Thermoforming Troubleshooting Guide For Heavy Gauge Thermoplastic (Sheet-Fed)

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This guide is provided to assist in determining the cause of the most common problems during the thermoforming process. It does not take into account problems that may occur as a result of defective or hard to form materials and it assumes that the equipment being used is up to modern standards. It is intended for this guide to be used by thermoforming professionals to assist in the training of operators, technicians and tooling personnel. There is no guarantee that the solutions in this guide will solve all problems encountered in the process.

Problem	Probable Cause	Course of Action
Sheet wrinkling webbing bridging between tools	• Sheet too hot	• Cooler heater temperature • Shorten heating cycle
	• Poor vacuum	• Add vacuum holes • Check vacuum system for 25 inches of Hg
	• Poor tool design	• Redesign tool
	• Improper drawer ratio for mold/ improper mold layout	• Add assist block in wrinkled area • Use recessed pocket in waste area near web • Increase draft and/or radii if possible • Use mechanical assist • If more than one tool, increase spacing between tools
Blisters, voids, pits, bubbles	• Heating too rapidly (over-heating)	• Cooler heater temperature • Slower heating cycle
	• Moisture in sheet	• Pre-dry sheet • Heat sheet from both sides • Cooler heater temperature • Use material immediately after pre-dry
	• Uneven heating	• Use screening method to even heat distribution • Check for defective heaters • Adjust heater zones
Excessive sheet sag	• Sheet too hot	• Cooler heater temperature • Shorter heating cycle
	• Sheet too large	• Use screens or zone heaters to cool center of sheet
Shiny streak, spots on formed parts	• Overheated sheet in area	• Use screens to cool shiny area of sheet • Cooler heater temperature • Shorter heating cycle
Part Warpage	• Uneven cooling	• Cool entire part consistently • If water cooled, add more channels or tubing/Check for plugged water flow
	• Poor tool design	• Add vacuum holes • Check for plugged vacuum holes • Create moat below trim line of tool
	• Wall thinning	• Use plug assist pre-stretch material before tool contact • Increase sheet gauge • Check for uniform heating of sheet
Sheet tears when forming	• Tool too cold	• Raise tool temperature just below sheet forming window
	• Part removed from tool too fast	• Increase cooling time
	• Large flat surface	• Use ribs, or make part concave, convex
	• Sheet too cold	• Increase heating cycle or heater temperature • Check for uniform heating of sheet
	• Sheet too hot	• Decrease heating cycle or heater temperature • Check for uniform heating of sheet
	• Tool design	• Increase radius of corner(s)
	• Feed rate of tool	• Slow down rate of speed when tool is pushed into sheet

Problem	Probable Cause	Course of Action
Poor definition, detail of forming	• Sheet too cold	• Increase heating cycle • Increase heater temperature
	• Poor vacuum	• Check for clogged vacuum holes • Add more vacuum holes, increase size of current vacuum holes • Check for vacuum leaks
	• Cold damp frame	• Preheat clamp frame
	• Slow vacuum, sheet not drawn fast enough	• Check system for 25 inches of Hg • Check for vacuum leaks • Check for plugged vacuum hose. Increase size of vacuum hose. Increase size of vacuum holes or add more holes • Add vacuum pump capacity
	• Additional pressure	• Use plug or frame assist • Use 20-50 psi air pressure on opposite side of tool surface
Mark off lines, chill marks	• Tool temperature too low	• Increase tool temperature, do not exceed forming window of material • Relieve mold corners • Check temperature control of tool, if using heated tool
	• Cool plug assist temperature	• Increase plug assist temperature
	• Sheet too hot	• Reduce heater setting • Lower surface temperature of sheet with forced air before tool contact • Heat sheet slower
Surface marking on formed part	• Poor vacuum	• Add vacuum holes • Check for vacuum leaks • Check for vacuum pressure
	• Air entrapment over smooth tool surface	• Lightly sand surface of tool to create scratch lines for trapped air to escape
	• Tool too hot	• Lower tool temperature
	• Tool too cool	• Increase tool temperature
	• Dirt on tool	• Clean tool surface
	• Dust in atmosphere	• Use ionized air gun • Isolate forming area
	• Dirt on sheet	• Use ionized forced air, clean sheet
	• Improper tool composite	• Use aluminum when possible • Avoid heat sink tool materials
	• Tool surface too rough	• Sand tool surface with fine grit sandpaper • Change tool material compound
Sheet whitening	• Sheet stretching beyond yield point because of under-heating	• Increase sheet temperature, vacuum, speed of drape
Nipples on tool side of formed part	• Sheet too hot	• Reduce heater temperature • Reduce heat cycle time
	• Vacuum holes too large	• Reduce sheet temperature before tool contact • Plug holes and re-drill
Sag variation between blanks	• Sheet variation temperature	• Check for air drafts during heat cycle
Excessive shrinkage or part distortion after tool removal	• Removed part too soon from tool	• Increase cooling cycle • Use cooling fixture

Problem	Probable Cause	Course of Action
Excessive wall thinning	• Improper sheet sag	• Mount mold on top platen • Use snap back method
	• Hot cold spots in sheet	• Check heat system for consistency • Use screens/heater zones for consistent heat temperature
	• Stray drafts on heated sheets	• Eliminate drafts in forming area
	• Cool tool	• Increase tool temperature
	• Too much sheet sag	• Use screens/zone heaters to control center sheet temperature
Thin corners in deep draw	• Sheet too thin	• Use heavier gauge material
	• Sheet temperature variation	• Check heating system for consistency • Use heating zones or screens for sheet consistency
	• Tool temperature	• Heat tool temperature just below forming window
	• Forming technique	• Use plug assist to pre-stretch material • Increase corner radii
Shrink marks in corners (inside radii of tool)	• Poor vacuum	• Check for plugged vacuum holes • Check for vacuum leaks • Add vacuum holes • Add vacuum pump capacity
	• Tool surface too smooth	• Sand smooth tool surface
Part sticking to tool	• Wooden tool	• Lower tool surface temperature • Use tool release agent
	• Tool too hot	• Lower surface temperature
	• Sheet too hot	• Lower sheet temperature before contact of tool
	• Tool undercut	• Increase air eject pressure • Remove tool ASAP and use cooling fixture on formed part • Redesign tool to breakaway
	• Poor draft angle	• Use female tool • Increase draft angle • Remove tool ASAP and use cooling fixture on formed part
	• Improper plug assist temperature	• Cool plug temperature • Use tool release compound
Sheet sticking to plug assist	• Heating of sheet uneven	• Use screens for uniform sheet heat • Check for malfunctioning heaters • Check for air leaks in clamp frame
Pre-stretch bubble non-uniform	• Air draft	• Enclose area around forming machine from draft • Use baffle in pre-stretch box
	• Inconsistent air blow	• Check air blow cycle
	• Insufficient sheet temperature	• Increase sheet temperature
Part cracks or breaks in use	• Stress concentration	• Reduce stress by increasing forming time and slower plug speed
	• Poor material selection	• Change materials

WHAT TYPE OF PLASTIC IS IT?

A Quick and Easy Guide to Identifying Thermoforming Sheet

1. Determine Specific Gravity by weighing a sheet 12" x 12".

Weight (lbs) divided by gauge (in thousandths of an inch) x 5.28 = Specific Gravity

Specific Gravity of 16 common materials (will vary depending on source)

Polypropylene	0.9	Polycarbonate	1.2
HDPE	0.96	PETG	1.27
HMWPE	0.96	PET	1.33
HIPS	1.04	PVC	1.34
ABS	1.05	PVC/Acrylic	1.35
ABS/PVC	1.07	RPET	1.33
Cast Acrylic	1.18		
Extruded Acrylic	1.19		

2. Apply a flame to the corner of the sheet for a few seconds, then remove.

Material	Keeps Burning	Smell	Flame Color	Smoke	Drips	Other Tips
Polypropylene (b)	yes, slowly	like asphalt	blue	trace of white smoke	yes	Shows a transparent hot area when burning
HDPE (a)	yes, slowly	paraffin	blue, yellow tip	trace of white smoke	yes	Scratches easier than HMWPE. Floats in water. See below
HMWPE (a)	yes, slowly	paraffin	blue, yellow tip	trace of white smoke	yes	Feels harder than HDPE. Floats in water. See below
HIPS (b)	yes, rapidly	floral	yellow	dense+soot	yes	Illuminating gas when burned
ABS (b)	yes	acrid rubbery	yellow, blue edges	black+soot	yes	Bubbles when burning
ABS/PVC (b)	no	acrid	yellow, blue edges	black+soot	no	Burn rate depends on amount of PVC content. Heavier than ABS
Cast Acrylic	yes, slowly	fruity	blue at source predominantly yellow	grey	no	Flame may spurt if rubber modified
Extruded Acrylic	yes, slowly	fruity	blue at source predominantly yellow	grey	yes	Flame may spurt if rubber modified
Polycarbonate	no, chars	sweet faint smell	orange	dense black, soot	yes	Metal-like ring when struck with hard object
PETG	yes, rapidly		yellow, spurting	black no soot	no	Will crack and break under stress
PET	yes, rapidly		yellow, spurting	black no soot	no	Will crack and break under stress
RPET	yes, rapidly		yellow, spurting	black no soot	no	Imperfections in the clarity and transparency will be noticeable
PVC	no	acrid smell	yellow, green spurts	chars+melts	no	
PVC/Acrylic	no	fruity	blue, yellow tip		no	

3. Some other clues

(a) HDPE vs HMWPE: Cut a sliver 6'' long from edge of sheet. Try to stretch it. The HDPE will break. The HMWPE will stretch before breaking.
(b) Generally not available in transparent.

Thermo Forming Division

THERMOFORMING TROUBLESHOOTING GUIDE

A probable cause and solution guide for **Heavy Gauge/Sheet Fed** thermoplastic