

## Troubleshooting Guide for Injection Molding

Troubleshooting is the art and science of remedying defects after the process has demonstrated the ability to produce acceptable production parts. Most defects respond to one of a variety of process and/or material changes. The goal is to correctly identify which problem is actually causing the defect and to know when a particular solution will work. When making adjustments consider the following recipe:

- Create a mental image of what should be happening,
- Look for obvious differences,
- Make only one change at a time, and
- Allow the process to stabilize after any change is made.

Studies have determined that about 60% of defects result from machines and equipment, 20% from molds and dies, 10% from material, and 10% from operator error. Software programs, either already installed on the machine's processor controller or available as a software package, can provide some help.

With all types of equipment, materials, and products, troubleshooting guides are set up (usually required) to take fast, corrective action when products do not meet their performance requirements. This problem-solving approach fits into the overall fabricating-design interface.

To understand potential problems and solutions (and eliminate myths), it is important to consider the relationships of machine and equipment capabilities, plastics processing variables, and product performances. A distinction has to be made between machine conditions and processing variables. Machine conditions could include operating temperatures, back pressures, screw rotation speed, die temperature, etc. Processing variables are more specific, such as melt conditions in the plasticator and die, melt flow rate versus temperature, etc.

When setting up troubleshooting guides, as well as reviewing any problems or even open discussions on the subject of fabricating, it is important that the terms used to identify a problem be understandable, clear, and properly defined.

Different terms are used throughout the industry to identify defects in plastic materials, fabricating equipment, and products. They include adhesive stringing, air bubble, applesauce, arrowhead, black speck, bleed, blister, blockage, bloom, blowhole, blush, burn line, chalking, coating defect, cosmetic defect, compressive buckling, crazing, degradation, electrostatic charge, fin, fines, fish-eye, flash, fracture, flaw mark, freeze-off, frosting, gas pocket, gel, globule, hairline, migration, orange peel, paint framing, pimple, pin hole, pit, plastic pocket, plate-out, pocket, pock mark, puckering, run, sag, scale, segregation, shark skin, sink mark, speck, splay mark, stain, starved area, streak, stress whitening, striation, surface finish, trim, void, weld line, yellowing, and so on.

Problem	Possible Causes	Possible Solutions
<b>1. Short Shot</b>	Underfilled part	<ul style="list-style-type: none"> <li>• Increase shot size</li> <li>• Inadequate cushion</li> <li>• Increase fill speed, pack pressure, and/or injection time</li> <li>• Increase melt and/or mold temperature</li> <li>• Plugged gates, runners, or vents</li> <li>• Inadequate melt flow rate (use higher MFR material)</li> <li>• Undersized gates, runners, and vents</li> </ul>
<b>2. Sink Marks</b>	Part is underfilled or has excessive shrinkage in thicker sections	<ul style="list-style-type: none"> <li>• Increase shot size</li> <li>• Increase cavity or hold pressure</li> <li>• Melt or mold temperature too high (if gate freeze-off too slow)</li> <li>• Increase hold time</li> <li>• Reduce fill rate</li> <li>• Reduce wall thickness of intersecting rib or boss</li> <li>• Improper gate locations or design</li> </ul>
<b>3. Shrinkage</b>	Volume decreases as plastic cools and crystallizes or part is not fully packed out due to gates freezing off too soon or insufficient cooling time	<ul style="list-style-type: none"> <li>• Excessive shrinkage – increase cavity pressure and hold time</li> <li>• Maintain adequate cushion</li> <li>• Increase hold time</li> <li>• Delay gate sealing to allow pack out (increase melt temperature)</li> <li>• Runners or gates too small</li> <li>• Wall thickness variation</li> </ul>
<b>4. Flash</b>	Insufficient clamp force, mold surface is deflecting, mold shutoff surfaces not seating properly	<ul style="list-style-type: none"> <li>• Decrease peak cavity pressure (decrease fill rate and/or use profile injection)</li> <li>• Decrease melt temperature</li> <li>• Increase clamp force</li> <li>• Clean mold surfaces</li> <li>• Check integrity of mold shutoff</li> </ul>

		<ul style="list-style-type: none"> <li>• Change gate location</li> <li>• Use larger press</li> </ul>
<b>5. Warpage</b>	Non-uniform stress due to excessive orientation and/or shrinkage	<ul style="list-style-type: none"> <li>• Part ejected too hot (increase cycle time)</li> <li>• Mold at high temperatures, low pressures, and moderate fill rates</li> <li>• Decrease injection fill rate</li> <li>• Molded in stress due to low stock temperature and cold mold</li> <li>• Minimize hot spots in mold</li> <li>• Flow too long, insufficient gates</li> <li>• Change gate location</li> </ul>
<b>6. Burning</b>	Compressed air in the mold degrades resin	<ul style="list-style-type: none"> <li>• Decrease peak cavity pressure (decrease fill rate and/or use profile injection)</li> <li>• Clean vents, increase size or number of vents</li> <li>• Reduce melt temperature</li> </ul>
<b>7. Poor Appearance (flow marks, low gloss, rough surface, jetting, orange peel, etc.)</b>	Flow front slips-sticks on mold surface, jets, or pulsates	<ul style="list-style-type: none"> <li>• Increase cavity pressure</li> <li>• Fill speed and/or packing time too low</li> <li>• Increase melt and/or mold temperature</li> <li>• Cool more slowly</li> <li>• Mold temperature non-uniform or too low</li> <li>• Insufficient lubrication (internal lubricant or on tool surface)</li> <li>• Excessive mold lubricant</li> <li>• Dirty mold surface (clean and/or polish)</li> <li>• Poor pigment dispersion</li> </ul>
<b>8. Voids</b>	Part is underfilled or has excessive shrinkage	<ul style="list-style-type: none"> <li>• Incomplete mold fill (short shot)</li> <li>• Maintain adequate cushion</li> <li>• Improper gate location</li> <li>• Injection rate too high</li> <li>• Excessive part thickness (+ 0.64 cm)</li> </ul>
<b>9. Poor Weld Line Strength</b>	The convergence of flow fronts past an obstacle or merging flow fronts in multi-gated molds results in a weak, interfacial bond	<ul style="list-style-type: none"> <li>• Increase peak cavity pressure (fill faster)</li> <li>• Increase mold and melt temperatures</li> <li>• Increase hold pressure and time</li> <li>• Change gate location</li> </ul>
<b>10. Brittleness</b>	Excessive orientation, degradation of resin, over packing, contamination, or improper design	<ul style="list-style-type: none"> <li>• Increase injection fill rate</li> <li>• Increase melt temperature</li> <li>• Increase mold temperature and cool time</li> <li>• Over packing (decrease hold pressure and time)</li> <li>• Degraded material (excessive melt temperature or long residence time in barrel)</li> <li>• Contamination from other polymers</li> <li>• Use of incompatible carrier resins in color concentrates or other additives</li> <li>• Unintentional nucleation from pigments</li> <li>• Improper design; inadequate radii at corners, notches, or</li> </ul>

		threads
<b>11. Nozzle Drool</b>	Excessive nozzle or melt temperature	<ul style="list-style-type: none"> <li>• Reduce heating</li> <li>• Purge barrel</li> </ul>
<b>12. Sticking in Mold</b>	Over packing, excessive shrinkage, tool design causes physical attachment to the core or cavity	<ul style="list-style-type: none"> <li>• Over packing, injection pressure too high – reduce</li> <li>• Under packing, excessive shrinkage – see solutions to short shot</li> <li>• Improperly balanced mold temperatures (colder on movable half)</li> <li>• Reduce cycle time (sticking on cores)</li> <li>• Increase cycle time (sticking in cavities)</li> <li>• Insufficient knockouts</li> <li>• Increase draft angles</li> <li>• Surface irregularities in the mold (polish cavity surfaces)</li> <li>• Highly polished core surface (vacuum lock), polish to a coarser finish, apply a surface coating</li> </ul>
<b>13. Black Specks or Discoloration</b>	degradation	<ul style="list-style-type: none"> <li>• Excessive melt temperature or residence time in barrel</li> <li>• Improper venting</li> <li>• Possible contamination</li> <li>• Excessive screw RPM</li> <li>• Excessive back-pressure</li> <li>• Excessive shear created by the use of a mixing screw</li> </ul>
<b>14. Splay</b>	Streaks on surface caused by volatiles such as moisture or degraded material	<ul style="list-style-type: none"> <li>• Excessive moisture (dry resin)</li> <li>• Reduce melt temperature</li> </ul>
<b>15. Gate Blush, Delamination or Cracking at the Gate</b>	Melt fracture	<ul style="list-style-type: none"> <li>• Adjust injection speed (increase or decrease)</li> <li>• Modify gate geometry</li> <li>• Increase melt and/or mold temperature</li> </ul>
<b>16. Gate Stringing</b>	Plastic strings on parts located at the gates formed during ejection	<ul style="list-style-type: none"> <li>• Increase gate size (reduce orientation)</li> <li>• Decrease melt temperature, increase cooling time</li> <li>• Increase mold opening speed (break strings upon ejection)</li> </ul>