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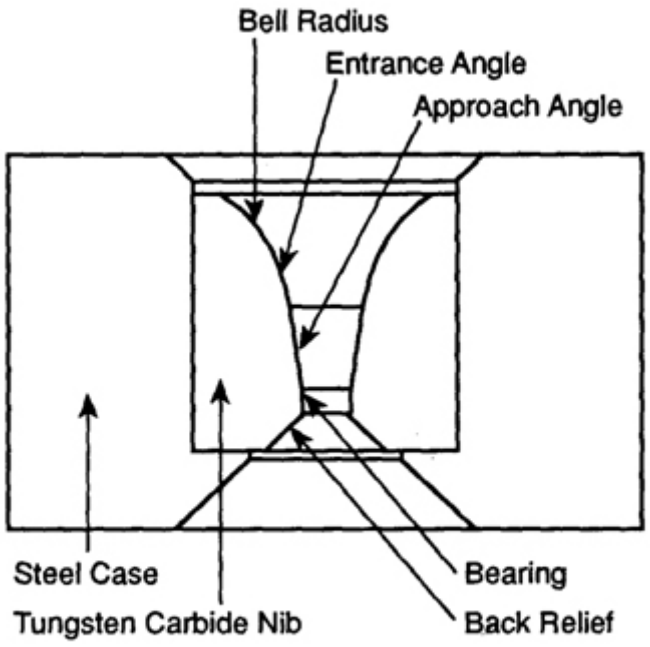
The Wire Drawing Process

Metalworking process used to reduce the cross-section of a wire by pulling the wire through a single, or series of, drawing die(s). There are many applications for wire drawing, including electrical wiring, cables, tension-loaded structural components, springs, paper clips, spokes for wheels, and stringed musical instruments. Although similar in process, drawing is different from extrusion, because in drawing the wire is pulled, rather than pushed, through the die. Drawing is usually performed at room temperature, thus classified as a cold working process, but it may be performed at elevated temperatures for large wires to reduce forces.

The process of wire drawing like the name implies is to draw a wire of a bigger diameter through a hole with smaller diameter hereby reducing the diameter through plastic deformation while the volume remains the same. To do this a tool called a drawing die is used. See picture below.



– Section through wire drawing die.

Process

The wire drawing process is quite simple in concept. The wire is prepared by shrinking the beginning of it, by hammering, filing, rolling or swaging, so that it will fit through the die; the wire is then pulled through the die. As the wire is pulled through the die, its volume remains the same, so as the diameter decreases, the length increases. Usually the wire will require more than one draw, through successively smaller dies, to reach the desired size. This can be done on a small scale with a draw

plate, or on a large commercial scale using automated machinery. The process of wire drawing improves material properties due to cold working.

The areal reduction of small wires are 15–25% and larger wires are 20–45%. Very fine wires are usually drawn in bundles. In a bundle, the wires are separated by a metal with similar properties, but with lower chemical resistance so that it can be removed after drawing. If the reduction in diameter is greater than 50%, the process may require annealing between the process of drawing the wire through the dies. Commercial wire drawing usually starts with a coil of hot rolled 9 mm (0.35 in) diameter wire. The surface is first treated to remove scales. It is then fed into either a single RBD or continuous wire drawing machine.

Single RBD wire drawing machines include means for holding the dies accurately in position and for drawing the wire steadily through the holes. The usual design consists of a cast-iron bench or table having a bracket standing up to hold the die, and a vertical drum which rotates and by coiling the wire around its surface pulls it through the die, the coil of wire being stored upon another drum or "swift" which lies behind the die and reels off the wire as fast as required. The wire drum or "RBD" is provided with means for rapidly coupling or uncoupling it to its vertical shaft, so that the motion of the wire may be stopped or started instantly. The RBD is also tapered, so that the coil of wire may be easily slipped off upwards when finished. Before the wire can be attached to the RBD, a sufficient length of it must be pulled through the die; this is effected by a pair of gripping pincers on the end of a chain which is wound around a revolving drum, so drawing the wire until enough can be coiled two or three times on the RBD, where the end is secured by a small screw clamp or vice. When the wire is on the RBD, it is set in motion and the wire is drawn steadily through the die; it is very important that the RBD rotates evenly and that it runs true and pulls the wire at a constant velocity, otherwise "snatching" occurs which will weaken or even break the wire. The speeds at which wire is drawn vary greatly, according to the material and the amount of reduction.

Continuous wire drawing machines differ from the single RBD machines in having a series of dies through which the wire passes in a continuous manner. The difficulty of feeding between each die is solved by introducing a RBD between each die. The speeds of the RBDs are increased successively, so that the elongation is taken up and any slip compensated for. One of these machines may contain 3 to 12 dies. The operation of threading the wire through all the dies and around the RBDs is termed "stringing-up". The arrangements for lubrication include a pump which floods the dies, and in many cases also the bottom portions of the RBDs run in lubricant.[3]

Often intermediate anneals are required to counter the effects of cold working, and to allow further drawing. A anneal is used on the finished product to maximize ductility and electrical conductivity.

Lubrication

Lubrication in the drawing process is essential for maintaining good surface finish and long die life. The following are different methods of lubrication:

Wet drawing: the dies and wire or rod are completely immersed in lubricant

Dry drawing: the wire or rod passes through a container of lubricant which coats the surface of the wire or rod

Various lubricants are employed. Another lubrication method is to immerse the wire in a copper sulfate solution, such that a film of copper is deposited which forms a kind of lubricant. In some classes of wire the copper is left after the final drawing to serve as a preventive of rust or to allow easy soldering.

Drawing dies are typically made of tool steel, tungsten carbide, or diamond, with tungsten carbide and manufactured diamond being the most common. For drawing very fine wire a single crystal diamond die is used. For hot drawing, cast-steel dies are used. For steel wire drawing, a tungsten carbide die is used. The dies are placed in a steel casing, which backs the die and allow for easy die changes. Die angles usually range from 6–15°, and each die has at least 2 different angles: the entering angle and approach angle. Wire dies usually are used with power as to pull the wire through them. There are coils of wire on either end of the die which pull and roll up the wire with a reduced diameter.