Interactive Product Design

November 7th 2012

Injection Molding
Figure 8.2  Schematic curve to show the glass transition temperature. Specific volume versus temperature.
8.2 Properties of Plastics

1. Crystalline structural polymer $< T_g$ (PMMA)

3. Semicrystalline just over $T_g$, rigid and tough (polyethylene)

2. Leathery at room temperature $> T_g$ (polyvinyl chloride sheet)

4. Elastomers (GRS; crosslinked in rubber region)

5. Crystalline but fibrous (nylon)

Figure 8.3 Design choices with polymers.
8.4.2 Injection Molding

Figure 8.14 shows the other major plastic processing method, injection molding.
7.29 Feed system for a single-impression mould (after Pye).
Figure 8.15 shows the details of the mold itself.
7.34 Eight types of gate used in injection moulding (after ICI plc).
7.31 Feed system of multi-impression mould as portrayed by the assembly when it is removed from the mould (after Pye).
7.33 An example of a hot-runner mould: an insulated runner mould with heated probes (after Modern Plastics Encyclopedia).
7.39 Dependence of ram position and mould-pressure on time during mould filling and packing: control sequence (1) and (2b) (after Barber-Colman Company).
7.32 A schematic diagram showing the $P-V-T$ path followed by a typical point within an amorphous polymer injection moulding. Lines $a$, $b$, $c$ represent isobars of increasing pressure.
8.3 Processing of Plastics I: The Injection Molding Method

Representative Design Guidelines for Injection Molding

<table>
<thead>
<tr>
<th>Guideline</th>
<th>Poor</th>
<th>Better</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintain uniform wall thickness and provide for gradual changes in wall thickness.</td>
<td><img src="image1" alt="Poor Design" /> <img src="image2" alt="Better Design" /></td>
<td><img src="image3" alt="Poor Design" /> <img src="image4" alt="Better Design" /></td>
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<tr>
<td>For a deep blind hole, use a stepped diameter.</td>
<td><img src="image5" alt="Poor Design" /> <img src="image6" alt="Better Design" /></td>
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<tr>
<td>Maintain uniform wall thickness in thermoset parts.</td>
<td><img src="image7" alt="Poor Design" /> <img src="image8" alt="Better Design" /></td>
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<tr>
<td>A bead at the parting line facilitates removal of mold flash.</td>
<td><img src="image9" alt="Poor Design" /> <img src="image10" alt="Better Design" /></td>
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</tbody>
</table>
Use decorative designs to conceal shrinkage.

Avoid undercuts and variation in wall thickness.

Deliberately offset side walls to hide defects caused when mold halves do not line up properly.

Minimum spacing for holes and sidewalls.

Minimum distance between a hole and the edge of the part.

Figure 8.11 Design guides for plastic injection molds. Reprinted with permission from Integrated Product and Process Design and Development by E. B. Magrab. Copyright CRC Press, Boca Raton, Florida.
Figure 8.12 Cantilever snap-fit assembly made possible in the injection molding process: (a) the direction of the arrows shows where core rods would be pulled down after molding to create the required undercuts; (b) the arrows show the direction of side pullouts. On the right is a Digital Corporation mouse that was redesigned with the Boothroyd and associates DFA methods—the snap fits are shown in the lower subassembly (both diagrams courtesy of Boothroyd et al., 1994).
Figure 8.12 Cantilever snap-fit assembly made possible in the injection molding process: (a) the direction of the arrows shows where core rods would be pulled down after molding to create the required undercuts; (b) the arrows show the direction of side pullouts. On the right is a Digital Corporation mouse that was redesigned with the Boothroyd and associates DFA methods—the snap fits are shown in the lower subassembly (both diagrams courtesy of Boothroyd et al., 1994).
7.44 Extrusion-blow moulding (after Crawford).