Session 5: Plastic Containers; Properties, Specifications & Sourcing
Plastic Container Specification

Product Considerations

- Type/nature of the product
- Quantities/weights/volumes to be packed
- Critical attributes/characteristics
- Proposed packing method and conditions
- Product protection requirements – physical, climatic, biological, security, etc.
Plastic Container Specification

Commercial Considerations

- Package quantities required/to be ordered, for which offers are required
- Delivery required/agreed
- Packing & shipping instructions
- Shelf life/storage needs of pack material
- Pricing, if agreed
- Delivery clauses: insurance/penalty clauses/terms of payment
Plastic Container Specification

Technical Considerations

- Designation of the pack (type, style, if known)
- Pack material(s): grade, quality, weight
- Construction of pack, if known/decided
- Relevant dimensions & tolerances
- Special features/properties/accessories
- Graphic design/printing/decoration required, on material or on labels
- Applicable standards & test methods
Proposed Filling/Packing Methods

- Manual or mechanised/automated filling
- Filled by volume, weight, or other measure
- Filling/closing/sealing method and equipment
- Filling temperature, pressure, ambient conditions
- Decoration/ labelling/coding methods
Package Barrier Properties Required

Against transmission of:

• Water and moisture vapour
• Oils & other hydrocarbons
• Alcohols, ethers, esters & ketones
• Air & gas barrier (oxygen, CO2, etc.)
• Light & UV radiation
• Aromas & other volatiles
Package Resistance Requirements

Resistance to:
• Edible oils and fats
• Acidic products
• Alkaline products
• Solvents (define type))
• High or low temperatures (define)
## Plastic Forming Methods & Typical Products

<table>
<thead>
<tr>
<th>Injection moulding: closures, dairy tubs, pails, pumps, jewel boxes, cosmetic, containers and parts.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extrusion cast film &amp; sheet, extrusion blown film for wraps, bags, label stock, laminating &amp; thermoform stock</td>
</tr>
<tr>
<td>Extrusion-blow moulding: bottles, jars, and other narrow-mouth containers, box and drum liners, handleware, multi-layer containers</td>
</tr>
<tr>
<td>Injection-blow moulding: bottles, jars, and other narrow-mouth containers, wide-mouth jars, containers with precision finishes</td>
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</tbody>
</table>
Plastic Tooling Costs

Tooling cost is a significant factor for plastic components

Profile extrusion and thermoforming involve low pressures: tooling costs are low.

Blow moulding of bottles is done with somewhat higher air pressures: tooling costs are moderate.

Injection moulding is done at high pressures and requires massive and complex molds: Tooling costs are very high
## Thermoforming Design & Production Factors

<table>
<thead>
<tr>
<th>Factor</th>
</tr>
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<tbody>
<tr>
<td>Economical low-pressure tooling (typically aluminium)</td>
</tr>
<tr>
<td>No sharp corners on products; use generous radii</td>
</tr>
<tr>
<td>Limited ability to produce closed and undercut forms</td>
</tr>
</tbody>
</table>
## Typical Thermoforming Applications

- **Polyvinyl chloride**: mostly clear blister and display packaging
- **Polystyrene**: cups, protective and display forms
- **Polypropylene**: cups, portion packs
- **Polyester**: large thermoforms, high strength applications
- **Crystallized polyester**: dual-ovenable food trays
Thermoformed Portion Packs, Jams

• Horizontal form-fill-seal for hot-filled conserves, Kyrgyzstan
• Offset printed, heat-sealed al. foil closure on thermoformed PS base
Hinged-lid, ventilated tray for soft fruit exports from Chile

- ‘Clam shell’ style transparent PS thermoforming
- Ventilation slots cut in lid portion
- Self-adhesive paper label on lid
- Bar code included on label
Multiple Thermoforming applications
## Common Thermoforming Plastics

<table>
<thead>
<tr>
<th>Material</th>
<th>Typical forming temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C°</td>
</tr>
<tr>
<td>polyvinyl chloride</td>
<td>138 – 176</td>
</tr>
<tr>
<td>polystyrene</td>
<td>143 – 176</td>
</tr>
<tr>
<td>high impact polystyrene</td>
<td>171 – 182</td>
</tr>
<tr>
<td>polypropylene</td>
<td>148 – 199</td>
</tr>
<tr>
<td>polyester</td>
<td>129 – 162</td>
</tr>
<tr>
<td>crystallized polyester</td>
<td>148 – 176</td>
</tr>
</tbody>
</table>
IM Caps & Cassettes, Runners Attached
Injection-Moulding Gate Styles

- Edge gate
- Pin point gate
- Fan gate
- Center gate

Runner
IM open basket for Physalis, Colombia

- Injection moulded LDPE basket
- Overwrapped in transparent PP film
- Film printed with product, brand and bar code in export market
## Thermal Expansion of Plastics

<table>
<thead>
<tr>
<th>Material</th>
<th>Linear Expansion Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>aluminium</td>
<td>$23.5 \times 10^{-6}$ / per degree $C^\circ$</td>
</tr>
<tr>
<td>steel</td>
<td>$10.8 \times 10^{-6}$ / per degree $C^\circ$</td>
</tr>
<tr>
<td>glass</td>
<td>$9.3 \times 10^{-6}$ / per degree $C^\circ$</td>
</tr>
<tr>
<td>polypropylene</td>
<td>$158 \times 10^{-6}$ / per degree $C^\circ$</td>
</tr>
<tr>
<td>nylon</td>
<td>$131 \times 10^{-6}$ / per degree $C^\circ$</td>
</tr>
<tr>
<td>polyethylene</td>
<td>$63 \times 10^{-6}$ / per degree $C^\circ$</td>
</tr>
</tbody>
</table>

Moulds for plastics are enlarged to accommodate the thermal expansion of the plastic that will be formed.
Plastic Shrinkage and Sink Marks

Most commonly seen behind closure threads

Sink marks over cup flange support ribs can cause sealing problems
Injection Moulded Closures
Typical Dairy Tub Design Details

Nest wall and ledges separate nested tubs, allowing for easy de-nesting on the filling line.

Lid skirts snap over larger diameter tub lips to make an interference seal. Stacking rings allow lids to be stacked on each other.
PP yoghurt tub with board label

- IM translucent PP tub for dairy products
- Detachable board support & label, printed both sides
- Heat sealed, printed foil closure
IM lidded tub for Pesto Paste

- PP translucent tub to display product, opaque lid
- Insert moulded paper labels on lid, and on base and sides of body
**Finish**: That part of a bottle or jar that accepts the closure

**Parison**: An initial shape that will be expanded into a bottle or jar in a second step

**Preform**: Describes the parison when using injection blow-moulding

**Moyle**: The pinch-off trim piece from an extrusion blow-moulded bottle
Extrusion Blow Molding (EBM)

1. Parison ready
2. Mold closes over parison
4. Bottle removed and trimmed.

Compressed air
Blow pin

Pinch-off trim
Finish trim
Untrimmed EBM Polypropylene Bottle

1. Finish trim
2. Handle knock-out
3. Tail, pinch-off trim or moyle
Parisons and Bottle Wall Thickness

Uniform-Walled Parison

Programed Parison
EBM jugs for detergents

- HDPE jugs with integral moulded-in handles, achieved with parison programming
- Paper labels applied in the blow mould
- IM PP screw caps and dispenser cap
Cast Film and Sheet Extrusion

Extruder #1
Extruder #2
Extruder #3
Material #1
Material #2
Material #3

Adjustable Pressure (Restrictor) Bar

Extrusion Die
Adjustable Die Lips
Coextruded Bottles

Typical high oxygen barrier coextrusion

Parallel coextrusion
Examples of Coextruded Bottles

1 & 2 Reduced pigment on inner layer
3 Three layer bottle with U.V. barrier central layer
EBM Bottles for dairy products

- HDPE coextruded blow moulded bottles for chocolate milk
- PP shrink-sleeve label & security seal
- PP screw cap
- Distortion printed nutrition data & bar code
Extrusion Blow-Fill-Seal

Parison formed

Blow-pin inflates bottle and immediately fills with product

Finish formed and sealed
Injection-Blow Moulding (IBM)

Preform carried over on core pin

Injection mold

Blow mold open
Blow mold closed

Preform expanded to blow mold

Air
IBM Preforms and Resultant Containers
ISBM PET honey jars, Kenya

- Clear PET jars injection blown and stretch formed
- IM LDPE screw caps with tamper-evident breakable rings
- Wrap-round paper labels
ISBM PET & Glass Bottles for Guyana Rum compared

- PET lighter, stronger & overall less costly
- Glass provides longer shelf life & greater size impression
- IM plastic cap on PET, Al. ROPP on glass
# EBM and IBM Compared

<table>
<thead>
<tr>
<th>Feature</th>
<th>Extrusion B.M.</th>
<th>Injection B.M.</th>
</tr>
</thead>
<tbody>
<tr>
<td>tooling</td>
<td>one mould set</td>
<td>two mould sets</td>
</tr>
<tr>
<td>mould cavities</td>
<td>commonly 2 or 3</td>
<td>12 and more possible</td>
</tr>
<tr>
<td>secondary operations</td>
<td>trim and regrind</td>
<td>no trim or regrind</td>
</tr>
<tr>
<td>finish tolerances</td>
<td>acceptable</td>
<td>precision</td>
</tr>
<tr>
<td>unique finish designs</td>
<td>limited</td>
<td>possible</td>
</tr>
<tr>
<td>handleware</td>
<td>common</td>
<td>complex</td>
</tr>
<tr>
<td>thin-wall containers</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>complex multi-layers</td>
<td>yes</td>
<td>difficult</td>
</tr>
<tr>
<td>large containers</td>
<td>yes (e.g. drums)</td>
<td>limited</td>
</tr>
<tr>
<td>base design</td>
<td>requires pinch-off</td>
<td>no pinch-off</td>
</tr>
</tbody>
</table>

.handleware common

-thin-wall containers yes

-complex multi-layers yes

-large containers yes (e.g. drums)

-base design requires pinch-off
Recognizing EBM and IBM Bottles

Injection blow moulded bottle

Gate residue

Register marks

Pinch-off line

Extrusion blow moulded bottle