5mm from bottom of mold
	Material on plug too long	Initiate vacuum bleed sooner
		Initiate forming pressure sooner
		Increase plug speed and time vacuum initiation to accompany end of plug travel
		Plug marks in walls near the bottom are difficult to avoid, especially in deep draw articles
	Sheet touching mold prior to forming	Line top of mold with felt
	Too much sheet sag	Place felt on top of mold
		Cool sheet to 195-210°F (90-100°C)
		Increase rail spread
Surface marks	Subtle differences in sheet surface characteristics compared to incumbent	Dust attracted to higher static charge on sheet
		Too much denest on surface
		Scratched sheet (see white marks)
Post forming warping	Material demolded too hot	Assess demolding part temperature -- is it below 130°F (55°C)?
		Increase molding time or decrease mold temperature
		Improve cooling efficiency of the mold (e.g. extra cooling channels, higher cooling water flow rate)
	Stresses relieved in storage	Ambient storage temperature ≤105°F (40°C)?
Skeleton breakage	Excess tension applied to sheet at skeleton winder as web indexes forward	Reduce winding power and winding speed. Consider installation of servo drive on skeleton winder
	Diameter of the guiding rollers too small causing snapping of the skeleton web	Smoothen the path angles as much as you can
Poor part trim quality	Shrinkage mismatch	Ensure proper tooling is used:
		Cut-in-place equipment: Ingeo biopolymer has similar part shrinkage compared to PS and PET, significantly less than PP
		Post-trim equipment: Ingeo biopolymer requires higher cutting forces
		Part shrinkage much less than PP, slightly less than PS, fairly similar to PET
		Post-trim tool may need to be adjusted to fit Ingeo biopolymer. When steel rule die equipment is used, heat rule to approximately 250°F (120°C)
	Inappropriate cutting clearance	PLA requires much tighter cutting tollerance compared to PS
		Worn tools and large clearance will cause poor cutting, dust and sharp rim area
	Sheet not aged	If off line trimming, allow parts to age 24hrs prior to trimming