

Extrusion and Drawing

(Boliden MKM Ltd)

Slide 1

What does extrusion require?

Firstly, a material to be extruded which is relatively soft at the extrusion temperature.

Secondly, a container to enclose this material.

Thirdly, a die to produce the desired shape.

Lastly, a means of applying pressure.

Most people will encounter a simple example of the extrusion process when using a tube of toothpaste.

Slide 2

So, why extrusion? What does it have to offer over other processes?

A high degree of flexibility in two dimensions, the third dimension being the direction of extrusion.

Near net shape. The ability to produce a product near to the finished size or profile within one operation.

Wide choice of batch size since this can be as little as the product of one billet although it is preferable for process efficiency reasons to produce multiple billet batches.

Fast change process. The product can be changed easily by using a different die at the front of the container.

Slides 3 and 4

Extrusion in the Brass industry falls into two main categories depicted in the following slides:

Direct extrusion, where the billet is placed into a container and pushed through a die by a ram at the back end.

Indirect extrusion, where the billet and container move forward together pushing the material through the die and along the centre of a hollow ram. This is the more modern process and offers significant advantages over direct extrusion.

Slides 5 and 6

The major significant difference in the two forms of extrusion is the relative movement of the billet to the container.

With direct extrusion, the billet moves through the container, producing frictional forces, resulting in an increase in the extrusion pressure. These forces also constrain the flow of the billet at the surface and the effect is that the surface layers accumulate next to the die in what is referred to as 'the dead zone'. This material contains the surface oxides from the billet and towards the end of the extrusion cycle, these oxides start to flow into the product, producing classical back end extrusion defect. It is necessary, in practice, to leave a discard typically 5 cm thick to contain as much of this oxide as possible. However, to be certain of freedom from defect, it is also usually necessary to fracture sound the back end of the extruded product.

With indirect extrusion, there is no relative movement between the billet and the container and therefore no frictional forces. As a result, extrusion pressure is reduced enabling smaller sizes of product to be extruded from a particular billet size. Conversely, larger diameter billets may be used for the same product size. For example, at Boliden, we previously produced ¼" diameter from a 9" diameter billet. The same size is now produced from 10" diameter on the indirect press. The added advantage with the indirect process is that the main flow zone is near to the billet surface so that there is little accumulation of oxides near to the die. Back end defect can therefore be contained in a substantially thinner discard and there is no need to fracture test the product – this has a significant effect on the necessary manning level. But, because the flow zone is near to the billet surface, it is essential that surface quality is of the highest order. When we installed our indirect press we also installed a continuous casting plant to produce high quality billets.

Slides 7 and 8

The next two slides show the indirect rod press at Boliden. The billets shown are 10" diameter and typically weigh around 560 kg each. In the photographs of the press, the container can be seen to the right of the top picture with the hollow stem to the left. The photograph of the cooling bank shows straight length extrusion but the press is also used for producing coiled material.

Slide 8

What constraints are there on the process?

In the Brass industry, we are typically extruding at 700°C with quite high extrusion pressures. The die material must be able to withstand these conditions without significant wear and distortion. We cannot, therefore, extrude profiles to the sort of sizes and thickness of section seen in the Aluminium industry. The available pressure of the press, i.e. the maximum force it can exert, is related by a mathematical formula to the area of the product, the area of the billet and a constant for the material at a given temperature. Thus, for a given press, the product size will be restricted – increased temperature can be used to some extent but there has to be a safety margin from the melting point of the material.

Flow during the extrusion process can be quite critical particularly where there is significant variation in section thickness. It can be difficult to balance the flow of a thin part of a section with a large block area. Modifications to the inlet to the die and skilled application of lubrication are often necessary to produce a good product.

Slide 9

What can we extrude?

The following slide shows a brief outline of the range of products which can be made on our four extrusion presses. Not all of these profiles will be in process at the same time, the majority of products being simple rounds and hexagon for machining purposes. Perhaps as many as 2,000 profiles of the 27,000 section products could be produced within a year.

Slides 11 and 12

The title of the presentation is Extrusion and Drawing.

So, if extrusion is so flexible, why draw?

Increasingly, customers are demanding tolerances and surface finish which cannot be achieved by the extrusion process. We would expect an extruded tolerance to be +/-0.13 mm but customers are demanding significantly tighter than this in many instances. Also, mechanical properties are being demanded which cannot be achieved with the extruded material. For an ordinary machining brass, tensile strength can be increased by about 30% by drawing, dependent on the size and shape of the product. With rod products, there is a significant improvement in process efficiency if the material can be extruded in coil form and drawn to straight length in one operation. Set up times are shorter and yield losses are reduced compared to extruding in straight length.

The next slide shows coil material being processed to straight length on a Schumag drawing machine. Product up to 1 ¼" diameter can be processed in this way.

Slides 13 and 14

The last two slides show examples of the type of product produced at Boliden. From round bar for machining to complex sections for lock parts and lifts, there is a multiplicity of choice from the extrusion process.