In the name of God

Technical English Language

for Materials Engineering and Metallurgy

Lesson 7: Forming Processes

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1. Forming Processes

This unit is proposed to deal with deformation which may be used to obtain intermediate or final shapes in metal. Liquid metal may be cast to shape in molds, sprayed to form intermediate or final shapes or made into powder which is pressed into shape and sintered to produce strong components. While each of these has a field of application, the overwhelming bulk of metal is shaped from the simple cast ingot by a series of deformation processes. The applicability and development of these processes is completely dependent on the plasticity of the solid metal.

The study of plasticity is concerned with the relationship between metal flow and applied stress. If this can be determined, then the required shapes can be achieved by the application of calculated forces in specified directions at controlled rates.

In practice the external load is applied by a tool and its shape controls the direction of application necessary to achieve the desired flow. The type of tool can be used to classify the different categories of deformation processes. Common industrial processes fall into six categories-deep drawing or pressing, rolling, forging, stretching, extrusion and wiredrawing. There are other working processes, *e.g.* roll forging, spray forming, *etc.*, but these are not yet of any great industrial significance. An outline of each of the important processes is given in the following.

2. Deep Drawing and Pressing

Deep drawing is an extension of pressing in that the metal blank is given a substantial third dimension after flowing through a die (Fig. 1). Simple pressing is carried out by loading a blank between a punch and a die so as to indent the blank and give the product a measure of rigidity. Can ends in food and beverage containers are the most widespread examples.

As will be seen later this process can only be carried out cold. Any attempt at hot drawing results in the metal necking and failing. The pressure ring in Fig. 1 prevents the blank from lifting away from the surface of the die as radial wrinkles or puckers tend to form in the metal flowing inwards from the periphery to the die aperture.

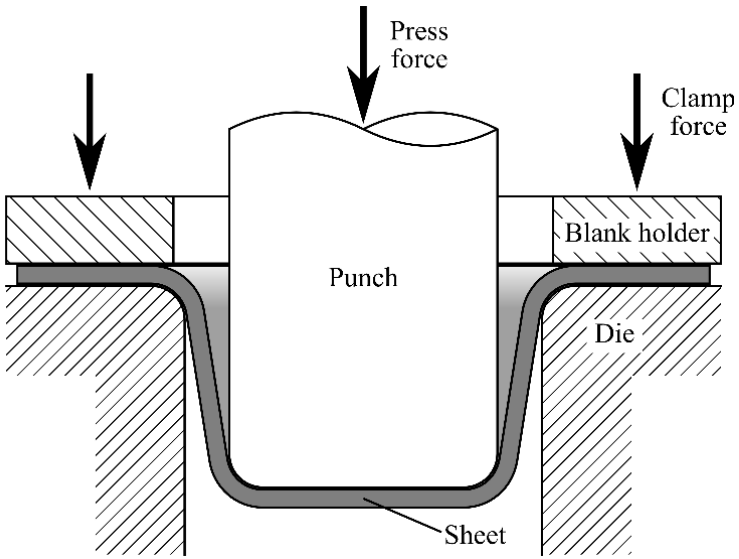

Fig. 1. A schematic of the deep drawing process.

3. Rolling

This is a process which reduces the thickness of the material passed between a pair of revolving rolls. (Fig. 2). The rolls are generally cylindrical producing a flat product such as sheets or strip. They can also be grooved or textured on the surface in order to change profile as well as emboss patterns. This deformation process can be carried out either hot or cold. Hot working is very widely used, because it is possible to achieve rapid and cheap change of shape. Cold rolling is carried out for special reasons such as the production of good surface finish or special mechanical properties. More metal is rolled than the total treated by all other processes.

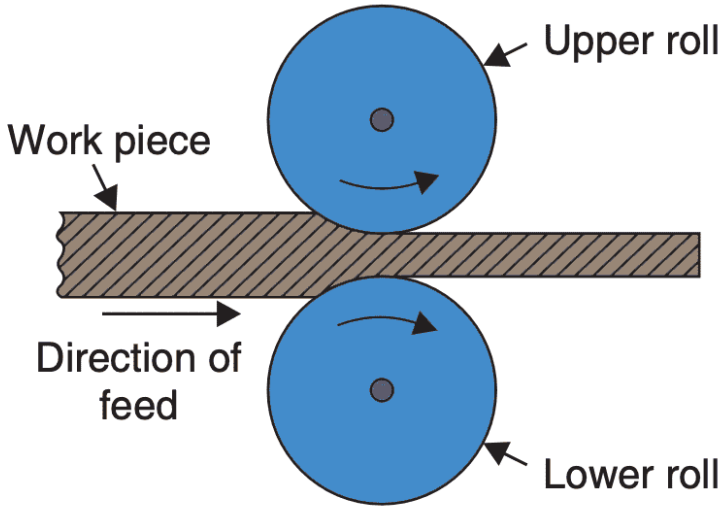

Fig. 2. A schematic of the rolling process.

This is an indirect compression process. Normally the only force or stress applied is the radial pressure from the rolls. This deforms the metal and pulls it through the roll gap. The process can be compared to compression or forging but differs in two respects in that compression takes place between a pair of platens at various inclinations to each other, and that the process is continuous (Fig. 3).

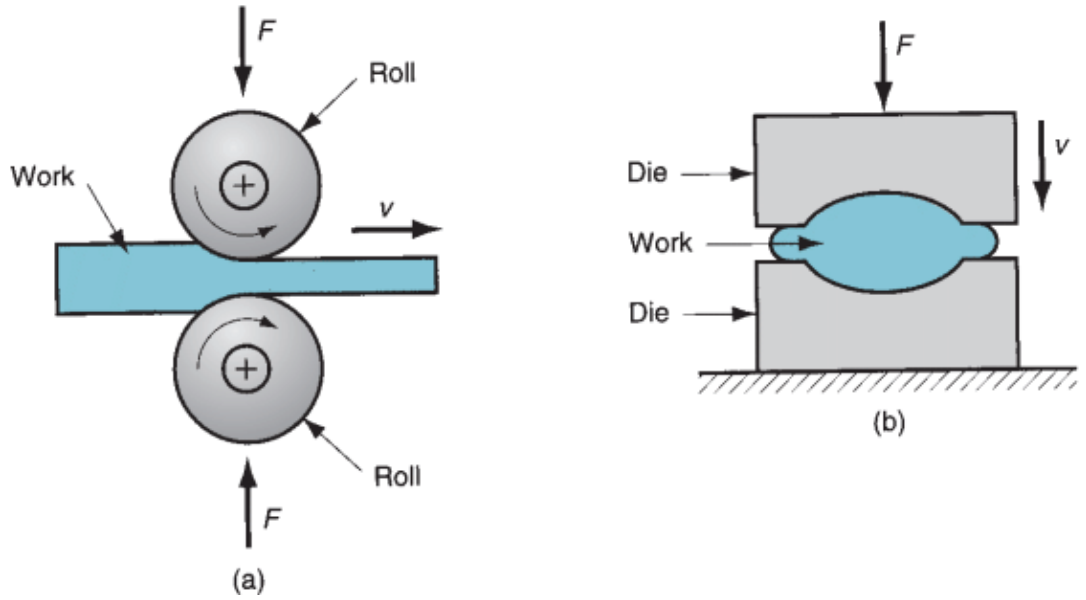

Fig. 3. The difference between a) rolling and b) forging processes.

Rolling is the most widely used deformation process and for the reason that there are so many versions the process has its own classification. This can be according to the arrangement of the rolls in the mill stand or according to the arrangement of the stands in sequence. Rolling mills are classified as in Fig. 4.

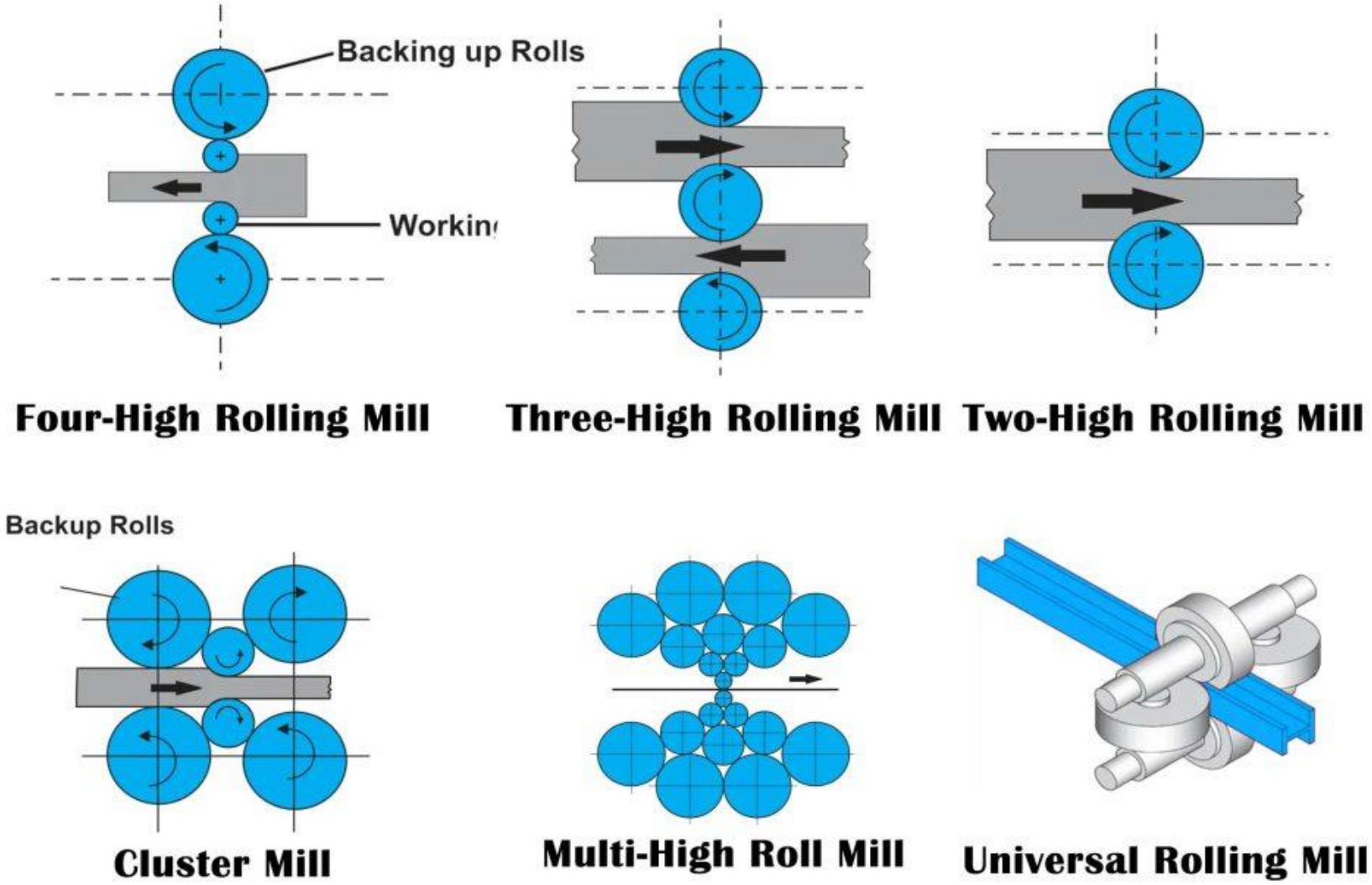

Fig. 4. The variety configurations of rolling mills.

4. Forging

Forging was the first of the indirect compression-type processes and is probably the oldest method of metal forming. It involves the application of a compressive stress which exceeds the flow stress of the metal. The stress can either be applied quickly or slowly. The process can be carried out hot or cold, choice of temperature being decided by such factors as whether ease and cheapness of deformation, production of certain mechanical properties or surface finish is the overriding factor.

There are two kinds of forging process: impact forging and press forging. In the former, the load is applied by impact, and deformation takes place over a very short time. Press forging, on the other hand, involves the gradual build-up of pressure to cause the metal to yield. The time of application is relatively long. Over 90% of forging processes are hot.

5. Wire Drawing

Metal rod is pointed at one end and then drawn through the tapered orifice of a die. The rod entering the die has a large diameter and leaves with a smaller diameter. In the early examples of this process, short lengths were drawn by hand through a series of holes of diminishing size in a cast-iron or forged-steel 'draw plate'.

Modern installations, in which long lengths are drawn continuously through a series of dies by the use of a number of mechanically- driven blocks, can produce very large quantities of wire in long lengths at high speed, using very little manpower. By using the appropriately-shaped orifice it is possible to draw a variety of shapes such as ovals, squares, hexagons, etc., by this process. Fig. 5 is a sample of this process.

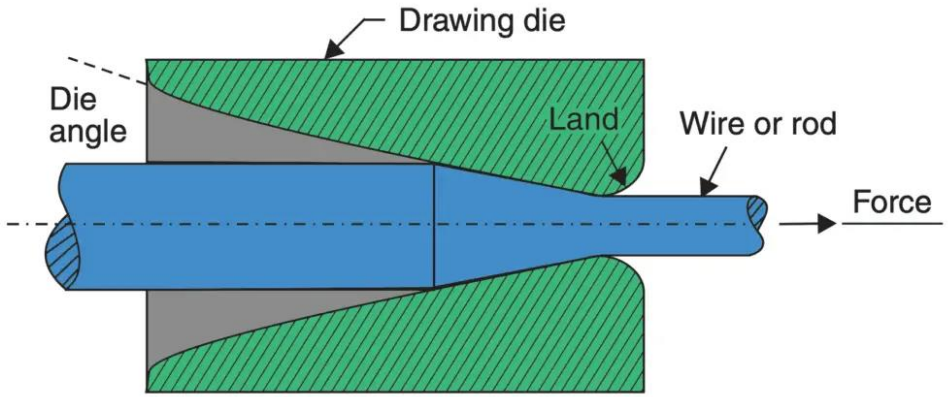

Fig. 5. A schematic of the wire drawing process.

In this the diameter of a cylindrical piece of metal is reduced by pulling it through a tapered hole which is the internal profile of a drawing die. The cylindrical feed metal is initially pointed so that it protrudes through the die orifice and can be gripped for drawing. The equipment can range from a simple draw bench for intermittent drawing to multiple draw blocks for continuous operation.

6. Extrusion

Extrusion is a deformation process used to produce long, straight, semi-finished metal products such as bars, solid and hollow sections, tubes, wires and strips. The principle is very simple: under a high load, a billet is squeezed from a closed container through a die to give a reduction in size. Cross sections of varying complexity can be extruded, depending on the material and the dies used. Extrusion can be carried out at room temperature or at high temperatures, depending on the alloy and the method. Fig. 6 shows how the extrusion load is transmitted via a hydraulically or mechanically driven ram through an intermediate dummy block to the billet. The container is constructed of several thick-wall cylinders, usually shrunk together to withstand the high radial stresses, and fitted with a wear-resistant liner. The axial load is applied to the die stack in the press platen (end housing).

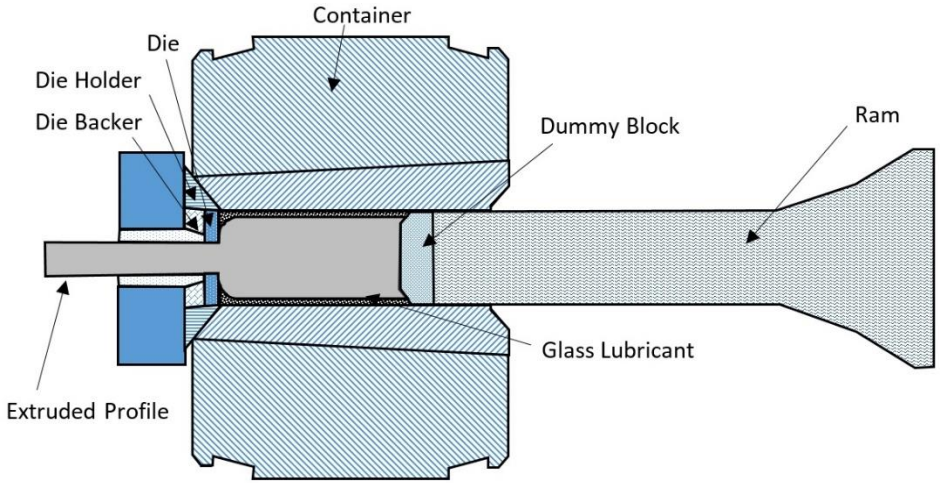

Fig. 6. Schematic diagram of the extrusion process.

The hydraulic extrusion press was invented in 1810 by the Englishman S. Bramah. His press was designed for extrusion of lead. The basic principle is still used today in the manufacture of lead tubes. The process was first successfully applied to higher melting point alloys by the German A. Dick, in the 1890s. He located a separate dummy block in front of the extrusion stem, allowing the discard and the dummy block to be ejected together. This was the first decisive invention that led to the extrusion of metals other than lead. Further development of the process to the present state of extrusion practice has been closely connected with advances in the mechanical construction of press installations, improvements in tooling and the development of hot working steels.

There are four characteristic differences among the various methods of extrusion and the presses used:

a) The movement of the extrusion relative to the stem-direct and indirect processes.

b) The position of the press axis-horizontal or vertical presses.

c) Type of drive-hydraulic (water or oil) or mechanical presses.

d) Method of load application-conventional or hydrostatic extrusion.

- Choose the best choice using your knowledge of metallurgy and the details in the previous reading.

1. The increased hardness allows a better surface finish to be achieved when …… .

a) normalizing b) tempering ✓ c) machining d) annealing

2. The most important part of the wire-drawing machine is the …….. .

✓ a) die b) diameters c) proportionality d) friction

3. Coining is an example of closed …….. forging.

a) died ✓ b) die c) dying d) dye

4. The basic operation in a primary mill is the gradual …… of the steel ingot between the surfaces of two rotating rolls.

a) fabrication b) compression c) extrusion ✓ d) progression

5. The rolling of bars and shapes ……. the rolling of sheet and strip in that the cross-section of the metal is reduced in two directions.

a) is the same b) different from ✓ c) differs from d) varies

6. The particular metal working method used depends not only on the ……. form of product, but also on the …….. of the metal being worked.

✓ a) desired, properties b) desiring, property c) desired, property d) desiring, properties

7. In forging simple flanged ……. from low-carbon and alloy carburizing steels, the heading tool usually …… faster than the gripper die.

a) forming, breaks b) portion, is broken ✓ c) shapes, wears d) shapes, breaking

8. When a force is applied to a wire, ……. the force, ……. the extension.

a) more, low b) less, high ✓ c) the larger, the greater d) more, high

4. Selected vocabulary

En	Fa	En	Fa
Workpiece	قطعه‌کار	Die orifice	روزنه قالب
Hydroforming	شکل‌دهی هیدرولیکی	Elevated temperature	دمای بالا
Wire drawing	کشش سیم	Blacksmith	آهنگر
Explosive forming	شکل‌دهی انفجاری	Lubricant	روانکار
Metal forging	آهنگری فلز	Reverse extrusion	اکستروژن (روزن‌رانی) معکوس
Deep drawing	کشش عمیق	Direct extrusion	اکستروژن (روزن‌رانی) مستقیم
Metal rolling	نورد فلز	Anvil	سندان
Coining	سکه‌زنی	Hammer	چکش
Punching	سوراخ‌کاری	Delicate parts	قطعات ظریف
Chip	پلیسه	Precision	دقت
As-built	همانطور ساخته شده	Accuracy	صحت
Wrought iron	آهن کار شده	Reliability	قابلیت اطمینان
Sheet/plate	ورق	Viability	قابلیت انجام
Die aperture	دهانه قالب	Repeatability	تکرارپذیری

4. Selected vocabulary (Welding)

En	Fa	En	Fa
Shielded metal arc welding	جوشکاری قوسی فلز محافظت شده	Weld decay	پوسیدگی جوش
Goggles	عینک جوشکاری	Lack of penetration (LoP)	نفوذ ناقص
Helmet	کلاه ایمنی جوشکاری	Lack of fusion (LoF)	ذوب ناقص
Filler metal	فلز پر کننده	Weld undercut	بریدگی لبه جوش
Shielding gas	گاز محافظ	Keyhole welding	جوشکاری سوراخ کلیدی
Butt joint	اتصال لب به لب	Dilution	رقت
Lap joint	اتصال لبه روی لبه	Mushy zone	منطقه خمیری
Groove weld	جوش شیاری	Solid-state welding	جوشکاری حالت جامد
Fillet weld	جوش نبشی	Friction stir welding	جوشکاری تلاطمی اصطکاکی
Seam weld	جوش درزی	Non-destructive testing	آزمایش غیرمخرب
Weld nugget	دکمهٔ جوش	Allowance limit	حد مجاز
Heat affected zone (HAZ)	منطقه متأثر از حرارت	Vertical/horizontal weld	جوش عمودی/افقی
Brazing	لحیم‌کاری سخت	Overhead/flat weld	جوش بالاسری/تخت
Soldering	لحیم‌کاری نرم	Weldment	قطعات بهم جوش داده شده