

Smooth or stepped neck – a technological question

The canmaking industry is increasingly forced to reduce the production costs of cans. Lower material consumption is the main approach to reducing the production costs of 3-piece cans. To date, the best way used to be a constant reduction in sheet gauge, which not only reduces material consumption but also lowers the licensing fees for recycling systems such as the German "Grüner Punkt". In addition, the consumer needs to transport less weight.

In recent years, considerable progress has been achieved with sheet gauge reduction. The potential for sheet gauge reductions in can bodies have already been exhausted to a large extent whereas some margin still appears to remain as regards sheet gauge reductions for top and bottom ends.

Such cans made of very thin material have problems as regards their altered reaction to mechanical stress:

- Axial and panelling resistance decrease continually.
- The risk of failure in the filler's autoclave rises appreciably.
- The risk of damages (dents) caused during transportation of the cans at the canner's and filler's plants is considerably higher.

Further reductions in sheet gauge as a means to reduce costs require progress as regards resistance and processing properties of the material.

Apart from linear sheet gauge reductions, necking of the cans is another highly efficient method to achieve appreciable material savings.

This method has a triple effect on material savings:

1. The cut edge of the ends is much smaller: material savings.
2. The total load per surface unit exerted on the end is smaller because of the smaller end surface. In consequence, the end can be made from thinner material: downgauging without loss of stability.
3. Due to lower stress exerted on the ends the seam dimensions can be reduced slightly: further reduction of the cut edge.

Below we have summarised three necking technologies and their various applications:

Die-necking

The diameter of the can body can be reduced at one end or at both ends simultaneously. A necking ring, a kind of drawing ring whose ring diameter equals the outer diameter of the non-necked body on one side and the desired necked diameter on the other side, is pushed axially onto the body. The neck geometry is thus shaped to the profile formed by the two ring diameters. An inner core prevents wrinkling and calibrates the exact neck diameter. The diameter reduction per necking step is limited and depends on material quality, sheet gauge and body diameter. Neck reductions in one step allow for reductions in diameter of up to 3 mm approx., whereas reductions of approx. 8 mm can be achieved by necks with multiple steps. Unlike 2-piece cans, 3-piece cans cannot be die-necked repeatedly to form a smooth neck because of the non-homogeneity of their welded seam.

Spin-flow necking

The spin-flow necking process, which devolved from the 2-piece canmaking industry in principle, has been developed into a patented version specifically designed for the production of 3-piece cans by Cantec. This spin-flow necking process has an adjustable degree of forming per rotation to adapt it to specific material properties and combines a maximum diameter reduction with an attractive neck geometry (smooth neck) for SR and - especially important - for DR material. Can diameters can thus be reduced by up to 13 mm.

A modified flow pressing process forms the neck between two inner tooling components, which rotate together with the can body, and an outer shaping roller. The number of shaping rotations depends on diameter reduction and material. It can be adjusted at infinitely variable increments up to a nominal rotary speed of up to 25 rotations per can.

Specially developed high-precision clamping tools ensure that the can body securely follows these rotations. Upper tool and lower tool are centered relative to each other during the necking process so that radial forces can be transmitted without deformation. An accurately concentric neck geometry achieved without time-consuming adjustments is the result.

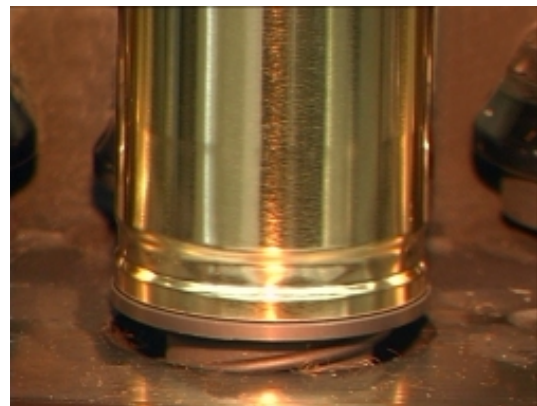


Spin-flow necking process

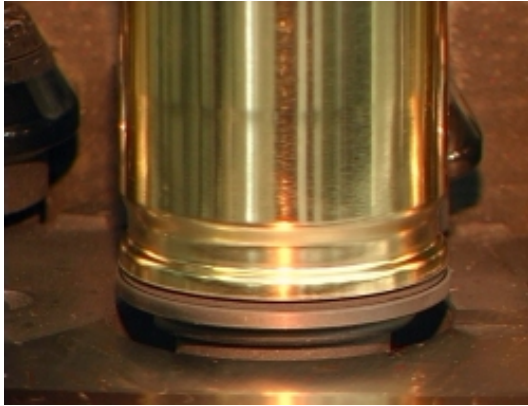
Spin-flow process steps:



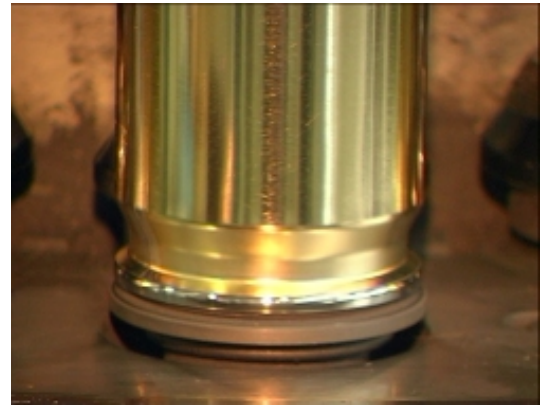
1



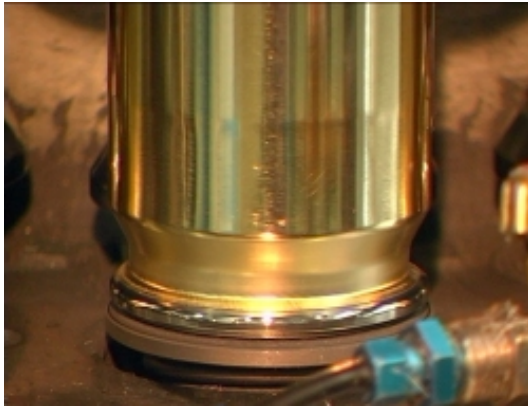
2



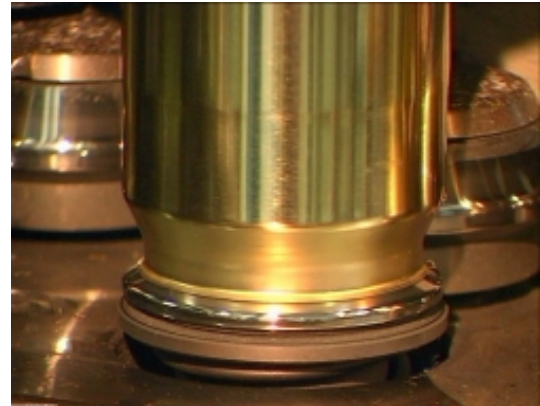
2



4



5



6

Die-shaping

This completely new process (patent pending) is, in principle, the reverse of the die-necking process. The bodies are welded to the "necking diameter". A shaping tool entering from both sides (as in pipe expanding) then expands the body to the final diameter at the points outside the necked profile. The design of the mandrel ends and the mandrel itself determine the necked profile and the surface shape of the can.

Thanks to this principle, die-shaping always forms a smooth neck with one step. The possible expansion, i.e. the difference in diameter between can body and necked portion, depends on the material and its plasticity, to a large extent, and on the welded seam. It can, however, reach up to 10 mm under favourable conditions.

The desired uniform reduction in sheet gauge (downgauging) of 5 % can be achieved in the cylindrical portions while the original sheet gauge remains at the shaped or necked portions which are subject to stress. The body is shortened by several millimeters by the expansion process.

The following table summarises properties and applications of these processes:

	Die-necking	Spin-flow necking	Die-shaping
Process	Die-forming	Spin-forming	Die-forming
Position of the neck in the machine	Top, bottom or both ends	Always at one end, at lower position in the machine; subsequent die-necking at the other end is possible	Always at one end, at upper position in the machine; subsequent die-necking at the other end is possible
Type of neck and diameter reduction	1 step: smooth neck up to 3 mm 2 steps: stepped neck up to 5.6 mm 3 steps: stepped neck up to 8 mm 2 steps: smooth neck up to 4 mm	1 step: smooth neck, up to 13 mm, combined with previous die-necking	1 step: smooth neck, T57 to T67, 5 mm to 10 mm
In production with up to	1 step: 0.13 mm DR 550 2 steps: 0.16 mm DR 550 3 steps: 0.18 mm T 64	0.155 DR 550	0,18 T64
Change in material	Slight thickening at the neck	Thinning at the neck	Thinning of the cylindrical portion
Process evaluation	Machine: simple design Process: reliable	Machine: complex Process: reliable, provided material and welding quality are appropriate and constant	Machine: simple Process: reliable, provided material and welding quality are appropriate and constant
Flanging operation	Spin-flanging or swing-flanging, also die-flanging if soft material is used	Spin-flanging only	Spin-flanging, in some cases also swing-flanging
Machine output in standard design	Up to 800 cpm	300 – 600 cpm, depending on type of material and diameter reduction	Up to 600 cpm

There are three different methods to flange necked (or unnecked) bodies. They differ with regard to their process sequence and their specific properties. Neither of them can flange all types of necked can.

Die-flanging

Die-flanging is the simplest and most robust method as far as machines and tools are concerned. The flange is formed simultaneously along the entire circumference by a die. Die-flanging exerts the highest stress on material and on the neck in axial direction.

Die-flanging is best suited to flange bodies made of thick, soft material and bodies with large diameters.

Bodies with spin-flow neck or die-shaped neck usually crush axially at the neck. Flange cracks may appear too.

Spin-flanging

The machines and tools required for spin-flanging are much more complex than those used for die-flanging. In contrast to the classic die-flanging process, spin-flanging forms the flange selectively, only at the points where the flanging rollers come into contact with the body. The body rolls around the flanging rollers, which stretch it into a polygon shape. The flange is formed by the slow penetration of the counter-rotating tools. The body runs along the flanging radius of the flanging rollers and the shoulder of the flanging rollers to the stop ring. The initial polygon shape lasts until a specific flanging width has been reached. Thereafter, the body remains round.

Spin-flanging exerts the lowest stress on the material and the lowest axial load on the neck. This method of flanging is suitable for all neck geometries.

Swing-flanging

With regard to the machinery required, swing-flanging tools are much simpler and more robust than spin-flanging tools.

The patented swing-flanging technique combines the advantages of die-flanging (minimum relative movement between tools and body, little abrasion, little flange width variation) and spin-flanging (local, continuously progressing forming) while largely avoiding the known disadvantages of these methods.

Swing-flanging is best characterised as a swinging die-flanging process. With swing-flanging the flange is formed sequentially, i.e. only at those points where the swing-flanging heads are currently in contact with the body. Due to the rotation of the inner spindle, the flanging head performs a swinging movement (but does not rotate itself) so that the point of contact with the body rotates around its circumference. The flange is formed or rolled out by the slow penetration of the swinging flanging heads. The body runs along the flanging radius of the flanging heads and the shoulder of the flanging heads to the stop ring. The stress exerted on the material is slightly lower than with die-flanging, but slightly higher than with spin-flanging. The absolute load acting on the neck is hardly higher than with spin-flanging, although unlike in spin-flanging the load is absorbed at sequential points located off-center.



Swing-Flanger