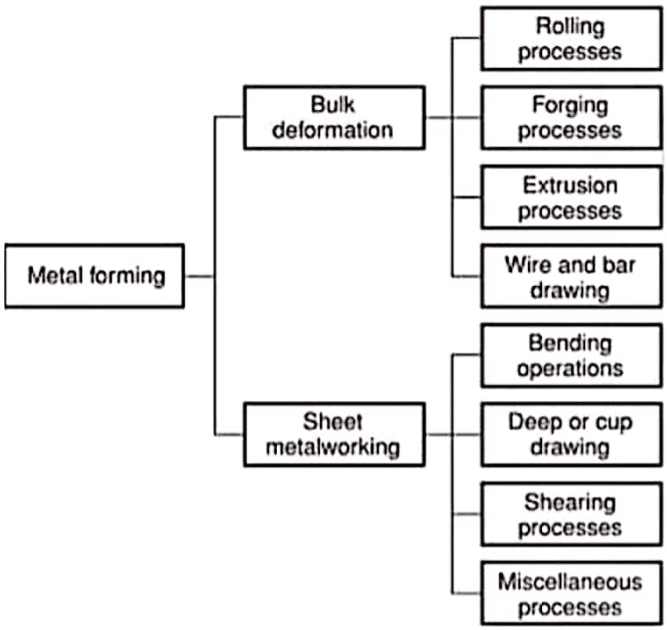
Metal Forming Processes

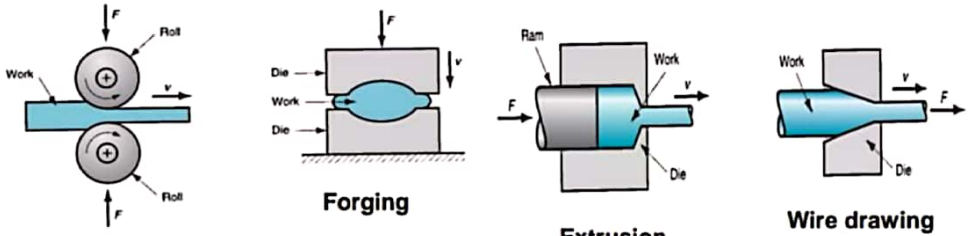
Metal forming processes, also known as mechanical working processes, are primary shaping processes in which a mass of metal or alloy is subjected to mechanical forces. Under the action of such forces, the shape and size of metal piece undergo a change. By mechanical working processes, the given shape and size of a machine part can be achieved with great economy in material and time.

Metal forming is possible in case of such metals or alloys which are sufficiently malleable and ductile. Mechanical working requires that the material may undergo "plastic deformation" during its processing. Frequently, work piece material is not sufficiently malleable or ductile at ordinary room temperature, but may become so when heated. Thus we have both hot and cold metal forming operations.

Classification of metal working process



Classification of basic bulk forming processes



Bulk forming: It is a severe deformation process resulting in massive shape change. The surface area-to-volume of the work is relatively small. Mostly done in hot working conditions.

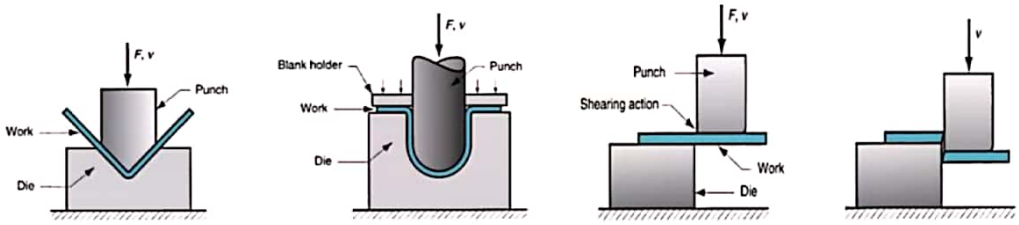
Rolling: In this process, the workpiece in the form of slab or plate is compressed between two rotating rolls in the thickness direction, so that the thickness is reduced. The rotating rolls draw the slab into the gap and compresses it. The final product is in the form of sheet.

Forging: The workpiece is compressed between two dies containing shaped contours. The die shapes are imparted into the final part.

Extrusion: In this, the workpiece is compressed or pushed into the die opening to take the shape of the die hole as its cross section.

Wire or rod drawing: similar to extrusion, except that the workpiece is pulled through the die opening to take the cross-section.

Classification of basic sheet forming processes



Bending **Deep drawing** **shearing**

Sheet forming: Sheet metal forming involves forming and cutting operations performed on metal sheets, strips, and coils. The surface area-to-volume ratio of the starting metal is relatively high. Tools include punch, die that are used to deform the sheets.

Bending: In this, the sheet material is strained by punch to give a bend shape (angle shape) usually in a straight axis.

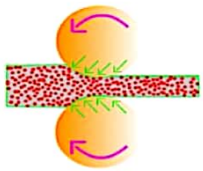
Deep (or cup) drawing: In this operation, forming of a flat metal sheet into a hollow or concave shape like a cup, is performed by stretching the metal in some regions. A blank-holder is used to clamp the blank on the die, while the punch pushes into the sheet metal. The sheet is drawn into the die hole taking the shape of the cavity.

Shearing: This is nothing but cutting of sheets by shearing action.

Hot Working Process

In hot working process, metals are plastically deformed at temperature above its recrystallization temperature but below its melting point. Generaly for pure metals recrystallization temperature is in the range of approximately 0.3 to 0.4 Tm and for alloys it is in the 0.5 Tm (Tm is the melting point). Being above the recrystallization temperature allows the material to recrystallize during deformation.

Some hot working processes are rolling, forging, extrusion and drawing etc.



Recrystallization

Recrystallization is a process by which deformed grains are replaced by a new set of defect-free grains.

Classification of hot working process

The classification of hot working processes is given below:

1. Hot rolling
2. Hot forging
3. Hot extrusion
4. Hot drawing
5. Hot spinning
6. Hot piercing or seamless tubing
7. Hot forming of welded pipes

Advantages

- Significant plastic deformation take places
- Significant change in workpiece shape
- Lesser forces are required for deformation
- Greater ductility of material is available, and therefore more deformation is possible
- Equipment of lesser power is needed

Disadvantages

- Poor surface finish of material due to scaling of surface
- Poor dimensional accuracy
- Heat energy is needed
- Handling and maintaining of hot metal is difficult
- Lower life of tooling and equipment.

Cold Working Process

Cold working is plastic deformation of metals below the recrystallization temperature and is generally performed at room temperature.

Some cold forming processes are rolling, extrusion, bending, drawing etc.

Advantages

- No heating is required
- Better surface finish and superior dimensional control are achieved.
- No materials loss
- Easier handling (low operating temperature)

Disadvantages

- Higher forces are required to initiate and complete the deformation
- Due to limited ductility at room temperature, production of complex shapes is not possible by cold working processes.
- Heavier and more powerful equipment are required

Classification of cold working process

The classification of cold working processes is given below:

Squeezing	***Bending***	***Shearing***	***Drawing***
Rolling	Angle	Shearing	Bar and tube drawing
Swaging	Roll	Slitting	Wire drawing
Cold forging	Roll forming	Blanking	Spinning
Sizing	Drawing	Piercing	Embossing
Extrusion	Seaming	Lancing	Stretch forming

Comparison between hot working and cold working process

Hot Working	Cold Working
Above recrystallization temperature	Below recrystallization temperature
Formation of new crystals	No formation of crystals
Surface finish is not good	Surface finish is good
Less force is required	More force is required
Heating is required	No heating is required
Handling and maintaining of hot metal is difficult	Handling and maintaining of metal is easy
Equipment of lesser power is needed	Heavier and more powerful equipment are required