Introduction to Packaging Engineering

Presented to the Activities Unlimited, Science Club

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Agenda

- What is Packaging?
- Packaging Technologies
- Focus on Glass
- Focus on Plastic
- Questions

Packaging Engineering is an applied science

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

Primitive Packaging

- Hunter gatherers followed the food source and needed carrying devises:
  - Leaves, animal skins, shells of nuts or gourds, hollow wood, fire carriers
- 5,000 B.C. with some domestication & larger social groups
  - Storage and transport needed
  - Sacks, baskets, bags, wood boxes, clay containers (pottery and ceramic)
- 2,500 – 1,500 B.C. Glass discovered
  - Egyptians create core formed glass containers

Rome to Renaissance

- Cities established, trade expands, armies move
  - Existing packaging practices grow in quality and quantity
  - 50 B.C. – glass blow pipe allows direct formation of hollow glass containers, wood barrel created
  - 105 A.D. – China's Ts'ai Lun makes first paper from the inner bark of the mulberry tree
  - 768 A.D. - wood cut printing traced back to Japan
  - 868 A.D. – oldest existing book, Diamond Sutra, printed in Turkistan

Industrial Revolution

- An Industrial Society with World Wide Connections
  - Rural workers migrate to city factories
  - Mass produced goods available, the consumer is born
  - Factory workers need commodities and food
  - Shops and stores open
  - Food needs to be transported to urban areas
- Impact on Packaging
  - Demand for barrels, boxes, kegs, baskets & bags
  - Mechanize the packaging industry to meet demand
  - Devise ways to preserve food beyond natural biological life

New Packaging Roles

- City dwellers had limited storage capability and needed to purchase goods and foods in smaller quantities
- Retailers received barrels of goods and sold in smaller units usually taken away by the consumer in their own package (sack).
- Expensive products like medicine, cosmetics, tea and liquor were the first prepackaged goods, sold generically
- Barrels marked with identification of manufacturer were the earliest form of Brand Names

Packaging Technologies studied at Rutgers

- Printing and Decorating
- Environmental and Sustainability Issues
- Paper and Paperboard
- Paperboard Cartons
- Metal Cans and Containers
- Glass Containers
- Polymer Chemistry

- Shaping Plastics
- Plastic Applications
- Closures
- Adhesives
- Flexible Packaging Laminates
- Corrugated Fiberboard
- Distribution Packaging

Glass Packaging

Glass Types and General Properties

Glass

- Inorganic substance, fused at high temperatures
- Cooled quickly, solidifies in a vitreous or non-crystalline condition
- Molecular structure of solid glass is the same as liquid glass
- Cooled glass is so viscous that the mass has become rigid
- Glass has no distinct melting point

Glass Types and General Properties

Glass Formation

- Silica sand fused with 10% Sodium (Na) compounds (carbonates) -> Sodium Silicate or "water glass" a water soluble glasslike form
- Insolubility is imparted by adding Calcium (Ca) compounds
- Soda-lime-silica (Soda-lime) glass is the type most commonly used for commercial bottles and jars

Glass Types and General Properties

Typical Soda-lime glass-making ingredients	
Ingredient	**% by weight**
Silica sand (silicone oxide)	68 – 73
Limestone (calcium carbonate)	10 - 13
Soda Ash (sodium carbonate)	12 – 15
Alumina (aluminum oxide)	1.5 - 2

Glass Types and General Properties

Other Glass Types rarely used for packaging	
Type of Glass	**Characteristic**
Crystal Glass	Lead compounds added to create a soft glass with exceptional clarity and optical properties; perfume bottles
Boron Compounds	Borax, Boron oxide; low thermal expansion, heat shock resistance
Borosilicate Glass	**Low extractables; used for critical parenteral drugs (injectable)**

Commercial Glass Manufacturing

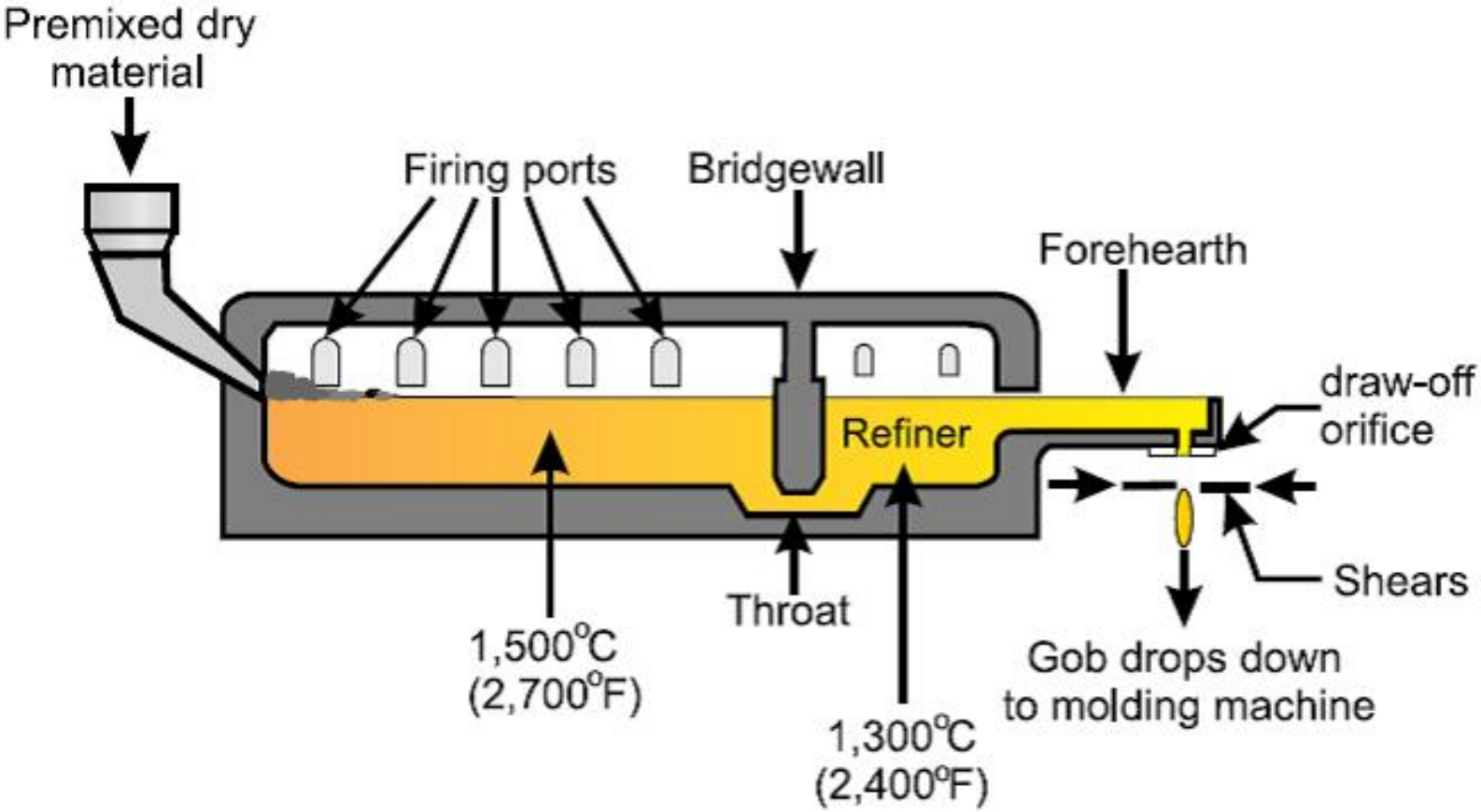
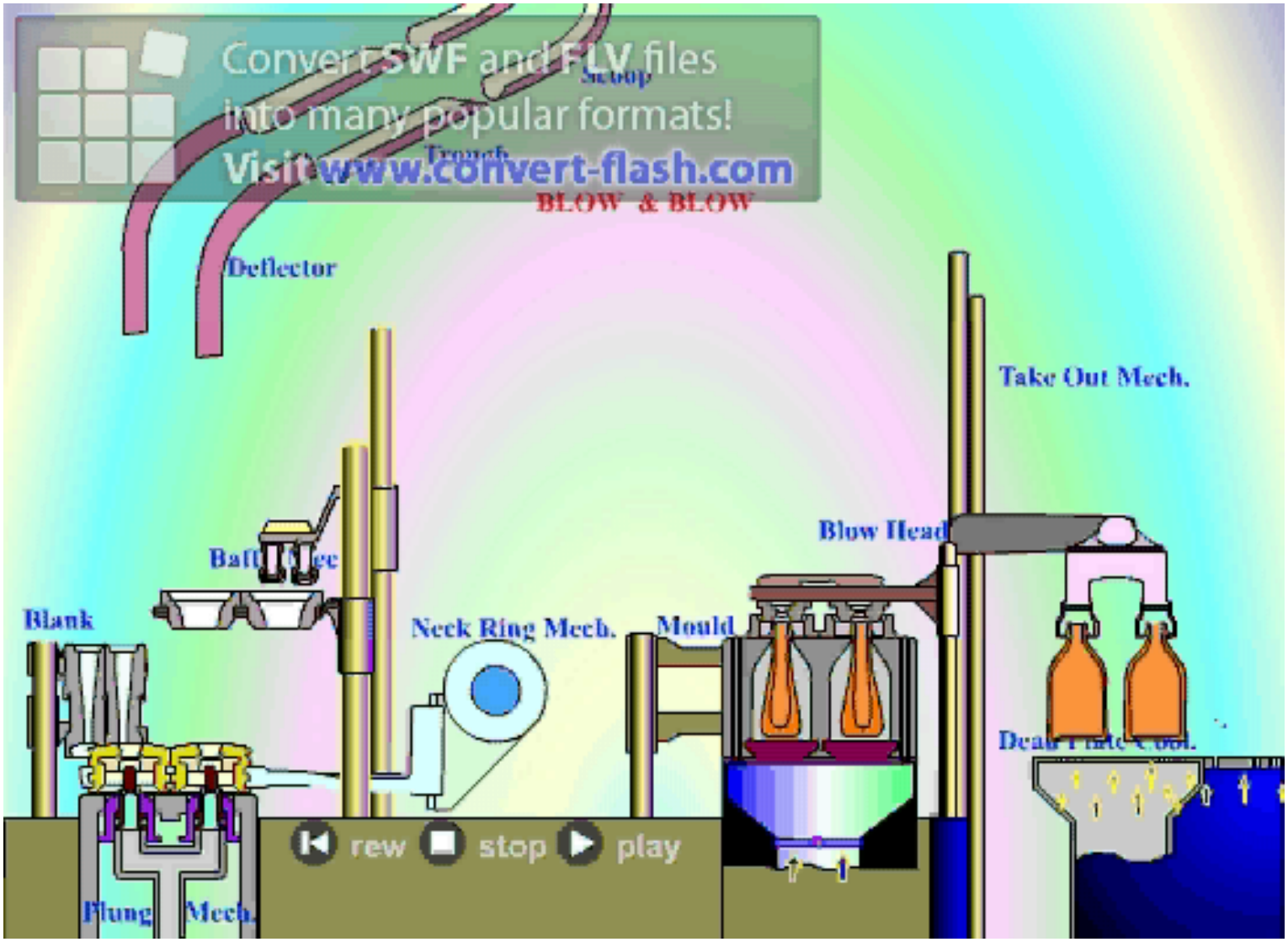


Figure 8.1

A glass furnace cross-section.

Glass Blow/Blow Manufacturing



Actual Glass Formation

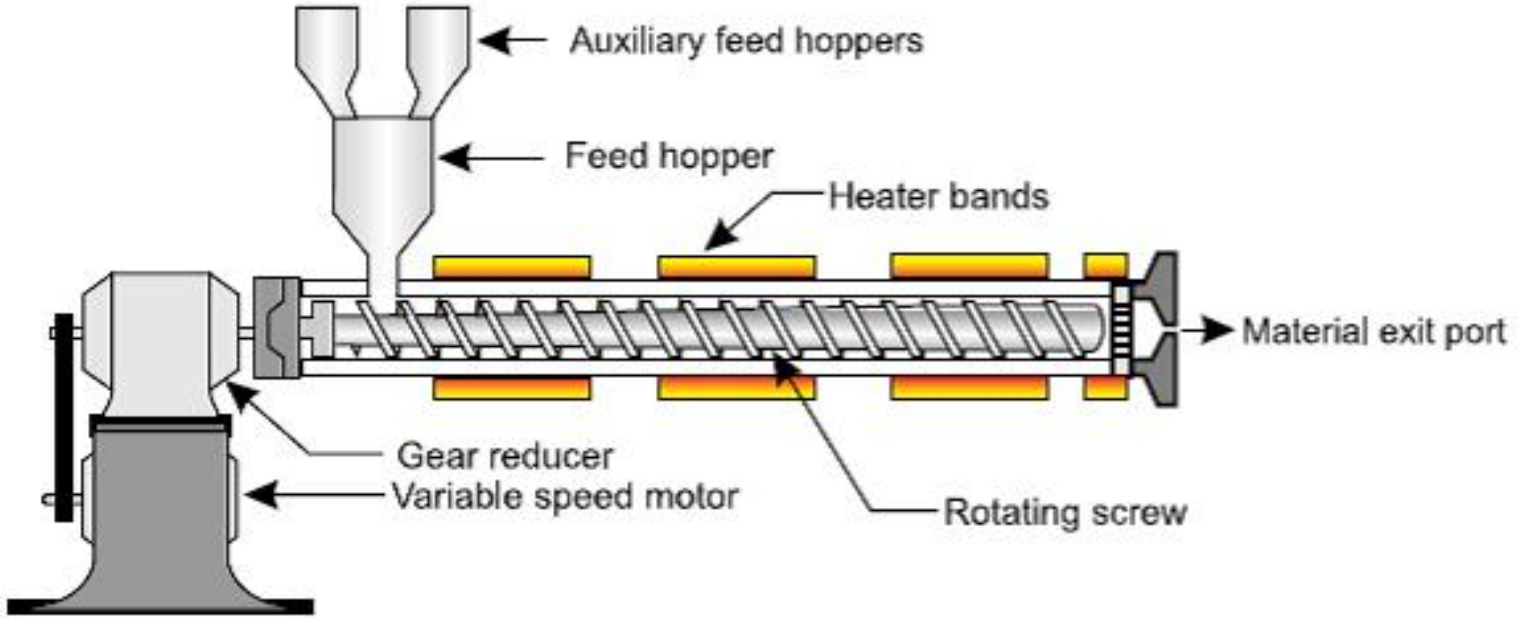
Shaping Plastics

Introduction to Plastics

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



Injection Molding

- Inject a precise amount of resin into a fully enclosed mold
- Hydraulic pressure drives molten resin through chilled passages (runners) in a mold to fill cavities before the resin solidifies
- Highest cost in plastic shaping
- Leading method for manufacturing closures, thermoplastic tubs, jewel boxes and complex dimensional shapes
- Most dimensionally accurate parts; all surfaces controlled by mold.

Injection Molding Machines

- Mold cavity is in the exact form of the part
- When the part cools, mold opens and part is ejected
- Mold clamp must resist pressure of plastic being injected and open far enough to allow the molded part to be ejected.
- Shot size is the amount of plastic being injected into the mold.

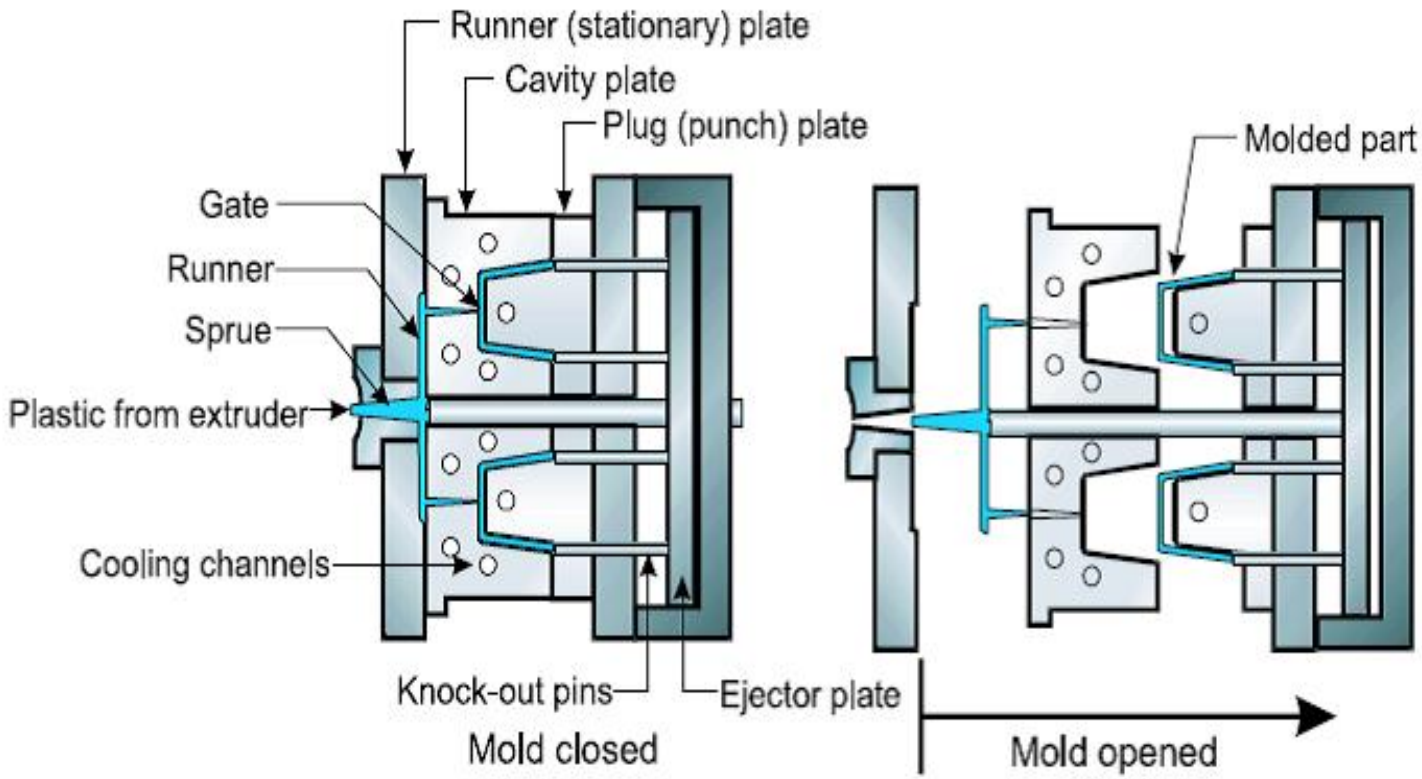
Injection Molds

- Core and Cavity halves
  - Molds can be single or multiple cavities
  - Virtually all packaging molds are multi-cavity
  - # of cavities will be an even number to allow a balanced system
- Cooling Systems provide mold accurate cooling temperature (water, water-glycol)
- Hygroscopic plastics are pre-conditioned (dried) on line (PET, Nylon, PC)

Injection Molds

Figure 10.13

A three-plate mold that strips sprue and runners away from the part. Knockout pins push the parts off the cores.



Injection Molding Video

Video

Injection Molding

Questions?

Thank You

And

Have a Good Day