TUBE DRAWING

Tube drawing is very similar to bar drawing, except the beginning stock is a tube. It is used to decrease the diameter, improve surface finish and improve dimensional accuracy. A mandrel may or may not be used depending on the specific process used.

The diameter and wall thickness of tubes that have been produced by extrusion or other processes can be reduced by tube drawing process. The process of tube drawing shown in Fig. 5 is similar to wire or rod drawing except that it usually requires a mandrel of the requisite diameter to form the internal hole. Tubes as large as 0.3 m in diameter can be drawn.

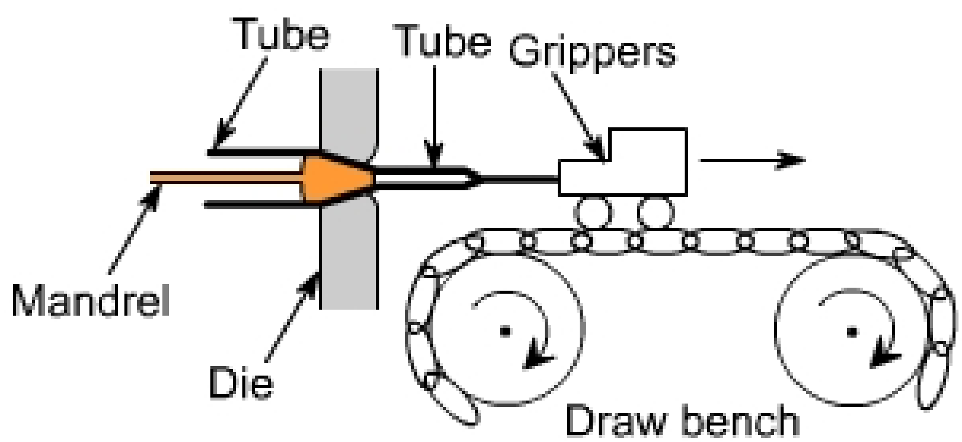

Fig. 5 Tube Drawing

Drawing Equipment

Drawing equipment can be of several designs. These designs can be classified into two basic types; Draw bench, and Bull block. A draw bench (Fig. 5) uses a single die and the pulling force is supplied by a chain drive or by hydraulic means. Draw bench is used for single length drawing of rod or tube with diameter greater than 20mm. Length can be as much as 30 m. The drawing speed attainable on a draw bench ranges from 5 m/min to 50 m/min. Draw benches are available having capacities to provide pull force of upto 1 MN.
Bull block or rotating drum (Fig. 3) is used for drawing rods or wires of very long length.

Production of this kind of products is far beyond the reach of the hot rolling, and so a substantial proportion of tubing is still cold drawn for the following reasons.

- To produce tubes with thinner walls than can be hot rolled.
- To produce tubes with smaller diameters.
- To produce tubes longer than can be hot rolled in certain sizes.
- To secure better surface finishes.
- To obtain closer dimensional tolerances.
- To increase certain mechanical properties, such as tensile strength.
- To produce shapes other than round.
- To produce tubes with varying diameters and wall thicknesses from end to end.
- To make small lots of tubing of odd sizes and gages that do not justify a hot mill run.

The practical minimum tube diameter produced by hot rolling is 33.3 mm (1 5/16 inches), and 2.1 mm (0.083 inch) is the thinnest wall of commercial hot-rolled tube.

Tube Drawing Processes

When a hollow tube is drawn through a die, generally a mandrel or plug is used to support the inside diameter of the tube, this process is called tube drawing. The function of the plug is to effect wall reduction and to control the size of the hole. However, the mandrel may be omitted if it is not necessary to make a reduction in the wall thickness, or if the dimensions and surface of the inside are not important. The process to draw a pipe without any mandrel is known as *tube sinking*.

In drawing tubes over a stationary mandrel, the maximum practical sectional area reduction does not exceed 40 per cent per pass the increased friction from the mandrel. If a carefully matched mandrel floats in the die throat of the die, it is possible to achieve a reduction in area of 45 percent, and for the same reduction the drawing loads are lower than for drawing with a fixed plug. This style is called the drawing with *floating plug*. To be mentioned is that in this style, tool design and lubrication can be very critical. Problems with friction in tube drawing are minimized in drawing with a long *mandrel*. The mandrel consists of along hard rod or wire that extends over the entire length of the tube and is drawn through the die with the tube. In this design, the area reduction can be 50 per cent. However, after drawing, the mandrel must be removed from the tube by rolling (reeling), which increases the tube diameter slightly and disturbs the dimensional tolerances.

The drawing process discussed above can be illustrated in the Fig. 6.

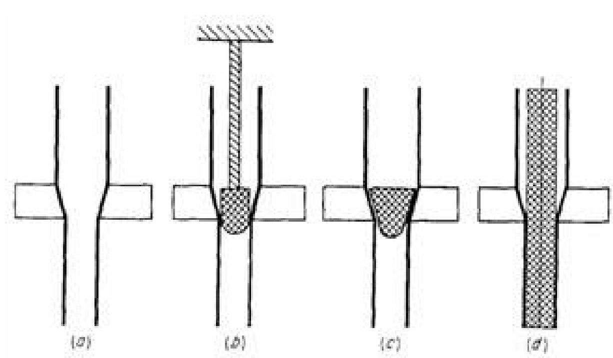

Fig. 6: Tube drawing processes
(a) Sinking; (b) fixed plug; (c) floating plug; (d) moving mandrel

A cold-draw bench for tubes consists of a heavy steel frame or bench, in the middle of which is located a die head for holding the die. At one end of the bench is located an adjustable holder to anchor the mandrel rod. At its other end a shaft is mounted carrying a sprocket wheel over which passes a heavy, endless, square-linked chain. This chain lies in a trough on top of the bench, which extends from the sprocket wheel to the die head, where the chain passes around an idler and returns underneath the bench to the sprocket wheel. The sprocket wheel is driven by a variable speed motor through suitable reduction gearing.

If cold drawn seamless tubing is require with small diameters, thin walls, or a smooth surface finish then the tubes manufacturing process is completed using cold drawing. Prior to cold drawing the scale resulting from rotary forging is removed by pickling.

A draw bench is used to pull the tube through a drawing die. One end of the tube to be drawn is collapsed and fed through the die. This end is then clamped to a travelling carriage. The carriage is then move away from the die using either mechanical or hydraulically traction. In practice several tubes may be drawn in parallel to increase productivity.

A number of process options are available as shown in the figure below.

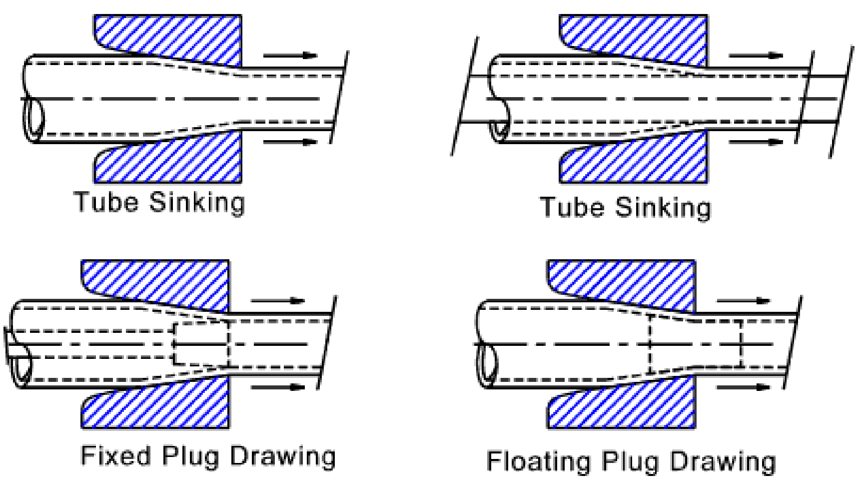

Fig. 7 Process options

Production Operation

The hot-rolled tubes after cooling are pointed on one end. This pointing consists of reducing the outside diameter, for a distance of about 150 mm (6 inches), sufficiently to permit the reduced portion to enter the hole in the draw die freely, so that the jaws of the plyer can grip this end of the tube. If more than one cold-draw pass is to be given the tube, the point is made slightly under the final die size, if possible.

In most cases, one cold-draw pass is sufficient to reach close dimensions, good surface, and required mechanical property of the products. Additional passes may be necessary to secure: (1) thinner walls, (2) better surface finishes, (3) smaller diameters, or (4) longer length.

For production with multiple passes, it is necessary to anneal them after each cold drawing operation. Before further cold-drawing, the annealed tubes must be pickled and lubricated. All tubes, except unannealed mechanical tubes, receive a final anneal or heat treatment after the last cold-draw pass. Many tubes receive a special normalizing treatment before the last pass in order to obtain the proper grain structure in the finished tube; this annealing is performed in either continuous tunnel or car-bottom batch furnaces fired with gas. The continuous furnaces are provided with heat-resisting driven rolls used to carry the tubes through the furnace at a predetermined rate depending on the tube section, annealing temperature, time at temperature, etc. The car-bottom batch furnaces are arranged in a battery and are served by a special charging crane. Further, the cold-drawn, annealed tubes are subjected to the finishing operation such as straightening, cutting, inspecting and testing.

Residual Stresses

For tube sinking and tube drawing over a plug and mandrel, assume the deformation is relatively uniform throughout the tube wall, the longitudinal residual stresses are tensile on the outer surface and compressive on the inner surface of the tube. The residual stresses in the circumferential direction follow the same pattern, while the stresses in the radial direction are negligible. Change of circumferential stresses on the outer surface of sunk tubes with increasing diameter reduction follows the same rate of the yield stress change.

Source : http://elearningatria.files.wordpress.com/2013/10/unit_5_drawing-notes.pdf