Extrusion Blow Molding

PL ET 370

- Big Growth
- Applications from Injection Molding
- Complete Assembled/Integrated Products

Extrusion Blow Molding

- Current Areas of Use
  - Containers
  - Gas Tanks
  - Toys
  - Seat Backs
  - Air Ducts
  - 55 gal Drums
Extrusion Blow Molding

• Types
  • Extrusion
    • Continuous
    • Intermittent
  • 3D
  • Moving Cores
• Injection
  • Basic
  • Stretch

Extrusion Blow Molding

• Parison Formation
  • Formed by Die & Mandrel
  • Pre-Blow
• Mold Close
• Blow Station
• Ejection

Extrusion Blow Molding

• Material Characteristics
  • Lower Temperatures
  • Wide Spec/Higher MW
  • Melt Strength
Extrusion Blow Molding

- **3D**

Extrusion Blow Molding

- **Moving Cores**
  - Help with Wall Thickness
  - Details perpendicular to the Parting Line

Extrusion Blow Molding

- **Shuttle Blow Molding**
Extrusion Blow Molding

- Wheel (Rotational) Blow Molding

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Extrusion Blow Molding

- Advantages - Extrusion Blow
  - Inexpensive Tooling
  - Lower Part Cost
  - Irregular Surfaces Easily Molded
  - Low Stress Parts
  - Combine Several Components
  - Fill Inside Volume with Foam

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Extrusion Blow Molding

- Advantages - Co-extrusion Blow
  - Better Barrier Properties
  - Ability to put recycled material in the middle layer
  - Use of different materials - cheaper
Extrusion Blow Molding

- Disadvantages - Extrusion
  - Problem Filling Corners and Deep Drawn
  - Wall Thickness Variation
  - Flash
  - Secondary Operations
  - Warpage of Flat Walls
  - Low Tolerance
  - Surface Appearance
  - Possible Weak Pinch Off

Extrusion Blow Molding

- Common Problems Associated with Processing
  - Blowout in Corners
  - Thin Spots in Corners
  - Variable Wall Thickness
  - Warpage on Flat Surfaces
  - Flash
  - Drag Marks

Extrusion Blow Molding

- Common Problems Associated with Processing (Cont.)
  - Poor Pinch-Off Strength
  - Appearance Problems At Parting Line
  - Thickness Variation - Off-Center Parison
Extrusion Blow Molding

- Parison Sag & Swell
- Die Swell - pressure
- Sag - Weight of the parison

Profile Extrusion

- Die Swell

Extrusion Blow Molding

- Parison Sag & Swell
Extrusion Blow Molding

- New Areas of Use
  - Automotive
  - Dash Boards
  - Crush Panels
  - Instrument Panels
  - Consumer Goods
  - Refrigerators
  - Kitchen Cabinets

Extrusion Blow Molding

- New Technology
  - 3D Blow Molding
  - Smooth Wall Blow Molding
  - Multiple Sectioning for Materials
  - CAE Analysis

Blow Molding

- General Part Design Guidelines
  - Blow Up Ratio - Depends on Material
  - Radii
  - Draft
  - Parting Line Placement
  - Ribs
  - Flat Surfaces
  - Tack-Offs
Blow Molding

- Blow Ratio (BR)
  - BR = ?

Blow Molding

- Radii
  - Tight
    - 0.020-0.040
    - Used mainly very close to parting line
  - Average
    - 0.060-0.200
    - Used with average BR
  - Large
    - 0.200-
    - Used with aggressive BR

Blow Molding

- Radii
  - Inside
    - Tight - More stretching to fill corner
    - Open - Easier to fill
  - Outside
    - Tight - More stretching as porision fills cavity
    - Open - Less stretching
Blow Molding

- Drafts
  - Higher Draft Angles Make More Uniform Wall Thickness

<table>
<thead>
<tr>
<th>Minimum Draft</th>
<th>1°</th>
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<tbody>
<tr>
<td>Recommended Draft</td>
<td>2°</td>
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<tr>
<td>For Each 0.001 Texture Depth</td>
<td>1°</td>
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</tbody>
</table>

Blow Molding

- Parting Line Placement
  - Dependent on BR
  - Cosmetics
  - Thickness Concerns

Blow Molding

- Ribs

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Blow Molding

- Flat Surfaces

- Tack-Offs

Small Contact Area

Extrusion Blow Molding

- Converging Die
Blow Molding

- Converging Head Tooling
- Greater Material Swell
  - Plastic Memory
  - Land Angle
- Used < Ø5 in
- Maintaining Tooling Temps
  - Less mass of Steel between Heater Bands and Flow Channel

Extrusion Blow Molding

- Diverging Die

Blow Molding

- Diverging Head Tooling
- Higher Pressure Drop
  - Increased Size
  - Increased Land Angle
- Used > Ø6 in
- Harder to Maintaining Tooling Temps
  - Higher Mass
Blow Molding

- Ovalized Head Tooling
  - Uniform Thickness
  - Ovalized Die & Mandrel
- Non-Uniform Thickness
  - Ovalized Die or Mandrel

Extrusion Blow Molding

- NonSymmetrical Parts

Extrusion Blow Molding

- Ovalized Parison
Extrusion Blow Molding
- Ovalized Die

Extrusion Blow Molding
- Ovalized Mandrel

Blow Molding
- Mold Nomenclature
  - Finish
  - Neck
  - Upper Pinch-Off
  - Panel
  - Chime
  - Push-Up
Blow Molding

- Mold Materials
  - Low Pressure
  - Low Clamp Force
  - Cast Aluminum
  - Beryllium-Copper
  - Steel
  - Aluminum Plate
    - Steel
    - Beryllium-Copper

Blow Molding

- Comparison of Thermal Conductivity

<table>
<thead>
<tr>
<th>Material</th>
<th>Thermal Conductivity</th>
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<tbody>
<tr>
<td>Beryllium-Copper</td>
<td>770</td>
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<tr>
<td>Kibrass</td>
<td>640</td>
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<tr>
<td>Aluminum</td>
<td>900</td>
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<tr>
<td>Steel</td>
<td>300</td>
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<tr>
<td>Stainless Steel</td>
<td>166</td>
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</tbody>
</table>

Blow Molding

- Cooling Lines
  - Cast Molds
    - Copper Tubing bent around Cavity Features
  - Machined Molds
    - Limited to what can be cut into Mold
  - Custom Cooling
    - Create a Shell around Cavity and Machine Cooling Channels around Contours
    - Like a Two Piece Mold
Blow Molding

- Surface Finish
  - Polished Mold
- Texture
  - May need Venting & Vacuum to capture all details

Blow Molding

- Venting
  - Parting Line
- Cavity Vents
  - Pins

Blow Molding

- Blow Pins
- Blowing Needles
Blow Molding

- CAE Analysis
  - Technology not as Advanced as Injection Molding
  - Modeling Problems
  - Material Characterization
  - Accuracy in Process Modeling

Blow Molding

- What Affects the Accuracy of the Results?
  - Modeling Considerations
  - Parison Geometry
  - Process Variable Inputs
  - Material Characterization

Blow Molding

- Types of Analyses
  - 2D Planar
  - 2D Axisymmetric
  - 3D Shell Elements
  - 3D Solid Elements
Blow Molding
3D Solid Elements

Parison Analysis
- Extrusion Analysis
  - 2D Axisymmetric
  - 3D solid
  - 3D Shell

Blow Molding Simulation Software Vendors
- CMOLD/Moldflow
- Polyflow
- BlowSIM