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Ecodesign in Food packaging

Unit 6: Metal Cans

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After learning this unit, the student will be able to:

- To know the functions of metal cans
- To be informed about the characteristics and possibilities of metal cans ecodesign.

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6.1 Requirements

The metal packaging plays an important role in the process of food preservation. The common expression used to describe such a food packaging is the cans/ canning. The total world market of metal containers is estimated at 410 billions of units per year. From this, the beverages bottles represent 320 billions and canning represent approx. 75 billions of euros. The rest are aerosols boxes and other products.

6.1.1 The functions of metal food packaging (cans)

• preserves and protects the product;

• to withstand the chemical actions of the product;

• to withstand the conditions of handling and processing;

• to withstand the conditions of the external environment;

• has the correct dimensions and the ability to be interchangeable with similar products from other supply sources (when necessary);

• to have the display properties necessary at the point of sale;

• allow an easy opening and simple / safe removal of the product;

• be constructed from recyclable raw materials.

In addition, these functions must continue to be met in a satisfactory manner and after the end of the stated shelf life. Most foods and drinks from containers for storage at the shelf, in the environment conditions, are subject to a heat processing to extend the product shelf life. For boxes with foods, this will normally offer a shelf life up to 2-3 years or more. The used cycles of the heating process are particularly severe and the containers must be specifically designed to withstand these conditions of temperature and pressure cycles in steam or in water. After heat processing, when the container temperature has returned to the ambient temperature, normally, in the can there will be a small depression. In these conditions, the food itself will not be subjected to compression due to the external tasks[1].

[1] RICHARD COLES, DEREK MCDOWELL, MARK J. KIRWAN FOOD PACKAGING TECHNOLOGY, Blackwell Publishing Ltd, 2003

6.1.2 Environmental Aspects

Cans are the most recycled food container in the world.
Thus:
• Cans are recyclable 100%.

• Containers made of steel can be endlessly recycled without lose its strength or quality.

• Each ton of recycled steel saves 2,500 kg of iron ore, 1,000 kg of coal and 40 kg of limestone.

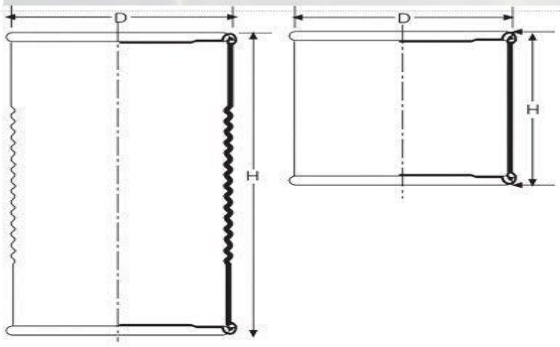
6.2 Cans, construction and materials

6.2.1. The cans construction

A can is generally made of a thin metal material. It opens sometimes by cutting one of the front parts of the box, sometimes it can have a lid that is removed.

- **Three-pieces cans**

Cans may have various forms, with round or oval, rectangular or trapezoidal section, etc. The most used can is the three-pieces can: the body (the thickness of 0.2 - 0.24 mm), lid and bottom (the thickness of 0,24 - 0,26 mm). Before the formation of the cans bodies, are applied the protective coatings to the surfaces inside and outside with a roller on the flat sheet. After the formation, the lid and the bottom are joined typically by seaming (double rolling); another solution especially met at aluminum cans is the two-pieces can (can stamped) - can in which the body and the bottom form a part (obtained by stamping) and the lid. They can have ribs, also can be strangled to one or both front sides. Their body may be joined by folding and soldering, by soldering withe the overlapping edges or can be stamped.



D (Çap / diameter)		H (mm)
52	min.	38
	max.	99
65	min.	34
	max.	240
73	min.	32
	max.	240
84	min.	33
	max.	240
99	min.	28
	max.	240
153	min.	67
	max.	242
215	min.	230
	max.	283
230	min.	230
	max.	283

Fig: 1 Different cans, folded or with removable cover

The cans with ribs are prefered and in terms of the containers format, those with small format are prefered, with the ratio H/D = 1/1;

a b c d

Fig 2: Different opening ways of cans

a - device for open the can with folding lid; b – lid with full opening of the round can;

c – side opening of the can; d - lid with full opening of the rectangular can.

https://en.wikipedia.org/wiki/Tin_can

Cans usually have a label of printed paper or a label of plastic glued on the outside of the curved surface, indicating its content. Some labels contain on the back additional informations, ex. recipes. Some labels can be directly printed on the metal.

Folding- The most important closure type used for metal containers is the double folding.

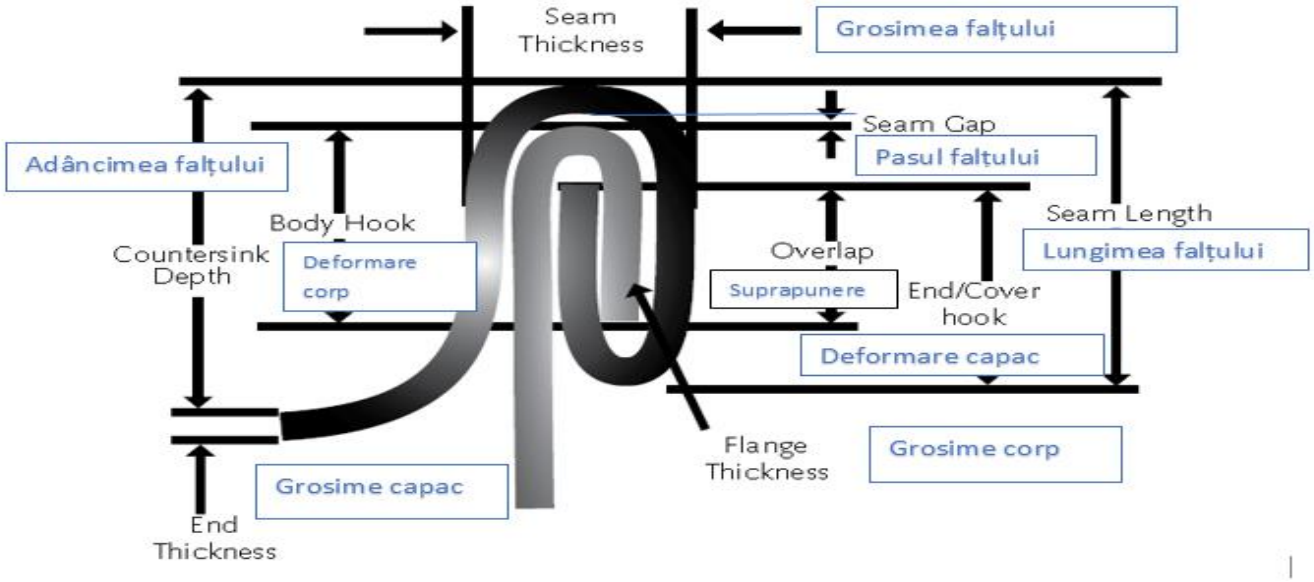


Fig 3: The elements of the normal double countersink[2]

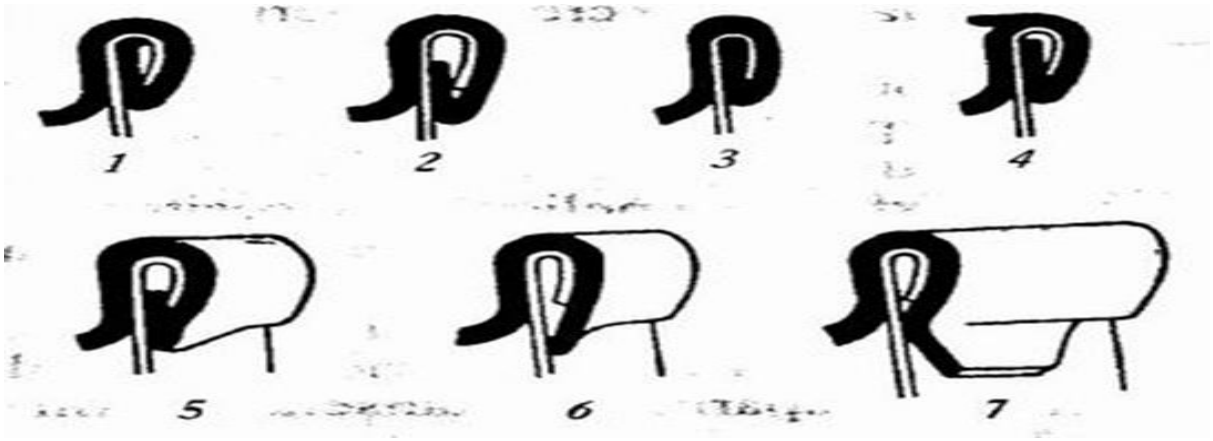


Fig 4. Forms of double countersink

[2] Peter K.T. Nehring, 7. Metal packaging for foodstuf, Prepared under the responsability of the ILSI Europe Packaging Materials Task Force, sept 2007

1 – normal countersink; 2 – high countersink; 3 - too tight countersink;

4 - countersink with ridge; 5 - countersink with the tongue; 6 - countersink with tooth;

7- countersink with lip.

http://www.creeaza.com/tehnologie/tehnica-mecanica

In *fig. 3* shows the normal form of countersink (fig 3.1) and the defects of the countersink formation which occur more frequently. The defects of the countersink formation can lead most often to compromising the can seal.

Countersink is considered correct if: the countersink is perfectly smooth, devoid of ridges; inside there are no metal parts and rubber paste came out; in his upper side, the countersink is thicker due to multiple layers of sheet metal and in the inside, is visible more tightly to the can body.

Countersink runs using specialized machines for closing the cans.

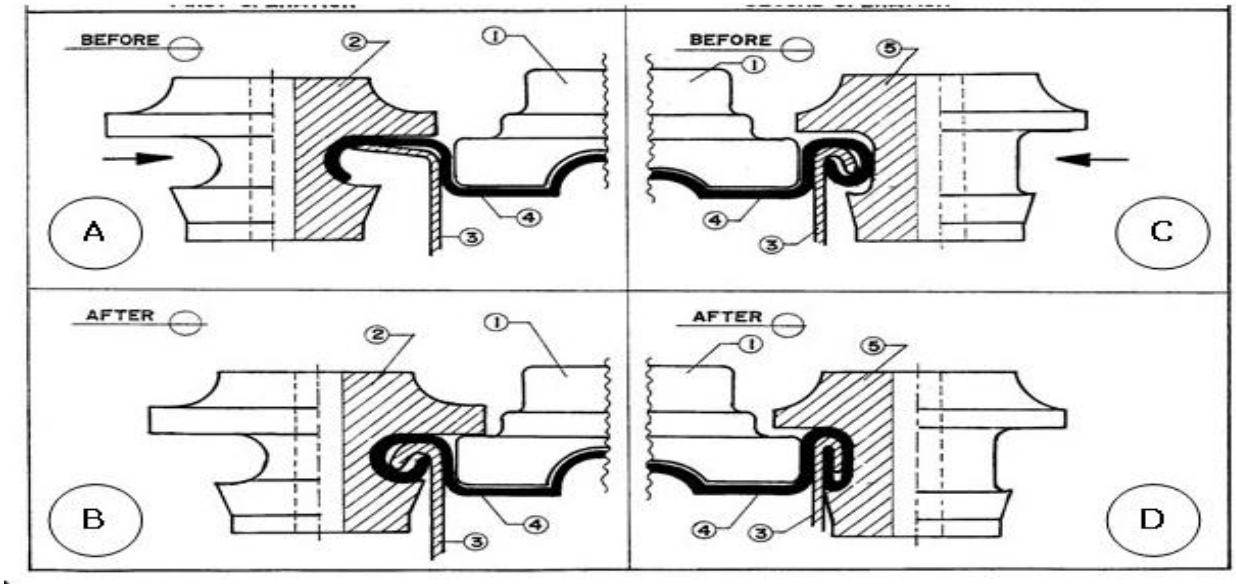


Fig. 5 Example of execution of the double countersink.

http://www.fao.org/docrep/010/ai407e/AI407E22.htm

After the can is filled with the food, the can is sealed with the so-called double countersink (double seam) (Fig. 5). The double seam, in final form, consists of three layers of lid (D, black) and two layers of body material (D, hatched). The layers need to overlap and all the curves must have a rounded shape to avoid small cracks. Each double seam is achieved in two unique operations referred to as "first operation" (A, B) and "second operation" (C, D).

- **Two-pieces cans**

The draw-and-iron aluminum cans made by deep drawing, by multiple drawing in two-pieces, are usually used as containers for beverages, but can also contain food and non-food products. Another type of can (sometimes called bottle) of aluminum is formed from a single piece, which is used for aerosols and pumped products, such as saline solution, perfume and freshener air, as well as products that are not pumped, as are the additives for fuel.

Two-pieces steel draw-and-iron cans are used for food. These are in general less deeply drawn and are used as containers for various food products like: tuna, salmon and snacks. Containers for foods are made from steel because they are usually vacuum packed.

The lids for the cans are usually made of metal plates and not from the metal scrolls. The coatings are applied by roller coating devices similar to those used in the coating operations of the sheets for the bodies of the three-pieces cans, and some installations use the same coating lines to cover their bodies and heads. The lids for easy-opening cans, which are covered, require additional manufacturing steps when the metal is marked and when an opening piece is attached. These steps are executed after finishing the piece, so the coating will be damaged. In the end, new coverage layers are necessary to be applied, to achieve the coatings integrity. The process of carrying by multiple drawing the two-pieces cans includes the following steps (http://www.mpma.org.uk/pages/data/2piecedrinkscan.pdf):

Fig. 6 Covered cans are dried in the oven.

a. The used aluminum or steel strips come in cannery factory in the form of large scrolls;

b. On the strip is applied a layer of ointment liquid, then the strip is cut on a stamping press;

c. Each cutout is drawn several times, through a series of rings made of tungsten carbide. Through this multiple drawing process, the can is obtained which is rectified to a

smaller diameter than the initial cropping and the walls are wearing thin while the workpiece height increase;

d. The opposite end of the piece bottom is snapped to the required size. it's;

e. The body thus formed passes through a washing machine, after which it is dried;

f. The can is covered with a base coating layer, colorless or pigmented, which is a good surface for printing ink, after which the covered cans are dried in the oven (see *fig. 6*);

g. In the next step on the is printed the required image using a sophisticated printer with six colors and at the base of each can is applied a colorless varnish layer;

h. The printed and varnished cans are dried again in the oven;

i. The inside of each can is protected by a spray of colorless anticorrosive varnish, after which it is dried again in the oven;

j. With a special device, the can neck is formed to fit the cover;

k. Each container is tested at every manufacturing stage. In the final stage, it passes through a tester with a light that automatically reject any can with holes or cracks;

l. The finished cans are then transferred to the warehouse where are automatically palletised before despatch to the filling.

Fig. 7 Packaged can a) *b)*

➢ **The draw-redraw forming process of the cans.**

As in the presented multiple drawning process, the aluminum or steel roll (coil) is continuously fed on a stamping press which cut metal plates which will become cans. Cans with low depth can be formed from a crossing. The more deep containers can additionally require one or two drawings. Then, the containers are stacked on pallets for storage. The processed cans are usually produced from pre-covered metal srolls (coils). So, the additional steps of coating in the manufacturing process are not required. Most of the containers made by draw-redraw process are labeled with printed paper. More recently, a new process called distortion printing have been developed, in which the images are printed on the box before it is formed. When the can is formed , the picture stretched to the designed size[3].

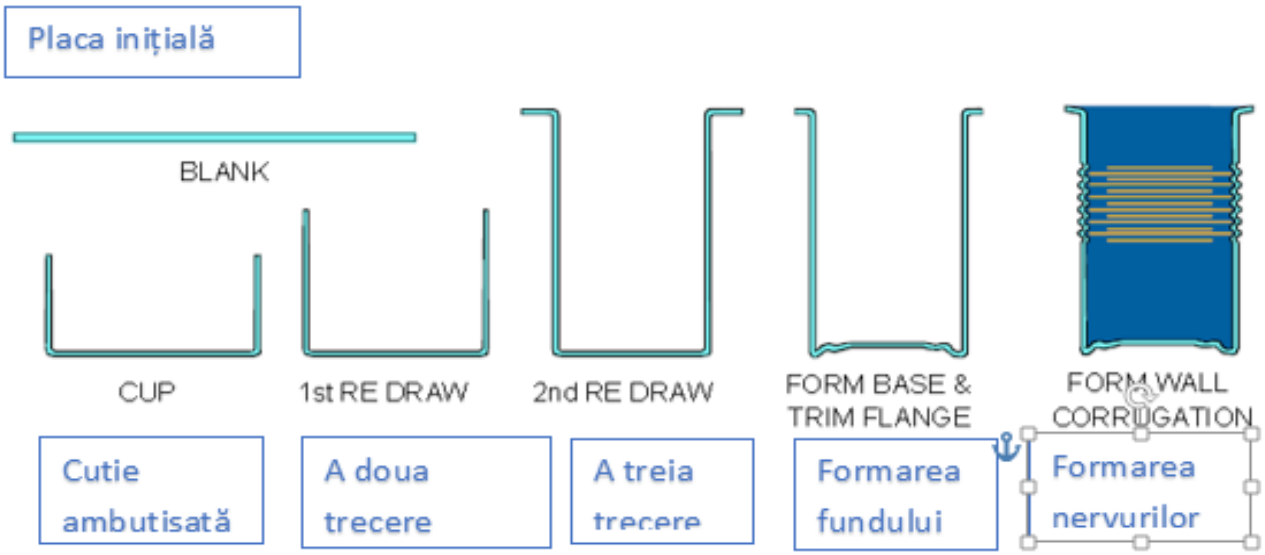


Fig.8 Draw-redraw process, after[4]

6.2.2. Materials

➢ **Steel**

Steel is used in the form of a table very thin laminated once or twice, after which it is covered electrolytic tinplate (ETP) or electrolytic chromium/chromium oxide coated steel

[3] Metal Can Manufacturing--Surface Coating, U. S. Environmental Protection Agency- 1998

[4] Eric Wootton, Alcan Deutschland GmbH, Göttingen, TALAT Lecture 3710
http://core.materials.ac.uk/repository/eaa/talat/3710.pdf

(ECCS), according to EN 10202:2001 (CEN, 2001). The mass of the tin layer varies depending on the final destination of the can, also depending on the later coverage. In general, the tin layer thickness ranges between 0.4 and 2.5 microns. The tin layers can be with equal thickness on the both surfaces of the sheet or they can have differentiated thickness. The tin layer with a sufficient thickness resists well to corrosion and it can be used as a layer in direct contact with many foods, as are the white fruits (ex. peaches, apricots, pineapple and pears) and certain products based on tomato (e.g., tomatoes in brine and beans in tomato sauce). For other products it is necessary the formation of a barrier layer by the additional coverage of the inner tin layer with a varnish layer. Lacquering for inner protection can be acid-resistant or sulpho-resistant depending on the aggressive action of the constituents from packed product. From the varnishing point of view, the cans can be unvarnished (white boxes); partially varnished, with the unvarnished body and the bottom and the lid varnished, completely varnished (made of varnished steel sheet).

Tin plate has excellent characteristics regarding the can welding, when the chrome (cheaper and with very good adhesion of the varnish layer) requires the removal of the chromium layer from the seam area and the coverage by varnishing. Also, after the coating with colorless varnish, the chrome surface is not reflective, as is the covered with tin. Depending on the way in which it restores varnishing, after welding we can meet: cans re-varnished (after the manufacture of varnished tin plate, to the interior another varnish layer is applied on the entire surface); adjusted cans (after the manufacturing from the varnished tin plate, the varnish is applied only on the longitudinal countersink where it breaks due to the metal sheet bending and the high temperature during soldering).

- **Aluminum**

The used aluminium alloys for improving the mechanical characteristics have as alloying elements mainly silicon and magnesium. It is known the aluminium resistance to corrosion due to the layer of aluminum oxide (Al2O3) formed on its surface. Aluminum cans are made by drawning. The inner surface of the aluminum can is always coverd with a organic varnish layer. Examples of aluminum brands used (after the International Alloy Designation System):

- Shallow drawn can bodies- AA 3005 H46 (varnished, ¾ hardness);
- Deep drawn can bodies, also easy-open lids - AA 5052 H44 (varnished ½ hardness);
- Full caps (Plain lids) - AA 3207 H48 (lacquered, 4/4 hardness).

6.2.3. Heat treatment

The temperatures to which the cans are exposed during food and beverages sterilisation (in the usual way at 115 to 135 ° C) and the pasteurization process (typically at 90-105 °C) are relatively low in comparison with those used in the manufacturing process of the cans. However, the temperature combined with mechanical stresses from the retort are loads that should be taken into account in the cans design.