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Introduction to Packaging Engineering
Blow Molding Bottles

Presented to the Activities Unlimited, Science Club
By Harry Bennett
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+ This is the third presentation in the consumer packaging series

- October 16, 2016
 - Packaging History, Glass, Injection Molding
- February 21, 2017
 - Paper, Paperboard, Metal forming

+ Agenda

- Review: What is Packaging?
- Review: Packaging Functions
- Focus on Plastic Bottles
- Final Exam & Questions

+ Packaging Engineering is an applied science

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+ All Disciplines of Engineering are Applied Sciences

Engineering – Applied Science	Basic Science
Mechanical Engineering	Physics – mechanics
Electrical Engineering	Physics – electricity and magnetism
Chemical Engineering	Chemistry
Biomedical Engineering	Biology
Packaging Engineering	All of the above plus: Material science Industrial Engineering Project Management Marketing Art and Design Communication skills Manufacturing Distribution

+ What is Packaging?

- A **coordinated system** for preparing goods for:
 - Transportation
 - Distribution
 - Storage
 - Retailing
 - Use
- A package can not exist without a product
- Packaging functions are both technical and marketing oriented

+ What are the Functions of Packaging?

Technical Functions		↔	Marketing Functions	
contain	measure		communicate	promote
protect	dispense		display	sell
preserve	Transport		inform	Motivate
			Connect	Engage
			Empower	Persuade

+ Plastic Blow Molding

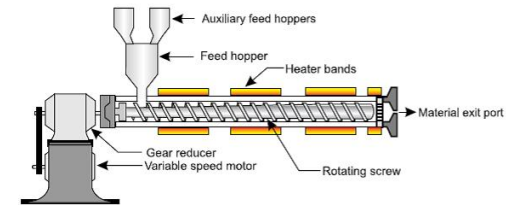
+ Introduction to Plastics

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Polymers

- Raw material for plastics
- Very large molecules
 - Water has 3 atoms, a polymer has hundreds or thousands of atoms
 - Large number of identical repeating monomer units joined together to create a large polymer molecule
- 2 Chemical Classes
 - Thermoplastic
 - Thermoset
- 2 Economic Groups
 - Commodity Polymers
 - Engineering Polymers

+ Plasticating Extruders



+ Blow Molding

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- Thermoplastic Bottles are made in 2 processes
 - Extrusion Blow Molding (EBM): detergent, oil, household bottles
 - Injection Blow Molding (IBM): mascara bottles
- EBM: Resin must have sufficient strength in the melt form to hold together when being extruded into the parison
 - HDPE, PS, PP, PVC account for majority of EBM bottles

+ Extrusion Blow Molding

+ Extrusion Blow Molding

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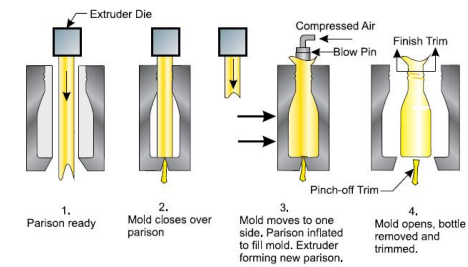
EBM Process

- Extrude hollow plastic tube (Parison)
- Parison captured in molten state by two mating halves of blow mold
- Air blown into Parison to expand it to conform to the mold walls
- Bottle held in mold while plastic cools enough to become rigid and retain shape
- Bottle removed from mold; base pinch off and neck finish flashing is trimmed

Extrusion Blow Molding

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Figure 10.19
Typical extrusion blow molding sequence.



Extrusion Blow Molding

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Figure 10.20

A properly designed mold will force some plastic back up into the bottle to form a uniform bead at the weld line. Poor weld lines will have a groove that significantly weakens the bottle.



+ Extrusion Blow Molds

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- Moderate Cost
 - Allow most users to create custom designs
- Materials
 - Aluminum (cheap and easy to machine)
 - Beryllium Copper (can be cast and easy to machine)
- High wear areas use replaceable steel inserts
 - Neck finish, Base pinch-off
- Mold Surface Finish
 - Polished for hard, high gloss, low shrink materials (PS, PVC)
 - Sand Blasted (matt) for high shrink materials (PE, PP)
- Clamping force is low; sufficient to have clean pinch-offs

Extrusion Blow Molds

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Figure 10.22
Blow molds must be cooled. Vent holes drilled into the cavity allow air to escape during the inflation cycle. The bottom pinch-off closes the parison and cuts off excess plastic.

Extrusion Blow Molds

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Figure 10.21
An aluminum extrusion blow mold with steel inserts for the finish and pinch-off. The mold has connections for water cooling.

Extrusion Blow Molds: Material Distribution

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Figure 10.24
Inflation of parallel-walled parisons into variable-diameter containers will give uneven wall thickness (left). The use of a programmed parison (right) results in more uniform wall thickness.

Extrusion Blow Molds: Material Distribution

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Figure 10.25
The programmed parison die mandrel moves up and down to provide different clearances for parison formation.

Extrusion Blow Molds: Material Distribution

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Figure 10.26

The process of expanding a parison to form a bottle tends to favor producing thicker side-panel cross-sections and thinner cross-sections at the shoulder and base areas.

1. Initially, parison expands with equal wall thickness in all directions
2. This part of the expanding parison freezes the moment it touches the chilled mold wall
3. This part of the parison continues to stretch after the parison center freezes
4. As a result, corner wall thickness is significantly reduced

Extrusion Blow Molds

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Figure 10.27

Standard bottle terminology. The 12 o'clock position is at right angles to the parting line when the container is turned so that mold numbers and other text are right side up.

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Injection Blow Molding

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+ Injection Blow Molding

IBM Process

- Injection Mold Parison and partially cool
 - More control of material distribution
 - Multiple cavitation, faster process
 - Ideal for small bottles; mascara
- Parison retained on core pin and transfer to blow mold station
- Finished bottle transfers to ejection station

Injection Blow Molding

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Figure 10.28
The injection blow molding process combines preform molding and a bottle blowing cycle.

Preform carried over on core pin

Air passage

Injection mold Blow mold (open) Blow mold (closed) Preform expanded to blow mold

Injection Blow Molding

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Figure 10.29
Configuration of a one-step IBM machine. One core rod is shown empty for illustration purposes.

Blow mold

Stripper Plate

Core Rod

Rotating table

Preforms

Injection Mold

Extruder

Injection Stretch Blow Molding

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Figure 10.30
A major application for injection-stretch blow molding is the manufacture of PET carbonated beverage bottles.

Air passage

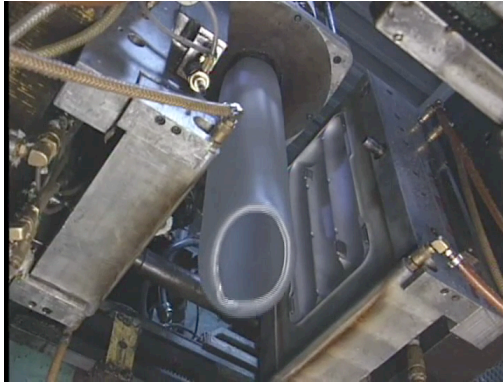
Preform and core rod placed in blow mold Core pin moves down, stretching the preform Preform blown to mold cavity shape

+ Recognizing Molding Methods

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- Look for **pinch off** for **EBM** molded bottles
- Look for **injection gate** at bottom of **IBM** bottles

+ Blow Molding Video



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- Final Exam:
 - What is a Parison?

Questions?

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Thank You
And
Have a Good Day