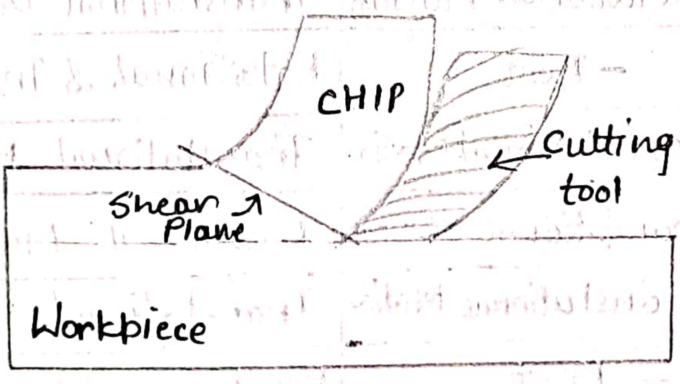
Tool Engineering

UNIT 1

Metal Cutting: It is a process of manufacturing a object of required shape and size by cutting or removing the material from a metallic workpiece in the form of chip with the help of a cutting tool.

- The machine on which metal cutting operation take place are called machine tool.
  Example; Lathe Machine, shaper, planer, drilling machine, Grinding machine, broaching machine.
- Tools which cut the material from work piece are called cutting tool.
- Metal cutting operation takes place by shearing action between tool and workpiece.
- There must be relative motion between tool and workpiece for metal cutting operation.



- Machining is a general term in which material removing.
- Metal cutting is a spacial kind of machining process in which metallic material removal process takes place.

Types of Manufacturing

- Zero Manufacturing:
  Example, All forming process like forging, extursion, Rolling, Drawing, Bending etc.
- Negative Manufacturing; (Metal Removing Process)
  Example, Metal cutting like Turning, Falling, Drilling etc.
- Positive Manufacturing; (Metal Adding Process)
  Example, All fabricating process like welding.
- Regenerative Manufacturing;
  Example, 3D Printing, In this manufacturing process there is a layer forming process take place.

Different Relative Motion Between Work piece and cutting tool:

Machine tool	Work piece	Tool Motion
Lathe	Rotational Motion	Translational Motion
Drilling	– Rest	Rotational & Translational both
Shaper	Translational Motion	Translational Motion
Milling	Translational Motion	Rotational Motion
Planer	Translational Motion	Translational Motion
Surface Grinding	– Rest	Rotational & Translational Both
Cylindrical Grinding	Rotational & Translational Both	Rotational Motion.

Independent & Dependent parameter in metal cutting;

Independent Parameter	Dependent Parameter
(i) Material of Tool and Workpiece.	(i) Power & Force
(ii) Tool Geometry	(ii) Temperature
(iii) Cutting Velocity	(iii) Surface Finish

Types of tool in metal cutting;

There are two types of cutting tool.

I. Single Point Cutting Tool;

If a single cutting edge of a tool engaged during cutting, then it is called single point cutting tool.

Example; Lathe tool, Shaper Tool, Planner tool, Boaring tool etc.

II. Multipoint cutting Tool;

If more than one cutting edge of a tool are engaged during metal cutting then it is called Multipoint cutting tool.

Example; Milling Cutter, Drilling Bits, Grinding Wheels, Broacher etc.

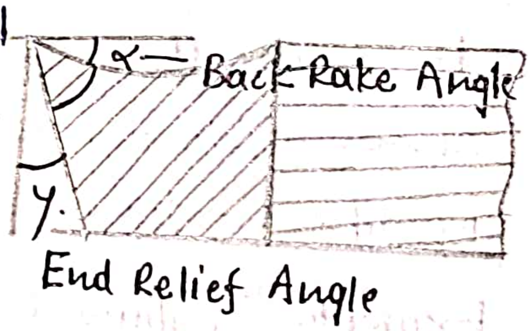
Shank - It is the main body of the tools also called tool holder.

Rake Face - It is the top surface of the tool on which chips flow.

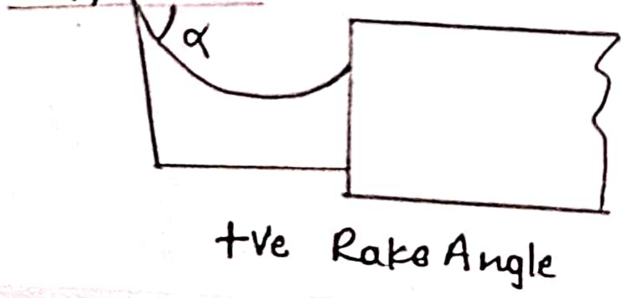
Flank - It is the surface adjustment below the cutting edge.

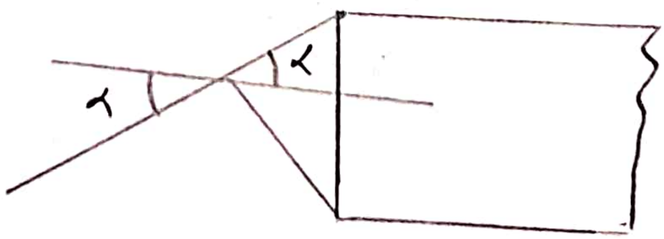
End Face - It is the surface adjustment below to the end cutting edge.

Back Rake Angle - Cut the tool with a plane perpendicular to the body, of the tool and parallel to length of the tool.



Rake surface inclined with an angle to the horizontal is called Rake angle.





Note ;

(i) Tool with negative rake angle is stronger than Tool with positive rake angle.

(ii) Chip easily flow on +ve rake angle than -ve rake angle tool.

(iii) To cut Harder material tool with negative rake angle is used.

(iv) In case of positive rake angle chips flow on the rake surface, easily as compared to negative rake angle.

(v) With the increases of positive rake tool life increases upto certain limit then decreases with increases of positive rake angle.

(vi) The range of positive rake angle lies between 8°-15°

End Relief Angle

It is the angle between vertical and end surface of the tool.

It is provided on the tool to maintain gap between finished part of the work piece and end surface of the tool.

Side Cutting Angle

It is the angle formed by the side cutting edge with a line parallel to the legth of the tool.

It is denoted by ϕ_s.

End cutting angle:

It is the angle between end cutting edge and a line parallel to width of the tool.

It is provided on the tool to insert the tool inside the workpiece.

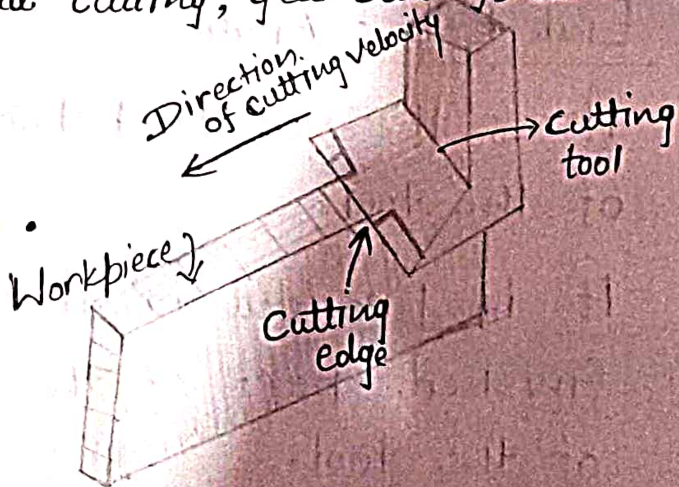
Lip Angle: It is the angle between rake surface and end flank of ~~tool~~.

- Lip ~~angle~~ angle signifies strength of tool. Higher is the lip angle more will be strength of the tool.

Zero Rake Angle:

Zero rake angle is used for machining of cast iron and Brass.

For all form cutting (thread cutting, gear cutting) uses zero rake angle.



Types Of Metal Cutting

There are two types of cutting.

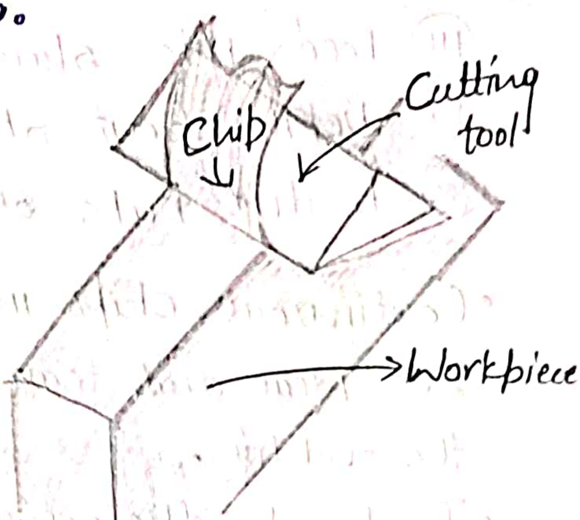
1. Orthogonal Cutting
2. Oblique cutting

Orthogonal Cutting:

- In orthogonal cutting velocity of cutting tool and cutting edge must be perpendicular to each other.
- Width of the workpiece should be greater than depth of cut and cutting edge should be extended either side of the workpiece

- Flow of chip on rake surface should be perpendicular to cutting edge.
- No. of forces involves in orthogonal cutting is two, so it is also called "2-D cutting".
- Shaping, planning slotting broaching are likely to orthogonal but not exactely orthogonal cutting.

~~Orthogonal~~ Oblique Cutting:



- ~~Orthogonal~~ oblique cutting is also called 3-D cutting, because of there three forces are involves.
- Cutting velocity and cutting edge of tool no any more at 90°
- This one is general form of metal cutting.
- Chips flow on rake surface at any angle of cutting edge of tool etc.
- Examples; Turning, Milling, Grinding etc.

CHIP FORMATION

Cutting of material by shearing action in the form chip is called chip formation.

There are four types of chip formation;

I Continuous chips

II Discontinuous chips

III Build-up chips

IV Serrated chips

Continuous Chip : The ribbon form of chip, without break-up is called continuous chip.

Condition for continuous chip;

(I) Metal of workpiece should be ductile.
(II) Cutting Velocity should be high.
(III) Feed rate should be small.
(IV) Depth of cut should be small.
(V) Positive rake surface of the tool.

- Continuous chips increases the friction on rake surface, so wear and tear are produced on tool, which reduces the tool life.
- To break the continuous chip, we provide chip breaker on the rake surface of the tool.
- Handling of continuous chip difficult.

Discontinuous Chips : Chips in segmented or of very smell are called discontinuous chip.

- It is easy to handle discontinuous chip
- Favourable condition for discontinuous chip formation
  (I) Workpiece material should be brittle.
  (II) Cutting speed should be low.
  (III) Depth of cutting should be high.
  (IV) Feed rate is low.
  (V) Rake surface should be negative.

Build-up Chips:

Continuous chip formation, at low cutting speed and high depth is termed as chip with build-up.

- When workpiece, welded to tool material at low cutting speed, is called build-up.
- Build up increases the tool life and power consumption of metal cutting.
- Metal cutting with build-up edge produces rough surface.

Serrated Chips:

This type of chip formed when a material of low thermal conducting is being cut.

- This type of chip has high localised print.
- In the cutting of titanium material is serrated form of chip.

Mechanics of Metal cutting:

Mechanics of metal cutting deals with the mechanism and parameter involves in the metal cutting.

- There are three fources involves in metal cutting.
  - Tangential / Cutting force (F_t)
  - Feed Force (F_d)
  - Radial Force or Thrust Force (F_r)

a) Tangential or cutting force (F_t)

It is the main force, responsible for metarial removal from work piece.

It has the maximum value out of three forces involve in metal cutting.

This is the force responsible for power ... cutting.

$$\boxed{(Power)_{consumed} = F_t \times V}$$

F_t = cutting force
V = Velocity of cut.

For turning

$$\boxed{\text{Cutting velocity } (V) = \frac{\pi D N}{60} \text{ m/sec}}$$

Where,
D - mean dia. of W/P
N - no. of revolution.

b) Feed Force (F_d) -

This is the force responsible for movement of tool along the workpiece to cut the different piece/parts of work piece.

The magnitude of this force is about 25% - 35% of main cutting force.

c) Radial or Thrust Force (F_r) -

This force is responsible for inserting the tool inside the workpiece.

The magnitude of this force is about 25% of feed force.

In case of higher thrust force, phenomenon of chattering occurs.

① Force involves in metal cutting are measured by "Force Dynamometer".

Shear Plane - Plane along which metal cuting take place by shear action is called shear plane.

Shear Angle - The angle through which the shear plane is inclined is called shear angle.

"Shear angle is one of the major parameter which decides, the power consumptions in metal cutting and thickness and width of chip formed."

If $\theta_2 > \theta_1$ W- width of chip.

then. $t_2 > t_1$

& $W_1 > W_2$

"When shear angle increases power consumption or force of cutting also increas & vice-versa."

Chip thickness ratio (cutting Ratio):

It is defined as the ratio of uncut chip thickness to the cut chip thickness.

∴ Chip thickness Ratio or cutting ratio,

$$\boxed{r = \frac{t_{uc}}{t_c}}$$

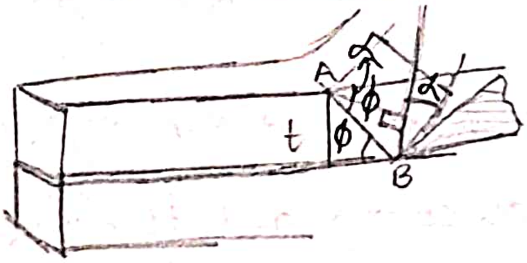
∵ $t_c > t_{uc}$ (Due to elasticity of material workpiece)

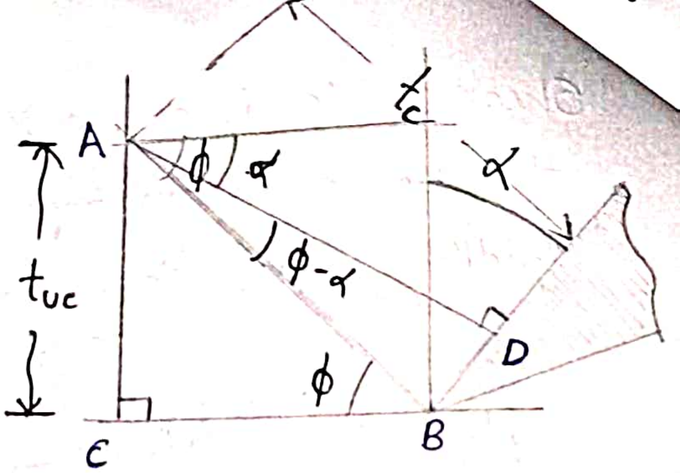
- Value of 'r' is always less than 1.
- In case of cast - Iron, $r \approx 1$.
- "The inverse of chip thickness ratio is called chip reduction ratio (h)." ∴ $\boxed{h = \frac{1}{r}}$; $\boxed{h > 1}$
- By applying conservation of material of chip formed,

ρ (Volume)uncut = ρ (Volume)cut

$W_{uc} \times t_{uc} \times L_{uc} = W_c \times t_c \times L_c$

$$∴ \boxed{\frac{t_{uc}}{t_c} = \frac{L_c}{L_{uc}} = r = \frac{V_c}{V_{uc}}}$$





In ΔABC,

$$\sin\phi = \frac{t_{uc}}{AB}$$

$$AB = \frac{t_{uc}}{\sin\phi} \quad - (1)$$

In ΔADB,

$$\cos(\phi-\alpha) = \frac{AD}{AB} = \frac{t_c}{AB}$$

$$AB = \frac{t_c}{\cos(\phi-\alpha)} \quad - (11)$$

$$\frac{t_{uc}}{\sin\phi} = \frac{t_c}{\cos(\phi-\alpha)}$$

$$\Rightarrow \frac{t_{uc}}{t_c} = \frac{\sin\phi}{\cos(\phi-\alpha)}$$

$$\Rightarrow r = \frac{\sin\phi}{\cos(\phi-\alpha)}$$

$$\Rightarrow r\,[\cos(\phi-\alpha)] = \sin\phi$$

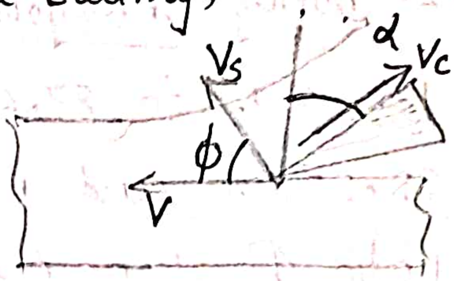
$$\Rightarrow r\cos\phi\cdot\cos\alpha + r\sin\phi\cdot\sin\alpha = \sin\phi$$

$$\Rightarrow r\cos\phi\cdot\cos\alpha = \sin\phi - r\sin\phi\cdot\sin\alpha$$

$$\Rightarrow r\cos\phi\cdot\cos\alpha = \sin\phi(1 - r\sin\alpha)$$

$$\Rightarrow \boxed{\frac{r\cos\alpha}{1-r\sin\alpha} = \tan\phi = \frac{\sin\phi}{\cos\phi}}$$

Different types of velocity in metal cutting;

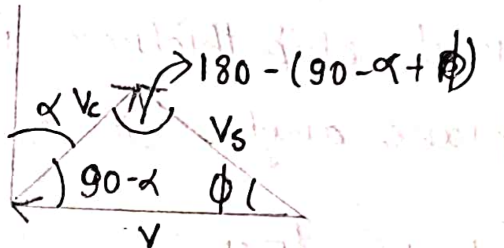


If V be cutting velocity of tool with respect to workpiece.

V_c = Chip velocity on rake surface of the tool with respect to tool.

V_s = Shear velocity with respect to workpiece.

By Sine rule,

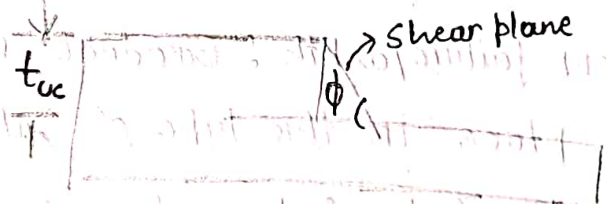


$$\frac{V}{\sin[90-(\phi-\alpha)]} = \frac{V_c}{\sin\phi} = \frac{V_s}{\sin(90-\alpha)}$$

$$\Rightarrow \boxed{\frac{V}{\cos(\phi-\alpha)} = \frac{V_c}{\sin\phi} = \frac{V_s}{\sin(90-\alpha)}}$$

$$\therefore \boxed{r = \frac{V_c}{V} = \frac{\sin\phi}{\cos(\phi-\alpha)}}$$

Shear Plane Area;



$$\because \sin\phi = \frac{t_{uc}}{AB}$$

$$AB = \frac{t}{\sin\phi}$$

$\Rightarrow$ **Area of shear plane = AB × Width of plane** $= \frac{t_{uc}}{\sin\phi} \times W$

$$\boxed{\text{Shear Strain} = \cot\phi + \tan(\phi - \alpha)}$$

Qn. 1. While doing orthogonal machineing of mild steel part a depth of cut of 0.75 mm is taken at 60 rpm, if chip thickness is 1.5 mm.

[live - 10 - TE]

Qu. 2. During orthogonal cutting of a bar of 90 mm diameter is reduced to 87.6 mm. If mean length of cut chip is 88.2 mm and rake angle is 15°. Calculate (i) cutting ratio (b) Shear Angle. [live - 10 - TE]

Qu. 3. During orthogonal cutting ~~of~~ with a tool having 12° rake angle, the chip thickness measured is 0.44 mm, the uncut chip thickness is 0.18 mm, Determine (i) Shear plane angle (ii) Shear strain. [live - 10 - TE]

Tool Wear / Failure:

The daviation from original geometory of tool and not peforming assigned work is called tool failure.

Type of tool failure;

(a) Slow failure/depth: Gradual removal or wear of tool is takes place in this type of failure.

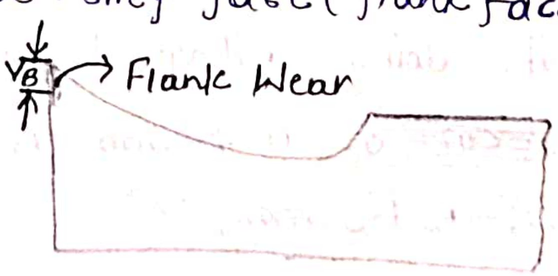
(b) Sudden failure: Premature is called sudden failure.

Type of Wear on tool;

There are three important type of Wear.

a). Flank Wear: It occure at the nose part, front relief face (end face) and side relief face (flank face).

It is denoted by V_B.



Reason behind Flank wear;

(I) Abrasion by hard particales with tool and inclusion in work piece.

(II) Shearing of micro welds between tool and workpiece.

(III) At higher cutting speed and material removal rate (MRR) flank wear predominates.

b) Crater Wear;

- Crater wear occures on rake surface of the tool.
- It is found in case of machining ductile material due to formation continuous chips.
- The main reason behind crator wear is high temperature due to high friction between chip and rake surface of the tool.

c) Chipping-off of the cutting edge;

Gradual removal of tool material from cutting edge is called chipping-off of cutting edge.

Reason behind cutting-off;

(I) Tool material is too brittle

(II) Weak design of tool like high positive rake angle.

Mechanism behind tool wear;

There are following type of mechanism involve in tool failure:

I Abrasion

II Adhesion

III Diffusion

IV Chemical or oxidation reaction

Abrasion: The loss of material due to interation of hard material to soft material is termed as abrasion.

- The mechanism invalved behind <u>Flank Wear</u> is "Abrasion".

Adhesion: The loss of material due to attraction of two particles of different material is taken as adhesion.

Diffusion: The flow of material from higher concentration to lower concentration is called diffusion.

- Diffusion proceeds faster at higher temperature.
- The mechanism invalved behind <u>crator wear</u> is "Diffusion".

Chemical Reaction:

Tool material may be affected or even change their property by chemically interacting with the surrounding of material cutting.

Tool Life

A tool life can be expressed in various following ways;

(a) Actual cutting time to failure
(b) Volume of material removal
(c) Number of parts produced
(d) Cutting speed for a given number
(e) length of workpiece machined.

TAYLOR's tool life equation;

It is based on Flank Wear,

Equation $VT^n = C$

Where, V - Cutting speed (m/min)
T - Time (min)
n - exponent depend on tool material
C - Constant based tool

• Value of 'n' (exponent) for different tool materials;

$n = 0.08 - 0.2$ [High speed steel tool]

$n = 0.1 - 0.15$ [Cast alloy]

$n = 0.2 - 0.4$ [Carbide tool]

$n = 0.4 - 0.7$ [Ceramics tool]

Qn. 4. In taylors tool life eqn $VT^n = C$ what is the Value of 'n' for ceramics tool.

(a) 0.15 - 0.5 (b) 0.4 - 0.55 (c) 0.6 - 0.75 (d) 0.8 - 0.9

Qn 5. In an orthogonal machining operation the tool life obtained is 10 min, at a cutting speed 100 m/min, While at 75 m/min for tool life is 30 min. Find the Value of 'n' in taylor's tool life equation. [live - 12 - TE]

Qn. 6. In a tool life test, doubling the cutting speed reduce the tool life 1/8 th of the original. The taylor's tool life index is ? [live - 13 - TE]

Qn. 7. In a single point turning operation of still with carbide tool, Taylor's tool life exponent is 0.25. if the cutting velocity is half, the tool life is increased by

(a) Two times (b) Four times (c) Eight times (d) Sixteen times

Qn. 8. A 50 mm diameter steal rod was turned as 284 rpm and tool failure occured in 10 min. Find the Value of constant (c) in taylor's tool life equation.

[live - 13 - TE].

Cutting Fluid ;

Cutting fluid used in metal cutting primarily for cool or remove heat from cutting zone.

Functions of cutting fluid ;

(i) It is used to remove the heat or cool the cutting zone.

(ii) It lubricate the surface between tool, workpiece or chips.

(iii) It can also be use for lubrication of moving parts of machine tool.

(iv) It helps to remove the chip from cutting zone.

(v) It also helps to improve the surface finish of finish product.

(vi) It help to prevent the formation of build-up edge.

Required properties of cutting fluid :

(i) A cutting fluid must have high thermal conductivity or high heat removal capacity.

(ii) It should have low viscosity for proper lubrication.

(iii) It should have high temperature of vapourasition.

(iv) It should be non hazardous and non reactive to the material of workpiece and tool.

(v) It should be transpararant for the operator of metal cutting.

TYPE OF CUTTING FLUID

Generally there are three type of cutting fluid;

I Straight Oil/Neat oil :

- The mineral oil directly used as cutting fluid are called straight or neat oil.
- These oils are not frequently used directly.
- Neat oil or straight oil have high viscosity.

II Water Miscible Oil :

- Some oil are soluble in water and form water miscible oil as cutting fluid.
- 90-95% cutting fluid is used as water miscible oil.
- Water miscible oil take all advantage of water and reduces the change of rusting.

III Synthetic oil :

The oil which are not mineral oil but used as cutting fluid are called synthetic oil.

- This type of oil has negligible used in metal cutting

Note;

- Kerosene oil is used as cutting fluid in case of machining of Aluminium.
- Dry air is used as cutting fluid for cast iron machining.

UNIT-2

Tool Material;

- Success of metal cutting depends on selection of tool material and geometry.
- There are wide varieties of tool material;
  1. High carbon steel / Medium alloy steel
  2. High speed steel
  3. Cast cobalt alloy
  4. Cemented carbide
  5. Coated carbide
  6. Coated High speed steel
  7. Ceramics
  8. Whisker reinforce ceramics
  9. Sailons
  10. CBN - Cubic Boron Nitride
  11. Natural diamond, Sintered polycrystalline diamond.

High Carbon Steel;

- It has limited tool life so not suitable for mass production.
- It has low cost.
- High carbon steel tool suited for Hand tool and wood working.
- It can be used for a maximum cutting speed at 8m/sec and upto a temperature 250°c.

High Speed Steel :

- These steel are used at much higher cutting speed (30 m/sec) then High carbon steel tool.
- It has better hot hardness than High carbon steel tool.
- Most of High speed steel contains Tungsten (W) as major element, other than this molybdenum (M.), chromium (Cr), Vanadium (Vd) ~~increases~~ and cobalt (Co) may also be present.
- Addition of large amount of cobalt (Co), Vanadium (V) increases hot hardness and wear resistance respectively.
- It is manufactured by powder metallurgy.

Different types of HSS ;

a) 18-4-1 HSS -

This High speed steel contains, 18% Tungsten (W), 4% Chromium (Cr) and 1% Vanadium (V).

- It is considerd to one of the best steel cutting tool.
- It is widely used in drill beat, lathe, planer, shaper, milling cutter, reamer, threading dies etc.

b) Molybdenum HSS -

It contain 6% of Molybdenum, 6% Tungsten ; 4% chromium and 2% Vanadium.

- It has almost same properties as 18-4-1 HSS but cost is less.

Super HSS ;

This is also called cobalt HSS :

- In this type of HSS 2-15% cobalt (Co) added to increase cutting efficiency at Higher temperature.
- Cobalt increases the hot hardness property of HSS.
- It contain 20% of Tungsten, 4% of chromium, 2% of Vanadium, 12% of cobalt.

Qn. 9. Vanadium in HSS

(a) Has a tendency to promote decarburization.
(b) Form very hard carbides and increase wear resistance.
(c) Help in acheive Hot Hardness
(d) None

Qn 10. The correct sequence of 18-4-1 HSS is

(a) W, Cr, V (b) Mo, Cr, V (c) Cr, Ni, C (d) Cu, Zn, Sn.

Qn. 11. The blade power saw ~~used~~ is made of

(a) Boron Steel (b) HSS (c) Stainless steel (d) Malleable Cast-Iron

Qn. 12. In an orthogonal machining of MS bar of 25 mm dia. on a lathe, depth of cut 0.2 mm and chips of 1.4 mm of thickness is removal at a rotational speed of 15 rpm with 10° rake angle. find,

(I) chip thickness ratio (r)
(II) Chip redⁿ ratio (h)
(III) length of chip removal in one minute
(IV) Shear angle. [live-16-TE]

Cast Cobalt Alloy / Stellite :-

- It is an non-ferrous tool material.
- It is alloy of cobalt.
- A part from cobalt, there is chromium, tungstan and carbon in the stellite.
- Cobalt alloy (stellite) is generally used in grinding.
- Cast cobalt alloy / stellite is currently not being used due to increasing cost and shortage of alloying element.

Qn. 13. Stellite is a non-ferrous cast alloy composed of

a) Cobalt, chromium, tungstun b) Tungstun, Vanadium, chromium

c) Molybdenum, Tungstun, chromium d) Non.

Cemented Carbides ;

- It is called cemented, because it is manufactured by powder metallurgy.
- It is also a non ferrous tool material.
- Most tool are used Tungstun, Carbaide, tool materials.
- In tungston carbide tool production, cobalt is used as binder.
- Apart from tungston carbide, titanium carbide is used in autobile industry metal cutting tool.
- In tungustun carbide, Molybdenum or nickel is used as binder.
- Cemented carbide tools are available in insert form in many shapes like square, triangle, hexagonal etc.
- Carbide tool are hard brittle.
- Carbide tool always provide -ve, tool rake angle.
- body or shank (tool holder) of carbide tool are made up of Hss.
- This tool are generally used for cutting hard material.

Ceramics :

- Ceramics are basically alumina (Al_2O_3)
- It is hard, brittle and can resist at high temperature
- It has very high hot hardness.
- It is used for cutting at very high speed which is close to 600 m/min.
- Ceramics tool can produce mirror like surface of cutting at cast iron.
- Ceramics material is too brittle to bear Impact load and it has low capacity of resistance against thermal shock, so it has low strength for impact load.
- It cannot be used for intermittent machineing but used for continuous machining at high cutting speed.

Ceramics classification ;

1 Oxides based ceramics

- Al_2O_3 (Alumina)
- Sailon (Si; Al oxide)
- Whisker toughned

2 Nitride based ceramics

- Zi corium
- Sic Whisker.

Cermets ; It is a mixture of hard particles ceramics and ductlile Metal like Ni and cobalt (Co).

Dimond ;

- Dimond is hardest material available in nature.
- It has low thermal expansion coefficient.
- It has high thermal conductivity.
- Diamond has very low coefficient of friction.
- A layer of diamond is provided on different tool material to form the diamond cutting tool.
- Diamond is used to cut the non-ferrous material. ie Cu, Al etc

- On ferrous material diamond is not suitable for diffusion of carbon from diamond to workpiece material.
- In generally diamond tool is used with positive rake angle.
- Oxidation of diamond start at temperature more than 450°c and that is the reason why diamond is flooded with cutting fluid ~~material~~ while machining. And speed 1000m/min.

CBN - Cubic Boron Nitride;

- Next to diamond, cubic boron nitride is the hardest material available.
- It is made by bonding a 0.5-1mm layer of CBN on cobolt base material.
- It has high toughness and hot hardness.
- It can be used for any material.
- It has only disadvantage, that has being to costly.

Coronite;

- It is basically a combination of HSS for strength & toughnes and Tungstun Carbide (WC) for hardness and wear resistance.

Machinability Index or machinability rating;
It is defined as the ratio of maximum velocity of cutting while machining of target material for a fixed tool life to the maximum velocity of cutting while machining of referance material, for that fixed tool.

i.e. Machinability Index (M) is given by

$$M = \frac{(V_t)_{60\,min}}{(V_r)_{60\,min}}$$

$V = \pi DN$

Where,

V_t - Max^M Velocity of cutting of target material for 60 Min. tool life.

V_r - Max^M Velocity of cutting of reference materal for 60 min. tool life.

Free cutting steel

By addition of lead (Pb) and phosphorous (P) reduces the shear strength of the steel and hence improve the machinability the steel which is called free cutting steel.

- lead reduces shear strength of steel by dispersing inside the steel as solid particle
- larger the grain size better will be machinability and vice-versa.

Heigh Surface Roughness;

$$h_{max} = \frac{f^2}{8R}$$

Where,

h_{max} - Height surface roughness

f - feed (mm/min or mm/rpm)

R - Nose radius,

Machinability: Machinability is related to material of workpiece (Job/Work) which are going to be machined.

- Machinability of material of workpiece is defined as the ease with which workpiece can be machined.
- In other words, machinability of material of Workpiece is defined as the ability of material being machined.

Machinability of material can be judge by;

- Tool Wear or Tool Life;
  If while machining of material of workpiece tool wear is less or tool life is more then machinability of material is better and vice-versa.
- Cutting Force or cutting Power;
  If cutting force required is large for machining then machinability is poor and vice-versa.
- Surface Finish; If surface finish of machined product is good then it indicate better machinability of material of workpiece and vice-versa.
- Magnitude of cutting temperature; If temperature during machining is found higher then machinability of material is poor and vice-versa.
- Chips Formation; Discontinuous chips formation while machining indicates better machinability of material of workpiece than that of Continuous chips.
- Hence in generlly briller materials has good machinobility than ductile materials.
- Cast-Iron (brittle material) has better machinability than Steel (ductile material).

Required Charateristics of tool materials;

Following are the important characteristics of tool materials;

ⓐ Tool material should be harder than the material of workpiece.

ⓑ Tool have good strength and able or withstand impact load that is, it should have toughness.

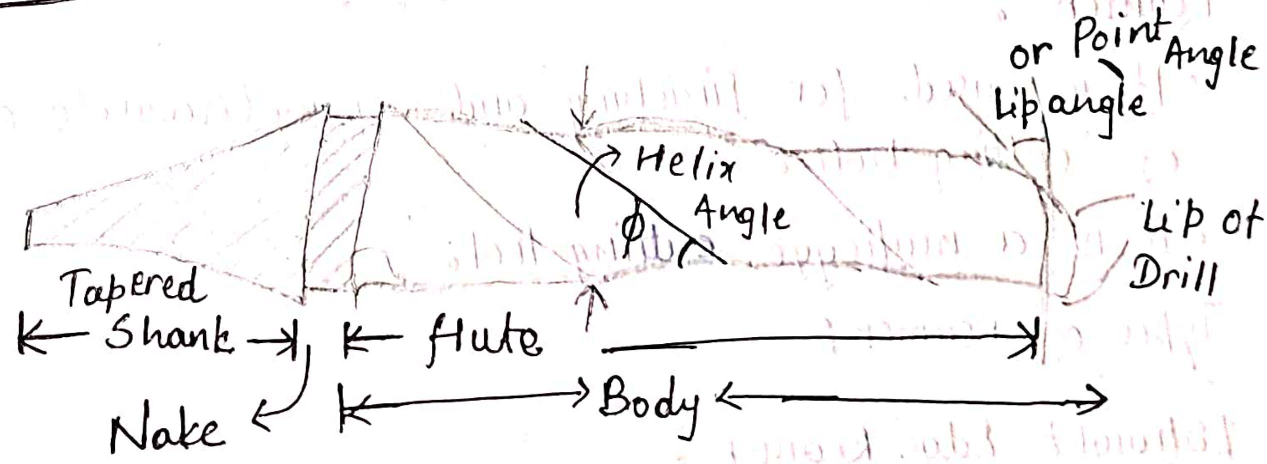
ⓒ Co-efficient of friction between workpiece and tool material shoud be less.

ⓓ Tool material have good surface wear resistance.

ⓔ Cost of tool should be low and fabrication tool should be easy.

ⓕ At elevated temperature properties of tool material should be stable, that is it has hotta hardness property.

Drill Bits;



- It is multipoint cutting tool (two cutting edge).
- It is used make (form) holes.

~~Milling Cutter~~;

Types of drill bits :

Slow spiral drills :

- It has the range of $12^\circ < \phi < 22^\circ$
- It is used to making holes of materials that produces discontinuous chips.
- This type of drill bits used for making "Through Holes".

Regular Spiral Drills :

- It has range of $28^\circ < \phi < 32^\circ$
- It is widely used type of drill bits.

High spiral Drills

- It has the range of $34^\circ < \phi < 38^\circ$
- It is used for ductile material that produces contineous chip.
- It has high chips lifting power in "Blind Holes".

Reamer :

- It is used for finishing and sizing (Accurate dimension) of cutting hole.
- It is a mutiegge cutting tool.

Types of reamer;

1 Straight Edge Reamer :

- It is used in Sizing and finishing of through Holes.

2. Left haug spriral Reamer :

- This is used for through holes cutting in ductile material.
- It hass less lifting power.

Primary Heat Treatment :

In this stage of heat treatment, material is heated to a different stable state level. Like "Steel is heated in Austenite state."

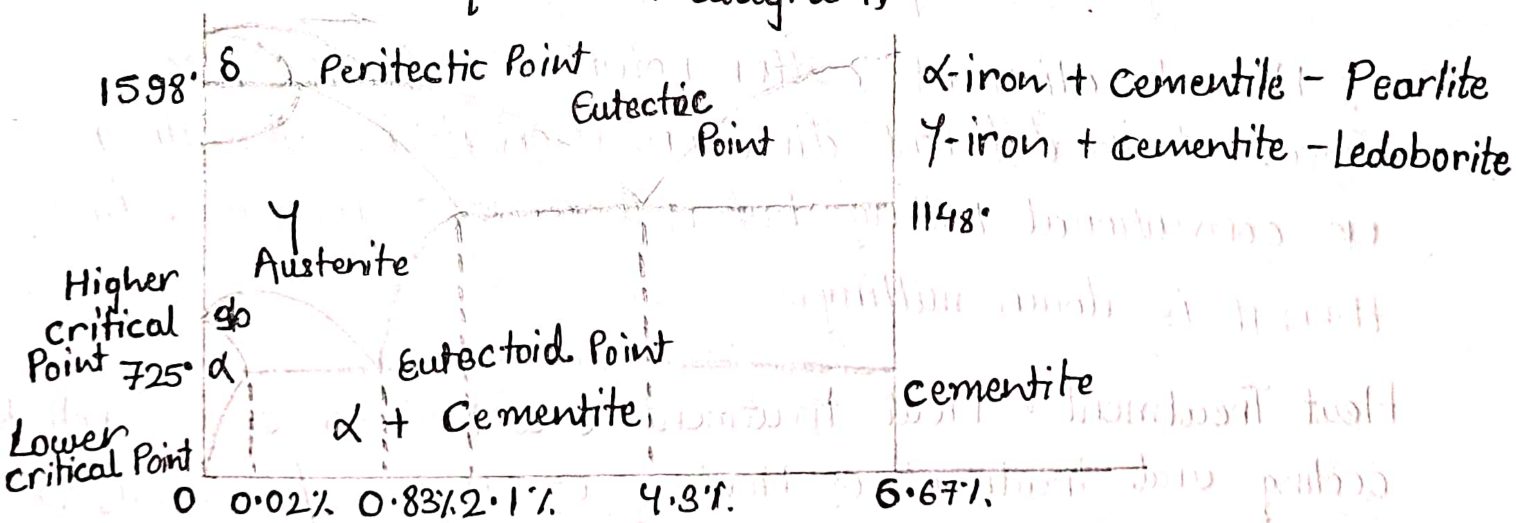
Secondary Heat Treatment :

In this stage of Heat treatment, control cooling of the material takes place to get the different microstructure (Bainite, Martensite etc) with different mechanical properties.

Tertiary Heat Treatment :

To get the homogeneous mechanical properties in the material, tertiary heat treatment takes place. like;
Anealing, Normalising, Tempering, Martemp, Austempering etc.

- Iron carbon equilibrium diagram;



Pure form of Iron - Wrought Iron (less then 0.00008%)

α- Iron or ferrite - 0.02%

Dead steel - 0.02% - 0.1%

low carbon/mild steel - 0.1% - 0.3%

Medium carbor steel - 0.3% - 0.6%

High carbon steel - 0.7% - 2.1%

Cast iron - 2.1% - 4.3%

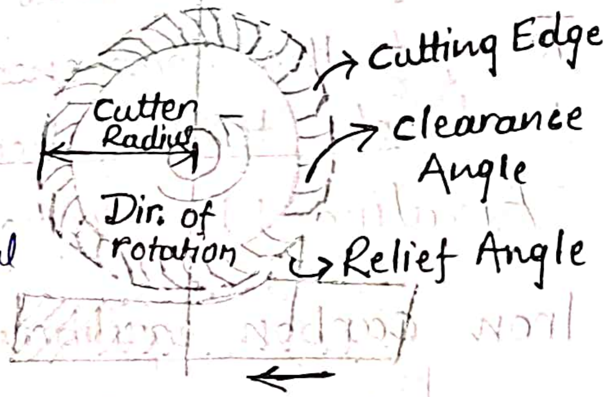
Pig iron - 4.3% - 6.67%

Righ Hand Reamer:

- It has high lifting power.
- It is used for cutting blind holes in ductile material that produces continuous chips.

Milling Cutter

- Milling cutter is a multipoint cutting tool used in milling machine.
- The component on which milling cutter material is mounted is called Knee.
- Milling Cutter;



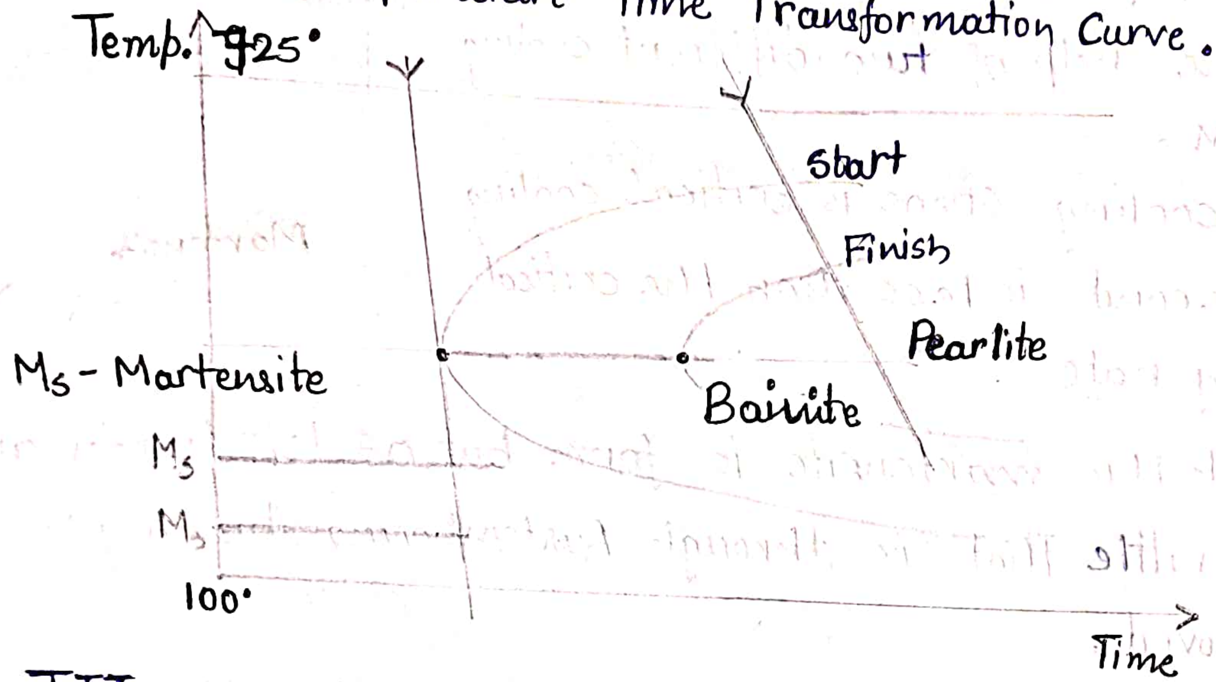
- In milling cutter positive axial rake angle and negative radial rake angle is widly used.
- If the direction of cutter rotation and workpiece movement in different direction, then it is up milling or conventional Milling, but if both are in same direction then it is down milling.

Heat Treatment: Heat treatment is a process of controlled cooling and treatment of Heating of substance/materials to change or improve the mechanical property of the substance or material.

- Mechanical property include, strength, Hardness, toughness ductility, britlleness, Elasticity etc.
- There are three stages of Heat treatment of material;
  - I Primary Heat Treatment
  - II Secondary Heat Treatment
  - III Tertiary Heat Treatment.

TTT curve or S-curve or C-curve :

TTT - Temperature Time Transformation Curve.



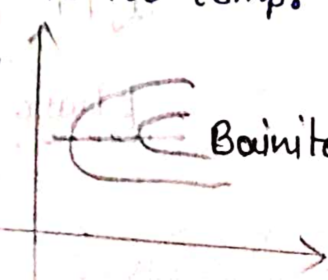
- TTT curve is drawn by heating a eutectoide composition (0.83% c) above the lower critical temperature that is in austenite range.
- By cooling at slow rate, particle/pearlite of coarse grain size is obtained.
- At the rate of critical cooling rate, martensite is formed.

Martensite

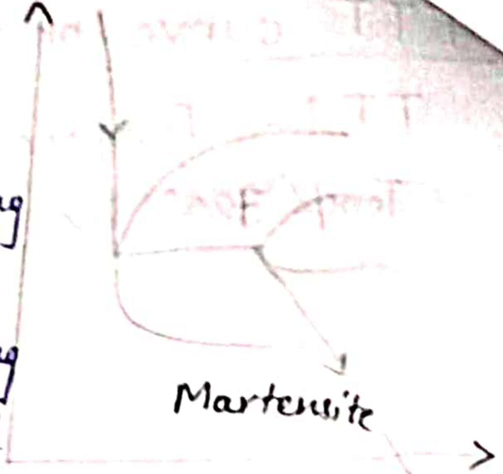
- It is the hardest phase of Iron.
- It is most brittle form of Iron.
- It has BCT (Body centered Tetragonal) crystal structure.
- It start to form at 200°c and finishes at 100°
- This phase of iron is only obtained in TTT diagram.

Austempering

- Austempering is a process in which at austenite temp. this process is act and Bainite is formed.
- Bainite has fine grain structure.
- It is not brittle like Martensite.
- Bainite is harden and brittle than pearlite



Martempering;



- It is the process two state cooling with the help of two different cooling medium.
- First cooling stage is critical cooling and second is less than the critical cooling rate
- Through this martensite is form but of less harder and less brittle that is through Austempering ductility is improved.

Anealing : It is a processes of Heat treatment in which a specimen is heated in a furnace and left inside the furnace to cool.

Due to Anealing following mechanical properties are achieved;

(i) Hardness of specimen is reduce.
(ii) Machinability is improve.
(iii) Ductility of the specimen is improved.
(iv) Internal stresses releaved.
(v) Grain size is improved, becomes spherical.

During full anealing of Hypo-eutectoide steel (<0.83%C) is heat 3°-40°c above upper cyitical temperature and after cooling composition of α-iron and pearlite phase is obtained.

During full anealing of Hypo-eutectoid steel (>0.83%c) is heated 50°-60° lower critical temperatute (725°) and after cooling Composition of pearlite and cementite phase is obtained.

Process Anealing

Process anealing in between the forming operation like between crolling of sheet metal.

- In process anealing specimen is heated below lower critical temperature.

Diffusion Anealing

Diffusion Anealing is also called homogeniousing process to get some mechanical properties throughout the volume of material.

- For diffusion anealining specimen is heated to a temperature around 1100°c.

Normalising

It is a process of heat treatment in which specimen is heated and cooled by normal air.

In normalising all kind of, weather it is hypo eutectoide, or hyper eutectoid is heated uper critical temperature.

After Normalising the following properties are achieved;

I. Ductility is less than anealing, but hardness is more than anealing.

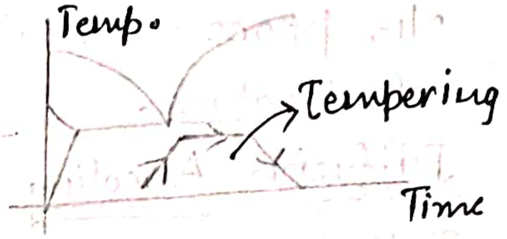
II. Tensile yield strength of the specimen is increased as compare to anealing.

III. In normalising rate of colling is faster than anealing.

IV. Due to normalising grain size is obtained smaller than anealing.

Tempering

It is a process in which hardness and brittleness of martensite is reduce by heating it below lower critical temperature, and holding for a time and then cool.



- After tempering;
  - I. Hardness of martensite is reduce.
  - II. Brittleness is reduce.
  - III. Toughness is increase.

Note; Some important quenching/cooling media

1. Normal Air - Normalising
2. Water
3. Oil
4. Alkaline Water or Solution of water with NAOH.
5. Brine.

- Cooling Rate; Alkaline Water → Water → Oil → Air.
- As the rate of cooling/quenching increases brittleness, hardness also increases and grain size decreases and vise-versa.

Hardening: It is the process of increasing the hardness of tool upto certain depth from surface of specimen by heating specimen to austenitic range & then cooling/quenching with the help of different cooling media.

- By hardening surface hardness increase keeping core of specimen unchange or soft.

Case Hardening/Surface Heat treatment;

- By surface hardening, Hardness & Brittleness of the surface of specimen is increased.
- This method is used for low carbon/Mild steel because of less carbon present, that can't be heat treated by other heat treatment processes.

• There are following techqunique used for case harding;

I Carburising

II Cyniding

III Nitriding

III flam- Hardening.

I. Carburising:

It is a process of increasing hardeness of surface of specimen by increasing the carbon content on the surface of specimen.

• In carburising process; specimen is kept inside a box with high carbon content material like charcole or carbon-mono-oxide (Gas carburising) and temperature and pressure of the box is increase to start diffusion, of carbon from high concentration to lower conceenteration and thus carbon content on surface of specimen is increase that increases the hardness of surface.

II. Cyniding:

It is a technique of increasing hardness of specimen surface.

• In cyniding low carbon content specimen is kept inside a box which is field with liquid cynide like Sodium Cynide (NaCn) and tries to achive condition of diffusion of carbon from high concentration to lower concentration, to increase the carbon contant on the surface of specimen.

Note; By cyniding shallow depth hardness is improved but more harder than carburising method.

III Nitriding-

- In nitriding, Nitrogen content (Atomic form) on the surface is induced which also increases the hardness of the specimen surface.
- In nitriding, specimen is kept in close atmosphere of amonia gas (NH_3) and Nitrogen in the atomic form from amonia gas releases and impart on the surface which increases the hardness of the surface.
- Degree of hardness order ;- Nitriding > Cyniding > Carburising

IV Flame Hardening;

- This technique of surface hardening is used for medium carbon steel.
- In this technique surface of specimen is heated with the help of a flam for short time and the quenched or cooled with water, that increases the hardness of surface.

Coating of Cutting Tool

A layer of different is imported on the surface of cutting tool to improve the hardness thoughness and wear resistance is called coating of tool.
Example; Coated Carbide Tools.

- After coating of cutting tools life of the tools increased significantely.
- Followings are the important material of coatings.
  (i) TiN (Titanium Nitride)
  (ii) TiC (Titanium Carbide)
  (iii) TiCN (Titanium Cyride)
  (iv) Al_2O_3 (Alumina)

Unit - 03

Die : Die is a female part of forming operation like forging, extrusion, drawing, punching, Blanking etc.

Die and punch are made up of tool steel material some of carbides material for higher production rate.

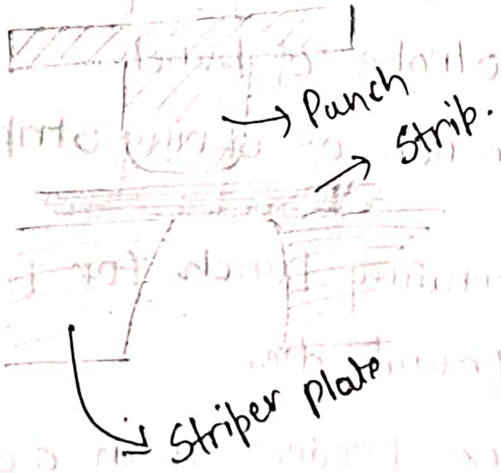
Types of Die :

There are following four types of die ;

- Simple Die
- Compound Die
- Combination Die
- Progressive Die

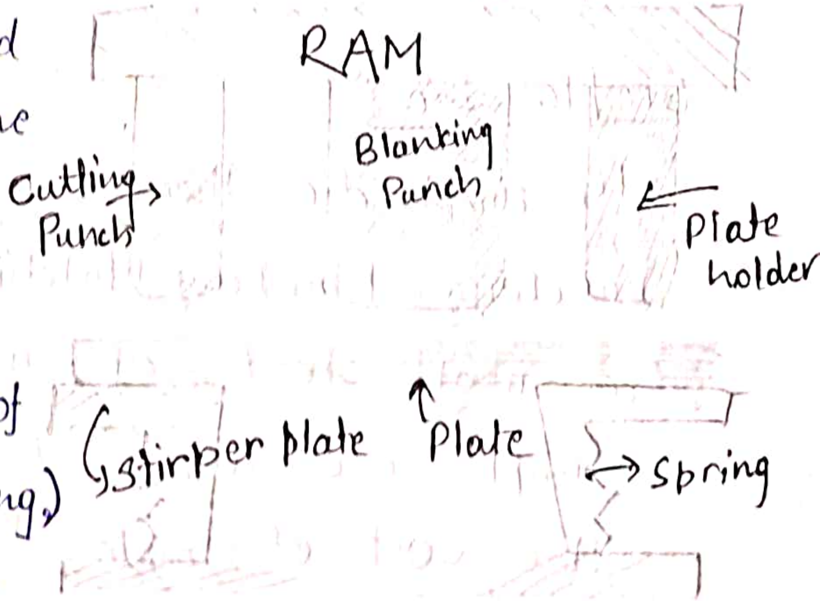
Simple Die

- In simple die, there can be only one operation like punching, Blanking, Notching etc are performed in a single stroke of punch.
- Simple die are used for production rate.
- The cost of simple die is less and skilled on required.



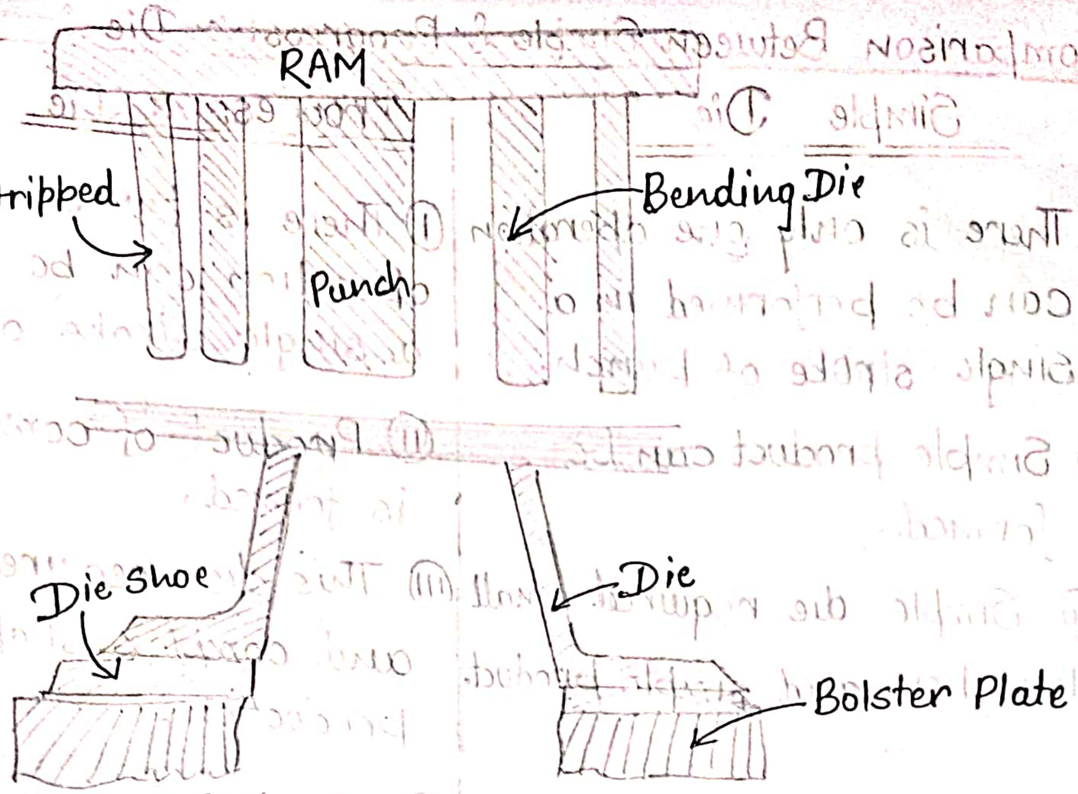
Compound Die

- In compound two operation of same nature (Blanking and cafting) are performed in a single stroke of the punch.
- An extra cutting punch is attached with blanking punch.
- There is stipper plate is attached with a spring to adjust the cutting die.
- There is also a plate/strip/sheet holder to hold the workpiece is attached with ram.
- The cost of compound die is more than the cost of simple die.



Combination Die

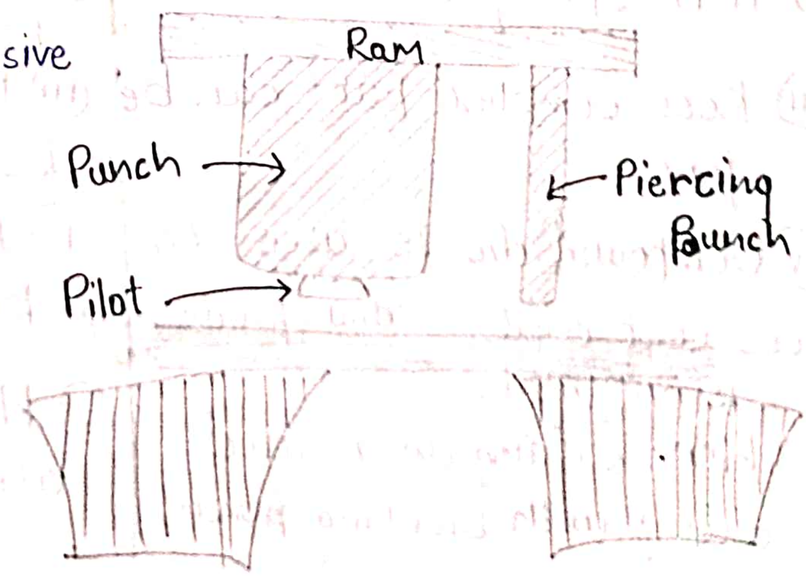
- In this die two operation of different nature (like Blanking) are performed at a single at a single stroke of punch.
- There is no use of spring stripper like in compound die.
- There is a bending punch for bending inplace of cutting die in compound die.
- More complex product than compound is formed with the help of combination die.

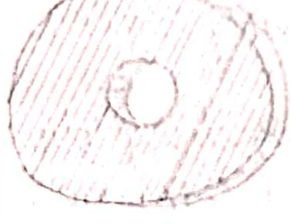


Combination Die

Progressive Die

- In progressive two or more than two operation are performed in successive stages.
- In progressive die simultaneowes operation like lancing, blanking, Peiercing, notching can be done simultaneously.
- Progressive die is not used for simple operation, but it is used for higher production.
- Most versatile and complex, part can be produced by progresive die. Example; ~~Mealic~~ Metalic Washer.
- The cost of progressive dee is too high.





Washer

Comparison Between Simple & Progressive Die :—

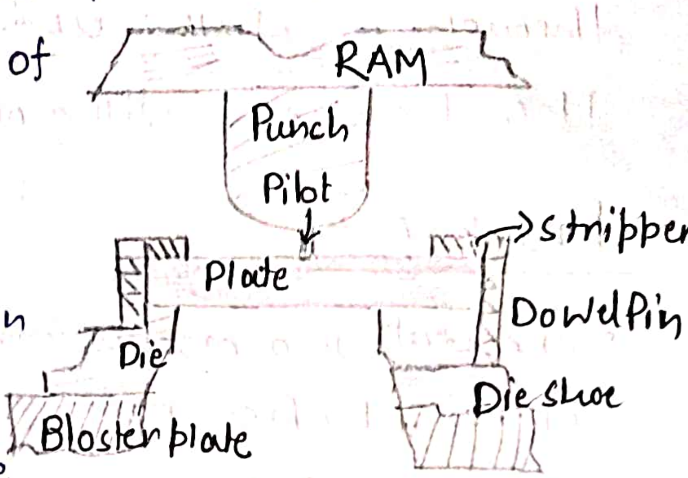
Simple Die	Progressive Die
(i) There is only one operation can be performed in a single stroke of punch.	(i) There is two or more than two operation can be performed in a single stroke of punch.
(ii) Simple product can be formed.	(ii) Product of complex shape is formed.
(iii) Simple die required small number and simple product.	(iii) This die required for higher and complex shape adjust production.
(iv) Productivity and efficiency of the operation is very low.	(iv) In progressive die, productivity and efficiency is higher.
(v) The cost is less.	(v) The cost of progressive die is more.

Difference Between Compound & Combination Die :—

Compound Die	Combination Die
(i) In compound die two operation of same nature performed in single stoke of the punch	(i) In this, two operation of different nature can be performed in single stoke of punch.
(ii) Here spring stipper is used.	(ii) Here there is no need of spring-stipper.
(iii) Less complex part can be form.	(iii) More complex part can be formed.
(iv) Compound die is used where less cost and medium productivity is required.	(iv) Here more cast and higher productivity can be achieved.
(v) Here cutting die is used along with blanking punch.	(v) Here bending die is used along with blanking punch.

Die Mounting

All the component of die and punch system are combindely called mounting of Punch and die system.

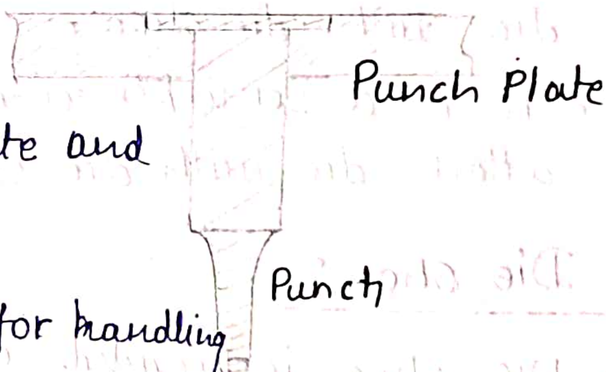


Bolster Plate

When many dies are runs in same press at different time the wear occuring on the bed/floor is very bolster used to take wear.

- Bolster plate is cheap in cost and easy to replace.
- It is attached to die shoe.

Punch Plate



- Punch plate is used to locate and hold the punch.
- This become very useful for handling small punches.

Stripper

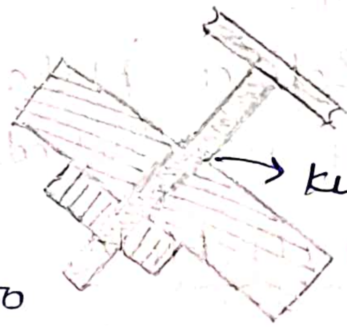
- This is used to hold the plate or stripper on the exact position on the die.
- In avoids the sticking of plate with punch or used to remove the sticked part of the plate or strip with the punch.
- There are two types of stripper is generally used in die-punch system;
  - Fixed Stripper: It is permanently hold the plate or strip which is being cut.

- Spring loaded stripper. It is connected with ram through a spring and it holds the plate or strip at the time of cutting or other operation.

Knock Out;

- knockout is a mechanism usually connect to ram and operate by press ram
- It is used to freeing or remove workpiece from Die.

Dowel Pin;

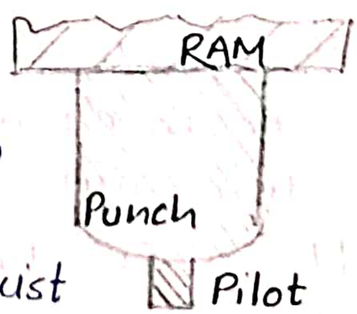


- Dowel Pin is used to connect die with die shoe.
- It is a semi permanent type pin to attach die with die shoe.

Die Shoe;

- Die shoe is provided at the base of die to support it.
- It is made-up of cast iron to support compressive load.
- It is built-up against Bolster plate which wear all the load of the die or die shoe.

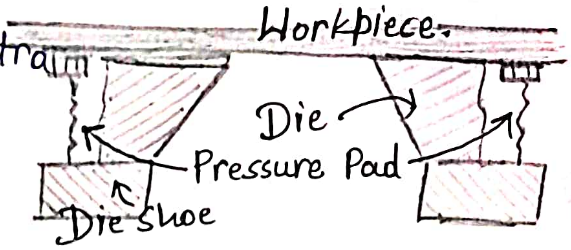
Pilot ;



- Pilot is provided with the punch to centring the hole in a blank.
- It ensure that hole of blank exist at the centre of blank.
- It is not an integral part of the punch but it is only used when a hole at the centre of blank is required.

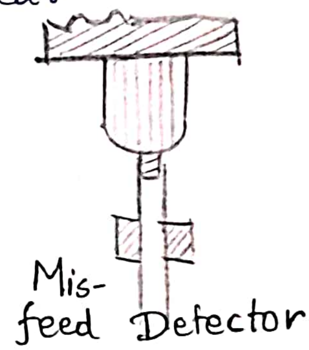
Pressure Pad :

- Pressure pad mounting is provided to support or bear the pressure on extra operation like cutting along with blanking and punching operation.



- It is also not integral component of die-punch system but it is provided when extra operation like cutting of extended part of plate/strip is required.

Misfeed Detector :



- Misfeed detector decided the position of the pilot to in centering.
- It provides the required area on which pillot centred in the hole.
- It is thinner than pilot and gives actual path.

UNIT-4

Ingot: It is the first solid product after solidification of liquid metal.

Bloom: It is the first product of square cross-sectional area after rolling (Reducing Thickness) of ingot.

Slab: It is rolled product of bloom, which has ractangular cross-sectional area.

Plate: Metallic product whose thickness is greater than 5mm and has rectangular X-Sectional area.

Sheet: Metalic product whose thickness is less than 5mm and width is grater than 600 mm and it has ractangular cross-sectional area.

Strip: It has width of less than 600 mm and thickness is less than 5mm.

Punching or Piercening

- It is an operation performed on sheet metal or metallic strip.
- Punching or Perceening is an operation for cutting a hole in metallic strip or sheet by shearing action.

Clearance in punching or piercering;

- In punch or piercering punch or press must be same size of hole.
- In punching or piercening size of die must be larger than punch size that clearance is provided on die

Size of Die = Size of punch (hole) + 2 c

where, c – radial clearance

Punc

Blanking

- Blanking is an operation performed on metallic sheet or strip.
- It is a shearing operation in which metal cut out from the sheet or strip is desired workpiece.
- Disc of circular shape is a general product by blanking operation.

Clearance in blanking;

- In blanking operation size of the die must be same as the size of blank/disk.
- In blanking operation clearance is provided on the punch or press.

Size of Punch = size of die − 2c

Where, c − radial clearance

For, clearance (c) = $0.0032 t \sqrt{\tau}$

where t → thickness of sheet/strip

τ → shear strength of material sheet/strip (N/mm²)

clearance (c) = Percentage (P) × thickness of sheet/strip

Qn. Determine the die and punch of blanking a circular disc of 20 mm diameter from a sheet whose thickness is 1.5 mm and shear strength of sheet material is 294 MPa.

Also determine the die and punch size for punching a circular hole of 20 mm diameter from the above sheet whose thickness is 1.5 mm.

[Tool - live - 23]

Punching and Blanking force required ;

Force Required (F) = $L \times t \times \tau$ (N)

for circular hole / blank = $2\pi r t \tau$

Where L = Shear length (mm)

t = thickness of sheet / strip (mm)

τ = Shear strength of material (N/mm²)

r = radius of hole / blank.

Press capacity will be = $F \times C$ generally, C = 1.62 to 1.75

Maximum size of hole punched / pierced ;

Shear force required = $\pi d t \tau$

Compressive force on punch for minimum size (d) hole

$$= \sigma_c \times \frac{\pi d^2}{4}$$

For punching,

$$\boxed{\pi d \times t \times \tau = \sigma_c \times \frac{\pi d^2}{4}}$$

Where, t - thickness

d - Size of hole

σ_c = Compressive strength of material punch / press.

Qn A hole is to be punched in a 15 mm thick plate having ultimate shear strength of 3 N/mm², if the allowable crussing stress in the punch is 6 N/mm² the diameter of smallest hole that can be punched will equal to?

[Tool - live - 23].

Qn. A hole of diameter 35 mm is to be punched in a sheat metal of thickness 't' and ultimate shear strength 400 MPa ultimate shear strength 400 MPa using punchig force 44 kN, The maximum value of 't' is ?

Qu. With a punch for which the maximum crushing Stress is 4 times the maximum shearing stress of the plate, the smallest hole that can be punched in the plate would be

(i) 1/4 × thickness of plate (ii) $\frac{1}{2}$ × thickness of plate

(iii) Plate thickness (iv) 2 × Plate thickness.

Providing Shear on punch or die :-

- Shear is provided either on punch or die to reduce or minimize the maximum force on punch or press.
- By providing shear on punch or die the maximum force of cutting decreases but energy involve in cutting remains constant.
- $Area_1 = Area_2$ = Energy involve in punching/blanking = Constant.

Force (F) on Punch with shear;

- Energy for punch/blanking with shear on punch

$= F_{max} \times P \times t$ where P - Percentage, t - thickness

Shear energy, $= F \times S$

Constant energy for blanking/Punching;

$$F_{max} \times P \times t = F \times S$$

$$\boxed{F = \frac{F_{max} \times P \times t}{S}}$$

Qn. A hole of 100 mm diameter is to be punched in steel plate of 5.6 mm thickness. The ultimate shear stress is 550 N/mm with normal clearance on tool, cutting is complete at 40% of peneteration of the punch, Give the suitable for the punching to bring the water with in the capacity of 30 T press. [Tool - live - 25]

Trimming : Cutting Unwanted excess material from the periphery of all ready formed object, is trimming.

Shaving : It is process of removing excess in the form of strip to get accurate dimension.

Lancing : A hole is partially out and one side is bent, there is no material removal takes place.

Notching : Material is removed from edge of the strip or sheet.

Perferating : Cutting Number of small holes which are very close to each other on a sheet/strip.

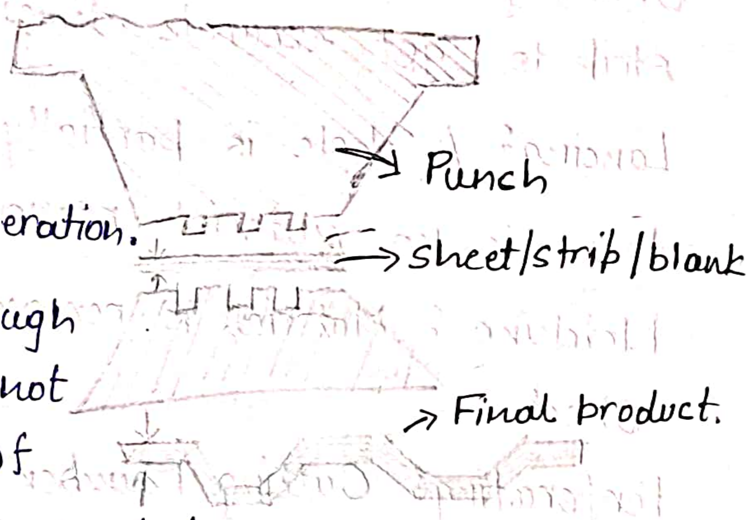
Slitting : Cutting a complex geometry on sheet/strip is called slitting.

Steel Rule : Complex slabs are cut on strip/sheet by a steel Rule.

Nibbleing : A single punch is moved up-down number of times to cut small material each to from complex geometry on sheet/strip.

Embossing:

- It is a cold working forming process.
- In this process dimples and projection are provided on sheet metal/strip, by using punch and die of corresponding shape.
- In this operation thickness of workpiece almost remains constant.
- Deformation of through out the volume of sheet metal takes place.
- It requires less force than coining.
- By embossing operation, product for decoration & relegious perposed formed.



Coining:

- It is cold working pressing operation.
- In the coining operation through out volume deformation does not takes but only on surface of the blank impression is imparted.
- In this operation large face is required than embossing.
- By coining operation Hard currency like coins and medals insignia badge etc are formed.

Curling: When a end/edge of a sheet/strip is partially bended, this is called curling.

Heming: This is the complete bounding of edge of sheet/strip.

UNIT-5

Drawing

- Tube Drawing (Seam less tube, By using moving Mandrel)
- Wire Drawing (Ductile Material)
- Drawing in forging (Reducing dia. of X-section of one side of Job).
- Sheet - Held & Deep Drawing

Drawing

It is plastic deformation process in which a flate plate or sheet (Blank) is formed in to a 3-dimensional object of shape like cup or hollow cylinder.

- Drawing is performed with the help of punch and die.

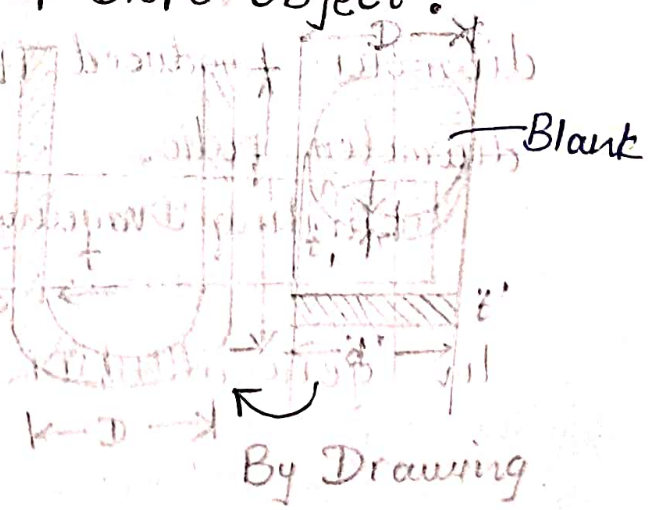
Deep Drawing:

If the height of cup shape object is greater than its diameter then the process of drawing is called deep drawing.

- In drawing thickness of blank (sheet/plate) and thickness of 3-D cup shape object almost remains constant.

Blank Diameter For 3-D Cup Slope Object :-

By conservation mass of the material by blank and cup.



Let,
- D - dia. of blank
- t - thickness of blank and cup
- d - dia. of cup
- h - height of cup

By conservation of mass,

$$(Mass)_{Blank} = (Mass)_{cup}$$

$$\rho \times volume = \rho \times Volume$$

$$\Rightarrow \frac{\pi}{4} D^2 \times t = \left(\frac{\pi}{4} d^2 + \pi d h\right) \times t$$

$$\Rightarrow \frac{D^2}{4} = \frac{d^2}{4} \times dh$$

$$\Rightarrow D^2 = d^2 + 4dh$$

$$\Rightarrow \boxed{D = \sqrt{d^2 + 4dh}}$$

$$\boxed{D = \sqrt{d^2 + 4dh} - 0.5r}$$ where r = Corner radius of die

$$\boxed{\text{Dia of Punch} = \text{Dia. of die} - 2.5t}$$

$$\boxed{\text{Punch Force} = \pi d t \sigma \left[\frac{D}{d} - C\right]}$$ σ = Tensile Strength

Drawing Ratio :

The ratio of blank diameter to the 3-d cup dia. is called drawing ratio.

$$\boxed{\text{Drawing Ratio} = \frac{D}{d}}$$

Limiting Drawing Ratio :

The ratio of diameter of blank to the minimum diameter produced in single draw is called limit diameter ratio.

$$\boxed{\text{Limiting Drawing Ratio} = \frac{D}{d_{min}}}$$

In general LDR is 1.6 to 2.3.

A cylinder vessel with flat bottom can be deep drawing by double action draw.

LDR :-

In first draw reduction = 50%.
In second draw reduction = 30%.
In third draw reduction = 25%.
In fourth draw reduction = 16%.

Qn. For obtaining a cup of diameter 25 mm and height 15 mm the size of round blank should be.

Qn. A shell of 100 mm diameter and 100 mm height with the corner radius 0.4 mm is tube by cup drawing, The required blank dia. is?

Qn. The initial blank diameter required to form a cylindrical cup of outside diameter 'd' and total height is 'h' having a corner radius 'r' is obtained using the formula.

(a) $D_o = \sqrt{d^2 + 4dh} - 0.5r$ ✓

(b) $D_o = d + 2h + 2r$

(c) $D_o = d^2 + 2h^2 + 2r$

(d) $D_o = \sqrt{d^2 + 4dh - 0.5r}$

Qn. A Cup of 50 mm diameter and 100 mm height is to be drawn from low carbon steel sheet, neglecting the influence of thickness and corner radius, (i) Calculate the blank diameter.
(ii) Decide whether it can be draw in a single draw, if maximum reduction permitted is 40%.

Qn. A symmetrical cup of circular cross-section with diameter 40 mm and height 60 mm with a corner radius 2 mm is to be obtained in C_{20} steel of 0.6 mm thickness. Calculate the blank size to draw the cup. will, It be possible to draw the cup in single step.

Qn. A cylindrical vessel with flat bottom can be deep drain by; I

ⓐ Shallow drawing ⓑ Single action deep drawing
ⓒ Double action deep drawing ✓
ⓓ Tripple action deep drawing

Qn. A cup of 10 cm height and 5 cm diameter is to be made from sheet metal of 2 mm thick. The number of deduction necessary will be.

ⓐ One ⓑ Two ⓒ Three ✓ ⓓ Four.

Qn. The bonding force required for 'V' bonding, 'U' bonding and edge bonding will be in ratio of

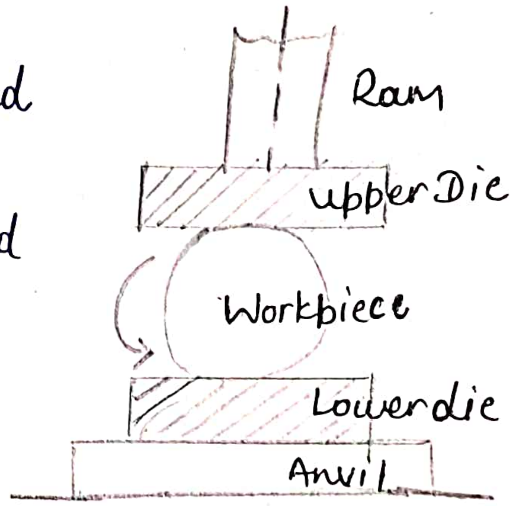
ⓐ 1:2:0.5 ✓ ⓑ 2:1:0.5 ⓒ 1:2:1 ⓓ 1:1:1

Extrusion Die:

- Extrusion is a forming process like squeezing of toothpaste out of take.
- In this process, metal is compressed and force to flow through suitable die to form a product of constant crosectional area.
- A solid ram drives the entire billet to and through a stationary die and also provided with addition power to over the function.
- Extrusion die are generally made of tight corbon or HSS steels.

Forging Die :

- Forging is a forming process in which product are manufactured or formed by compressing force between two dies.
- Malleability is the essential properties of material required for forging.
- Forging die consist of two symetrical die called upper die and lower die.
- Upper die attached with the ram and lower lies on anvil.
- With help of upper which attached with ram compressive force is applied on the workpiece to give desire shape of object.



Die Casting :-

- Liquid metal is poured into a metal die and then solidify it, This process is called die casting.

Types of die casting ;

1. Gravity Die-casting

- Liquid metal poured into mettalic die by gravity force, So it is called gravity die-casting.
- Surface finish obtained is bettar than other casting.
- Application :-

It is used for casting of automobile parts of aluminium.

Pressure Die casting:

- Liquid -metal of smaller melting point is casted by pressure die casting.
- It is used to form complex shape of the object.
- pressure die-casting is used for casting of materials like Lead (Pb), Tin (Sn), Zinc (Zn) etc.

Tool Engineering Important

UNIT-1

Qn. 1. Define Metal cutting with its types and also write type of metal cutting tool.

Qn. 2. Write the nomneclature of cutting tool.

Qn. 3. Write down about chip formation with its types.

Qn. 4. Write about mechanics of metal cutting

- Tangetialor cutting force
- Feed force
- Radial force.

Qn 5. Write about tool wear with types and mechanism behind tool wear.

Qn. 6. Explain cutting fluid with its function and properties. Also write types of cutting fluid.

UNIT-2

Qn. 1. Explain in deep about machinability.

Qn. 2. Write about Tool material with its wide varities.

Qn. 3. Explain,

- High carbon steel
- High speed steel
  - 18-4-1 Hss
  - Molybdenum Hss
  - Super Hss
- Cemented carbide
- Ceramics
- Diamond
- Cubic Boron Nitride.

Qn. 4. Write the Nomenaclature of drill bits.

Qn 5. Write about reamer and milling cutter with its type.

Qn. 6. Write about Heat treatment.

Qn. 7. Define.
- Martempering
- Anealing
- Normalising
- Tempering
- Hardening with its different techqunies

Qn 8. Write about coating on cutting Tool.

UNIT - 3.

Qn. 1. Write about die and its type with neat sketch

Qn. 2. Differentiate between,
(i) simple die and Progressive Die
(ii) Compound die and combination die.

Qn. 3. Explain Die mounting in deep.

UNIT 4 & 5

Qn. 1. Explain Punching / Piearcening and blanking.

Qn. 2. Explain,
- Triming, • Shaving, • Lancing, • Notching,
- Perferating, • Slitting, • Steel Rule, • Nibbleing.
- Embossing, • Coining, • Curling, Heming.

Qn. 3. Write about Drawing. Deep drawing, Drawing ratio.

Qn. 4 Define,
- Extrusion Die
- Forging Die
- Die casing
  - Gravity die casing
  - Pressure die casing