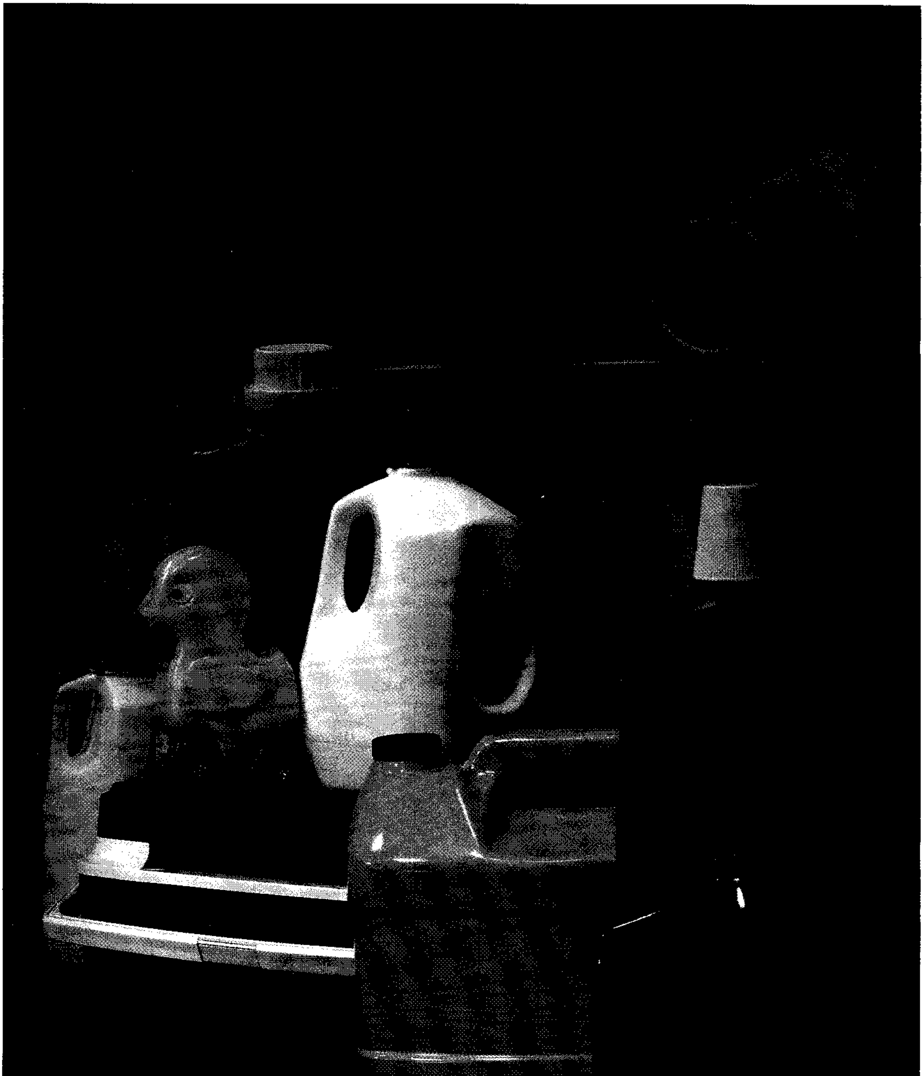
How to Solve Blow Molding Problems



Quantum

How to Solve Blow Molding Problems

This booklet reviews some problems that may occur during blow molding operations. Although millions of objects are blow molded each year, blow molding is not a simple processing technique. Possible defects are many and various. This booklet primarily deals with these problems as they appear in lightweight, thin-walled parts, such as bottles and containers. However, many of the recommended solutions also apply to heavier, thicker objects.

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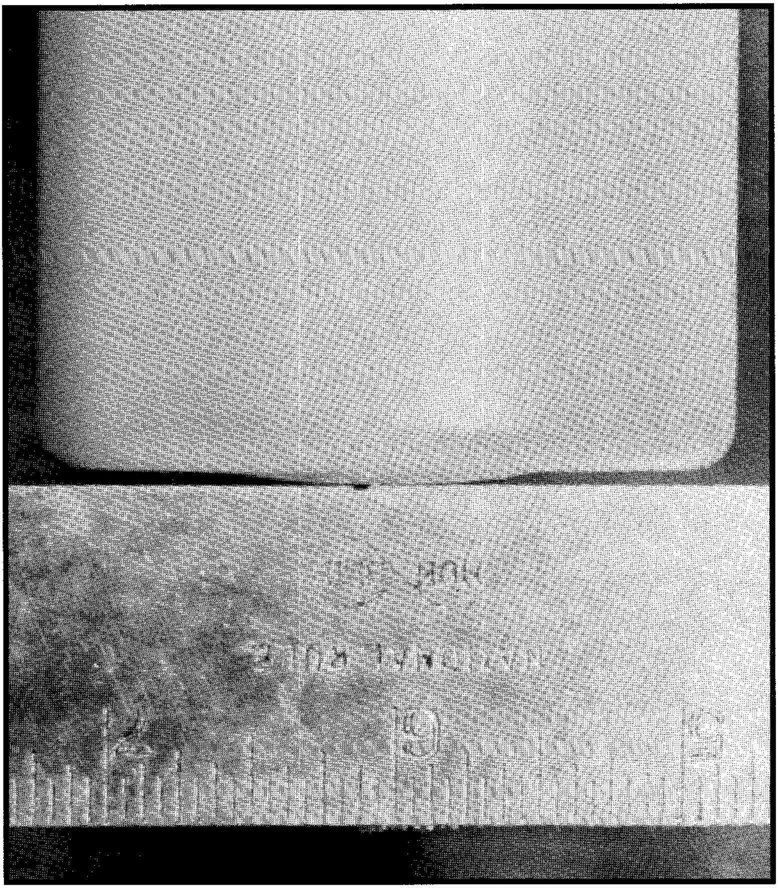
Rocker Bottoms and Oval Necks

These two defects in blow molded objects are the result of warpage. The cause is, in general, the same that results in warping in parts made from other plastics molding processes: inadequate cooling of the part prior to its removal from the mold. Possible causes and solutions follow:



Rocker Bottoms

1. Insufficient cooling water to the mold
—Increase flow and determine if this eliminates warpage.

2. Too high a stock temperature
—Try dropping the temperature by small amounts to see if this will solve the problem without resulting in new concerns such as cold spots in the container wall.

3. Blocked cooling channels
—Check the throughput. If it is significantly less than when the mold was new, a thorough cleaning of the channels is needed.

4. Cycles too short
—If 1, 2 and 3 have not solved the problem, determine whether the cycles are unrealistically short to keep productivity high. If cycles are reasonable, proceed to the next group of possibilities below.

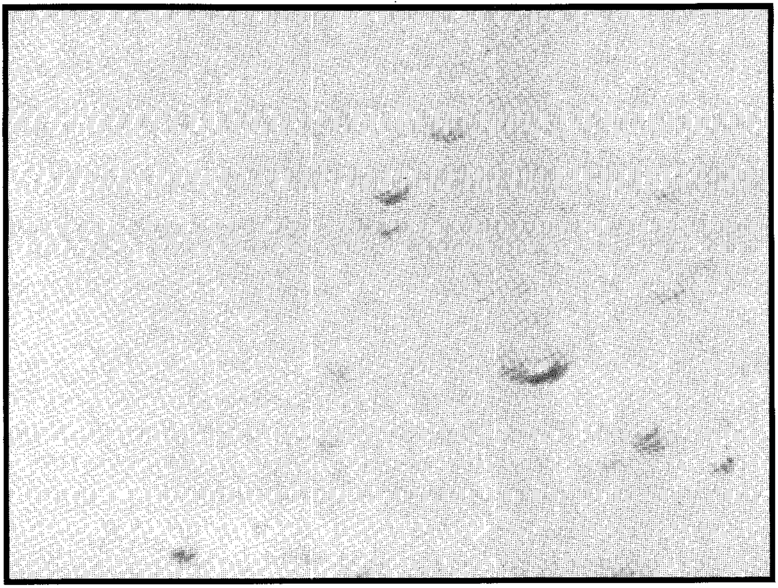
5. Poorly designed cooling channels
—The mold may have to be reworked to increase cooling capability or the uniformity of cooling.

6. Poorly designed part
—Too great a variation in the distribution of material in the part, yielding unnecessarily thick and thin sections, result in warpage unless the part is thoroughly cooled. This may demand an uneconomically long cycle. Parison programming or a redesign of the part itself may be necessary.

Defects Within the Blown Wall

Bubbles in the wall and cold spots both spoil the appearance of the blow molded object. While these two defects are unrelated, they may have similar causes.

Bubbles are generally symmetrical areas on the wall of the object, usually clearer than the surrounding area. Moisture in the melt is the usual cause. Following are some methods for eliminating this problem.



Bubbles

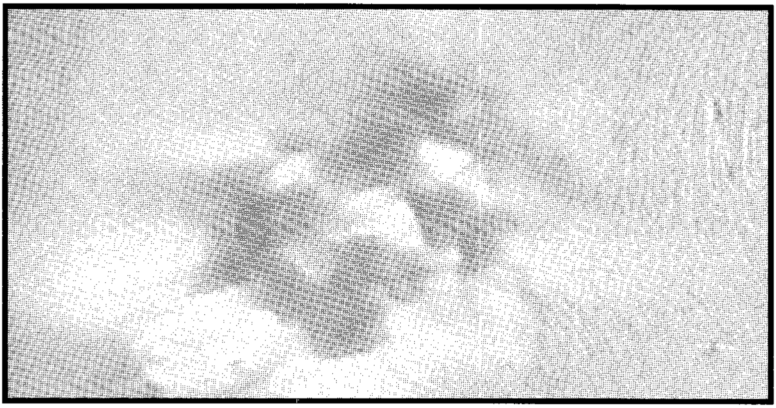
1. Moisture condenses on the surface of cold resin that is exposed to the warmth of the blow molding shop.
—Allow the resin to warm up and the moisture to evaporate before it enters the extruder.
—Let the resin warm up by keeping a few unopened gaylords in a warm room.
—Discharge direct draws from hopper cars or trucks into surge bins where the resin can warm up and moisture evaporate before moving to the extruder hopper.
—Increase barrel temperature in the transition section of the screw to remove any further moisture.

2. Overdone water cooling on the throat of the extruder, resulting in water condensing in the barrel
—Decrease water cooling on the throat.

3. Non-moisture causes of bubbles
—Check material leaking from mismatched head sections and rectify, as this also can be a source of degraded resin.
—Make sure back pressure is sufficient. If not, adjust the back pressure gauge on reciprocating blow molding machines and change to a finer mesh screen pack on continuous extruders.
—Check for screw wear. If severe, replace the screw.

Cold Spots show up as non-homogeneous areas in the wall of the blown object. This can also be caused by insufficient back pressure or non-uniformity in the melt. Solutions are the same as for bubbles.

Cold Spots also can result from a resin mixture in which some material has a lower melt index. The resin does not melt completely and extrusion conditions are inadequate for the lower melt index material, resulting in defects on the blow molded part.



Cold Spots

Poor Weld or Pinch-off and Indented Parting Lines

There are three distinct weld or pinch-off defects:

Thinning of the weld
Tearing of the flash during trimming
Cutting at the pinch-off

Causes include the resin used, molding conditions, mold design or a combination of these factors.

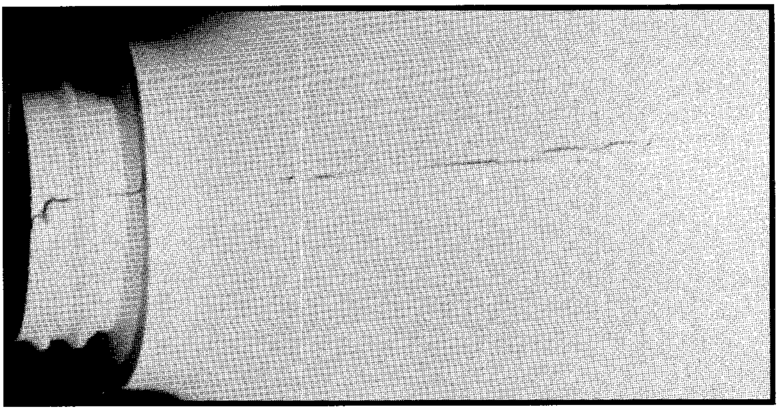
Thinning

1. Stock temperature too high
—As the molds close and the pinch-off is made, the pinch-off lands fail to force enough material into

the weld line to make a strong weld. First, gradually drop the stock temperature to see if this solves the problem. If it does not, continue below.

2. Too short or too sharp a pinch-off land length
—Adjust the pinch-off land length.

3. Excessive pre-blow or high pressure air coming on too early
—Gradually back off the pre-blow air to a point that does not affect the other areas of the container.
—If the above does not solve the problem, increase the blow delay time. Care must be taken when doing this to avoid affecting other areas of the container.



Thinning of the Weld

Tearing

1. Pinch-off land length too long
—Long pinch-off land length forces more material into the weld line, resulting in a strong weld. If overdone, however, a long pinch-off land length can prevent the molds from closing completely, leaving a thick pinch-off line that is apt to tear during trimming. The weld is then ragged, rough and possibly torn open.

Tearing of the Flash

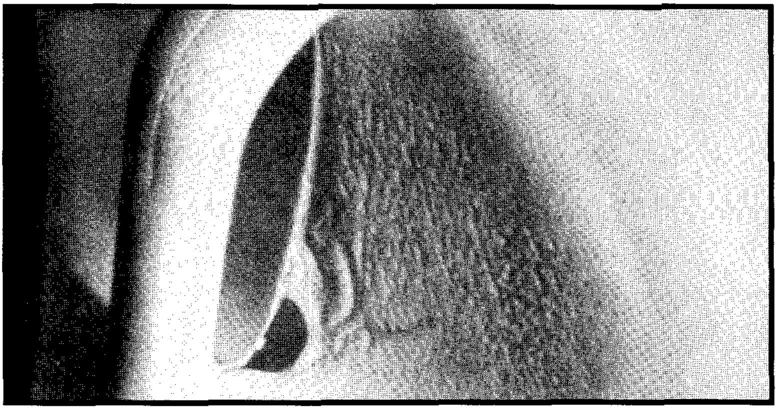
—Have the molds reworked to reduce the land length to 0.010 to 0.015 inch, the common range in polyethylene blow molding. This land length results in a good balance between a strong weld and a trimmable pinch-off.

2. Pinch-offs worn
—Correct temporarily by rolling them back; refurbishing is necessary.

3. Molds mismatched
—Caused by worn locating pins which must be replaced.

4. Molds damaged
—Nicks and other damage in the pinch-off areas indicate a need to fill and regrind the molds.

5. Mold clamp pressure uneven
—Molds that appear to have torn pinch-offs in one area and not another are probably not closing and clamping evenly. Adjust the clamp. If the clamp cannot be adjusted, the molds can be shimmed out at the problem area.



Cutting at the Pinch-off

Cutting can be the problem if a hole or slit is found in a weld in a part with flash attached.

1. Stock temperature too low
—If the weld and pinch-off both seem satisfactory but there is a hole or slit along the weld, the parison may be tearing as the mold closes because of cold stock. Raise the stock temperature in 5-10°F increments until the cutting ceases.

2. Molds close too fast and slam or snap shut
—Ease off the closing cycle to make better welds and preserve the molds.

Indented Parting Lines appear as a "V" shape where they pull into the blown object.

1. Insufficient blow pressure or air entrapment due to poor venting
—Raise the blow pressure.
—Clean the mold vents.
—If the above do not work, sandblast the molds to improve venting.

Poor Bottle Surface

Roughness, pits and "orange peel" are only a few of the terms used to describe the less than perfect surfaces that can be found on blown bottles. One cause is an imperfect parison. Other causes are related to the mold and the blow molding process.

1. Poor mold surface
—Refinish a poor or worn mold surface. The mold should have a fine matte finish to allow air to vent quickly and the parison to conform to the mold surface while it is still hot.

2. Plugged or inadequate vents
—Clean plugged or dirty vents, particularly those along the parting line.
—Rework the mold to enlarge vents that are too small or increase the number of vents to enable air to escape rapidly. When air cannot escape, surface problems result.

3. Low blow pressure or blow rate
—Increase the blow pressure.
—Determine whether the blow pin is large enough to handle the required amount of air to fully and rapidly blow mold the part.
—Check for restrictions or partial plugging of the air lines.

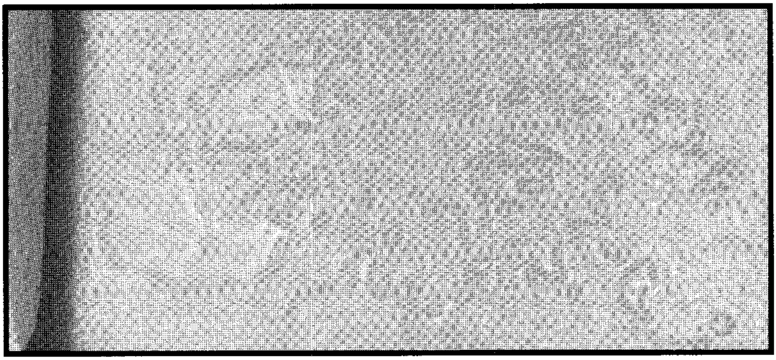
4. Air leak around the blow pin
—Repair the leak. Air leakage around the blow pin means that there is not sufficient air pressure to hold the part tightly against the mold.

5. Low stock temperature
—Gradually increase the stock temperature. A cold parison will not reproduce the surface of the mold well, particularly if lettering or designs are involved. However, be careful when raising temperatures. Raising temperatures too fast or too extensively can lead to the problems associated with too high a stock temperature.

6. Condensed water in the mold

—Gradually raise the mold temperature, if possible.

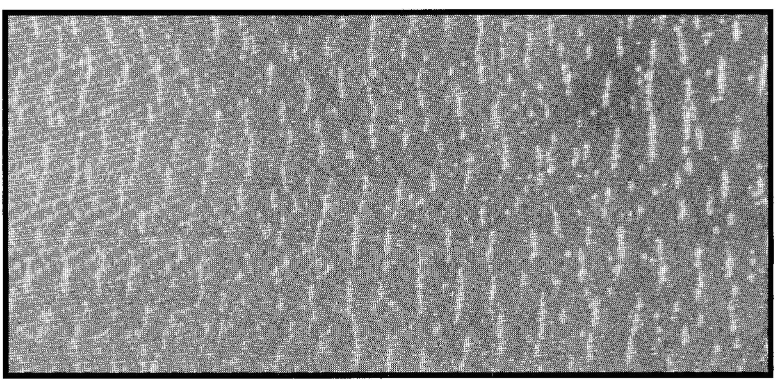
—If raising the mold temperature cannot be done without increasing cycle time, it may be necessary to air condition some localized areas of the plant during periods of high humidity. High humidity combined with low mold temperatures can result in water condensing in the mold between the ejection of a part and the blow molding of the next.



Condensed Water in Mold

7. Rough parison

—A rough parison usually results from operating the blow molding process at a shear rate that produces instability in the melt. Melt instability is more likely to occur when continuous extruders are run near or at the highest rates of which they are capable. With reciprocating or accumulator types of blow molding machines, melt instability is more likely to occur when the extruders are run near or at the slowest rates of which they are capable.



Rough Parison

With continuous extruders:

—decrease the extrusion pressure until rough parisons no longer occur.

With reciprocating or accumulator type extruders:

—decrease extrusion rates (increase drop time)—but this is generally unsatisfactory because of the decrease in productivity.

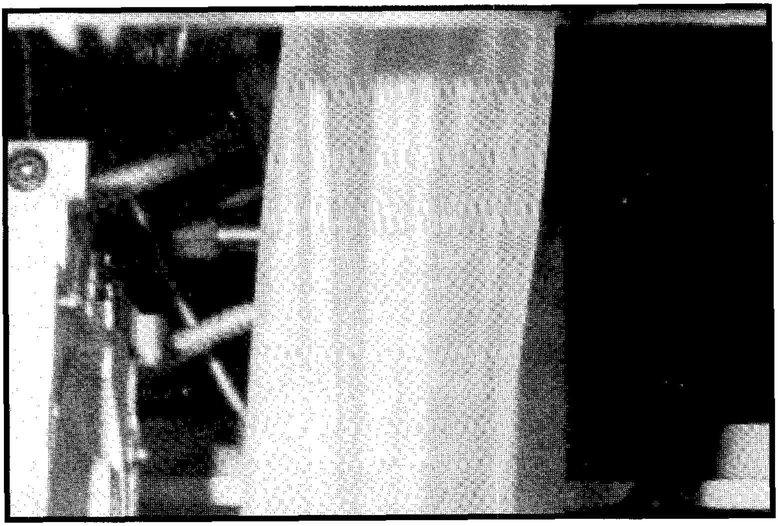
—increase extrusion rates, and thus move up out of the region of melt instability (decrease drop time)—a more satisfactory solution.

—increase stock temperature or change to a higher melt index resin, if extrusion rates cannot be increased.

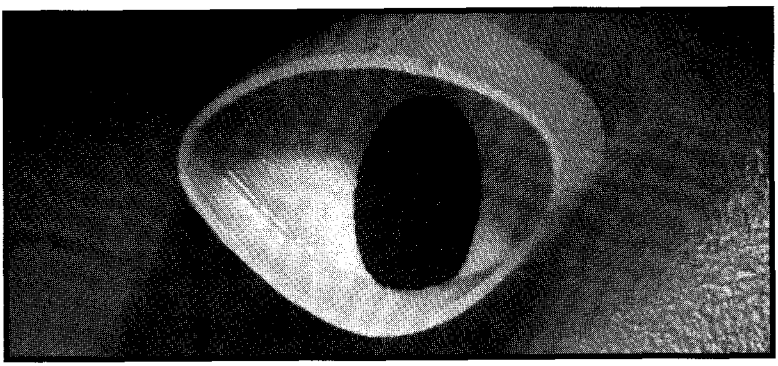
If accumulator or reciprocating type blow molding machines are run at extremely high shear rates, melt fracture may occur, also resulting in rough surfaces on the part. Melt fracture happens rarely in blow molding and the solution is to decrease extrusion pressure.

Curtaining and Webbing

Curtaining or folding of the parison as it extrudes from the die is the cause of webbing in bottle necks and handles. If the effect is severe, the handle can be partially or completely blocked. Folds in the neck can lead to problems in filling operations or in reaming and facing, thus affecting the fit of the cap.



Curtaining of the Parison



Webbing in the Handle

1. Poor tooling design
—Too short a land length between bushing and mandrel results in poor control of flow through the die gap, leading to areas of high and low flow. The result is parison folding.

2. Die misalignment
—Bushing and mandrel misalignment also produces differential flow rates in different areas, resulting in folding.

3. High stock temperature
—Very high stock temperatures result in parisons with low melt strengths. Such parisons collapse and fold before they can be blown.

4. Resin mismatch
—If the resin used has too high a weight swell, an attempt is often made to reduce part weight by decreasing the die gap. However, decreasing the die gap can yield a very thin parison that quickly collapses and folds. A resin with low diameter swell characteristics may cause lower handle webbing and in severe cases, even blow-outs. In this case, the parison is caught in two places by the inner handle pinch-off. When blown, these areas meet to form a heavy area known as a web.

5. Low parison diameter swell
—High stock temperature and/or low shot pressure will yield a parison with low diameter swell, resulting in lower handle webbing.

6. Mold position
—Improperly positioned molds that are shifted away from the parison will result in containers with lower handle webbing.

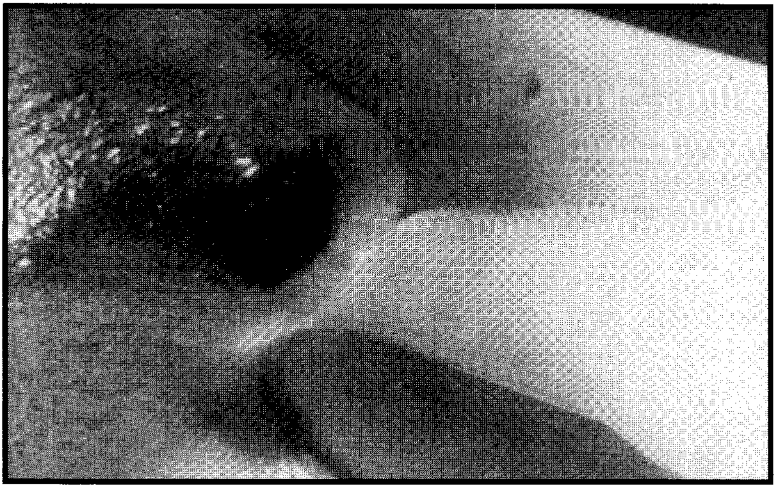
7. Hooking parison
—If the parison hooks away from the handle, webbing problems similar to those described above will also occur.

8. Ovalized tooling
—If oval tooling is improperly designed, the problems described above can occur.

9. Pre-blow air pressure
—If pre-blow air pressure is low or is lacking entirely, curtaining and webbing can occur. Increase the pre-blow air pressure to minimize this effect.

Blow-Outs

The blow-out of a part can have many causes. Several are listed on the following pages, along with suggestions for correcting the conditions that caused the problems. Start with the cause that seems most probable and check it first; then continue down the list of possibilities.



Blow-out of the Part

1. Too sharp a pinch-off
—This can cut the parison and cause a blow-out. Increase the width of the pinch-off land.

2. Too wide a pinch-off
—This causes mold separation and the chance of a blow-out.

3. Too low a clamp pressure
—This also can cause mold separation and blow-outs.

4. Too hot a pinch-off
—Poor or uneven mold cooling can prevent the pinch-off from cooling sufficiently and cause it to cut the parison just as it would if it were too sharp. Refer to the section on “Warping” for solutions.

5. Too high a blow pressure
—Stretching the parison at too high a rate can lead to blow-outs. Back off gradually on the pressure to solve this problem.

6. Too short a parison
—A short parison is not caught at the bottom pinch-off and result in a blow-out. Lengthen the parison.

7. Too high a blow-up ratio
—If there is a large difference between the diameters of the parison and the final blown part,

the parison may be stretched too much, resulting in a thin area on the end product. A blow-out can occur. Change the head tooling to a larger diameter die.

8. Too low a resin swell
—A low swell results in a smaller than expected parison, yielding a blown part with thin spots and blow-outs, similar to #7 on the previous page. Additionally, the bottle handle can be missed. Switch to a higher swell resin.

Parison Curl, Stringing, Hooking, Sag and Length Inconsistency

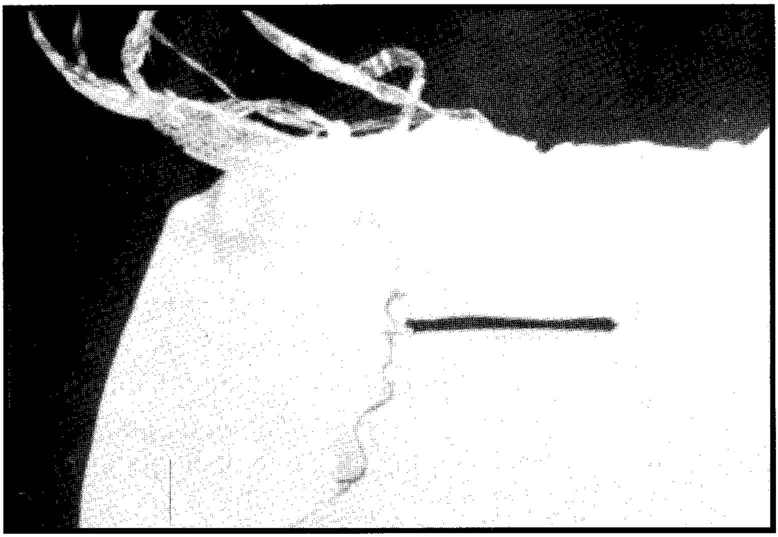
Parison curl **occurs during the extrusion of the parison as a result of too cold a melt temperature. Parison curl is sometimes called "doughnutting," and usually results from one of the three causes described below:**

1. Too cold a mandrel or bushing
—If the curling occurs when the blow molding machine is started, then gradually disappears as the machine approaches operating temperature, check the mandrel or bushing. Allow a longer warm-up period before starting production.
—Check whether the die bushing heater, with which most blow molding machines are equipped, is working. If the heater is not operating properly, a very long warm-up time will be needed.

2. Die or mandrel misalignment
—If the machine is fully warmed up and parison curl occurs, check the die and mandrel alignment. Usually, the mandrel edge is recessed within the die. As a result, the parison contacts the die and tends to hang up on one side and curl. Sometimes this misalignment has been purposeful, in an attempt to blow a bottle lighter in weight than that for which the tooling was designed.

—Obtain new tooling or machine the die bushing to bring the mandrel back to a flush or lower position with the die face.
—Parison curl also can result from air leakage around the tooling thus cooling the mandrel or die.

3. Foreign matter or degraded resin in the die bushing
—Uneven build-up of foreign material on the die bushing can distort the parison as it is extruded. Thoroughly clean the die to prevent foreign matter from accumulating in the bushing.



Melt Stringing

Parison stringing also occurs when the parison is extruded, but is caused by too high a melt temperature. Thin, feathery strings of melt are attached to the top and bottom flash of the blown part. If stringing is severe, bottles remain attached to each other and the lower bottle's weight may thin out the next parison to the point that blow-outs occur, particularly in a handled bottle. Causes follow:

1. Too high a stock temperature
—Gradually lower the temperature. However, if cold spots occur when the temperature is lowered, it may be necessary to change to a different resin.

2. Too high a fill pressure on reciprocating screw-type machines
—Excessive "weeping" of polymer from the die occurs, causing the parison to string during part removal.

Parison hooking occurs when a parison does not drop straight, but "hooks" to one side. This results in poor distribution of resin to the walls, webbing and/or blow-outs in the handle. Causes follow:

1. Non-uniform die temperature
2. Warped die or mandrel
3. Die gap out of adjustment
4. Air flowing on parison

Parison sag or drawdown occurs when a parison thins out near the die during extrusion and appears to do so from its own weight. Causes follow:

1. Too high a stock temperature
2. Too slow an extrusion rate
3. Too long a mold open time
4. High die heats
5. Resin with too high a melt index

Parison length inconsistency occurs when the parisons vary from too short, resulting in blow-outs, to too long, resulting in wall distribution problems and tails sticking to the blown part during unloading. Parison length can vary for the following reasons:

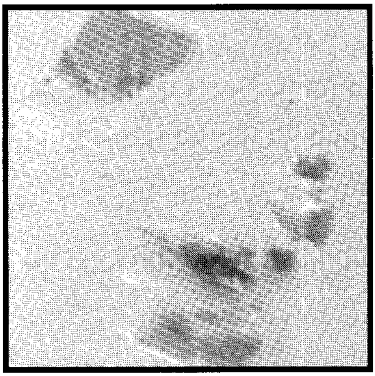
1. Insufficient back pressure in the extruder
2. Changing the regrind/virgin resin mixture
3. Malfunctioning temperature controllers
4. Bridged or colored screw
5. Worn barrel of screw

Parison length inconsistency from head to head is self-explanatory. It can be caused by:

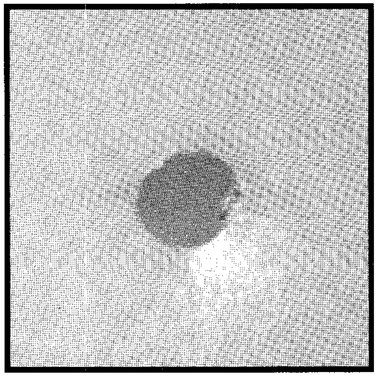
1. Non-uniform head heats
2. Non-uniform bottle weights
3. Manifold chocks out of adjustment
4. Head chocks out of adjustment

Foreign Matter in the Melt

Foreign matter in the melt, whether from outside contamination of the resin or degraded resin, manifests itself in several ways, such as die lines or streaking in the parison, off-colored particles in the wall of the molded part or holes or "windows" in the blown part. The only solution to this problem is locating and eliminating the source of the foreign material. Possible sources are described below.



Foreign Matter (Close-up)



Hole or "Window"

1. The easiest potential source to check is material handling procedures and general housekeeping in the blow molding shop.

—Keep the resin clean and free of contamination. Close all gaylords to prevent dust accumulation. Carefully introduce bagged resin into the feed in a way that prevents dirt and lint from entering at the same time.

—Keep regrind free from contamination as well. Keep parts with foreign matter in them out of the grinder.

Note: If parison streaking is occurring, before checking for foreign matter, check heater bands. A burned-out band will cause a cold spot in the barrel, resulting in uneven melt flow and parison streaking. Replace the inoperative band.

2. The source of degraded resin is more difficult to pinpoint. To locate it, follow the procedures outlined below:

—If 1 to 3 streaks suddenly appear in the parison, it is likely that foreign matter has become lodged between the die and the mandrel. Increase the die gap briefly to purge the particles; then reset to the original gap.

—If parison streaking or defective bottles (foreign particles or holes) are occurring regularly, and materials handling procedures have been eliminated as a source of contamination, the degraded resin may be generated from within the head, adaptor or in the extruder. There is probably a blind spot or non-streamlined area where the melt is hanging up, degrading and then breaking away periodically. A poor fit between head and adaptor, or adaptor and extruder barrel are two possible causes of this. Rework the parts for a smoother fit.

—The gradual appearance of many die lines or streaks after extended periods of operation indicate a build-up of carbon or degraded resin in the head. Usually this occurs on the die and mandrel which are easily accessible. Clean these with a copper or brass tool which does not mar the surfaces or damage these parts of the machine.

—Not all the foreign matter will have lodged in the die. If the dead spots in the head have been eliminated as a source, it will be necessary to check out the extruder. Check the extruder head for mismatched or non-streamlined head sections or inadequate seals that are allowing polymer to leak.

—Degraded resin more often results from operating error, such as:

- Poor purge when changing from one resin to another.
- Not allowing the extruder to cool down on purge before shutting it off can result in specks in bottles upon start-up. This results from resin in

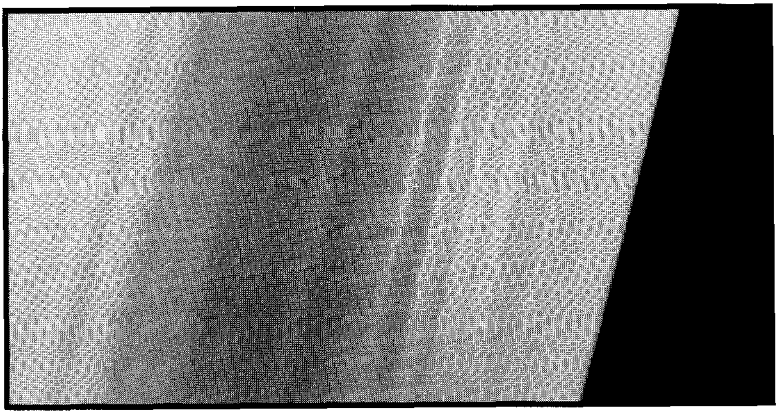
the die lips which has been oxidized by exposure to air. Shorten both shut-down and start-up times by installing an air-lock plant to seal off the die lips from the air during these periods.

- Running at too high a temperature at some point or points along the barrel may cause resin degradation back in the extruder barrel. The high temperature may be intentional in an effort to run a difficult resin and still maintain fast cycle times. If slowing the screw speed is not an acceptable solution, switch to a resin that is easier to extrude.
- Too high a temperature in the metering zone of the screw also can yield degraded resin. Try a reverse temperature profile:
  a. increase the temperature in the transition zone
  b. decrease the temperature in the metering zone
  c. smoothly increase the temperature to the desired final melt temperature through the adaptor and head

  Purge the extruder once a workable temperature profile has been found. However, if the degraded resin situation has existed for a long time, the extruder may require a thorough cleaning.

Die Lines or Streaking in the Parison

Streaking is usually the result of foreign matter or degraded resin lodged between the die and mandrel. See the section on degraded resin under "Foreign Matter in the Melt," on the preceding page.



Die Lines or "Streaking"

Shrinkage

Some shrinkage in a polyethylene container after molding is normal. Excessive shrinkage can be caused by a variety of problems. Causes are described below and the solutions involve adjustments in various machine settings. If additional shrinkage is required for your application, the reverse of these solutions helps.

1. Wall thickness or weight too high
2. Mold temperature too high
3. Stock temperature too high
4. Low blow pressure
5. Blow time too short
6. Mold volume incorrect
7. Bottle storage area too hot
8. Density of resin too high

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