THE ULTIMATE

THERMOFORMING TROUBLESHOOTING GUIDE

by THERMOFORA

XV
CHAPTERS

300+
DEFECTS DESCRIBED

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I. Thermal Imbalance Defects

Temperature control is the single most critical variable in thermoforming. The defects in this section stem from three conditions: too much heat, too little heat, or heat unevenly distributed across the sheet. Each condition produces a distinct and recognizable pattern of failures.

1. Overheating

1. Blisters and Internal Bubbles

- **Cause**: Moisture trapped in the sheet vaporizes under heat, forming internal pockets. Overheating drives vapor pressure beyond the polymer's melt strength. Severe cases cause the surface to rupture - known as a steam burst. Hygroscopic materials (PC, ABS, Acrylic) are most at risk.
- **Solution:** Pre-dry hygroscopic sheets before forming (PC requires approx. 1 hr/mm at 90°C). Reduce the heat cycle time and monitor bottom sheet temperature with an IR sensor. Use staged pre-heating at 60°C to allow moisture to escape gradually before reaching forming temperature.

2. Microbubbles

- **Cause:** Polymer breakdown and gasification during the heating cycle - distinct from moisture blisters. Indicates the material is approaching its thermal degradation limit.
- **Solution:** Reduce oven temperature or dwell time. Avoid repeated re-extrusion of regrind material.

3. Surface Boiling Effect

- **Cause:** Extreme overheating causes the material surface to physically boil, producing a pitted or severely textured appearance.
- **Solution:** Decrease oven temperature and increase the distance between heating elements and the sheet.

4. Surface Gloss Change

- **Cause:** Overheating makes the material too fluid, causing it to copy mold imperfections prematurely or react to air currents, resulting in gloss loss or undulation.
- **Solution:** Reduce heating time and form at the correct tempering temperature rather than the upper operational limit.

5. Orange Peel Texture

- **Cause:** Prolonged heat soak at elevated temperature causes surface irregularities, particularly in thinner drawn areas.
- **Solution:** Eliminate heat soak for sensitive materials. Use screening (aluminum mesh) to reduce radiant energy in areas prone to thinning.

6. Sheet Sag and Pre-form Collapse

- **Cause:** When the polymer reaches its viscous state, gravity overcomes melt strength and the sheet sags uncontrollably. In large-format sheets or overly heated material, the pre-stretch bubble becomes unstable.
- **Solution:** Reduce heating cycle time. Install a photo-electric sag eye to trigger automatic air injection for sheet leveling. Use cooling screens in the center of the sheet for large formats.

7. Corner Tearing from Over-softened Sheet

- **Cause:** Excessive heat reduces tensile strength, causing the sheet to rupture when stretched over sharp radii or during deep draws.
- **Solution:** Decrease heat cycle time. Increase corner radii in the mold design.

8. Plug Mark Imprint

- **Cause:** When the sheet surface is too fluid, contact with a plug assist leaves a visible impression immediately upon touch.
- **Solution:** Wrap the plug in felt or flannel. Reduce heating time to maintain some surface resistance.

9. Nipples from Vent Holes

- **Cause:** Overheated, fluid material is drawn into vacuum vent holes by atmospheric pressure, forming small protrusions. Oversized vent holes make this worse.

- **Solution:** Reduce the heating cycle. Keep vent hole diameters between 1/32″ and 1/8″ (0.8-3.0 mm). Plug and re-drill any oversized holes.

10. Edge Thinning Collapse

- **Cause:** Excessive heat near the clamping frame - often from high perimeter zone settings - causes the sheet edges to pull away and thin severely.
- **Solution:** Use lower zone temperatures or aluminum screening at the perimeter.

11. Material Burning

- **Cause:** Unchecked heat absorption leads to polymer degradation: bubbling, charring, or scorching of the surface.
- **Solution:** Check for faulty heater zones or hot spots. Reduce overall temperature settings.

12. Acrylic Masking Damage

- **Cause:** Surface temperatures exceeding 420°F (215°C) cause protective masking to bake onto the sheet. It then breaks off in strips rather than peeling cleanly - this applies equally during forming and when stored at elevated temperatures.
- **Solution:** Use thermolabels to verify surface temperature stays below 420°F. Reduce top heater wattage or increase the heater-to-sheet distance.

13. Polymer Degradation Odor

- **Cause:** Overheating triggers molecular scission, releasing free monomers as a strong plastic-like smell - particularly in styrenics. Indicates irreversible reduction in molecular weight.
- **Solution:** Improve ventilation in the forming area. Optimize the heat cycle to prevent degradation temperatures from being reached.

14. Surface Discoloration

- **Cause:** Thermal instability causes yellowing or color loss in HIPS, ABS, and PVC at excessive temperatures.
- **Solution:** Reduce heating time and verify the material's thermal stability range with the supplier.

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