PROCESS CHARACTERISTICS OF WIRE DRAWING

- Pulls a wire rod through a die, reducing its diameter
- Increases the length of the wire as its diameter decreases
- May use several dies in succession (tandem) for small diameter wire
- Improves material properties due to cold working
- Wire temper can be controlled by swaging, drawing, and annealing treatments

Wire drawing consists of pulling a metal wire through a small circular opening called a die. This results in a stretching or elongation of the material along with a reduction in cross sectional area. The pulling force is limited by the strength of the material: pull too hard and the metal will break. The force needed to pull the wire through the die is determined by the extent of the reduction in cross-sectional area: the larger the reduction, the greater the force needed. Thus it can be seen that the maximum achievable reduction in diameter is limited by the yield strength of the wire.

Yield strength depends on material composition but typically the reduction in area through a die is in the region of 20 to 40%. If a greater reduction is needed this must be done by drawing the wire through a series of dies, each one smaller than the one before.

However, the plastic deformation experienced by the metal as it is pulled through the die tends to increase hardness and reduce ductility. (Ductility refers to the ease with which metal can be deformed.) As this will make it harder to reduce the cross-section, it is often necessary to perform an annealing process between successive draws to improve the way the metal deforms. On the other hand, the increased tensile strength resulting from drawing is often seen as a very desirable material property.

Wire drawing is usually performed cold, although there are some cases where metal is drawn hot to improve ductility. Die lubrication is essential in cold drawing to achieve a good surface finish as well to maximize the life of the die.

In contrast to wire drawing, deep drawing is a sheet metal process where the material is stretched over a male form. This can be used to create complex three-dimensional shapes such as sinks or beverage cans. This is often carried out in progressive dies, where the metal workpiece is moved through a series of tools that gradually stretch the material to the required form. One design issue to be addressed in deep drawing is that as the metal stretches it also becomes thinner. Unless care is taken in engineering the way the metal deforms this can result in hole in the workpiece.

Both wire drawing and deep drawing involve stretching metal to the required shape, and as such are considered deformation rather than removal processes. A significant advantage of drawing is that there is very little material waste. However, this benefit has to be set against the high cost of the dies and the possible need to carry out annealing to counteract work hardening.

Wire drawing terms:

$$\text{Draft} = D_o - D_f$$

$$\%\ \text{reduction in area} = \frac{A_o - A_f}{A_f} \times 100 = \frac{D_o^2 - D_f^2}{D_f^2} \times 100$$

$$\%\ \text{elongation} = \frac{L_f - L_o}{L_o}$$

Where D_o, D_f , L_o and L_f are the original and final diameter and length. A_o and A_f are original and final cross sectional area.

For a single cold drawing pass, the percent area reduction that can be done depends upon many factors. These include the type of material, its size, initial metallurgical condition, the final size and mechanical properties desired, die design and lubrication efficiency. The percent of area reduction per pass can range from near zero to 50%.

Die pull

The force required to pull the stock through the die (under frictionless conditions) can be computed as follows.

$$F = Y_{avg} \cdot A_f \cdot \ln\left(\frac{A_o}{A_f}\right)$$

Where F = die pull, i.e. the force required to pull the stock through the die

Y_{avg} = average true stress of the material in the die gap

A_o , A_f = original and final areas of cross section of material.

Alternatively, the following expression can be used

$F = c\, s_t\, (A_o - A_f)$

where c is a constant whose value is in the range 1.5 to 3.0 depending upon the % area reduction, (lower value for higher % reduction), and s_t is tensile strength of material before drawing.

The pull force determines the machine capacity needed.

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