4.1 CAN:  Design of Cans and Can Ends

• Cylindrical shape is strong. Dissolved gases improve strength
• Steel is stronger than aluminium
• Generally better graphics printing on aluminium
• Aluminium has higher recycle value
• Line set up needs to be tuned between different metals for maximum efficiency
• Can interiors are lacquered
• Must be able to withstand pressures of filling and pasteurization
• Dimensions are important as cans are filled to a level
• Can top flange must accept an end
• Can end diameters are decreasing to save cost
• Usually stay on tab, “ gulper ” apertures
• Protect cans in wrap etc

Shape.

Affect on beer quality.

Durability.

Dimensions.

Special features.
The following summarises the important features of design of aluminium and steel cans:

<table>
<thead>
<tr>
<th>Material</th>
<th>Aluminium.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shape</td>
<td>Beer cans are round. Circular shapes have the strength to withstand the internal pressures generated during filling and pasteurising.</td>
</tr>
<tr>
<td>Affect on beer quality</td>
<td>Some of the aluminium would dissolve in the beer and beer cans have an internal lacquer to protect the beer and the consumer.</td>
</tr>
<tr>
<td>Resistance to wear &amp; tear</td>
<td>Aluminium cans are easily damaged, therefore the packaging process involves hicone, trays and shrink wrapping to protect the product. Aluminium is not strong enough to withstand the pressures created by the in can insert (widget) system.</td>
</tr>
<tr>
<td>Dimensions</td>
<td>The can’s volume is important because, with machines filling to a level, the beer volume depends on the precision of the can’s dimensions. The profile of the top of the can body is important because it is required to seal on the filler head and onto the can end.</td>
</tr>
<tr>
<td>Special features</td>
<td>Aluminium cans are very light and easily fall over on the packaging line’s conveyors. Aluminium is recyclable, but mixed metals are being discouraged.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Material</th>
<th>Steel.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shape</td>
<td>See aluminium cans.</td>
</tr>
<tr>
<td>Affect on beer quality</td>
<td>Some of the iron would dissolve in the beer producing a metallic flavour and beer cans have an internal lacquer to protect the beer and the consumer.</td>
</tr>
<tr>
<td>Resistance to wear &amp; tear</td>
<td>Steel cans can be damaged, therefore the packaging process involves hicone, trays and shrink wrapping to protect the product. Steel is strong enough to withstand the pressures created by the in can insert (widget) system.</td>
</tr>
<tr>
<td>Dimensions</td>
<td>See aluminium cans.</td>
</tr>
<tr>
<td>Special features</td>
<td>Empty steel cans are light and easily fall over on the packaging line’s conveyors. Steel is recyclable, but has a lower value than aluminium.</td>
</tr>
</tbody>
</table>
The Completed Can and End Seam

Four essential seam measurements

- Correct tightness
- Body hook
- Correct body and end hook overlap
- No other distortions
4.2 CAN: Can and End Manufacture – Materials and Decoration

In 1935, flat topped cans were first used in the USA for drinks and were introduced to Britain in the 1950s. In the early days a lever type triangular opener was used to puncture two holes in the end in order to open the can. In 1963 the aluminium lid with the easy open end (TOT or tear off tab) was invented. The two-piece aluminium can was developed in the States in 1964 and this technology, known as the ‘drawn and wall ironed’, extended to steel in the 1970s.

The diameter of the drinks can is “211”, which means 2 inches and 11/16ths. The standard end is now “202” introduced in 2003 (previously was 206 or 209. The SOT or stay on tab was adopted in 1990. The large opening end (sometimes known as the ‘gulper’) was introduced in 1998. Steel ends have been tried, being on the market in 1993 but they were not successful.

The benefits of cans over other types of packaging are:

- Transport – against long neck bottles the 330ml can is half the height. A glass bottle weighs c200g, a steel can is c35g and aluminium c15g (a PET bottle weighs c35g)
- Total UV (Ultra Violet) protection
- Hermetic Seal
- No oxygen ingress or carbon dioxide egress
- Faster pasteurization in package – less use of energy
- Faster and more efficient packaging lines
- Safer than glass
- Easy to open
- Tamper evident
- Steel and Aluminium recyclable
- Traceability
- All round decoration

The negatives:

- One shape – marketing have always objected to this. Shaped cans are possible but they are expensive and difficult to run down the line
- It is not hygienic to drink from the top of the can
- They are not refillable
- Need to be pressurised to keep them rigid
- May burst when dropped

Design Criteria - Cans

- Pressure Vessel – needs to hold 8 bar (120psi), including the ends. Standard ends are normally tested to 6 bar (90psi).
- Closing – good flange for seaming
- Stackable – shelves at supermarkets etc
- Optimum Metal Economy – light-weighting, but the can still strong
Food Contact – no contamination, inside lacquer is necessary
Decoration – 4 to 6 inking stations give good quality finish
Transport/Storage – stackable on pallets – can take the load

Design Criteria – Ends

Pressure Vessel – See above
Closing – good curl and compound
Easy Opening – Tab can be lifted and the score is correct depth allowing tear but not leakage – end thickness only 0.28mm or less! Also needs to vent properly when opened
Food Contact – as above

4.2.1. CAN: Can Manufacture

Most cans used for beverages today are produced using two piece technology, either aluminium or steel. However, there are still some countries in the world using three piece cans, so called because they have a cylindrical body and two ends; the raw material is tin plate.
Aluminium and Steel Two Piece Cans are made by a similar process.

Aluminium coils weighing up to 10 tonnes are supplied to the line. One tonne will produce approx 60,000 can bodies of 0.210-0.355mm thickness. The coil is pre-lubricated with mineral oil and is then re-lubricated with soluble oil and water before it enters the cupping press.

Cups are first produced by a process is known as the ‘blank and draw’ operation and produces shallow cups which are then fed into the can former.

Can formation is achieved by feeding the cup onto the body maker with a horizontal punch which, in a single stroke, draw the can wall to the desired thickness (Mid-wall thickness is presently 114 microns for aluminium; 68 microns for steel – with light-weighting they are made thinner and thicknesses will tend to vary plant to plant and manufacturer to manufacturer).

The base or dome of the can is formed on completion of the stroke. The ragged edge of the cylinder shaped can is then trimmed before it is washed to
remove the lubricating oils and etching the surface in preparation for receiving the base coat.
Washing comprises of a chemical wash, a water rinse, a chemical etch and surface treatment with zirconium and rinsing with de-ionised water. Steel only needs a water wash as the steel does not require lubrication before the ironing operation. It is then dried before the base coat colour is applied, before complete decoration.

The decorator is unique to the can making business and usually comprises of 6 inkers placed around a rotating drum on which there are 6 to 8 latex blankets which receive the ink from each ink station building up the complete image. The image is then transferred to the rotating can as it travels over the blanket in one full rotation. The can then passes through an oven to cure the ink before further processing takes place. After this, a coating of varnish is applied to the bottom radius of the can to aid mobility on the line and inhibit corrosion.

Each can also receives an internal coating of water based epoxy lacquer from twin spray guns as the can rotates. The can is then baked once more and the decoration UV tested to ensure complete lacquer coverage before passing to the necking and flanging machines.

Necking

This takes place immediately after the cans leave the oven and it is normal to neck in both the top and bottom of the can.

Flanging

Again both the bottom and the top of the can are flanged so that a rim is formed which is 90° to the vertical axis of the cylinder.

The can is now ready for inspection before being dispatched. A vision system checks for damage and contamination, and statistical checks are carried out to ensure that the process is in control. There is also a light tester which checks for fractures and pin holes. The cans are then palletised, each layer being separated by board or plastic layer pads. The trend is now towards using plastic layer pads and plastic pallets.
A typical pallet would be made up as follows:

- 33cl: 22 layers, 351 cans per layer
- 44cl: 17 layers, 351 cans per layer
- 50cl: 15 layers, 351 cans per layer

**A flow diagram of the process**

4.2.2. CAN: Manufacture of Ends

Ends are all fabricated from aluminium. Steel were unsuccessful. The aluminium is supplied in 8 tonne rolls. Each coil will produce up to 2.5 million ends. The coil is pre-lacquered and is fed into a press known as the ‘Minster Shell Press’ which produces the basic shell at the rate of 8,000 shells per minute. The shells then pass on to the curling operation situated at the rear of the press. They then go into a balancing system which allows the operation to be continuous before entering the compound lining machines – each machine is capable of running at up to 2000 ends per minute.
The end shells enter a starwheel and the ends are then rotated in the machine as a very precise bead of compound sealant is applied around the inside of the curl. The ends are then discharged via a discharge starwheel and baked.

Water based compounds, rather than solvent based, are more commonly used and have proved to be very effective. The ends are inspected for compound faults and for any oil or grease contamination. The ends now enter another balancing system before entering the ‘Conversion Press’ where the shell meets the tab.

The shell passes through seven stages as follows:

1. Bubble station
2. Button and panel coil station
3. First form and button base reform station
4. Score station
5. The 2nd form station
6. Stake station
7. Fully converted end

The tabs are also converted through about twenty stages before meeting the shell at the stake station. The diagram below gives an indication of the complexity in just making the tab.

The die for making the tabs is known as the ‘Stolle Tab Die’
After assembly the ends are bagged at the bagging stations. Quality is a crucial part of this operation and camera systems are extensively used for inspection. Equipment is used to measure finished shells for curl diameter, panel and countersink depth.
Quality Issues – Cans

Print
- May be aesthetically unacceptable
- In case of barcodes create retail problems
- Wrong varnish may affect line performance

Body damage
- Could result in can collapse in Filler/Seamer with consequent line jams or double seam defects.

Flange Damage
- Filling or seaming problems

Base rim coat
- Missing or sparse covering may give mobility issues leading to spillage at filler and/or line efficiency reduction.

Dome depth/formation
- Reduced strength resulting in dome reversal
- Excessive dome growth during pasteurization.

Flange width / Neck diameter
- Possible double seam integrity
- Can to End fit problem

Quality Issues – Ends

Clipped or Damaged Curls
- Double seam deficiencies and potential leakage / gas loss.

High Score Residual
- Difficulties in opening
- Tab failure / Fracture.

Split Rivets
- Leaker or gas loss
4.3 CAN: Packaging Materials

Packaging materials are one of the vital parts of packaging and the understanding of them is important. So often a high speed machine fails to run as designed because the material purchased has not been properly specified for that machine.

The following defines Primary, Secondary and Tertiary packaging.

Primary
The product cannot be sold without these materials. They contain the product and meet legislation e.g. bottle, crown and label or can and can end with product and best before information.

Examples
Cans and Can Ends (Aluminium & Steel).

Secondary
This effectively is the material that collates the primary package in some form i.e. a second layer of packaging. This turns the primary package into a saleable or marketable unit.

Examples
Board (Carton, Layer Board, Kraft & Corrugated, Sleeve Wrap & Multipacks (Board & Film), FEC (Board & Film), Hi-Cone.

Tertiary
This relates to the remainder of the packaging. It is really there to protect the finished product, and allow it to be transported safely, and without damage, to its final destination.

Examples
Pallets, Locator Boards, Stretch & Shrink Film.

Packaging Materials Functions
There are two main functions of packaging, these are:

- Technical Functions
- Marketing Functions

a) Technical Functions

- Containment
  - Holds contents without leakage
- Protection
  - Product does not hurt the consumer
- Preservation
  - Product will keep for the period described as the shelf life of the product which be up to the best before date and is not responsible for imparting flavours
- Measurement
  - Holds the legally declared quantity
Storage
- Will travel and store successfully

b) Marketing Functions

Communication
- Product name and anything else about the product

Display
- Looks good on the shelf. Neat, tidy and well packaged

Information
- Contents, ABV, Best Before, Batch Number and any other relevant information which will normally be a legal requirement

Promotion
- Packaging is often used to promote a product – a peelable label for example

Selling
- Final packaging will sell the product

Materials Specifications

The functions can be understood, but it is important that the materials that are purchased enable the final package to function as perceived. Poor specifications can be responsible for issues on the packaging line or in trade. These specifications also need to be controlled. One approach, to make control easier, is to divide the specification into three parts.

The first part is an overall policy statement. This would normally relate to a restriction in chemical treatment or the use of compounds which could affect the product. This would include the requirement for tests, should the supplier wish to use a different form of treatment; for example, the use of a different lacquer inside a beverage can. It may also include an environmentally based statement that requires a percentage of the supplied material to be recycled. This of course needs to be done with great sensitivity, as some materials will have a significantly reduced performance if there is a recycled content.

The second part will cover all components that come under a common heading, such as bottles, cans, trays, cartons, film etc. This will include the general description, technical requirements, quality and environment specific to the component.

Finally, the third part will be specific to the actual component, giving dimensions, type of material, barcodes, artwork and so on. This is agreed with the supplier and with other parties, such as marketing, sales and manufacturing. As and when components are added or changed there is a minimum quantity of documentation involved – whether it is computer based or in a file. Each component is given a code – either alphanumeric or numeric.