Leak Testing High Speed PET Bottles a.k.a. Reheat (Two-Step) Stretch Blow Molding Process


The Stretch Blow Molding Process involves the production of hollow objects, such as bottles, having biaxial molecular orientation. Biaxial orientation provides enhanced physical properties, clarity, and gas barrier properties.

In the stretch blow molding (SBM) process, the plastic is first molded into a “preform” using the injection molding process. These preforms are produced with the necks of the bottles, including threads (the “finish”) on one end. The preforms are packaged, and fed later (after cooling) into a reheat stretch blow molding machine.

In the SBM process, the preforms are heated (typically using infrared heaters) above their glass transition temperature, then blown using high pressure air into bottles using metal blow molds. The preform is always stretched with a core rod as part of the process. The stretching of some polymers, such as PET (polyethylene terephthalate), results in strain hardening of the resin, allowing the bottles to resist deforming under the pressures formed by carbonated beverages, which typically approach 60 psi. The main applications are bottles, jars and other containers.

**Common Machinery Types**

*Sidel Matrix or Universal (www.sidel.com)*
Common Bottle Types and Speeds

The majority of clear bottles are produced on high speed PET blow molders. Common bottle types include carbonated soft drinks, water, sport drinks, juices, specialty beverages, ready-to-drink teas, dressings, sauces, food oils, wide mouth jars produced at high volumes, cleaners, and many others. The process is ideal for high speed and efficient production of clear containers with precise neck finishes.
ALPS has sold numerous **NexGen Rotary** leak testers for PET bottles produced at high speeds. Many of the available features were designed specifically for PET with many of the applications for Hot Fill and Custom bottle applications. Benefits of the **NGR** include:

- Standard machine sizes available for speeds up to the 1,000 to 1,200 BPM (60,000 to 72,000 BPH) range
- High-speed handling features developed from experience running thousands of different container types
- “Quick-change no-tool” change parts for rapid and efficient changeovers. A complete mechanical changeover can be completed in 10-15 minutes for even the largest machine size.
- “LTC” Leak Test Controller test heads on each station can be easily removed for maintenance, and replaced with a test head from stock with a downtime of less than 30 seconds
- Turntable Vacuum System is available to allow detection of smaller gate pinholes or cracks, which is a common and critical defect for the PET blow molding process
- Topload and Laser Height options were mainly developed to address common PET bottle defects
**NGR Standard Machine Sizes**

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Normal Maximum Testing Rate</th>
<th>Approximate Dimensions* L x W x H (C=Conveyor Height)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NexGen Rotary 4</td>
<td>100 CPM (6,000 CPH)</td>
<td>127” x 70” x (C + 63”) 3226 x 1778 x (C + 1600)mm</td>
</tr>
<tr>
<td>NexGen Rotary 6</td>
<td>150 CPM (9,000 CPH)</td>
<td>127” x 70” x (C + 63”) 3226 x 1778 x (C + 1600)mm</td>
</tr>
<tr>
<td>NexGen Rotary 8</td>
<td>220 CPM (13,200 CPH)</td>
<td>127” x 70” x (C + 63”) 3226 x 1778 x (C + 1600)mm</td>
</tr>
<tr>
<td>NexGen Rotary 10</td>
<td>300 CPM (18,000 CPH)</td>
<td>127” x 70” x (C + 63”) 3226 x 1778 x (C + 1600)mm</td>
</tr>
<tr>
<td>NexGen Rotary 12</td>
<td>400 CPM (24,000 CPH)</td>
<td>131” x 79” x (C + 63”) 3328 x 2006 x (C + 1600)mm</td>
</tr>
<tr>
<td>NexGen Rotary 14</td>
<td>467 CPM (28,000 CPH)</td>
<td>131” x 79” x (C + 63”) 3328 x 2006 x (C + 1600)mm</td>
</tr>
<tr>
<td>NexGen Rotary 16</td>
<td>533 CPM (32,000 CPH)</td>
<td>131” x 79” x (C + 63”) 3328 x 2006 x (C + 1600)mm</td>
</tr>
<tr>
<td>NexGen Rotary 18</td>
<td>600 CPM (36,000 CPH)</td>
<td>131” x 92” x (C + 63”) 3328 x 2338 x (C + 1600)mm</td>
</tr>
<tr>
<td>NexGen Rotary 21</td>
<td>700 CPM (42,000 CPH)</td>
<td>131” x 92” x (C + 63”) 3328 x 2338 x (C + 1600)mm</td>
</tr>
<tr>
<td>NexGen Rotary 24</td>
<td>800 CPM (48,000 CPH)</td>
<td>131” x 92” x (C + 63”) 3328 x 2338 x (C + 1600)mm</td>
</tr>
<tr>
<td>NexGen Rotary 27</td>
<td>900 CPM (54,000 CPH)</td>
<td>131” x 92” x (C + 63”) 3328 x 2338 x (C + 1600)mm</td>
</tr>
<tr>
<td>NexGen Rotary 30</td>
<td>1000 CPM (60,000 CPH)</td>
<td>131” x 92” x (C + 63”) 3328 x 2338 x (C + 1600)mm</td>
</tr>
</tbody>
</table>

*Dimensions are approximate and for reference only.

**Turntable Vacuum System (U.S. Patent #7,559,232)**

The patented ALPS Turntable Vacuum System was designed to detect smaller pinholes in the gate region of PET bottles. The bottom of the bottle base must be flat to achieve the full effect.

The standard ALPS leak test uses a Pressure Decay method, looking for a pressure drop from the inside of the bottle to detect leakage. With the Turntable Vacuum System, a high vacuum level is applied underneath each leak test station, through a hole in the turntable. If there is a pinhole in the base of the bottle, the suction from the vacuum system draws air through the pinhole at a high rate. This creates a more rapid pressure drop from the inside of the bottle, allowing detection of significantly smaller holes during the duration of the leak test.
Topload Deflection Detection and Laser Height Inspection Options

The Topload Deflection Detection option is a “go-no go” inspection utilizing an additional sensor on each probe cylinder. The sensor is adjusted to “turn on” at a specific height when the test probe is sealed onto the bottle. If the container partially collapses due to the probe force, the switch turns off and the bottle is rejected.

This method will detect bottles that are grossly short, or deformed, due to a lack of topload capacity.

The Laser Height Inspection option was designed for the PET market, due to customer demand to monitor container heights directly after bottles are blow molded.

A through-beam laser sensor is mounted over an infeed or exit starwheel. As the bottle passes through the sensor, controlled by the starwheel, a ‘high average’ is taken of readings from the top of the bottle. A small amount of vacuum is typically applied underneath the inspection zone, to assist stabilization of the bottles.

‘Coding Device Ready’ Option

Specifically for the PET market, ALPS has developed the ability for a customer to integrate Laser Coding onto the inspection turntable. This provides a position to code bottles when they are precisely controlled for purposes of leak testing. Interface signals are provided to track containers, trigger the code, and ensure the coder is working. The coder is positioned on the infeed side of the machine, approximately 90 degrees from the bottle entry point.
### Line Integration

![Image of line integration](image)

**Standard high speed photo-eye configuration**  
**Tabletop conveyor**  
**Air conveyor example**

For high speed PET lines, the machine is equipped with three upstream sensors to regulate the speed and keep the infeed timing screw full of containers (for the most efficient handling).

The machine is designed for easy installation onto an existing continuous tabletop conveyor. If the production line utilizes air conveyor, which is common for high speed PET, a tabletop conveyor section is required for the leak tester. (Air conveyor handles containers by the neck as opposed to tabletop which handles bottles by the base).

In this case, bottles are fed directly from the air conveyor into the ALPS timing screw infeed. On the exit side of the tabletop conveyor, bottles are then transferred back onto the air conveyor.

### ALPS Speed-Glider multi-station moving head leak testers

The **Speed-Glider** family of machines are applicable for higher speed, or higher sensitivity, applications where single-station machines are not fast or sensitive enough. The **Speed-Glider** uses a Timing Screw for each bottle, to space the bottles for leak testing and to provide positive bottle handling. The machine incorporates a single servo-driven slide to match the slide speed to the timing screw.

**Speed-Gliders** are available in configurations including 2, 3, 4, 5, 6, 7 and 8 stations for speeds from 30 up to 500 Bottles-Per-Minute. Typically the conveyor underneath the leak tester is synchronized to the machine, by means of a 4-20mA signal, to match the conveyor speed to the slide speed and ensure the most efficient performance. Benefits of the **Speed-Glider** include:

- Continuous motion operation for smooth and efficient container flow at high speeds
- Moving test heads, which allow the use of fewer test stations to achieve higher speeds and greater test times for a more accurate leak test
- Timing Screw handling, which provides positive container handling and control to easily optimize machine performance
SpeedGlider Standard Machine Sizes

<table>
<thead>
<tr>
<th>Machine Model</th>
<th>Number of Leak Testing Stations</th>
<th>Top Speed</th>
<th>Frame Length</th>
<th>Maximum Rectangular Container Dimensions</th>
<th>Maximum Round Container Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed-Glider 8.1.5</td>
<td>Eight</td>
<td>500 CPM</td>
<td>L = 78” (1981 mm)</td>
<td>1.5” x 1.5” (38mm x 38mm)</td>
<td>2 inches (51mm)</td>
</tr>
<tr>
<td>Speed-Glider 7.2</td>
<td>Seven</td>
<td>435 CPM</td>
<td>L = 78” (1981 mm)</td>
<td>2” x 2” (51mm x 51mm)</td>
<td>2.5 inches (63.5mm)</td>
</tr>
<tr>
<td>Speed-Glider 6.3</td>
<td>Six</td>
<td>375 CPM</td>
<td>L = 78” (1981 mm)</td>
<td>3” x 3” (76mm x 76mm)</td>
<td>3.5 inches (88.9mm)</td>
</tr>
<tr>
<td>Speed-Glider 5.4</td>
<td>Five</td>
<td>310 CPM</td>
<td>L = 78” (1981 mm)</td>
<td>4” x 4” (101.6mm x 101.6mm)</td>
<td>4.5 inches (114.3mm)</td>
</tr>
<tr>
<td>Speed-Glider 4.1.5</td>
<td>Four</td>
<td>250 CPM</td>
<td>L = 78” (1981 mm)</td>
<td>1.5” x 1.5” (38.1mm x 38.1mm)</td>
<td>2 inches (50.8mm)</td>
</tr>
<tr>
<td>Speed-Glider 4.5</td>
<td>Four</td>
<td>250 CPM</td>
<td>L = 78” (1981 mm)</td>
<td>5” x 5” (127mm x 127mm)</td>
<td>6.25 inches (158mm)</td>
</tr>
<tr>
<td>Speed-Glider 3.85</td>
<td>Three</td>
<td>185 CPM</td>
<td>L = 78” (1981mm)</td>
<td>8.5” x 5” (216mm x 127mm)</td>
<td>6.25 inches (158mm)</td>
</tr>
<tr>
<td>Speed-Glider 2.10</td>
<td>Two</td>
<td>125 BPM</td>
<td>L = 78” (1981mm)</td>
<td>10” x 5” (254mm x 127mm)</td>
<td>6.25 inches (158mm)</td>
</tr>
<tr>
<td>Speed-Glider 2.5</td>
<td>Two</td>
<td>150 CPM</td>
<td>L = 53.5” (1359mm)</td>
<td>5” x 5” (127mm x 127mm)</td>
<td>6.25 inches (158mm)</td>
</tr>
</tbody>
</table>

Please note that the test sensitivity will be different, compared to rotary machines, typically less sensitive per station due to comparatively less test time on the bottle. Consult ALPS for guidance on hole size sensitivities for various packages.

How The Speed-Glider Works

The leak test probes are attached to a common carriage that is mounted to a servo-driven linear. The probes travel together and have a fixed “pitch”, or distance between test heads. A variable speed frequency drive operates the Timing Screw, and the servo automatically synchronizes with the Timing Screw through the use of an encoder.
Common Defect Types

- Gate pinholes
- Gate cracks
- Laser-coding holes
- Contamination holes
- ‘Thin wall’ holes
  - Short shots
- Seal surface nicks
- Cocked necks
- Cocked bottles
- Malformed bottles
  - Tall bottles (height option)
  - Short bottles (height or topload option)
  - Thin/weak shoulders (topload option)
  - Thin/weak bases (topload option)