# WIRE DRAWING

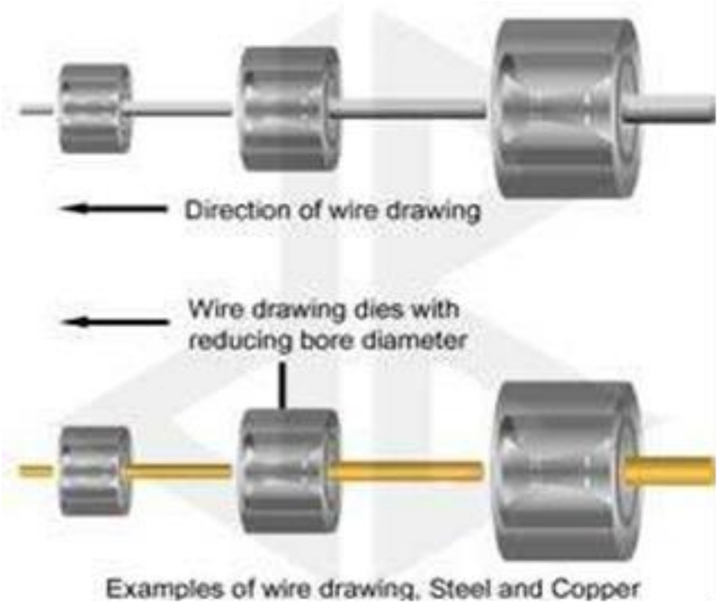
# Objectives

- • This chapter provides fundamental background on processes of drawing of rods, wires and tubes.

- • Mathematical approaches for the calculation of drawing load will be introduced.

- • Finally drawing defects occurring during the process will be highlighted and its solutions will be included.

# Introduction : wire drawing




• Wire drawing involves reducing the diameter of a rod or wire by passing through a series of drawing dies or plates.

• The subsequent drawing die must have smaller bore diameter than the previous drawing die.

# Introduction

• Drawing operations involve pulling metal through a die by means of a tensile force applied to the exit side of the die.

• The plastic flow is caused by compression force, arising from the reaction of the metal with the die.

• Starting materials: hot rolled stock (ferrous) and extruded (non- ferrous).

• Material should have high ductility and good tensile strength.

• Bar, wire and tube drawing are usually carried out at room temperature, except for large deformation, which leads to considerable rise in temperature during drawing.

• The metal usually has a circular symmetry (but not always, depending on requirements).

# Rod and wiredrawing

rod

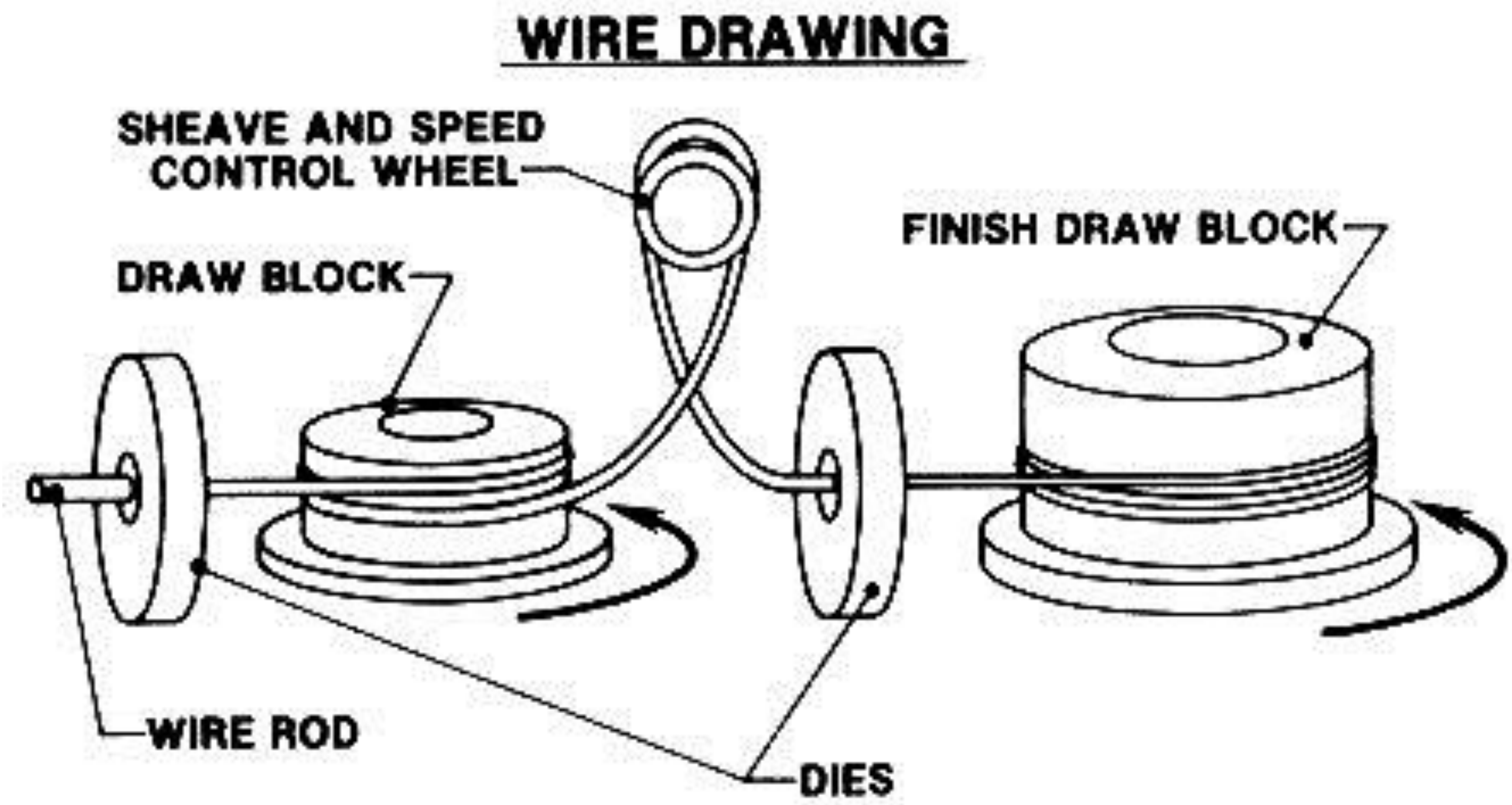
- • Reducing the diameter through plastic deformation while the volume remains the same.
- • Same principals for drawing bars, rods, and wire but equipment is different in sizes depending on products.

Rods relatively larger diameter products.

Wires small diameter products < 5 mm diameter.

wire

# WIRE DRAWING



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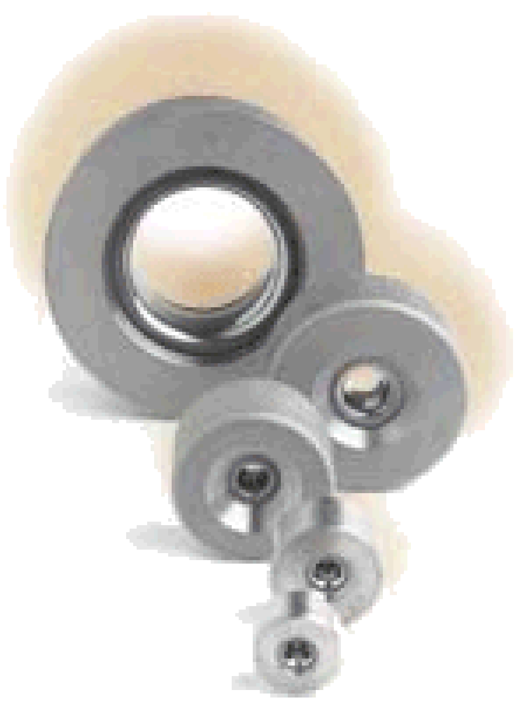
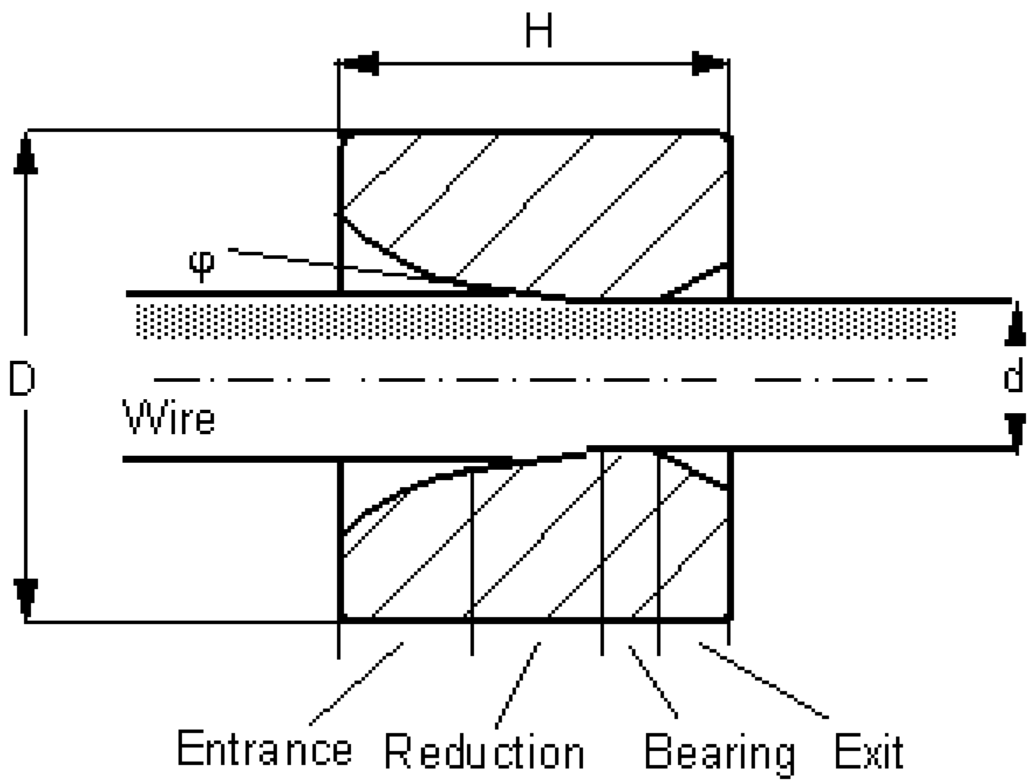
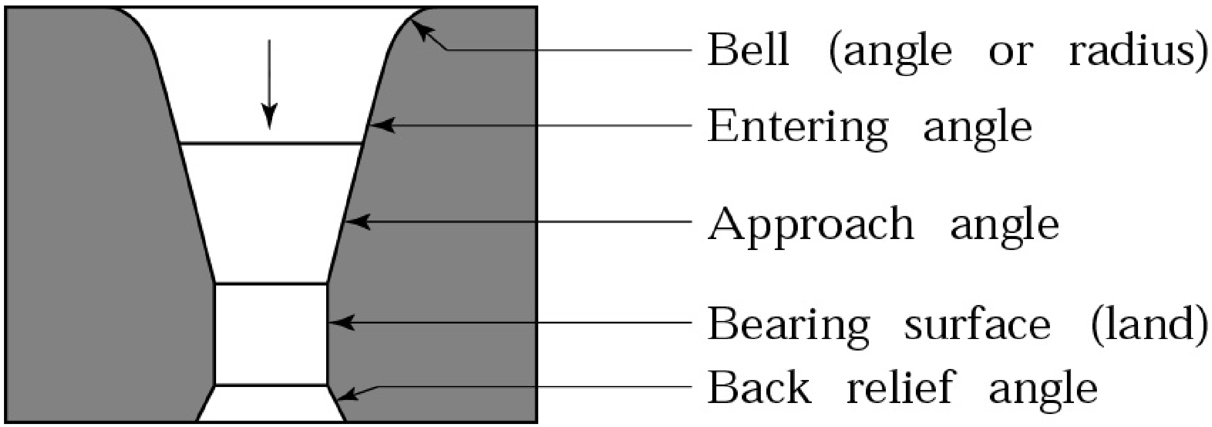


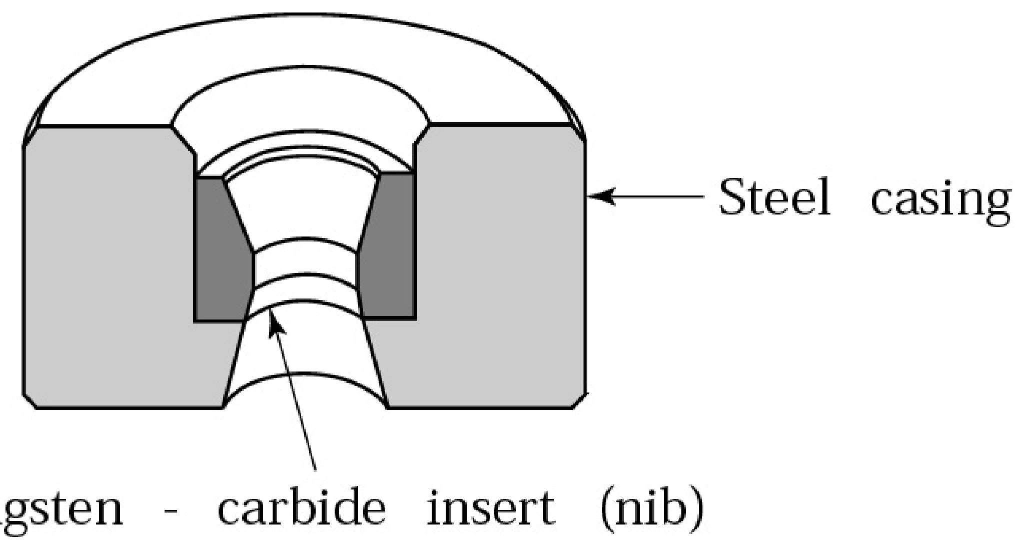


# Die for Round Drawing



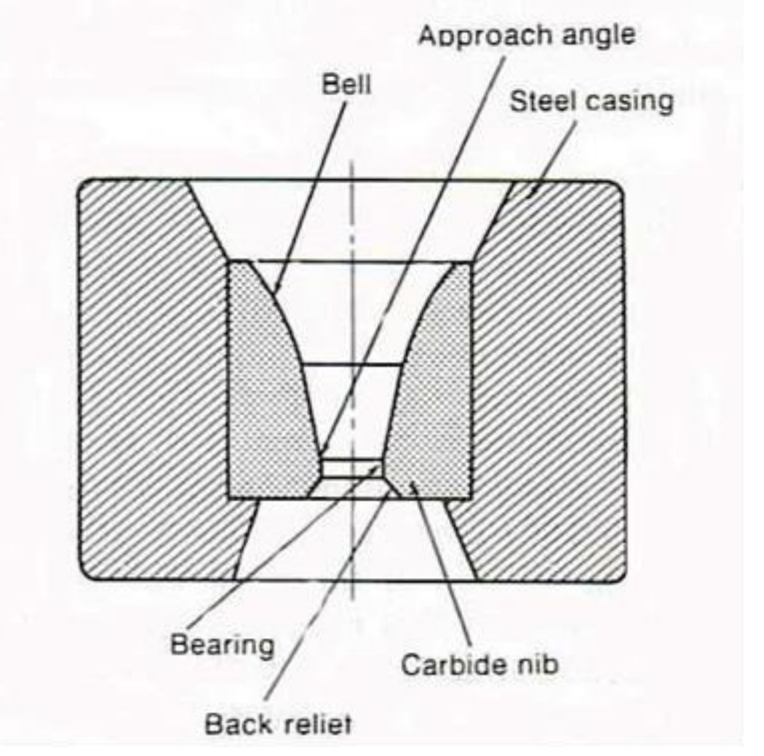

**Terminology of a typical die used for drawing round rod or wire.**

**Tungsten- carbide die insert in a steel casing. Diamond dies, used in drawing thin wire, are encased in a similar manner.**



# Wire drawing die

Conical drawing die




- Shape of the bell causes hydrostatic pressure to increase and promotes the flow of lubricant into the die.

- The approach angle – where the actual reduction in diameter occurs, giving the half die angle α

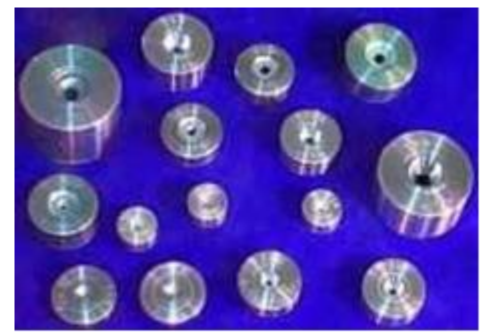
The bearing region produces a frictional drag on the wire and also remove surface damage due to die wear, without changing dimensions.

**The die nib** made from cemented carbide or diamond is encased for protection in a thick steel casing.

- The back relief allows the metal to expand slightly as the wire leaves the die and also minimizes abrasion if the drawing stops or the die is out of alignment.

# Die Materials Overview

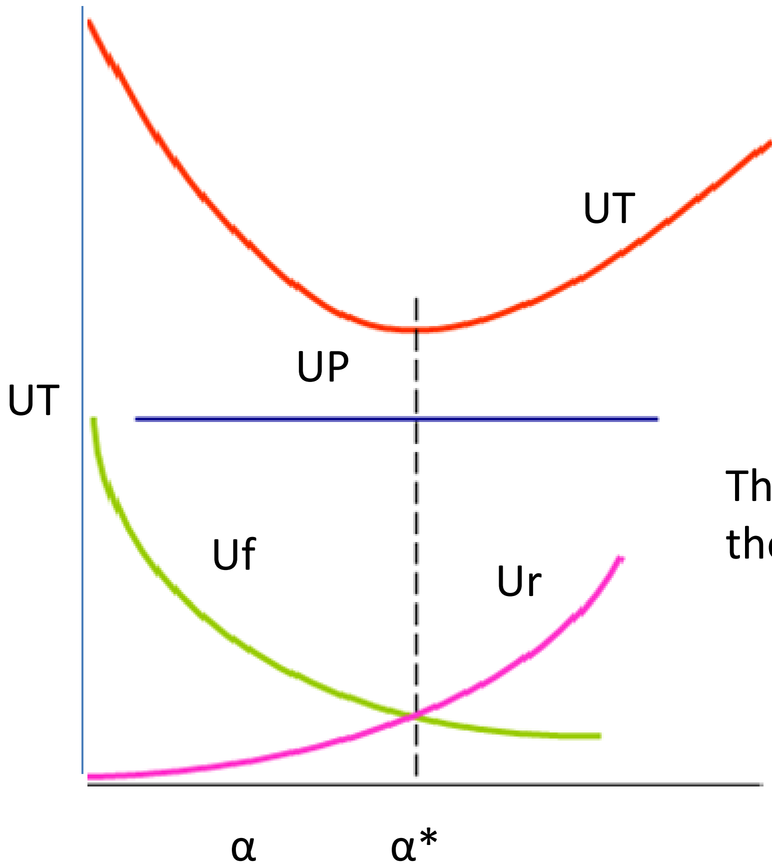
• Cemented carbides are the most widely used for drawing dies due to their superior strength, toughness, and wear resistance.



• Most drawing dies are cemented carbide or industrial diamond (for fine wires).
• Cemented carbide is composed of carbides of Ti, W, Ni, Mo, Ta,

• Polycrystalline Diamond (PCD) used for wire drawing dies – for fine wires. Longer die life, high resistance to wear, cracking or bearing.

# The effect of die angle on the total energy required to cause deformation




Ideal work of plastic deformation UP independent of die angle α.

α Work to overcome friction Uf

α Redundant work Ur

The summation of Up, Uf and Ur gives the total energy UT.

This has a minimum at some optimum die angle α*.

The reduction and the friction α*

# Wire drawing process

Hot rolled rod

Pickling, descaling — Remove scale -causing surface defects.

Lubricating →

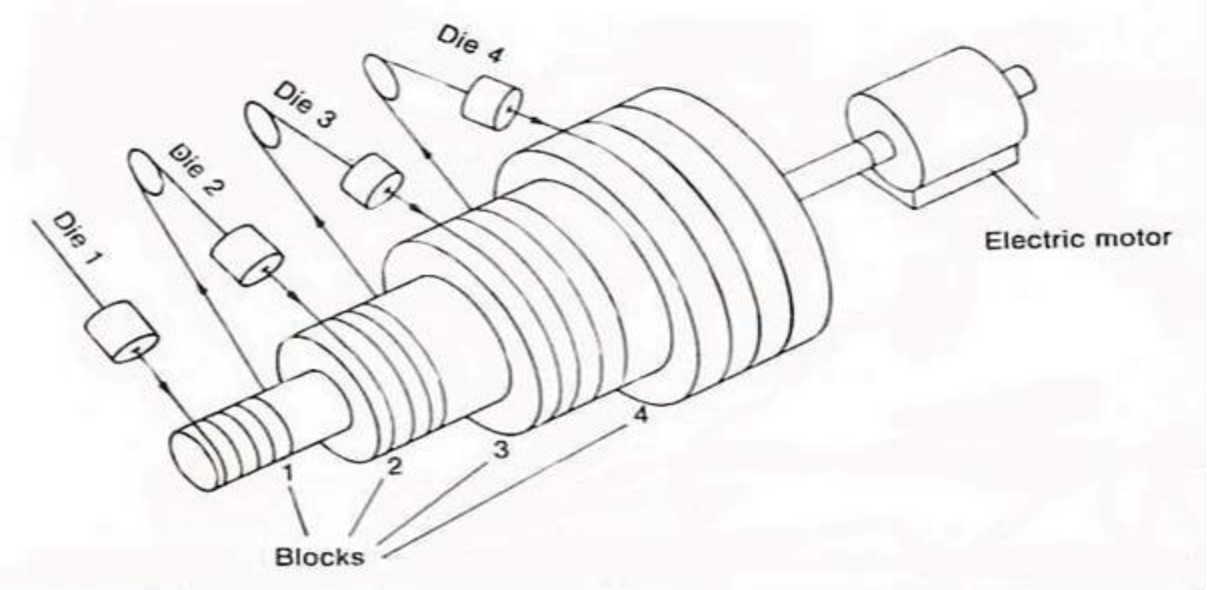
- Cu and Sn are used as lubricants for high strength materials. Or conversion coating such as sulphates or oxalates.

- Oils and greases for wire drawing
- Mulsifiable oils for wet wire drawing
- Soap for dry drawing.

drawing\

# Mechanical descaling

# Stepped-cone multiple-pass wiredrawing




- More economical design.
- Use a single electrical motor  to drive a series of stepped cones.
- The diameter of each cone is designed to produce a peripheral speed equivalent to a certain size reduction.

# Rod drawing

**Rods which can not be coiled, are produced on draw benches.**

**Rod is swaged**

↓

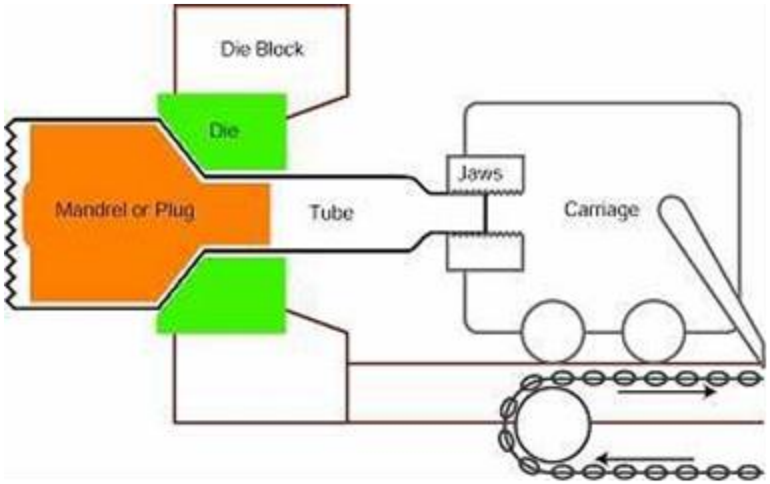
**Insert though the die**

↓

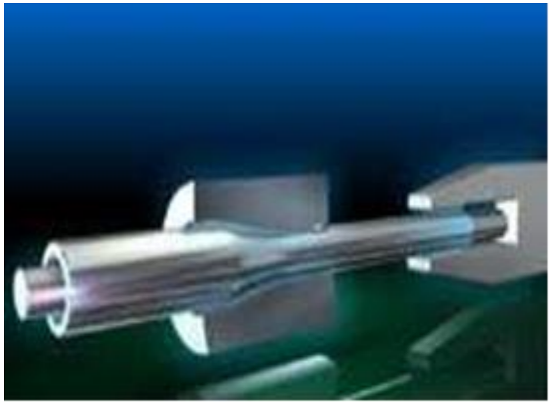
**Clamped to the jaws of the draw head**

↓

**The draw head is moved by a hydraulic mechanism**



# Classification of tube drawing processes

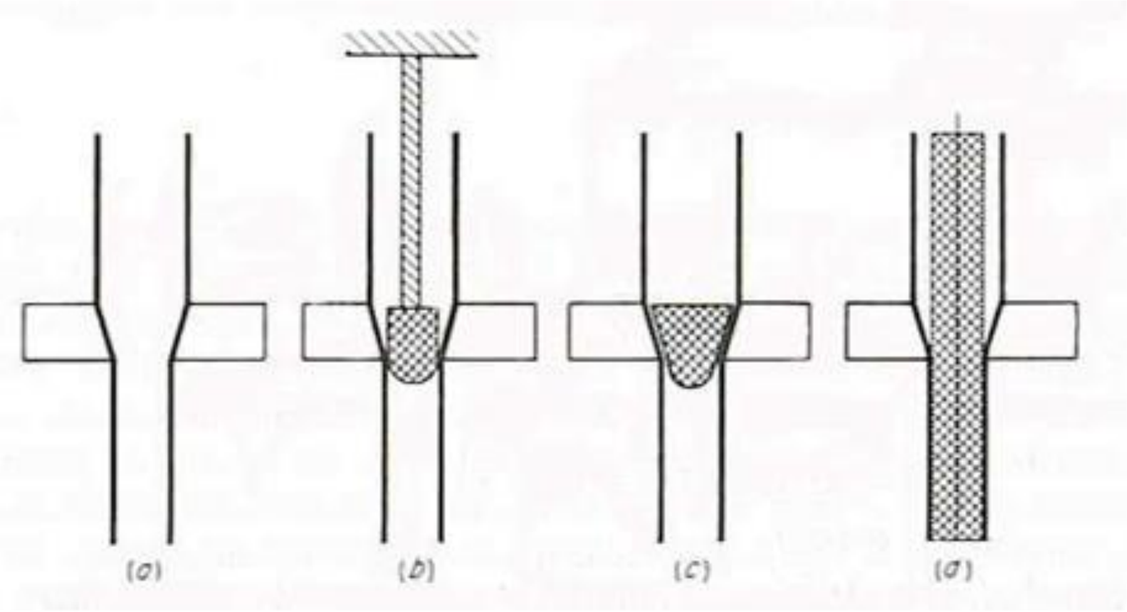


There are three basic types of tube-drawing processes

- Sinking
- Plug drawing

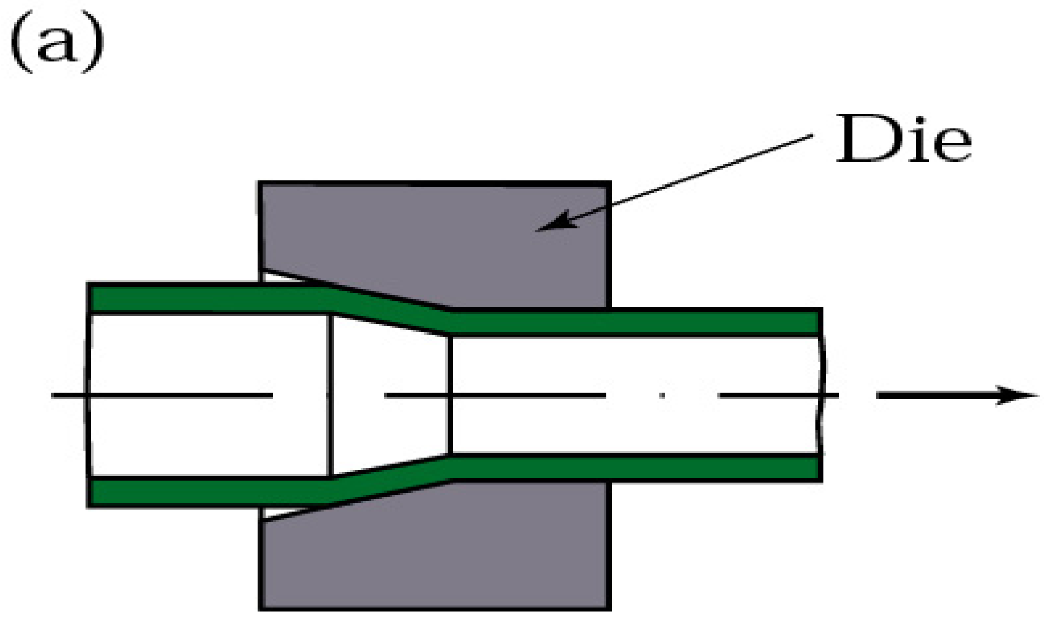
- Fixed plug
- Floating plug

- Mandrel drawing.




Tube sinking Fixed plug Floating plug Moving mandrel

# Sinking



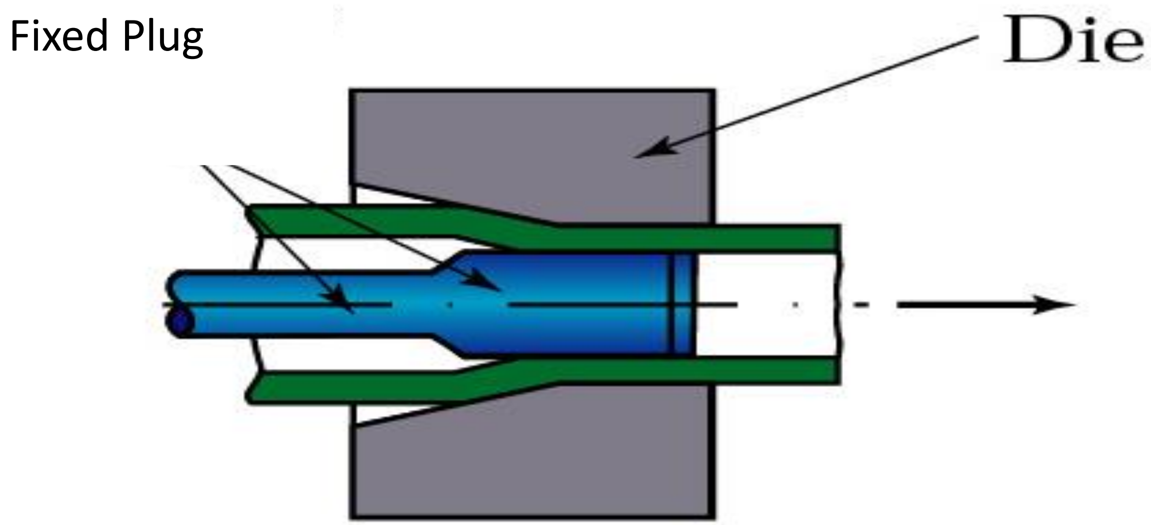

• The tube, while passing through the die, shrinks in outer radius from the original radius

• No internal tooling (internal wall is not supported), the wall then thicken slightly.

• The final thickness of the tube depends on original diameter of the tube, the die diameter and friction between tube and die.

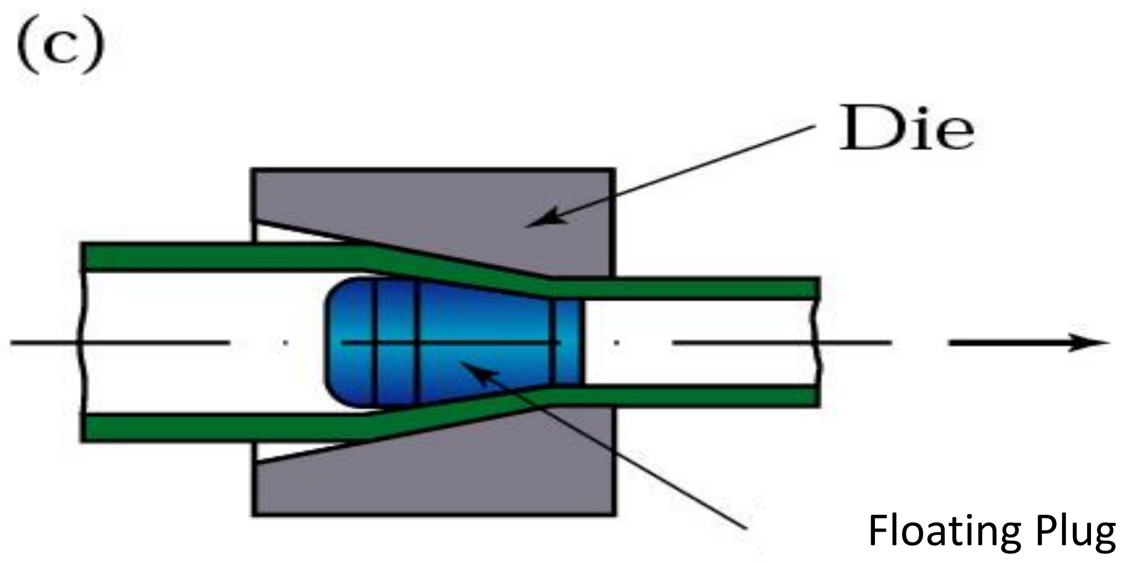
• Lower limiting deformation.

# Stationary plug




- Use conical plug to control size/shape of inside diameter.
- Use higher drawing loads than floating plug drawing.
- Greater dimensional accuracy than tube sinking.
- Increased friction from the plug limit the reduction in area (seldom > 30%).
- can draw and coil long lengths of tubing.

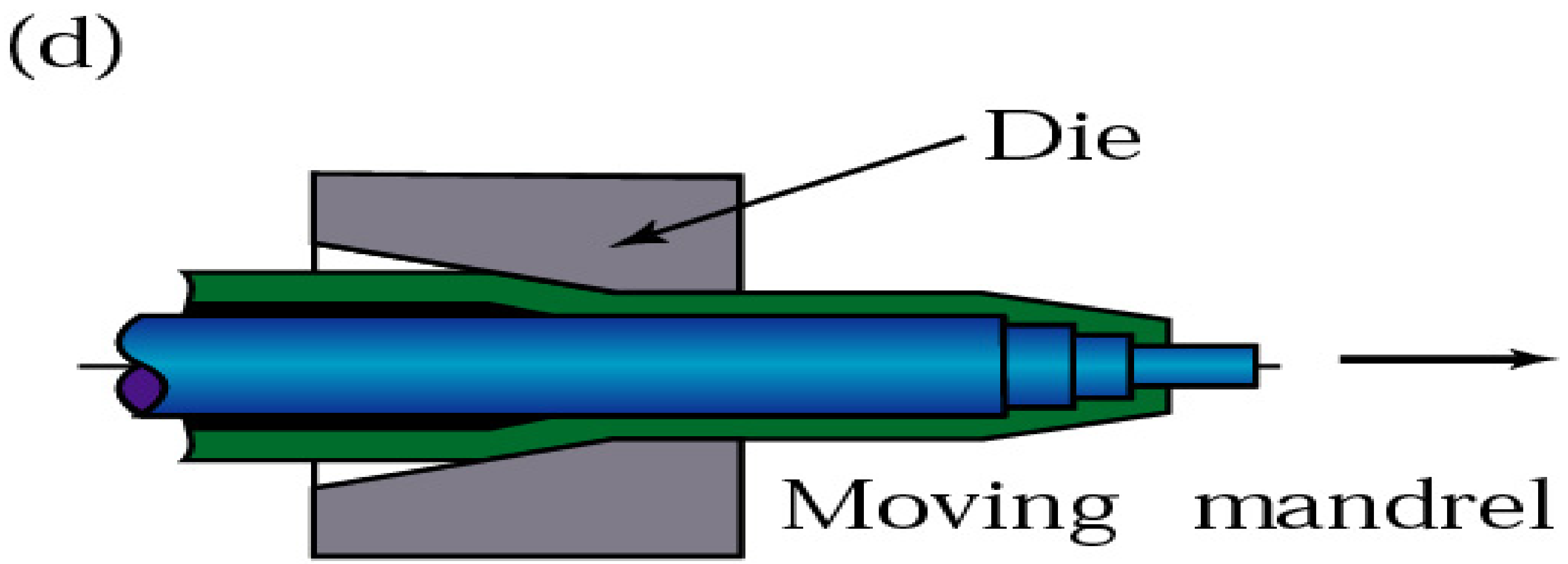
# Floating plug




A tapered plug is placed inside the tube.

- As the tube is drawn the plug and the die act together to reduce both the outside/inside diameters of the tube.
- Improved reduction in area than tube sinking (~ 45%).
- Lower drawing load than fixed plug drawing.
- Long lengths of tubing is possible.
- Tool design and lubrication can be very critical.

# Moving mandrel



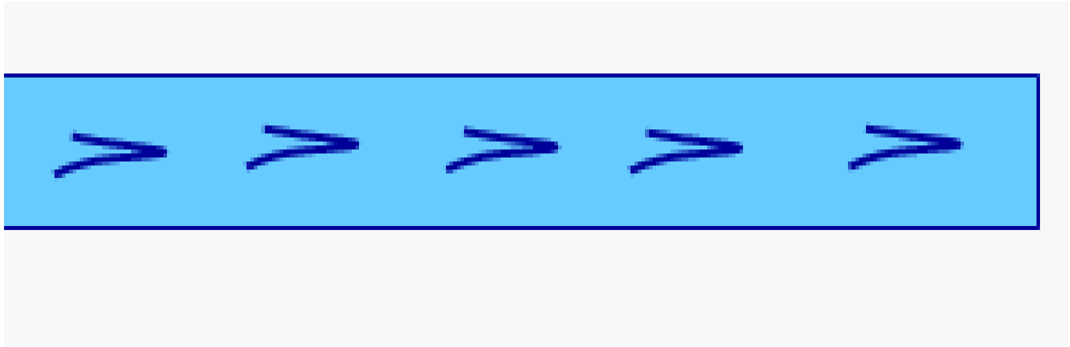

Draw force is transmitted to the metal by the pull on the exit section and by the friction forces acting along the tube -mandrel interface.

- minimized friction.
- V mandrel = V tube
- The mandrel also imparts a smooth inside finish surface of the tube.
- mandrel removal disturbs dimensional tolerance.

# Defects in rod and wiredrawing

Defects in the starting rod (seams, slivers and pipe).

Defects from the deformation process, i.e., center burst or cracking (cupping).



- This defect will occur for low die angles at low reductions.
- For a given reduction and die angle, the critical reduction to prevent fracture increases with the friction.