BHADRAK ENGINEERING SCHOOL & TECHNOLOGY
(BEST), ASURALI, BHADRAK

Production Technology (Th- 01)

(As per the 2020-21 syllabus of the SCTE&VT, Bhubaneswar, Odisha)

Third Semester

Mechanical Engg.

Prepared By: *Er. P. K. Mohanty*

PRODUCTION TECHNOLOGY

TOPIC WISE DISTRIBUTION PERIODS

Sl. No.	Name of the chapter as per the syllabus	No of Periods as Per the Syllabus	No of Periods Actually Needed	Expected marks
01	Metal Forming Process	07	07	15
02	Welding	16	19	20
03	Casting	16	24	20
04	Powder Metallurgy	07	06	15
05	Press Work	07	07	15
06	Jigs And Fixtures	07	06	15
	TOTAL	**60**	**69**	**100**

CHAPTER NO. – 01

METAL FORMING PROCESS

Learning Objectives:

1.1 Extrusion: Definition & Classification

1.2 Explain direct, indirect and impact extrusion process.

1.3 Define rolling. Classify it.

1.4 Differentiate between cold rolling and hot rolling process.

1.5 List the different types of rolling mills used in Rolling process.

1.1 Extrusion: Definition & Classification:

Definition:

- It is a metal forming process in which a hot metal billet is forced to pass at a high pressure through a very small opening called die.
- This method is used to produce long uniform and non-uniform cross-sectional objects.

Classification Of Extrusion:

1. Direct extrusion
2. Indirect extrusion
3. Impact extrusion

1.2 Explain direct, indirect and impact extrusion process:

Direct extrusion:

- Direct extrusion process consists of a container, a ram and a die. In this method the hot metal billet is forced to pass through a die by pushing through a ram. The hot billet takes the shape of the die is known as extruded component. In this extrusion method the metal will flow in the same direction as the direction of the ram. The oxide formation occurs due to high but do not mix with the product. It is a hot working process.

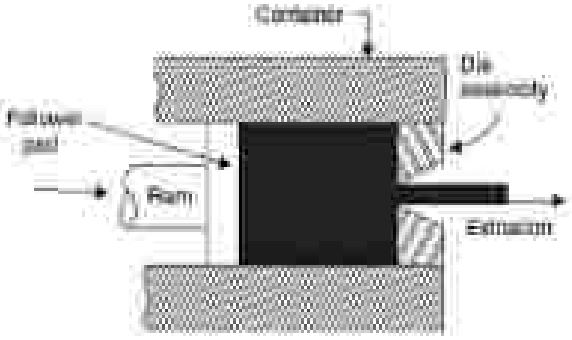
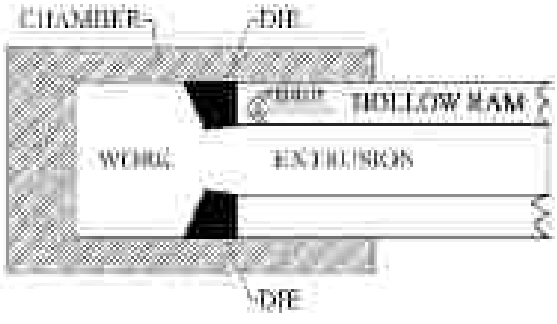


Figure 1.1 Direct extrusion

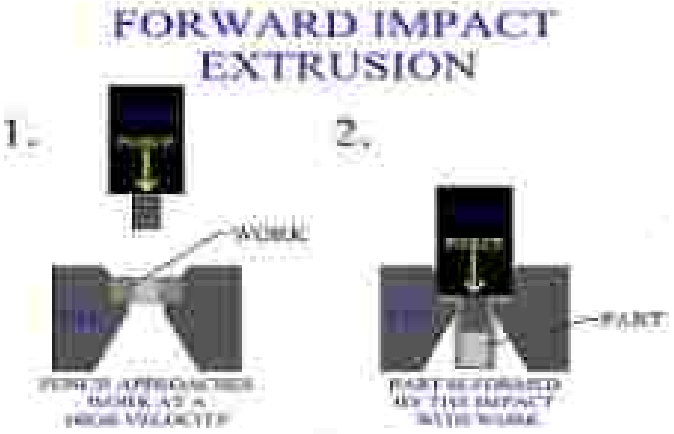
Indirect Extrusion:

- This process consists of a container, a ram and a die. In this process hot billet remains stationary, while die is pushed into the billet by a hollow ram through which extrusion takes place. Indirect extrusion does not require as much force as compare to direct extrusion because no force is required to move the hot billet inside the chamber wall. The length of the product in indirect extrusion size of the ram. Indirect extrusion method is also a hot working process.



Impact Extrusion:

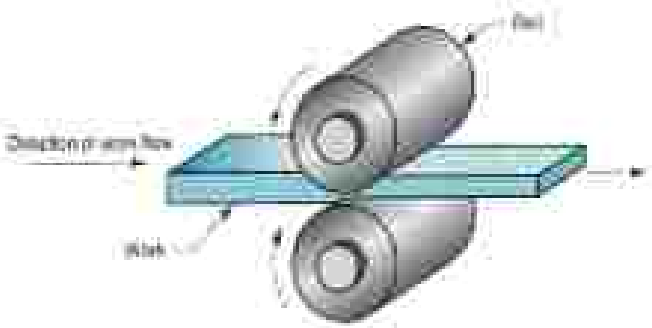
- It is a cold working extrusion process. This method is same as hot extrusion method except that in impact extrusion the metals working without application of heat. The metals used in this process must have high degrees of ductility. The purpose of impact extrusion is mostly that producing a finished product. In this process a punch is used to force the metal work piece into the die cavity to take the shape of the cavity. Collapsible tubes of leads, tin and aluminium are produced by this method.



1.3 Define rolling. Classify it:

Rolling:

- In metal working, rolling is a metal forming process in which a metal stock passed through one or more pair of rolls to reduce the thickness and to make the thickness uniform.



Classification of Rolling:

Rolling process are classified into two types.

1. **Hot Rolling**: In hot rolling the metal stock to be rolled is preheated above recrystallization temp.

2. **Cold Rolling:** In cold rolling the metal stock is rolled at room temp.

1.4 Differentiate between cold rolling and hot rolling process:

Hot Rolling	Cold Rolling
1. Metal is the feed to the rolls after being heated above recrystallization temp. 2. In general, rolled metal doesn't show work hardening effect. 3. Co efficient of friction between the rolls and the stock is higher. 4. Heavy reduction in area of the work piece can be obtained. 5. Surface finish is not good. 6. Very thin section is not obtained by hot rolling.	1. Metal is feed to the rolls at its regular temp. 2. The metal shows the work hardening effect after being cold rolled. 3. Co efficient of friction between the rolls and stock is lower. 4. Heavy reduction is not possible. 5. Very smooth surface can be obtained. 6. Aluminium foils as thin 0.02mm can be obtained by cold rolling.

1.5 List the different types of rolling mills used in Rolling process:

Rolling mills:

- Rolling mills are the places where various types of rollers are arranged sequentially to obtain the desired reduction.
- In general rolling mills are five types.
    1. Two high rolling mills.
    2. Three high rolling mills
    3. Four high rolling mills.
    4. Tendom rolling mill.
    5. Cluster rolling mill.

1. Two high rolling mill:

- It has two rolls only. It can rotate both direction that is clock wise and anticlockwise. The work piece after passing once between the roller the desired thickness is reduced and is again passed backward between the same roller to get the required reduction.

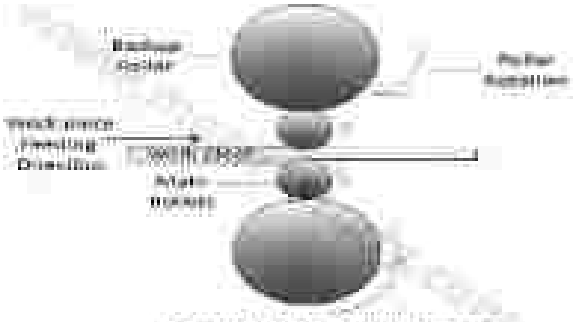
TWO HIGH ROLLING MILL

2. Three high rolling mill:

- It consists of a roll stand with three parallel rolls one above the other. Adjacent rolls rotate in opposite direction. So that the material may be passed between the top and the middle roll in one direction and the bottom and middle role in opposite one. So that the thickness is reduce at each pass. It is used for blooming mills and finishing rolling.

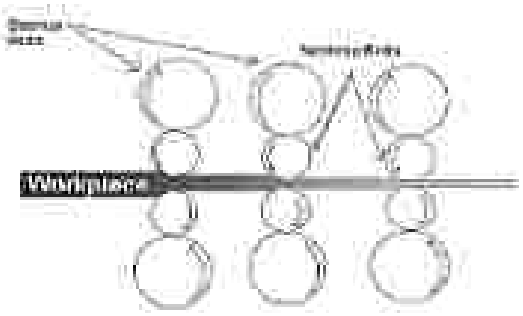
3. Four high rolling mill:

- It has a roll stand with four parallel rolls one above the other. The top and the bottom rolls rotate in opposite direction as to the same to the two middle rolls. The two middle rolls are smaller in size then the top and bottom rolls which are called back up rolls for providing the necessary to the smaller rolls. Four high rolling mill is used for hot rolling of plates as well as cold rolling of plates, sheet and strips.


FOUR HIGH ROLLING MILL

4. Tendom rolling mill:

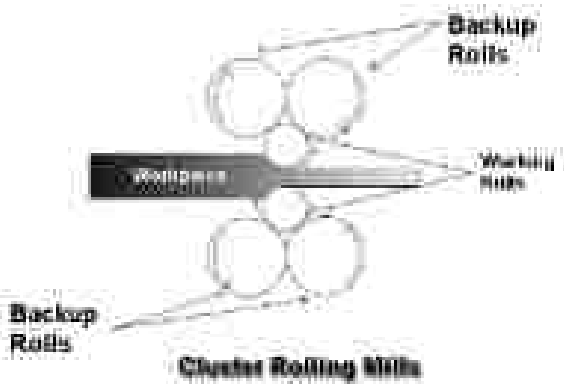
- It is setup of two or more stands of rolls shape in parallel alignment. So that a continuous pass may be made through each one successively without change the direction of material.



Tandem or Continuous Rolling Machine

5. Cluster rolling mill:

- It is a special type of four high rolling mill in which each of the two working rolls is backed up by two or more of the larger backup rolls for rolling hard in material. It may be necessary to employ work rolls of a very small diameter but of considerable length.



Cluster Rolling Mills

POSSIBLE SHORT TYPE QUESTIONS WITH ANSWER

1. What is extrusion? (2018-W,2019-W/S,2020-W)

Answer- It is a metal forming process in which a hot metal billet is forced to passed at high pressure through a very small opening called die.

2. Define Rolling and classify it. (2017-W2018-W,2019-W,2020-W,2022-W)

Answer-In metal working rolling is a metal forming process in which the metal stock is passed through one or more pair of rolls to reduce the thickness and to make the thickness uniform.

Rolling is classified into two types-

1. Hot rolling

2. Cold rolling

3. What do understand by recrystallization temperature? (2019-W)

Answer- It is a particular temperature point below the melting point of a metal or material. It changes the strength and shape of the metal.

4. What are the benefits of production technology in engineering ? (2020-W)

Answer-

- Improved production method
- Higher productivity
- Less production time
- Increased production rate

5. Name an extrusion process by which a toothpaste tube can be produced. (2019-W)

Answer- By indirect extrusion process the toothpaste tube can be produced, because the ram move to the opposite direction of the billet.

6. What is metal forming? (2021-W)

Answer- Metal forming can be defined as a process which the desired size and shape are obtained through the deformation of metals plastically under the action of externally applied forces.

7. Define impact extrusion process. (2022-W)

Answer- It is a cold working extrusion process. The purpose of impact extrusion is mostly that producing a finished product.

POSSIBLE LONG TYPE QUESTIONS

1. Describe with neat sketch the direct extrusion process. (2019-W)
2. Describe with neat sketch the different types of rolling process. (2019-S/W, 2021-W)
3. Write the different between hot rolling and cold rolling. (2018-W,2019-W, 2020-S)
4. Differentiate between direct extrusion and indirect extrusion process. (2018-W, 2020-W)
5. Differentiate between Indirect and impact extrusion process. (2019-W)
6. Write short notes on- (2020-W)
    1. Direct extrusion

CHAPTER NO. – 02

WELDING

Learning Objectives:

2.1 Define welding and classify various welding processes.

2.2 Explain fluxes used in welding.

2.3 Explain Oxy-acetylene welding process.

2.4 Explain various types of flames used in Oxy-acetylene welding process.

2.5 Explain Arc welding process.

2.6 Specify arc welding electrodes.

2.7 Define resistance welding and classify it.

2.8 Describe various resistance welding processes such as butt welding, spot welding, flash welding, projection welding and seam welding.

2.9 Explain TIG and MIG welding process.

2.10 State different welding defects with causes and remedies.

2.1 Define welding and classify various welding processes:

Definition:

- Welding is a process of joining two similar or dissimilar materials with the help of heat and flux material and with or without application of pressure.

Classification of Welding:

In general, various welding process are classified as follows.

1. Gas Welding:

a) Air acetylene welding.
b) Oxy acetylene welding.
c) Oxy hydrogen welding.

2. Arc welding:

a. Carbon arc welding.
b. Sub merged arc welding.
c. TIG welding.
d. MIG welding.
e. Plasma welding.

3. Resistance welding:

a. Spot welding.
b. Seam welding.
c. Projection welding.
d. Resistance butt welding.
e. Flash butt welding.

4. Solid state welding:

a. Cold welding.
b. Explosive welding.
c. Ultrasonic welding.

5.Thermo chemical welding process:

a. Thermit welding.

b. Atomic hydrogen welding process.

2.2 Explain fluxes used in welding:

- During welding the metal is melted in air, oxygen form the air combines with the metal to form oxides which result in poor qualities and low strength welds. In order to avoid this difficulty, the flux is used during welding. A flux is a material use to prevent the oxidation of molten metal by facilating the removal of oxides. The flux is fusible and non-metallic. During welding flux chemically react with the oxides and a slag is form. This slag covers molten metal and avoid the mixing of atmospheric oxygen. Fluxes are available as powders or paste.
- Example- Boric acid, magnesium, lithium paste, paste of boron, phosphate, lime.

2.3 Explain Oxy-acetylene welding process:

- Oxy acetylene welding is a fusion welding process under the category of gas welding technic.

Principle of operation:

- When acetylene is mixed with oxygen in correct proportion in the welding torch and ignited. The flame resulting at the top of the torch is sufficiently hot to melt and join the parent metal.

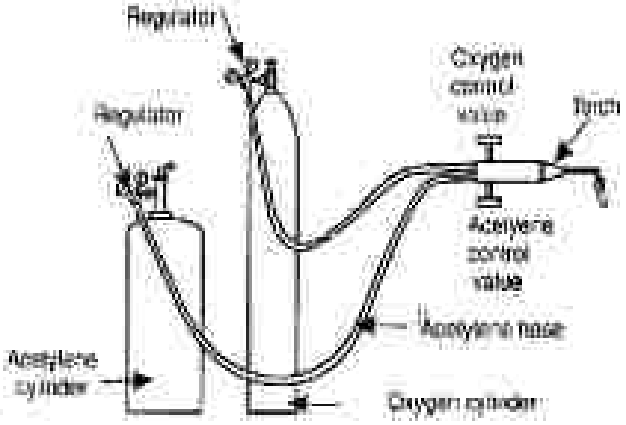


Fig. 7.3. Oxy-acetylene welding equipment.

Procedure:

- Open the acetylene control valve of the welding torch so that the system is filled with burning gas. Acetylene control valve is then adjusted until to smoke occur. Then the oxygen control valve is open to adjust the proper mixing of oxygen and acetylene and ignited. In this welding process three types of flames are produced, these are–
  1. Neutral flame.
  2. Oxidising flame.
  3. Reduction flame.

Application of Welding:

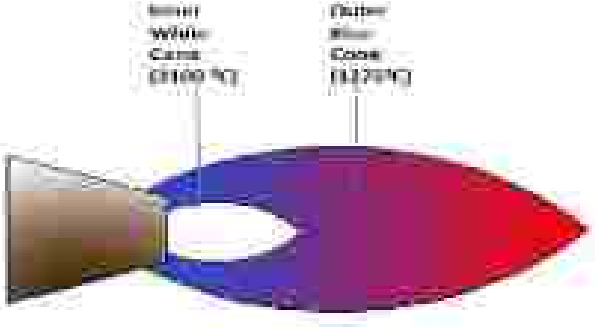
- The oxy acetylene welding is used in industries, automobile construction, bridge construction.

2.4 Explain various types of flames used in Oxy-acetylene welding process:

- There are three types of flame are used in oxyacetylene welding.

1. Neutral flame:

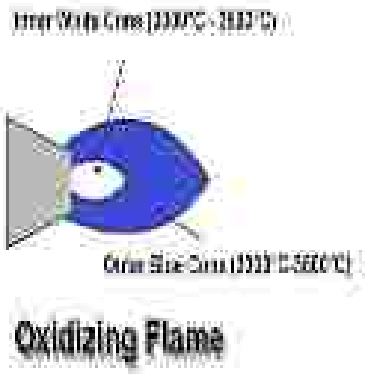
- *(Acetylene and oxygen mixed in equal proportion.)*. The temperature of neutral flame is 3100°C The flame has an inner cone which is light blue or white in colour. The inner cone is surrounded by a colour flame envelope which is dark blue in colour. The neutral flame is commonly used for welding mild steel, stain less steel, cast iron etc.



Natural Flame

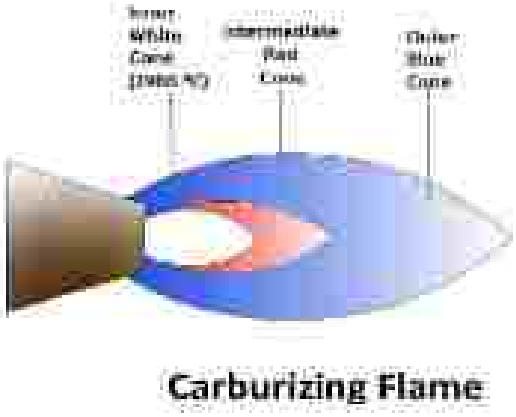
2. Oxidising flame:

- *(Excess in oxygen)*. If the supply of oxygen is further increased the result will be an oxidising flame. The flame has a shorter inner cone which much blue in colour and more pointed than the neutral flame. The outer envelope is much shorter tend to fan out at the end. This flame burns with a loud roar. The maximum temperature of oxidising flame is 3500 C. The oxidising flame is used for welding steel, copper base metal, zinc base metal.



3. Reduction flame:

- *(Excess in acetylene/Reduce of oxygen)*. It is otherwise called as carburising flame. If the volume of oxygen supplies to the neutral flame is reduced and acetylene is increased the resulting flame will be reducing flame. A reducing flame is recognised by acetylene feather which exist between inner cone and outer envelope. The outer envelope is longer than the neutral flame and is much brighter in colour. Reducing flame has a temperature of 3038°C. A reducing flame is used in welding of lead, low alloy steel etc.



2.5 Explain arc welding process:

- In this type of welding process, a joint is produced by heating the work piece with an electric arc set up between flux coated electrode and the work piece. The flux covering decomposes due to arc heat and performs many functions like arc stability, weld metal protection etc. The electrode melts by the arc and supplies the necessary filler metal. The arc temperature and the arc heat can increase and decreased by providing higher or lower arc current. Material droplets are transfered from electrode to the work piece through the arc and deposited along the joint to be welded. The gaseous shield formed by flux coating protect the atmospheric oxygen to enter the molten pool thus no oxide formation.

2.6 Specify arc Welding Electrodes:

- They are low melting point electrodes made up of different metals and their alloys. When the arc between the electrode and the job is struck end of the electrode starts melting and transfers to the job in the form of droplets. The droplets transforming to the work piece and depositing them.

Classification of electrode:

- The electrode are two types, consumable and non-consumable. The classification of consumable electrode are as follows.

1. Bare electrode:

- They consist of a metal or alloy wire without any flux coating on them.

2. Lightly coated electrode:

- Electrode with a coating factor approximately *1.25* are termed as lightly coated electrode.
- *Coating factor= dia of electrode mm/dia* of core wire mm.
- A filler metal electrode used in arc welding which consists of a metal wire having a light coating to stabilise the arc.

3. Medium coated electrode:

- Electrode with a coating factor of *1.45* are known as medium coated electrode.

4. Heavily coated electrode

- Electrodes with a coating factor of *2.2* are known as heavily coated electrode. This electrode gives more concentrated arc to the metal work piece.

2.7 Define resistance welding and classify it:

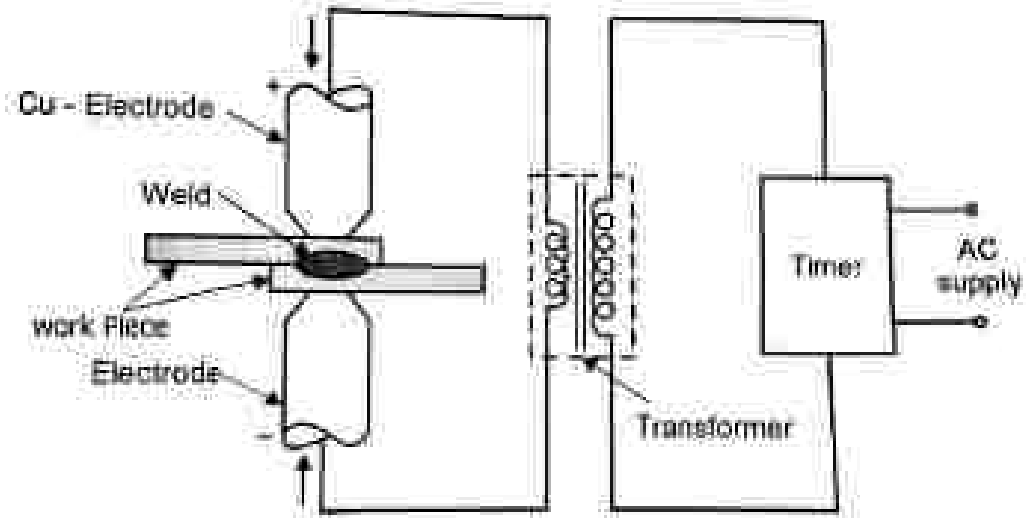
Definition:

- Resistance welding is a group of welding processes where a joint is produced between two work pieces by the heat obtained from resistance to flow electric current in a circuit through the same work piece.

Fundamental of resistance welding:

The two factors mainly responsible for resistance welding are:

- The generation of heat at the place where two work pieces are to be joint.
- The application of pressure at the place where a weld joint is to be formed.



Classification:

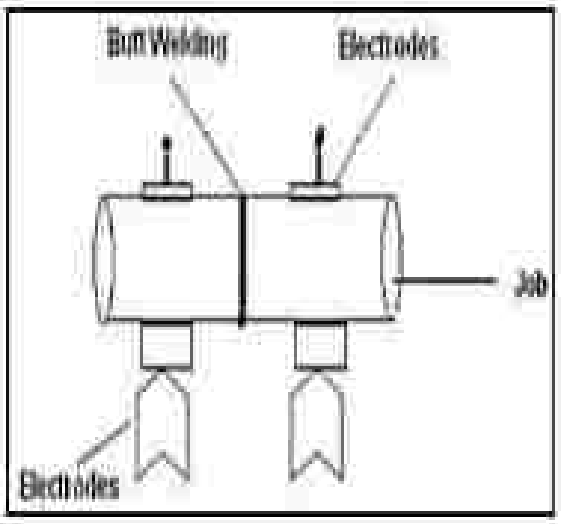
Resistance welding may be classified into following types.

- Butt resistance welding
- Spot welding
- Flash butt welding
- Projection welding
- Seam welding

2.8 Describe various resistance welding processes such as butt welding, spot welding, flash welding, projection welding and seam welding:

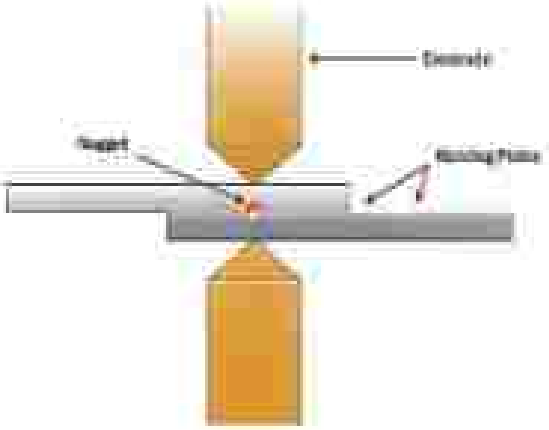
Butt welding:

- Butt welding is a resistance welding process in which an upset joint is curved between two work pieces. This joint is formed when heating the two-work piece by supplying heavy current and holding them with axial pressure. Initially the two-work piece to be butt welded are gripped firmly, one in each clamp and are correctly aligned. Force is applied so that the faces of two pieces touch together and remain under pressure. Then a heavy current is passed between them so that the resistance to the electric current flow, heats the faces to fusion temperature. When the faces of the pieces become plastic, they are pressed together more firmly, upsetting the metal pieces to form a dance joint.



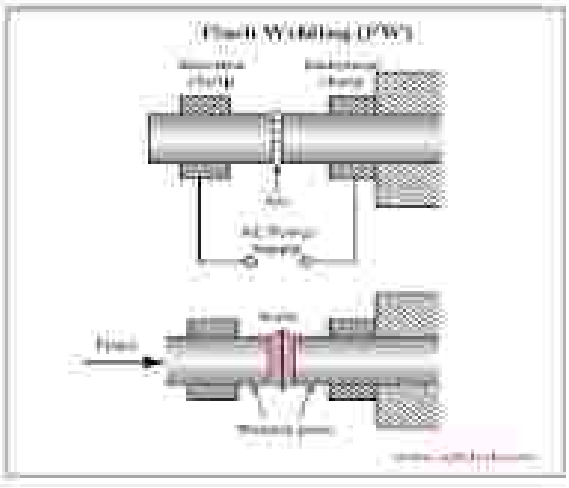
Spot Welding:

- Spot welding is a resistance welding processes in which spot (nugget) is produced by supplying heavy current between two cupper electrodes. Due to maximum contact resistance between the two-work piece heat generation will take place. After getting sufficient amount of heat switch off the power supply and provide mechanical pressure on the work piece through the cupper electrode. Due to external Pressure the spot formed between work piece called nugget. For spot welding less thickness work piece (t<3mm) we can use this technic.



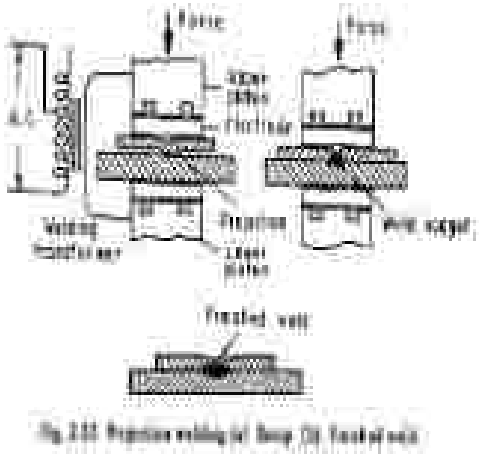
Flash butt welding:

- For welding of objects end to end, edge to edge we can use this technic. It is a resistance welding process where a joint is formed on the entire face of the two-work piece by the heat of a flash generated from the supply voltage and current. The two-work piece will be hold between electrode holders and power supply will be given to the work piece through the electrode holder. By making the contact of the work piece, flash will be formed at the contact area due to resistance heat generation. After getting sufficient heat, stop the power supply and increase the axial pressure due to which joint will be formed.



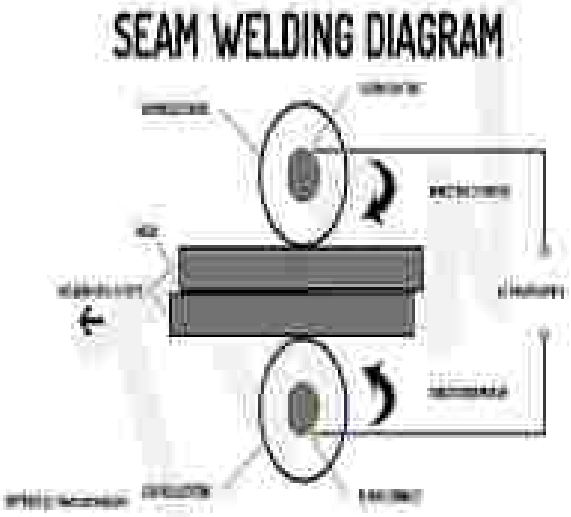
Projection welding:

- To produce the joints without any indentation on the work piece we can use this technic. The electrode is relatively flat and large in surface area. On one of the sheets to be welded there are some projections are provided. The projection in the upper strip is held in contact with the lower sheet under electrode pressure. The current flows and being localized to the region around the projection, heats the metal in that area to the plastic step. The heated and softened projection collapses under the pressure of the electrodes and formed the weld.



Seam welding:

- Seam welding technic is generally used to obtain leak proof joint. This process is also known as continuous spot welding used to produce leak proof joint at a faster rate. In this process the two copper rollers are rotating in opposite direction and the two-work piece to be kept between them. Then the power supply will be given through the rollers. At the contact of the two-work piece heat generation will be takes place and by applying the roller pressure the joint will be formed. Because of rolling of rollers, work piece will be moved in linear direction and hence can cover lapping nuggets will be formed.



2.9 Explain TIG and MIG welding process:

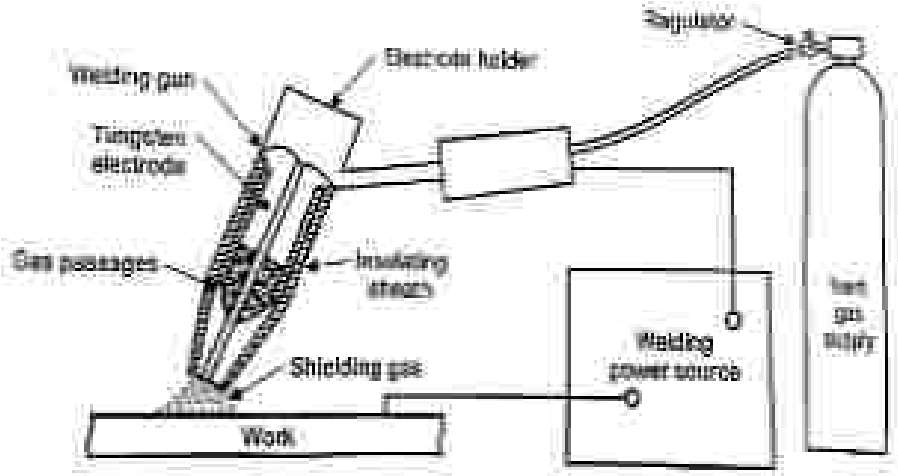
TIG Welding:

The following components are necessary to perform tungsten inert gas welding.

1. Power supply (A.C or D.C)
2. Non-consumable tungsten electrode.
3. Inert gas supply.
4. Filler rod (used depending on the nature of work piece).
5. Welding head.

Working:

- The work piece to be welded is placed on the work table. The non-consumable tungsten electrode and the work piece are connected to the power supply. As the electrode is brought near the work piece (leaving a small air gap) an arc is produced. This arc Is used for melting and welding the work piece. In tungsten inert gas welding filler rod may or may not be used. The usage of filler rod depends on the nature of the work piece to be welded. If filler rod is used, it is continuously melted by the arc and fed into the weld pool. Tungsten has high melting point (3422°C). Hence, tungsten electrode does not melt during the welding process. Inert gas supply is constantly provided around the electrode during the welding process. The inert gas forms a gas shielding around the weld. It protects the weld from the external atmosphere.



Advantages:

1. TIG welding produces high quality weld.
2. The weld is automatically protected by the inert gas during the welding process.
3. No slag is produced.
4. TIG welding can be done in any position.

Disadvantages:

1. TIG welding is a slow process.
2. Highly skilled labour is needed.
3. Welder is exposed to huge intensities of light.
4. TIG welding is more expensive when compared to MIG welding.

Application:

- Welding of sheet metal and thin sections used in air craft. TIG welding is used for welding a variety of metals like stainless steel, alloy steel, aluminium, titanium, copper, magnesium, nickel alloy.

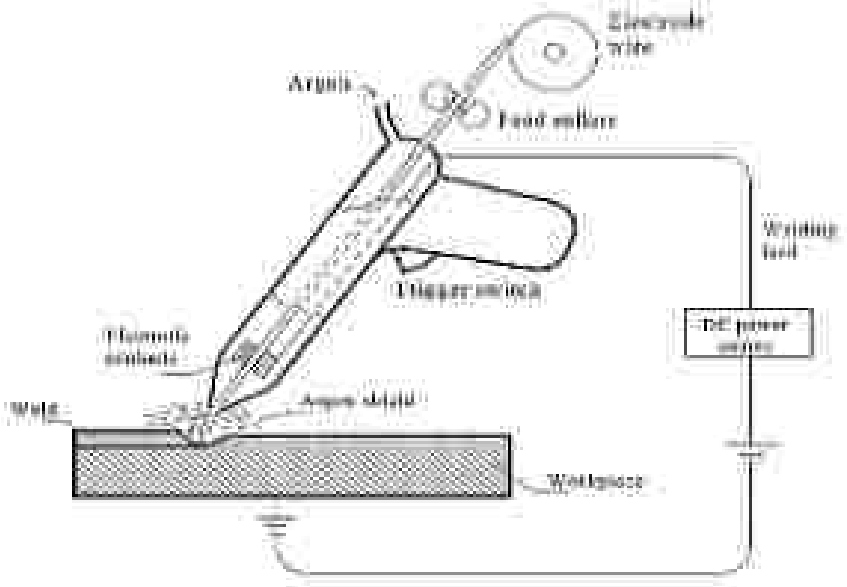
MIG Welding:

The following components are necessary to perform metal inert gas welding.

1. Consumable electrode
2. Inert gas supply
3. Welding torch
4. AC or DC power supply
5. Electrode feeding mechanism

Working:

- The work piece to be welded the consumable electrode (in the form of wire) is brought near the work piece (with a small air gap), an arc is produced. This arc melts the electrode. The melted electrode fills uniformly over the required regions of the work piece. During the welding the inert gas forms a shield around the arc and the weld. This protects the weld from the external atmosphere. This type of electrode and the shielding gas used primarily depends on the material to be welded. Consumable electrode is continuously supplied from the spool by a suitable feeding mechanism. Commonly servo mechanisms are used for feeding long electrodes. In MIG welding consumable electrode itself acts as filler metals so, no separate filler rod or filler wire is needed.



Advantages:

- Consumable electrodes are easy to feed.
- No filler rod is needed.
- Welding is simple.
- Inert gas shield protects the weld automatically.

Disadvantages:

- If not handled properly, weld may become porous.
- MIG welding exposes welder to hazardous gases.
- Workpiece and electrodes should be kept clean before welding.

Application:

- Welding of Al, Mg, Cu, in aerospace industry. Welding of tool and die.

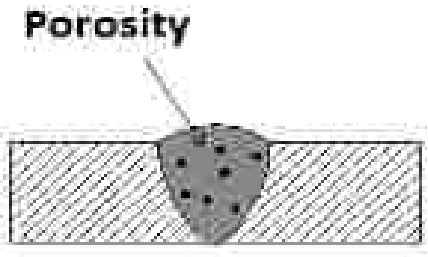
2.10 State different welding defects with causes and remedies:

The most important welding defects are as follows.

a. Porosity and blow holes.
b. Slag inclusion.
c. Cracks.
d. Distortion.
e. Spatters.
f. Under cutting.
g. Poor weld bead appearance.
h. Incomplete fusion and penetration.

Porosity and blow holes:

- Porosity is the condition in which the gas or small bubbles gets strapped in the welded zone. Blow holes are the large gas cavities or bubbles create in the welded zone.



Causes:

- High welding speed.
- Dirty base metal.

Remedies:

- Reduce welding speed, to allow time gases to escape.
- Clean the base metal properly.

Slag inclusion:

- Flux used in welding reacts with impurities and forms a slag. If this slag is mixed with weld bead, that effects is called slag inclusion.

Slag inclusion

Causes:

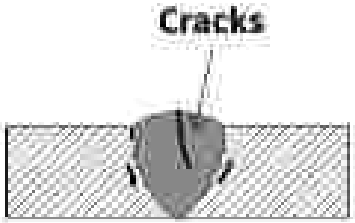
- Slag removal is not proper. Oxide inclusion.

Remedies:

- Clean surface and previous weld bead properly.
- Use more electrode angle, fresh and proper electrode.

Cracks:

- Cracks may occur in various locations and directions such as in the weld, root etc. Cracks are two type that is hot or cold.



Causes:

- High cooling rate.
- Low ductility.

Remedies:

- Cooling rate should be reduced.
- Use high ductility material.

Distortion:

- Distortion is the change in shape and difference between the position of the two-work piece before welding and after welding.

Causes:

- Poor cooling and fixture.
- High cooling rate.

Remedies:

- Use proper clamps, jigs and fixtures.
- Required proper cooling.

Spatter:

- Spatter refers to small particles of metals, which are scattered around the weld along its length.

Causes:

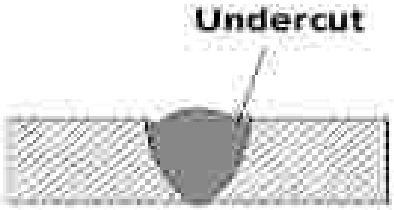
- Use of an excessive current.
- Use of too long arc length.

Remedies:

- Use proper welding current.
- Use fresh electrode.

Under cutting:

- If the groove gets formed in the parent metal allow the side of the weld bead that is called under cutting.



Causes:

- High current.
- Faster arc travel speed.

Remedies:

- Use proper current.
- Maintain proper arc travel speed.

Poor welds bead appearance:

- If the weld bead deposited is not straight, width of bead is not constant, then the weld bead is called poor.

Causes:

- If arc length is not constant.
- Improper welding technic.

Remedies:

- Maintain constant arc length.
- Use proper welding technic.

Incomplete fusion and penetration:

These defects occur when the depth of the welded joint is in sufficient and the fusion of the metal is improper.

Causes:

- Less arc currents.
- Faster arc travel speed.
- Improper electrode position.

Remedies:

- Use proper arc current.
- Use less arc travel speed.
- Maintain proper electrode position.

Testing of welded joint:

1.Destructive test (DT):

- Some of these tests, such as tensile and bending test are destructive, in that the test specimen are loaded until they fail. So, the desired information can be gained.
- Destructive test are two types:
    1. Work shop-based test.
    2. Laboratory test.
        a. progressive
        b. chemical
        c. microscope and macro scope.

2. Non-Destructive test:

- Other testing method such as x-ray and hydro static test are non -destructive. This type of testing is also refered to NDE or Non-destructive examination and NDI or Non-destructive inspection. The goal of these methods to examine the welds without causing any damage.

POSSIBLE SHORT TYPE QUESTIONS WITH ANSWER

1.Define welding? (2016,2018-W)
Answer: - Welding is a process of joining two similar or dissimilar material with the help of heat and flux material and with or without application of pressure.

2.What is the function of fluxes in welding? (2019-W/S, 2022-W)
Answer: - A flux is a material used to prevent the oxidisation of molten metal by facilating the removals of oxides.

3. Define ARC welding? (2019-W/S)
Answer: - In this type of welding process a joint is produced by heating the work piece with an electric arc setup between flux coated electrode and the work piece.

4. Write various types of flames used in oxy-acetylene welding process. (2017, 2019-W, 2022-W)
Answer: -The flames are used in oxy-acetylene welding process are-
Neutral flame, Oxidising flame, Carburising flame.

5. Define resistance welding?
Answer:- Resistance welding is a group of welding process where a joint is produced between two workpieces by the heat obtained from resistance to flow electric current in a circuit through the same work piece.

6. What do you understand by gas welding? (2019-W)
Answer:- metal joining process in which the ends of pieces to be joined are heated at their interface by producing coalescence with one or more gas flames such as oxygen and acetylene, with or without the use of a filler metal.

7. Name any two materials suitable for oxy-acetylene welding process. (2020-W)
Answer:- Materials suitable for oxy-acetylene gas welding are-
Stainless steel, aluminium, copper, brass.

8. Classify the welding process. (2021-W)
Answer:-1.Gas welding
2. Arc welding
3. Resistance welding
4. Solid state welding

9. Name any four types of welding defects. (2021-W)
Answer: - porosity and blow holes, slag inclusion, cracks, distortion, spatter.

POSSIBLE LONG TYPE QUESTIONS

1. Describe with neat sketch the working principle of oxy acetylene welding. (2017)

2. Describe with neat sketch the working principle of resistance welding. (2016, 2018-W, 2019-S/W, 2020-W)

3. Describe with neat sketch the working principle of T.I.G. welding. (2017, 2019-W)

4. Explain with neat sketch types of flames used in oxy acetylene welding. (2019-W/S)

5. Discuss the various types of welding defects with causes and remedies. (2019-W/S, 2022-W)

6. Discuss about various types of destructive and non-destructive types of tests carried out to detect welding defects. (2020-W)

7. Explain the functions of fluxes used in the manufacturing of filler rods. (2017, 2021-W)

8. What is resistance welding? Write short notes on spot welding and seam welding. (2019-S, 2020-W, 2022-W)

9. Explain TIG and MIG welding process. (2019-S)

10. Explain briefly about carburizing flame and oxidizing flame. (2019-W)

11. Differentiate between TIG and MIG welding process. (2019-W, 2021-W, 2022-W)

12. Explain MIG welding process. (2019-W)

13. Write short notes on-(2020-W)
    Under cut.
14. Explain GMAW process with neat sketch. (2020-W)

15. Describe electric ARC welding process with neat sketch. (2021-W)

CHAPTER NO. – 03
CASTING

Learning Objectives:

3.1 Define Casting and Classify the various Casting processes.
3.2 Explain the procedure of Sand mould casting.
3.3 Explain different types of moulding sands with their composition and properties.
3.4 Classify different pattern and state various pattern allowances.
3.5 Classify core.
3.6 Describe construction and working of cupola and crucible furnace.
3.7 Explain die casting method.
3.8 Explain centrifugal casting such as true centrifugal casting, centrifuging with advantages, limitation and area of application.
3.9 Explain various casting defects with their causes and remedies.

3.1 Define Casting and Classify the various Casting processes:

- Casting is a manufacturing process in which a liquid material is usually poured into a mould, which contains a hollow cavity of the desired shape, and then allowed to solidify. The solidified part is also known as a casting, which is ejected or broken out of the mould to complete the process.

Steps involved in making of casting:

- Make the pattern out of wood, metal or plastics.
- Prepare the mould or core.
- Pour the molten metal in to the cavity.
- Remove the casting from the mould after the metal solidifies.
- Clean and finish the casting.

Types of casting:

Casting may be classified as follows-

1. Investment casting.
2. Centrifugal casting.
3. Semi centrifugal casting.
4. Die casting.
5. Cold chamber die casting.
6. Hot chamber die casting.
7. Continuous casting.

3.2 Explain the procedure of Sand mould casting:

The procedure for sand mould casting is as follows.

1. **Selection of sand**
   - Select the sand for preparation of mould box. The sand should have good mechanical as well as thermal properties like binding property and permeability.
2. **Pattern making**
   - Prepare the pattern required for the mould. The pattern is the replica of the object to be produced. Patterns are generally made in wood, plastics, etc.

3. **Preparation of mould box**
   - Keep ready the mould in which the moulding sand are well set. The mould box should strong enough to with stand the force of liquid metal.
4. **Preparation of pouring cavity**
   - Now punch and remove once the pattern inside the moulding sand in order to make a cavity exactly similar to pattern.
5. **Pouring of molten metal**
   - Now pour the liquid metal in to the cavity with minimum cavity force and keep the liquid metal to cool and solid.
6. **Breaking the mould**
   - By breaking the mould remove the solid components and do machining process to make it use.

3.3 Explain different types moulding sand with their composition and properties:

Types of moulding sand:

The principal material used for mould making in the casting. All sands are formed by the breaking up of rocks due to the action of forces. Moulding sand are following types:

1. **Silica sand**

   The sand which forms the major portion of the moulding sand is called silica sand.

   Composition
   - Silica (Sio_2) =96%
   - Al, Na, Mg, Oxide=2%
   - Water=2%

2. **Zircon sand**
   - It is basically a zirconium silicate ($ZrSio_4$)

   Composition
   - ZrO_2=66.25%
   - SiO_2=3.96%
   - Al_2O_3=1.92%
   - Fe_2O_3=0.74%

3. **Chromite sand**
   - This sand is crushed from chromcore. It is used for manufacturing of steel.

   Composition
   - Cr_2O_3=44%
   - Fe_2O_3=28%
   - SiO_2=2.5%
   - Cao=0.5%

4. **Olivine**
   - Olivine contains the minerals foistenit and fagaite. It is very versatile sand can be used for smooth finish product.

Properties of moulding sand:

1. **Flowability**
   - It is the ability of the moulding sand to flow away from the pattern due to ramming.
2. **Collapsibility**
   - Ability of the moulding sand so that it will not offer only resistance against the contraction of casting material.
3. **Permeability**
   - Gas involving capacity of moulding sand is called permeability.
4. **Refractoriness**
   - It is the ability of moulding sand to with stand at high temperature.
5. **Adhesiveness**
   - It is the ability of moulding sand to not stick to the molten metal.

3.4 Classify different pattern and state various pattern allowances:

Pattern:

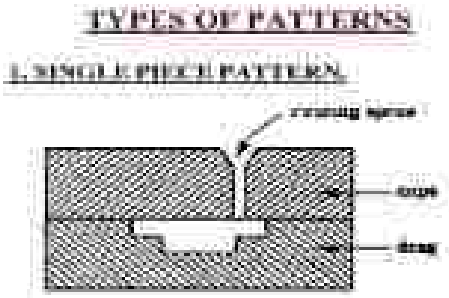
- It is a replica of the object to be produced with some modification. The modification is in the form of allowances core prints and paddings.

Classification of patterns:

1. Single piece pattern
2. Split piece pattern
3. Loose piece pattern
4. Gated Pattern
5. Sweep pattern
6. Match plate pattern
7. Skeleton pattern

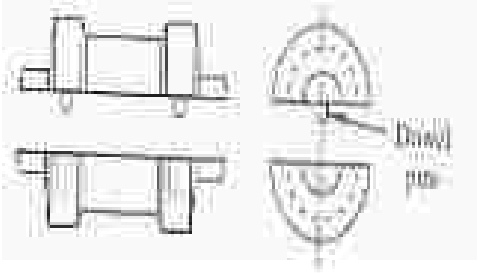
Single piece pattern:

- It is made in one piece usually from wood and is best suited for limited production.



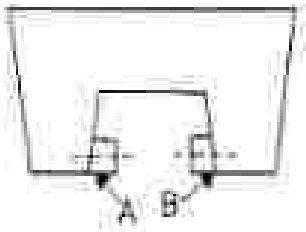
Split piece pattern:

- This is used when casting components having complex design. It is split along the parting surface.



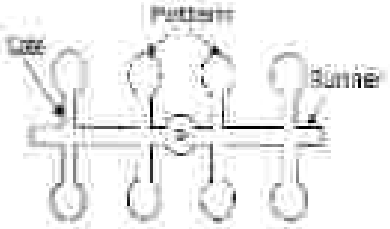
Loose piece pattern:

- It is required when one piece or split pattern is suitable for withdrawal from the mould.



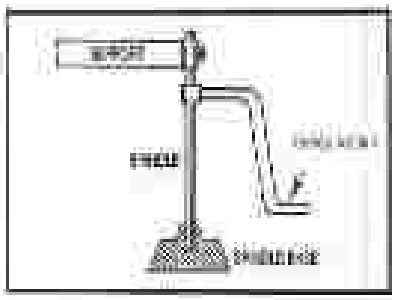
Gated pattern:

- To produce a greater number of small size product in a single run we can use gated pattern.



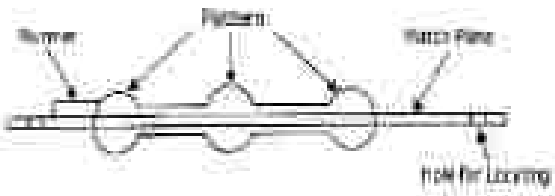
Sweep pattern:

- To produce complex 3d objects using 2d plane pattern we use this pattern.



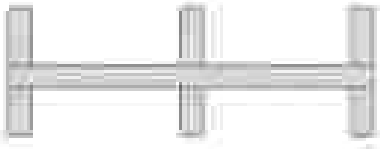
Match plate pattern:

- To produce small size components having more complex shape in mass production we can use this pattern.



Skeleton pattern:

- To reduce the amount of material consumed in preparation of large size 3D components we can use this pattern.



Pattern allowances:

- Meaning of allowances in engineering points of view is that kept something extra material over the specified size.
- There are five types of allowances:
  - Shrinkage or contraction allowances
  - Draft or tapper allowances
  - Machining allowances
  - Rapping or shaking allowances
  - Distortion allowances

Shrinkage or contraction allowances:

- After solidification of the metal from further cooling the dimensions of the pattern increases. So, pattern size is bigger than that of the finished product. This is known as shrinkage allowances.

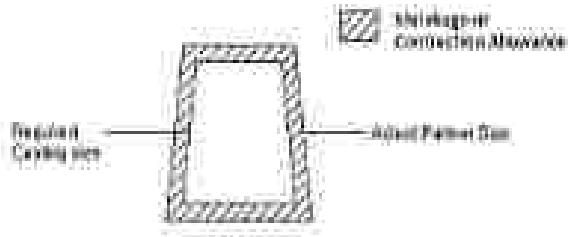
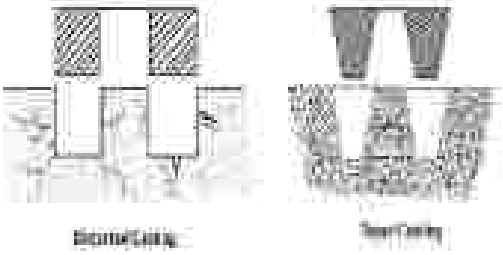


Figure. Shrinkage or contraction Allowance

Draft or tapper allowances:

- Pattern draft is the taper placed on the pattern surfaces that are parallel to the direction in which the pattern is withdrawn from the mould, to allow removal of the pattern without damaging the mould cavity. It depends on the sand mixture used, the design, method of moulding.



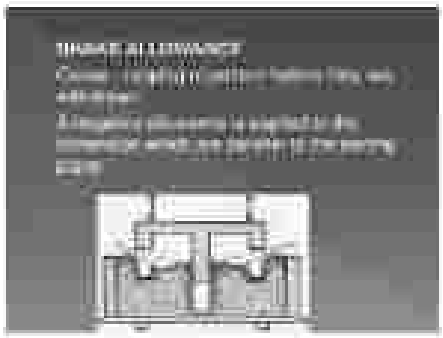
Draft Allowance

Machining allowances:

- Machining allowances is the finishing allowances which is given in the pattern to get better surface finish. It depends on the size, shape and volume of casting, configuration of casting, characteristics of metal etc.

Rapping or shaking allowances (negative allowances):

- When the pattern is Shaked for easy withdrawal the mould cavity gets slightly larger in dimension. This also causes the casting size to increase for compensating this factor the pattern should initially be made slightly smaller than the desired size.



Distortion allowances:

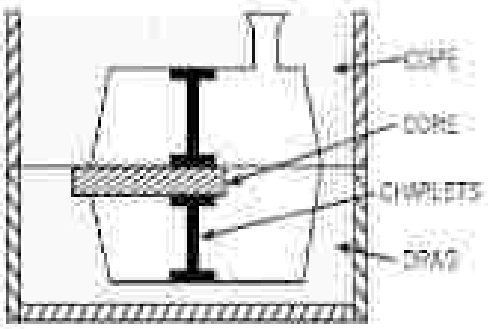
- Depending upon shape and size of the casting due to difference in shrinkage rate, there is a possibility of distortion of the casting to overcome this opposite to the direction of distortion the pattern will design by providing some distortion allowances.

Distortion Allowance

3.5 Classify core:

Core:

- A core may be defined as a sand shape or from which makes the cavity of a casting for which no provision has been made in the pattern for moulding.



Function of core:

- For producing hollow casting, cores are provided.
- Cores may be employed to improve the mould surface.
- Cores may be used to increase the strength if the mould.
- Cores may be used to form the gating system of large size moulds.

Classification of cores:

Cores may be classified into following types:

a. The state or condition of core.
   1. Green sand core.
   2. Dry sand core

b. The nature of core material employed.
   1. Oil bonded core.
   2. Resin bonded core
   3. Shell core
   4. Sodium silicate core

c. The shape and position of core

1. Horizontal core
2. Vertical core
3. Hanging core
4. Ram up core
5. Balanced core

d. The type of core handling process employed.

1. Co_2 process
2. The hot box process
3. The cold set process
4. Oil no bake process

Construction of core:

Steps involved in construction or preparation of core are as follows.

Core sand preparation:

- Core sand is a suitable sand mixture for making cores.
- Cores sand must have to pass different quality test such as strength, hardness, permeability.

Making the core:

- Small cores can be made manually in hand rammed core boxes.
- Cores of mass scale are produced on a variety core making machine such as jolt machine, sand slinger, core blower, core extrusion machine, shell core machine.

Baking the core:

- once the cores having prepares, they are placed on core plates and send for baking.
- Core baking develops the properties of the organic binders.

Finishing of core:

- Baked cores are finished before they can be set in the mould.
- Core finishing consist of cleaning, sizing and core assembly.

Sitting the core:

- Core sitting means placing the core in the mould.
- Small cores sitting means placing the core in the mould.
- Small cores are set in the mould by hand where as big cores required machine.

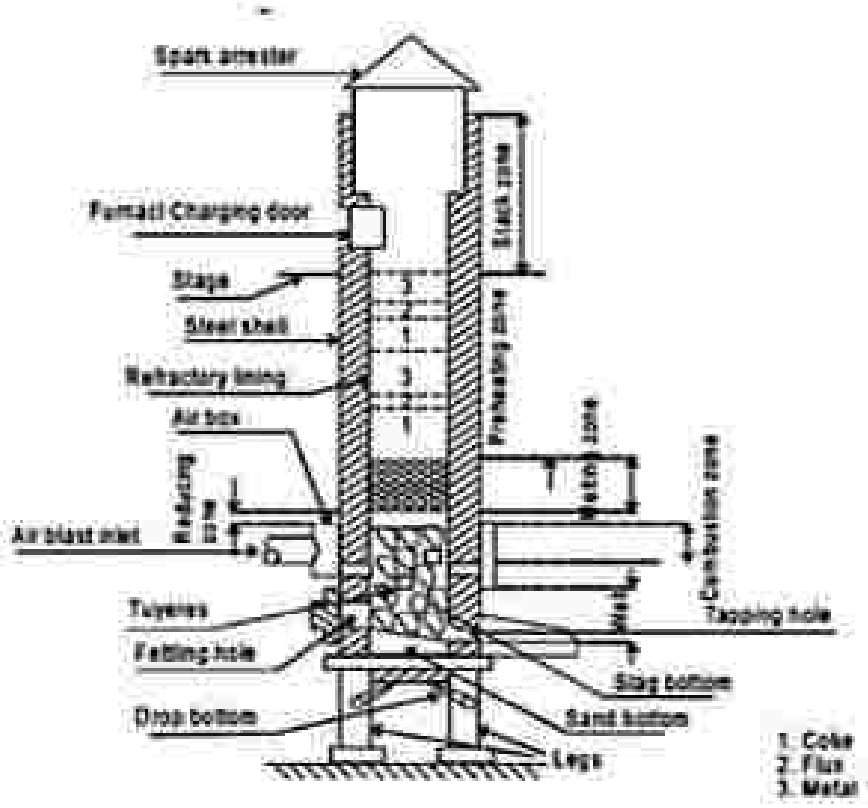
3.6 Describe construction and working of cupola and crucible furnace:

- Cupola furnace is employed for melting scrap metal or (over 90% of) the pig iron used in the production of casting.

Construction:

- A cupola is a cylindrical shell constructed (welded or riveted) from boiler plate (6 to 10 mm) is open at both its top and bottom and is lined with firebrick and clay.
- Air from the blower comes through the blast pipe and enters into wind box which surrounds the cupola and supplies air evenly to all the Tuyeres.
- Tuyeres extend through the steel shell and refractory wall to the combustion zone and supply air necessary for combustion.

- There is a tap hole in the cupola from where the molten metal is taken out to pour into the moulds.
- Opposite of the tap hole and a little higher than metal floats over the molten metal and is removed through the slag hole.



- Cupola remains either open or has a metal shield or a spark arrester at its top.
- In addition, a cupola is provided with a charging platform and a charging door at suitable height to feed the charge in cupola.
- Cupola capacities vary from 1 to 15 tons (or even more) of melted iron per heat.
- The height of a cupola is commonly about 6mtrs and the diameters of cupola ranges from 75cm to 2.5 meters.
- Sometimes, a cupola may be fitted with a collector, filter and precipitator to minimize atmospheric pollution.

Working:

The different steps involved in cupola furnace operations are-

(a) Preparation of Cupola:

- The bottom door is dropped to open.
- The contents (unburned coke, slag and metal) in the cupola left from the previous melting operation are dumped under the furnace and removed.
- Slag, coke and iron sticking to the side walls of the furnace are chipped off.
- Damaged fire bricks (burned, cracked or broken) are replaced by new ones.
- Sand bed is prepared with slope toward the hole.
- Once the furnace is reconditioned the bottom opening door is closed and duly supported.
- Ramming should be uniform and proper to avoid any leakage of molten iron through the bottom opening door.

(b) Lighting the fire in the coke bed:

- Cupola is started i.e., fired about three hours before the molten metal is suitable for pouring in to the moulds.

- For starting the cupola, soft and dry pieces of wood are placed on the sand bed rammed above the bottom opening door.
- Air necessary for combustion of coke enters from the Tuyeres.
- Besides using wooden pieces for initiating fire in the cupola, the other methods which are used for the purpose employ (1) electric spark igniters (2) gas torches.

(c) Charging of copula:

- After the coke bed is properly ignited the cupola is charged from the charging door.
- Charging of cupola means adding layer of lime stone(flux), iron (metal) and coke (fuel) up to the level of charging door.
- Flux is a substance which aids forming slag to remove impurities and retired oxidation of iron.
- The fluxes are lime stone ($caco_3$), fluorspar (caf), calcium carbide ($caco_3$), dolomite, magnesium carbonate etc.
- The melting ratio carbonates that to melt 10 tons of iron, one ton of cake is required.

(d) Melting or soaking:

- After the cupola is fully charged, a soaking period of about 30 minutes to one hour is given to permit the charge to preheat.
- After the air blast has been on for about 10 minutes, molten iron starts accumulating in the furnace and appears at the tap hole.

(e) Opening of air blast:

- After soaking (melting), now the air blast fully opened.
- The metal gets heated and begin to melt and flow downward continuously.

(f) Dropping down the bottom:

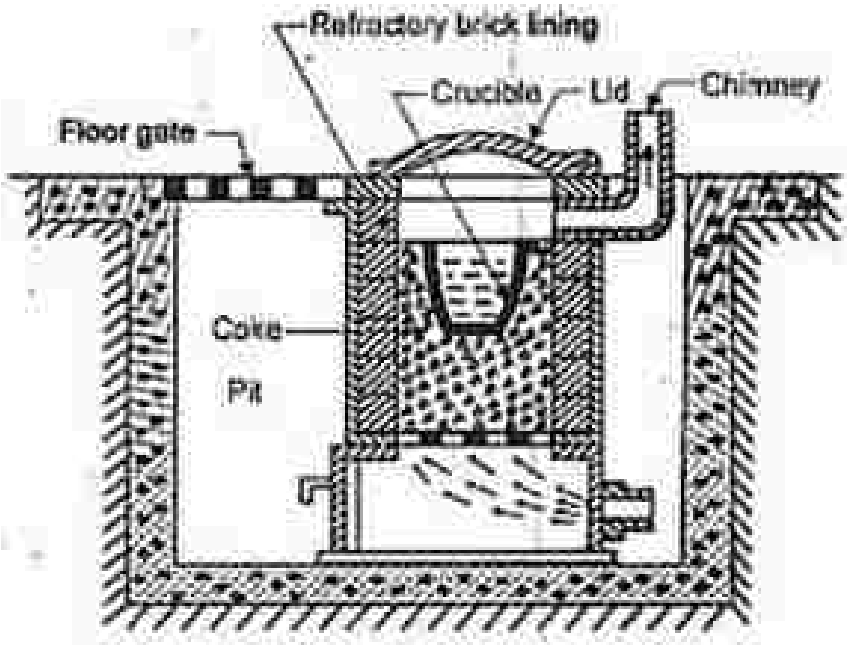
- Near the end of the cupola heat, charging of cupola is stopped.
- At this stage the air blast is shut off the bottom opening door is knocked down and the remains in the cupola are either dropped on to the floor or into a bucket.

Crucible furnace:

- In a crucible furnace the metal charge is placed and melted in a crucible.
- A crucible is made up of silicon carbide, graphite or other refractory materials and it can withstand high temperature.
- Crucibles are available in different sizes ranging from no.1 to no.400.
- A crucible furnace is though mainly used for melting of non-ferrous metal and low melting point alloys, it has also used for melting of cast iron and steel also.
- A crucible furnace consists of a steel shell provided with refractory (fire brick) lining inside.
- A crucible furnace has the following advantages:
  - i. **Low initial cost**
  - ii. **Easy to operate.**
  - iii. **Low cost of fuel etc.**

Construction and working:

- A pit furnace has crucible placed in a pit below the ground level.
- It may be coke, oil, or gas fired furnace, but usually it is fired with coke.
- Enough coke is packed round and above the crucible pot so as to melt and superheat the metal charge.



- The metal charge consists of pig iron, foundry returns and broken castings.
- The coke bed is formed, ignited, and allowed to burn.
- The crucible is surrounded from all sides with the coke and its top is covered with a lid.
- A blower is used to provide the necessary air for the combustion of coke while the charge is melting.
- As the charge melts and attains the required pouring temperature, crucible is brought out of the furnace with the help of tongs and is taken to the place of pouring.

3.7 Explain die casting method:

In this method molten metal is forced into permanent mould (die) cavity under pressure.

- The pressure is generally obtained by compressed air or hydraulically.
- The pressure varies from 70 to 300 kg cm^2 and is maintained while the casting solidifies.
- Associated with the high-pressure air the liquid metal is injected in to the die cavity.

Die casting machine:

A die casting machine performed the following functions:

- Holding the two die halves firmly together.
- Closing the die.
- Injecting molten metal in to die.
- Opening the die.
- Ejecting the casting of the die.

A die casting machine consists of four basic elements:

1. Frame.
2. Source of molten metal and molten metal transfer.
3. Die casting dies.
4. metal injection mechanism.

Types of die casting:

It is two types:

1. Hot chamber die casting.
2. Cold chamber die casting.

Hot chamber die casting (goose -neck type):

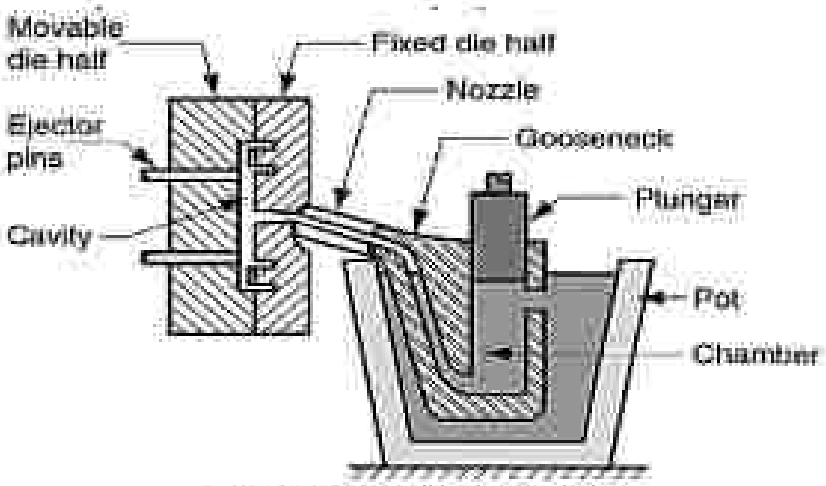


Figure: Hot chamber die casting

- The cast iron goose-neck is so pivoted that it can be dipped beneath the surface of the molten metal to receive the same when needed. The molten metal fills the cylindrical portion and the curved passage ways of the goose-neck.
- Goose-neck is then raised and connected to an airline which supplies air pressure to force the molten metal into the closed die.
- Air pressure required for injecting metal into the die is of the order of 30 to 45 kg/cm^2. After the casting has solidified the goosneck is again dipped beneath the molten metal to receive molten metal again for the next cycle.
- In the meantime, die halves open out, casting is ejected and die closes in order to receive molten for producing the next casting. The cycle repeats time and again.

Advantages:

- It is a simple machine as regards its construction and operation.
- Unlike submerged plunger type machine this machine carries no moving parts (i.e. plunger etc.)

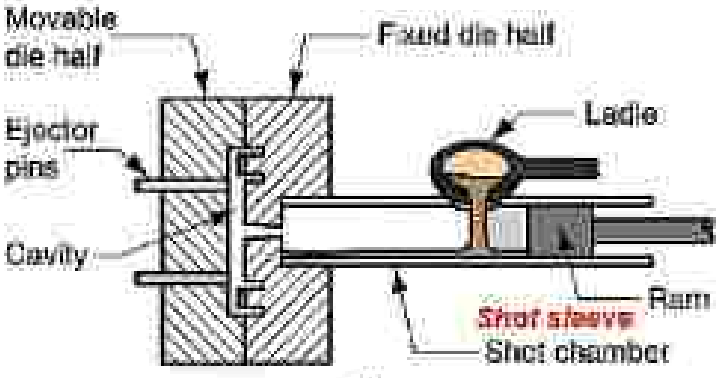
Disadvantages:

- Production rate is lower when compare to submerge plunger type machine.
- Compressed air does not produce pressure on molten metal so effectively as the plunger does.

Application:

- Air injection type of hot chamber die casting machine can produce casting of low melting metal such as zinc, tin and lead.

Cold chamber die casting:



(1)

- In this die casting method, the melting unit is not an integral part of the cold chamber die casting machine. Molten metal is brought and poured into the die casting machine with the help of ladles.

Working:

- This machine consists of a pressure chamber or cold chamber of cylindrical shape fitted with a ram usually operated by hydraulic pressure.
- Strong, high grade, heat resistance alloy steel is used for making the working parts of the machine and die because of the effects of temperature and high pressure associated with this process.
- A major quantity of molten metal is brought in a ladle and poured into the cold chamber after the die is closed.
- The ram forces the molten metal into the die.
- The pressure required to force metal into the die is 200 to 2000 kg/cm^2 and hence high squeezing action is exerted on the metal while it solidifies.
- Once the casting has solidified the moveable half of the die is slides away and the die opens.
- Cores are withdrawn, ram moves in backward direction and the ejector advanced to force the casting out of the die half.

Advantage:

- Casting produces are of greater density.
- Separation of melting unit from the working parts of die casting machine increases its life and efficiency.

Disadvantages:

- Since very high pressure are involved in cold chamber die casting, dies will have to be made stronger in order to with stand the same.

Application:

- Used for making casting in brass, magnesium etc.

3.8 Explain centrifugal casting such as true centrifugal casting, centrifuging with advantages, limitation and area of application:

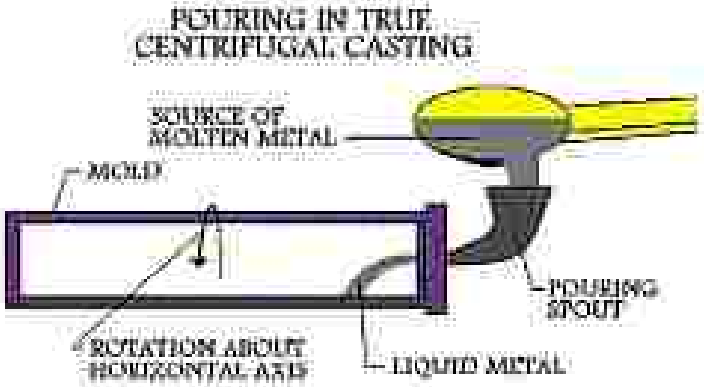
Centrifugal casting:

- The essential feature of centrifugal casting is the introduction of liquid metal into a rotating mould. Centrifugal force plays a major role in the shaping and feeding of the casting.
- The centrifugal casting is classified into the following types-

True centrifugal casting:

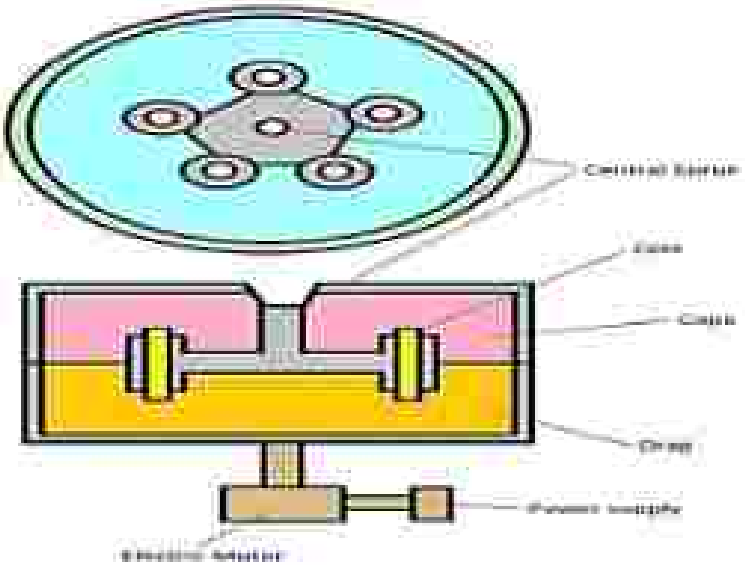
- True centrifugal casting is of straight uniform inner diameter and are produced by spinning the mould about its own axis, either vertically or horizontally.
- They have more or less symmetrical configuration.
- A cylindrical mould is made to rotate on its own axis at a speed such that the metal being poured is thrown to the outer surface of the mould cavity.
- The metal solidifies in the form of a hollow cylinder. The cylinder wall thickness is controlled by the amount of liquid metal poured.
- Casting cools and solidifies from outside towards the axis of rotation by providing conditions which setup directional solidification to produce castings free from shrinkage.

- True centrifugal castings may be produced in metal or sand lined moulds depending largely upon the quality desired.



Centrifuged casting:

- Parts not symmetrical about any axis of rotation may be cast in a group of mould arranged in a circle to balance each other.
- The axis of mould and that of rotation do not coincide with each other.
- The centre is revolved around the centre of the circle to introduced pressure on the metal in the mould.
- Casting shape imposes no special limitation in this process and an almost unlimited variety of smaller shape can be cast.
- Mould cavities are feed by a central sprue under the action of centrifugal force.
- When casting in multiple layers are above the other are produced in one mould, the method is called stack moulding.
- It is used for producing valve bodies, plugs and a wide variety of other industrial castings in large quantities.



Advantages:

- Casting has high density of production, high mechanical strength, and fined grained structure.
- Inclusions and impurities are less.
- High output.
- Formation of hollow interiors without core.

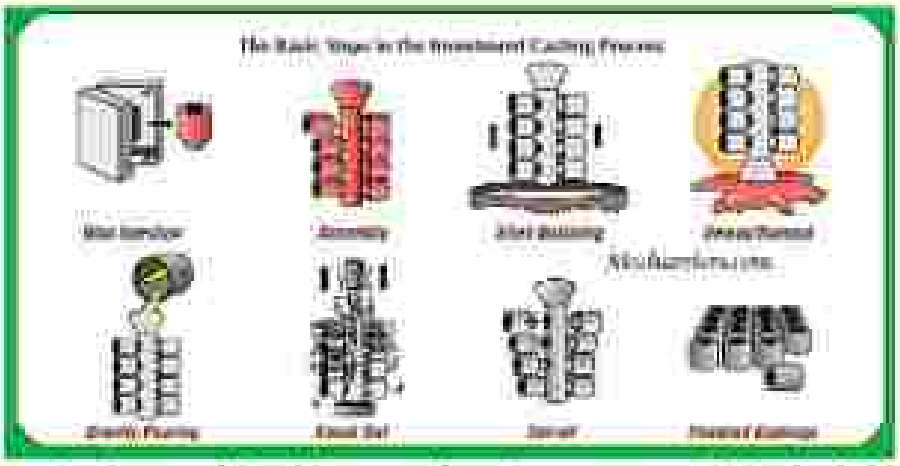
Disadvantages:

- An inaccurate diameter of the inner surface of the casting.
- Not all alloys can be cast in this way.

Application:

- For casting of pipes, bushings, gears, flywheel etc.

Investment casting:



- Investment casting is one of the oldest manufacturing processes, dating back 1000 of years, in this process molten metal is poured into an expandable ceramic mould.
- The procedure for investment casting are as follows-

1. Pattern creation:

The wax pattern is typically injection moulded into a metal die and are formed as one piece. core may be used to form any internal features on the pattern.

2. Mould creation:

this pattern is dipped into a ceramic slurry which contains silica flour, ethyl silicate binder and H_2O.

3. Pouring:

The mould is preheated in a furnace and the molten metal is poured by a ladle into the gating system of the mould for filling the mould cavity.

Pouring is typically achieved manually under the force of gravity and also pressure.

4. Cooling:

After the mould has been filled, the molten metal is allowed to cool and solidify into the shape of the final casting. Cooling time depends on the thickness of the part, thickness of the mould and the material used.

5. Casting removal:

After the molten metal cooled, the mould can be broken and the casting remove. The mould is broken by using water or air jets.

6. Finishing:

Often times, finishing operation such as grinding are used to smooth the parts. Heat treatment is also sometimes used to harden the casting parts.

Advantages:

- Can form complex shapes fine details.
- Any material operations.
- High strength parts.
- Very good surface finish
- Little need for secondary machining.

Disadvantages:

- Time consuming process.
- High labour cost.
- High cooling cost.

Application:

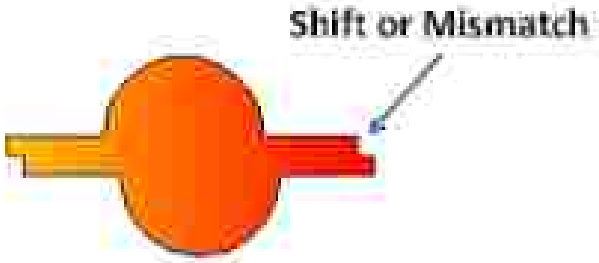
- Turbine blades, ornament parts, pipe fittings, lock part, hand tools jewellery etc.

3.9 Explain various casting defects with their causes and remedies:

- Under normal conditions, like all metallurgical products, castings also contain certain imperfections which contribute to a normal quality variation.
- Defects found in casting may be divided into three types:
    1. Defects which can be noticed on visual examination or measurement of the casting.
    2. Defects which exist under surface and are revealed by machining, sectioning, or radiography.
    3. Material defects discovered by mechanical testing (tensile, bending, impact, etc.) of the casting.

The following casting defects are described below:

1. Mismatch or mould shift:



- It produces a casting which does not match at the parting line.

Causes:

- Worn or loose dowels in pattern made in halves.
- Faulty registering of top and bottom halves of patterns mounted on plates.

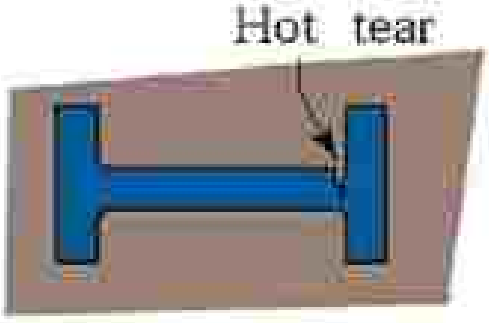
2. Pin holes:

- Pin holes are numerous very small holes revealed on the surface of a casting after the surface has been cleaned by shot blasting.

Causes:

- Sand with high moisture content.
- Sand containing gas generating ingredients.
- Faulty metal.
- Gas dissolved in the alloy and alloy not being properly degassed.

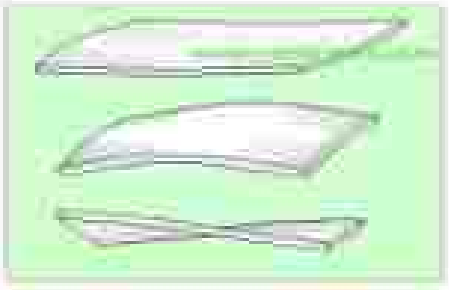
3. **Hot tears:**
   - They are internal or external cracks having ragged edges occurring immediately after solidification.



Causes:

- High dry and hot strength of the sand mould.
- Too much shrinkage of metal while solidifying.
- Slow running of molten metal due to small gates.

4. **Wrapage:**
   - Casting warp or deform because of stress set up in them internally, due to different solidification rate experienced by different sections of large, long and wide flat castings.



Causes:

- Faulty casting designs.
- Absence of directional solidification.

5. **Hard spots:**
   - Hard spots occur in grey iron casting having insufficient silicon content.
   - Such castings get hardened by the chilling action of moulding sand.
   - Hard spots make machining of the casting difficult.

Causes:

- Faulty metal composition.
- Faulty casting design, leading to rapid cooling of some parts of the castings as compared to other parts.

6. **Fusion:**
    - Sand may fuse and stick to the casting with a resultant rough glossy appearance.

Causes:
- Lack of refractorness of sand.
- Too high molten metal temperature.
- Faulty gating system.

7. **Metal penetration and rough surfaces:**
    - Molten metal enters into the spaces between the sand grains and results in metal penetration and rough casting surface.

Causes:
- High permeability.
- Low dry strength of sand.
- Large grain sized.
- Soft ramming.

Inspection of casting:
- In casting process, first few castings will be inspected dimensionally and the pattern is qualified after wards, only few random inspections will be done. every casting must be inspected for finding out the defects in casting process.

Methods of inspections:
- Different methods of inspections are as follows.

Visual inspection:
- Common defects such as surface roughness omission of cores, surface cracks can be detected by visual inspection of casting.

Hydro static pressure test:
- The hydrostatic pressure test is conducted on a casting to be used as a pressure vessel.
- Then the casting is filled with water, oil or compressed air. There after the casting is submerged in a soap solution when any leak will be evident by the bubbles that comes out.

Radio graphic examination:
- This method is expensive and is used only for sub surface exploration various defects like voids, inclusions, porosity, cracks, and tears can be detected by X-ray and Y-ray and gamma ray in this method.

Ultrasonic inspection:
- In this method an oscillator used to send an ultrasonic signal through the casting.
- The signal is reflected back and this reflected signal is then detected by an ultrasonic detector.
- The time interval between sending the signal and receiving its reflection determines the location of discontinuity.

Economy of casting:
- Casting has been used for shaping metals since the earliest days of civilization.

- A wide variety of sizes and shapes of simple and complicated nature can be produced in different metals.
- Casting is the most versatile manufacturing process.
- Casting provides the greatest freedom of design in terms of shape, size and the product quality.
- Casting produces machinable parts.
- Casting process can be usefully employed for mass production.

POSSIBLE SHORT TYPE QUESTIONS WITH ANSWER

1. Define castings process. (2016,2018-W,2019-S/W)

Ans: Casting is a process of producing metal components of desired shape and size by pouring and solidify it in the two-casting box.

2. What is core? (2019-S,2020-W)

Ans: A core is a body of sand which is employed to produce a cavity in the casting.

3. Write different properties of moulding sand.

Ans: Flow ability
Collapsibility
Permeability
Refractoriness
Adhesiveness

4. What is centrifugal casting?

Ans: The essential features of centrifugal casting are the introduction of liquid metal into a rotating mould. Centrifugal force plays a major role in the shaping and feeding of the casting.

5. Define die casting. (2016-W)

Ans: In this method molten metal is forced into permanent mould cavity under pressure. The pressure is generally obtained by compressed air or hydraulically.

6. What do you mean by pattern in casting? Write the types of pattern. (2016, 2017, 2019-W, 2022-W)

Ans: In casting, pattern is a replica of the object to be cast, used to prepare the cavity into which molten material will be poured during the casting process.
Types of pattern- single piece pattern, loose piece pattern, gated pattern, split piece pattern, skeleton pattern.

7. What do you mean by permeability? (2019-W, 2022-W)

Ans: Permeability is the property by which we can know the ability of material to transmit fluid or gasses.

8. What do you understand by the term Riser and Gate? (2019-W)

Ans:

- Riser - It is known as a feeder, reservoir built into a metal casting mould to prevent cavities due to shrinkage.
- Gate: A gate is a channel which connects runner with a mould cavity and through which molten metal flows to fill the mould cavity.

9. What do we understand by economics of casting? (2020-W)

Ans: Casting has been used for shaping metals in simple and complicated form. It is most versatile manufacturing process. It is used for mass production.

10. What are the advantages and disadvantages of casting process? (2019-W)

Answer :-

Advantages

- It can creates any complex structure economically

- The size of object doesn't matter for casting
- This can create an accurate object

Disadvantages

- It gives poor surface finish
- Casting defects involves in this process
- It is not economical for mass production.

11. What do you mean by remability of moulding sand? (2021-W)

Answer: - Since large quantity of sand are used in a foundry it is very important that the sand be reusable otherwise apart from cost it will create disposal problems.

12. What is meant by machining allowances in pattern making? (2021-W)

Answer:- Machining allowances or finishing allowances is the extra material added to the certain parts of the casting to enable their machining to the required size, accuracy and surface finish.

13. State the steps in core preparation. (2021-W)

Answer:- Core sand preparation, making the core, baking the core, finishing of core, setting the core

14. Define porosity and its remedies.(2022-W)

Answer:-Porosity is the condition in which the gas or small bubbles get strapped in the welded zone. Blow holes are the large gas cavities or bubbles create in the welded zone.

Remedies

- Reducing pouring metal speed, to allow the gases to escape
- Use proper moulding sand.
-

15. What is the function of chill and chaplet? (2022-W)

Answer:-

Chill

A chill is an object used to promote solidification in a specification of a metal casting mould

Chaplet

Chaplets are used to support the core inside the mould cavity to take care of its own weight and overcome the metallostic forces.

POSSIBLE LONG TYPE QUESTIONS

1. Describe with neat sketch the construction and working of copula furnace. (2017, 2019-W/S, 2021-W, 2022-W)

2. Describe with neat sketch the construction and working of crucible furnace. (2016, 2019-W, 2018-W)

3. Write a short note on different types of moulding sand with their composition. (2017, 2019 -W/S)

4. Describe hot chamber die casting with neat sketch. (2019-W)

5. Describe cold chamber die casting with neat sketch.

6. Explain moulding sand. Explain different types of moulding sand .State the desirable properties of moulding sand. (2019-S)

7. Describe centrifugal casting with neat sketch. (2016, 2018 - W, 2019 – W, 2022-W)

8. Describe various casting defects. State there causes and remedies. (2017, 2018-W, 2019-S, 2020-W,2022-W)

9. Explain various types of patterns used in casting. (2018-W, 2019-W)

10. Explain various pattern allowances in casting. (2016, 2017, 2018, 2019 - S/W, 2022-W)

11. Explain die casting with advantages and dis advantages. (2019-S)

12. Explain moulding sands with their compositions. (2019-W)

13. Discuss about the oxidizing and reducing zones of a copula furnace. (2020-W)

14. What do mean by a hanging g core? Explain briefly. (2021-W)

15. Explain about different non-destructive tests carried out to detect casting defects. (2021-W)

CHAPTER NO. – 04

POWDER METALLURGY

Learning Objectives:

4.1 Define powder metallurgy process.

4.2 State advantages of powder metallurgy technology technique.

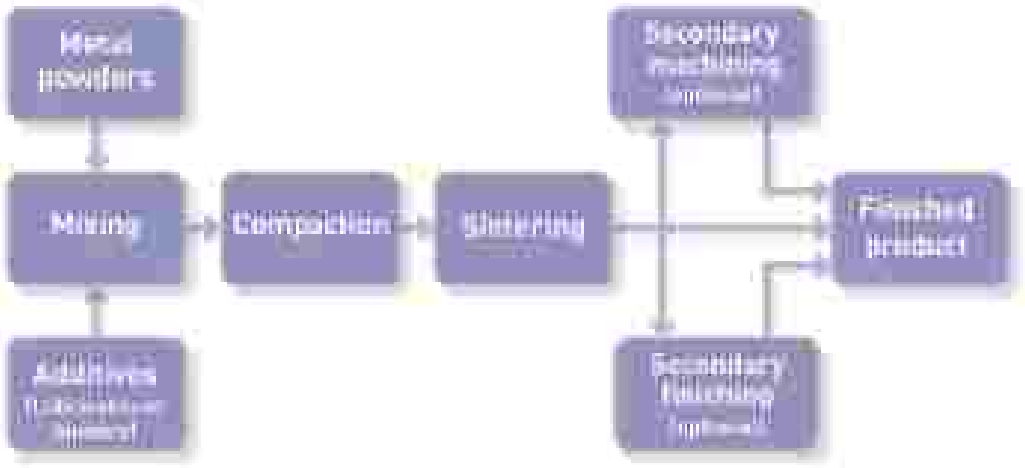
4.3 Describe the methods of producing components by powder metallurgy technique.

4.4 Explain sintering.

4.5 Economics of powder metallurgy.

4.1 Define powder metallurgy process:

- Powder metallurgy (PM) is a process of forming metal parts by heating compacted metal powders to just below their melting point.
- Or, in other words, it is the process of blending fine powdered materials, pressing them into a desired shape (compacting)and then heating in a controlled atmosphere to bond the material(sintering).



The powder metallurgy process consists of four basic steps:

1. powder manufacturing
2. powder blending
3. compacting
4. sintering

4.2 State advantages of powder metallurgy technology technique:

- Huge potential savings in production by using powder metallurgy which is geared towards mass production.
- Raw material easily obtainable and relatively in expensive.
- The process generates very little scrap.
- Parts have good chemical homogeneity.
- Potentially very high production rates, especially compared to machining.

4.3 Describe the methods of producing components by powder metallurgy technique:

The following steps are involved in powder metallurgy process:

1. Powder production:

- Virtually all iron powders for powder metallurgy are produced by metal crusher or water atomization.
- In powder metallurgy process the following techniques are used for production of powders.

a. Mechanical pulverization:

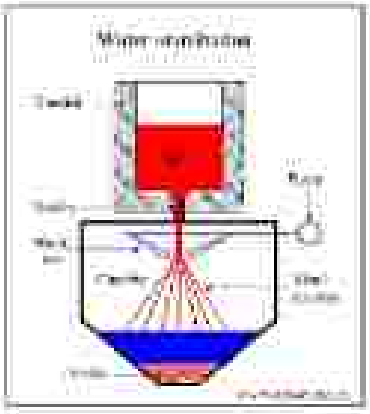
- It is done by using mechanical pulveriser such as counter rotating blades, rapidly moving hammers. Due to mechanical forces, it breaks the metal particles into fine powders. Brittle metals and alloys can be powdered, by this method to a size of 0.001mm.

b. Shotting:

- This is another method of producing metal powders. In this process, the molten metal is passed through an orifice and cooling it by dropping into the water.

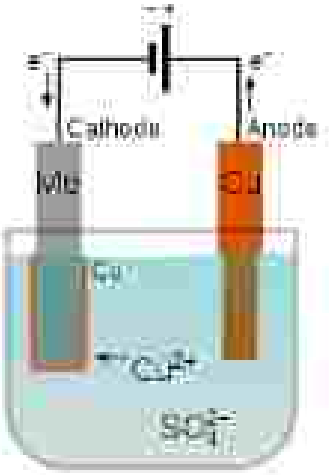
c. Atomization:

- In atomisation process, the metal is forced through a small orifice called nozzle and is disintegrated by a stream of compressed air or water jet and then cooled into fine powders. since the particles are very small like atoms, this process is called atomization. Oxidation of the metal powder can be prevented by maintaining inert atmosphere. This process generally used for metals having low melting point.



d. Electrolytic deposit:

- The principle involved in this method is similar to that of electrolysis, during which a powdery deposit is obtained in the cathode. The deposit powder scrapped, washed, dried and then pulverised further to get fine powder of desired size.
- For making Cu powder, Cu plates are placed as anode and inert metal plates (Al) are placed as cathode. On passing electric current, copper powder deposits on the cathode and is scrapped off.



2. Blending or mixing of powder:

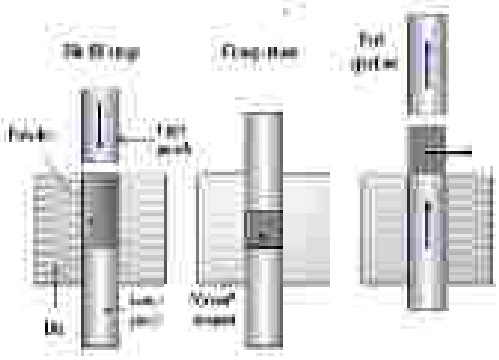
- The fine powders are mixed with lubricants. The lubricants help in imparting good fluidity to the powders. Binders such as wax or thermoplastic polymers are added to improve green strength.

3. Compacting:

- The main purpose of compacting process is the forming of metal powders into compacts of desired shape with sufficient strength to withstand ejection from the tools and handling it without breakage or damage.
- Various methods of powder compaction are:

a. Die compaction:

- Dies are usually made of ground, hardened steels. The die consists of two parts lower punch and upper punch. The metal powder is introduced into the cavity of the die. Required pressure is given by movement of upper and lower punches towards each other, after the green compact is ejected from the lower punch. This pressure commonly employed ranges from 19-50 tons/sq. inch. It may be obtained by hydraulic or mechanical.



b. Powder extrusion:

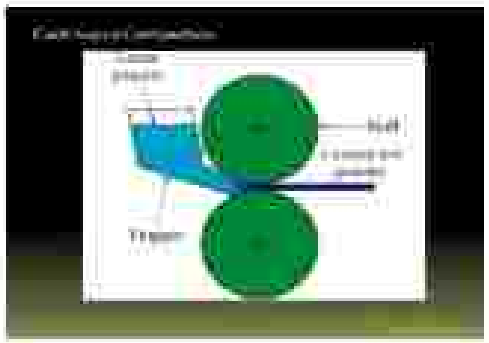
- In this process the powder is canned and placed in some kind of metal container. The sealed container is heated and then extruded. After extruding, the container material is removed either mechanically or chemically. This technique is extremely used for high densities of production.

c. Vibratory compaction:

- Vibratory compacting involves the application of pressure vibration simultaneously during pressing of a mass of powder within a rigid die.

d. Roll compacting:

- In powder rolling, the rolls are set side by side so that the strip emerges vertically downwards. The continuous feeding of the powder produces the strip of infinite length. Then the strip is sintered for a very short time.



e. Continuous compaction:

- In this process, the metal powder may be applied in the form of a slurry to be coated on a metal screen or solid metal sheet for electrodes in nickel cadmium rechargeable batteries.

4. Sintering:

- The compacted mass is heated at a temperature below the melting point of major constituent in a furnace with controlled atmosphere.

5. **Secondary operation:**

- It includes the process such as sizing, machining, treatment and inspection.

a. **Sizing:**

- The sintered component is poured in a mould or dies to form the composent and achieve high dimensional accuracy.

b. **Machining:**

- It requires final machining is done on some specific locations including drilling very small holes.

c. **Treatment:**

- Parts are subjected to debarring and tumbling to remove any small projections and other treatment like oil impregnation technology are given.

d. **Inspection:**

- finally, parts are inspected to check the quality.

4.4 Explain sintering:

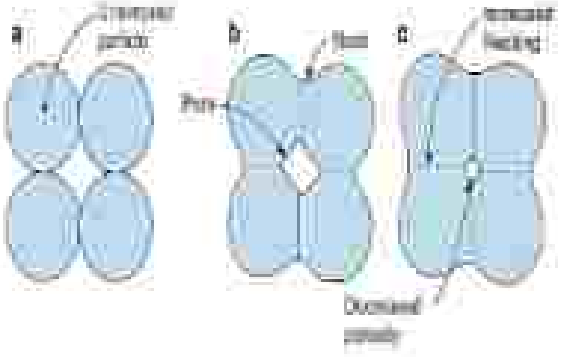
- Sintering is a heat treatment operation performed on the compact to bond its metallic particles, thereby increase in strength and hardness.
- The treatment is usually carried out at temperature between 0.7 to 0.9 of the metals melting point.
- Compressed metal powder is heated in a controlled atmosphere furnace.
- The sintering process consists of three steps:
  Preheat, sinter, cool down.

Types of sintering:

Sintering is classified into two types.
1.solid state sintering
2.liquid phase sintering

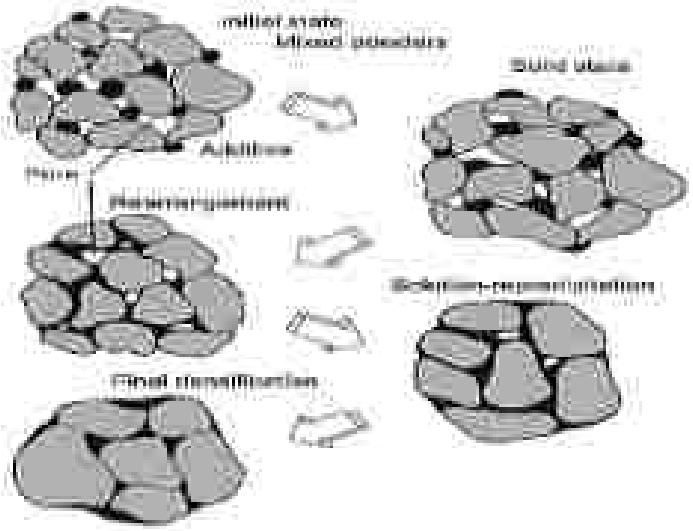
Solid state sintering:

- Only solid phases are present at sintering temperature.
- It involves heating the powder below melting point to allow solid state diffusion and bonding the particles together.
- Particle bonding is initiated contact point which then grow into necks, reducing the porous between particles.
- Prolonged heating develops grain boundaries between particle in place of necked regions.



Liquid phase sintering:

- Liquid phase sintering usually involves mixing of iron powder.
- Small amount of liquid phases is present during sintering.
- With a liquid forming powder (boride, carbide, phosphates, copper etc.).
- Then heating to a temperature where the liquid forms spread and contributes to the two particles bonding and densification.



4.5 Economics Of powder metallurgy:

- The powder metallurgy mainly used for, cost saving compared with other processes and very unique property obtained by powder metallurgy.
- PM process enables product to be made that are capable of absorbing 35% of selected fluids.
- In PM better material utilization with closed dimensional tolerance.
- The PM process has:
  1.The highest raw material utilization over (95%).

  2.lowest energy requirement per kg of finished part.

  3.comparing with other manufacturing process.

POSSIBLE SHORT TYPE QUESTIONS WITH ANSWER

1. Define powder metallurgy. (2018-W)

Ans: Powder metallurgy is a process for forming metal parts by heating compacted metal powders to just below their melting point.

2. State advantages of PM.

Ans: Huge potential savings

Mass production

Good chemical homogeneity.

3. Define sintering. (2019-S/W, 2020-W,2021-W)

Ans: The compacted mass is heated at a temperature below the melting point of major constituent in a furnace with controlled atmosphere.

POSSIBLE LONG TYPE QUESTIONS

1. Explain the methods of producing components by powder metallurgy technique. (2016)

2. Explain in brief the sintering process. (2018-W, 2019-W, 2022-W)

3. Write the advantages of powder metallurgy. (2018-W,2020-W)

4. Explain powder metallurgy process step by step. (2019-W, 2022-W)

5. Write short notes on Blending. (2020-W)

6. Explain compacting process in powder metallurgy (2021-W)

7. Discuss briefly about the different secondary processes for producing components using powder metallurgy technique. (2021-W)

CHAPTER NO. – 05

PRESS WORK

Learning Objectives:

5.1 Describe Press Works: blanking, piercing and trimming

5.2 List various types of die and punch

5.3 Explain simple, Compound & Progressive dies

5.4 Describe the various advantages & disadvantages of above dies

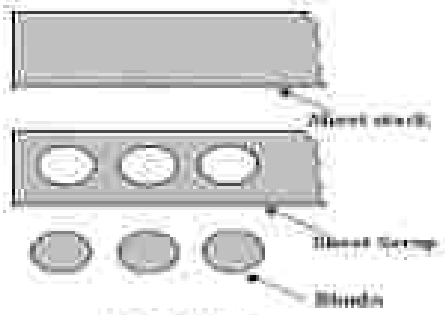
5.1 Describe Press Works: blanking, piercing and trimming:

Introduction:

- The press work means applyuse force by a punch on a sheet metal to produce various components by cutting or shearing the sheet metal.
- Various press works are Blanking, Piercing, Trimming.

Blanking:

- Blanking is the operation of cutting a flat shape sheet metal. The article punched out is called the blank and the required product.
- The hole and metal left behind is discarded as waste.



BLANKING

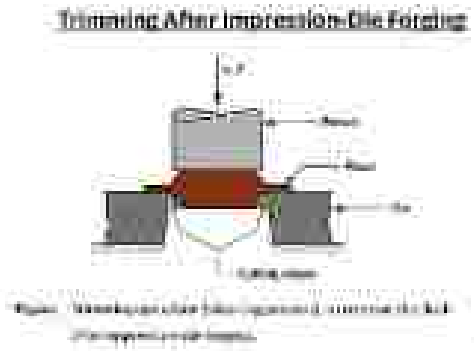
- The important points in blanking operation are-
  - Extremely sharp punches and dies are required.
  - Reduce die clearance by 5%
  - Determine which blank dimensions and clearance are critical.
  - Punches should be flat faced or with slight one-way shear.
  - In blanking operation sheet metal cutting to separate piece (called blank) from surrounding stock.
  - Blank size=Die size - Clearance

Piercing or Punching:

- It is a cutting operation by which various shaped holes are made in sheet metal.
- Punching is similar to blanking except that in punching the hole is the desired product, the material punched out from the hole being waste.
- Product size=Punch size – Total clearance
- Punching is accomplished by a blanking operation before, after or at the same time.

Trimming:

- It is a cutting operation to remove flash from work part.
- Usually done while work is rough, so a separate trimming place is included at the forging station.
- Trimming can also be done by alternating methods such as grinding.



5.2 List various types of die and punch:

The dies are classified into three types.

1. Simple die

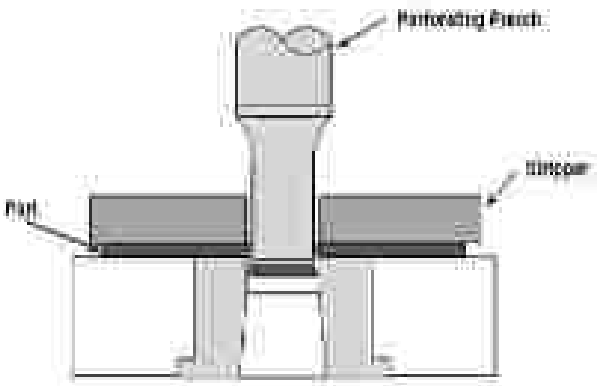
2. Compound die

3. Progressive die

5.3 Explain simple, Compound & Progressive dies:

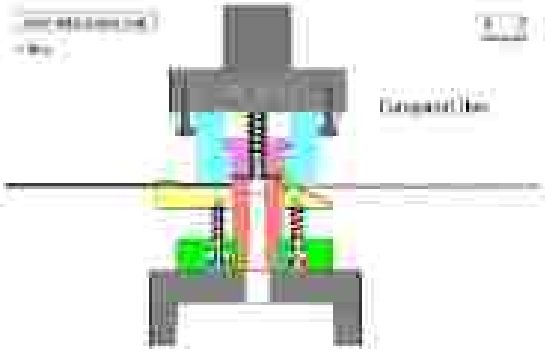
Simple die:

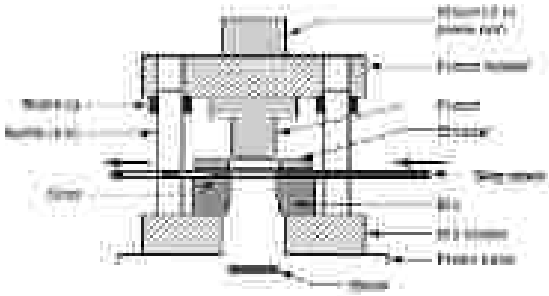
- A simple operation die is used when there is only blanking, piercing or simple trimming and cutting operation.
- This die also called single operation die.
- Shank portion is held in the ram.
- The metal sheet is held between the stripper plate and die block, resting against the stops so that the same amount of sheet stock is fed every time.
- As the punch descends it cuts the sheet metal, the punch fits into the hole in the die block.



Compound die:

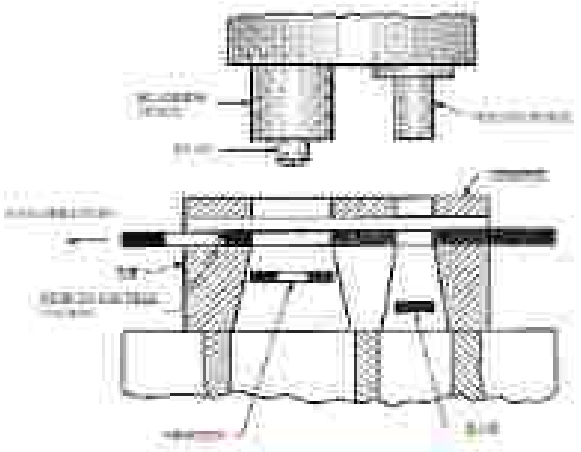
- Does only cutting operation.
- The metal sheet is placed between the upper die and lower die.
- Both blanking and piercing are carried out during the same stroke of the machine.
- The blanking operation on the metal sheet is carried out by the telescopic action of the upper and lower dies as the upper die descends.
- At the same time the punch creates a hole in the centre of the blank.
- Compound dies make close tolerance and concentric parts, as all work is done in one stroke.





Progressive die:

- Progressive die is a multiple station die.
- It consists of a die shoe and a stripper plate. It also consists of multiple punch known as gang punch.
- It consists of a die and stopper arrangement to keep the sheet metal in proper position.
- It required to do operations of the components whose depth to diameter ratio is too large.
- The metal strip to be operated upon is fed between the die and stripper plate.
- A stop is provided for locating the leading end of the strip and during this first stroke only the slot is punched.
- The strip is next advanced the distance between adjacent stop stages to another stop.
- During the next stroke, two operations are performed on the strip stock, at one at each stage.
- A progressive die can perform very complex work doing piercing, blanking, forming, notching, etc.



PROGRESSIVE DIE

5.4 Describe the various advantages & disadvantages of above dies:

Advantages of simple die:

- Simple in construction.
- Less cost.
- Need unskilled labour.
- Less space required.

Disadvantages of simple die:

- Only one type of operation can be performed at a time.
- Tolerance limit is high.
- Products are not fit for accuracy machines.

Advantages of compound die:

- Both blanking and piercing operations can be done in a single stroke of punch.
- Tolerance limit is less because of heavy construction and balancing.
- Less energy conservation.

Disadvantages of compound die:

- High cost of machine.
- Skilled labour required.
- More space required.

Advantages of progressive die:

- Progressive die can operate more than operation at a time in a sequence.
- Which eliminates the ideal time in the sheet metal working.
- Progressive die parts are quality parts.

Disadvantages of progressive die:

- Progressive dies initial cost is very high. It rarely used in small scale industries.
- Since progressive die produce parts in batch as well as mass production, but not used in variable production.
- Even though it reduces man power still it requires a program and a supervisor.

POSSIBLE SHORT TYPE QUESTION WITH ANSWER

1. What is press work?

Ans: The press work means by applying force by a punch on a sheet metal produce various components by cutting or shearing the sheet metal.

2. What is blanking? (2016, 2019-W, 2020-W)

Ans: It is the operation of cutting a flat shape sheet metal. The article punched out is called the blank and is the required product of the operation.

3. What is piercing? (2019-S/W)

Ans: It is similar to blanking except that in punching the hole is the desired product, the material punched out from the hole being waste.

4. Write the types of dies.

Ans: 1. cutting dies

2. forming dies

3. simple dies

4. compound dies

5. progressive dies

5. What is trimming? (2018-W, S)

Ans: Trimming is a manufacturing process that is used as a finishing operation for forged parts, in order to remove flash.

6. Name the various sheet metal cutting operations. (2017-W)

Ans: The various sheet metal cutting operations are

Piercing, trimming, blanking, notching.

7. Why dies are used in press work? (2020-W)

Ans: A die is a pre shaped tool that works in conjunction with a press to manipulate the material into the desired shape and size.

POSSIBLE LONG TYPE QUESTIONS

1. Write the difference between compound die and progressive die. (2019-W)
2. With neat sketch explain working of compound die. (2016-W)
3. With neat sketch explain about progressive die. (2019-S)
4. Describe the advantages and limitations of simple die and compound die. (2016-W)
5. Differentiate a simple and a compound die. (2017-W)
6. Differentiate between compound die and progressive die. (2019-W)
7. Discuss about various types of punches. (2020-W)
8. Write short notes on- Compound dies (2020-W)
9. Describe briefly about progressive dies with a neat sketch. (2021-W)
10. Explain compound die and progressive die. (2022-W)

CHAPTER NO. – 06

JIGS AND FIXTURES

Learning Objectives:

6.1 Define jigs and fixtures

6.2 State advantages of using jigs and fixtures

6.3 State the principle of locations

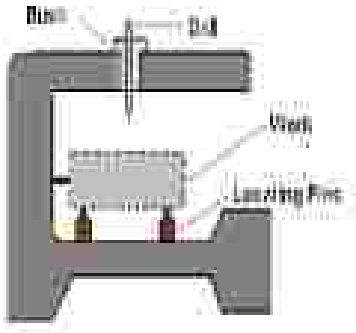
6.4 Describe the methods of location with respect to 3-2-1 point location of rectangular jig

6.5 List various types of jig and fixtures.

6.1 Define jigs and fixtures:

Jigs:

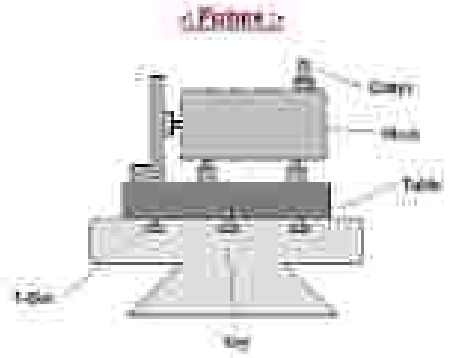
- A jig may be defined as a device which holds and locates a work piece, guides and controls one or more cutting tools.
- The holding of the work and guiding of the tools are such that they are located in true positions relative to each other.
- In construction, a jig comprises a plate, structure or box made of metal having positions for holding components one after other and then guiding the tool in correct position on the work in accordance with the drawing, specification, layout.
- Jigs are used in drilling, reaming, boring, etc.



Jig

Fixtures:

- A fixture may be defined as a device which holds and locates a work piece during inspection.
- It does not guide the tool.
- In construction the fixtures use specially designed work holding devices, which are clamped on the machine table to hold the work in position.



Difference between jigs and fixture:

- A fixture holds and position the work but does not guide the tool, where as a jig holds, locates and as well as guides the tool.
- The fixtures are generally heavier in construction and are bolted rigidly on the machine table, whereas the jigs are made lighter for quicker handling and clamping with the table is often necessary.
- The fixtures are employed for holding work in milling, grinding, planning, turning operation, whereas jigs are used for holding the work and guiding the tool particularly in drilling, reaming, boring operations.

6.2 State advantages of using jigs and fixtures:

- It eliminates the marking out, measuring and other setting methods before machining.
- It increases the machining accuracy, because the work piece is automatically located and the tool is guided without making any manual adjustment.
- It enables production of identical parts which are interchangeable.
- It reduces the operators labour as the handling operations are minimized.
- It reduces the expenditure on the quality control of the finished product.

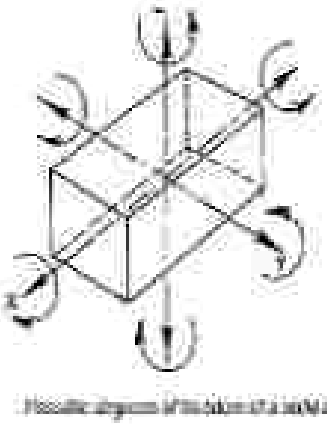
6.3 State the principle of locations:

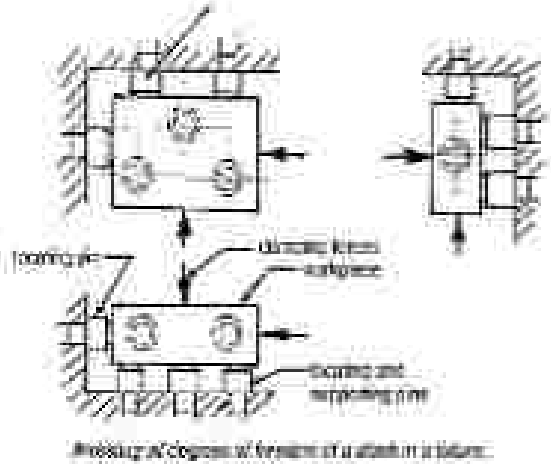
- The principle of location is being discussed here with the help of most popular example which is available in any of the jigs and fixture block.
- The location refers to the establishment of a desired relationship between the work piece and the jigs and fixture correctness of location directly influences the accuracy of finished product.
- The jigs and fixture are designed so that all the undesirable movement of the work piece are restricted.

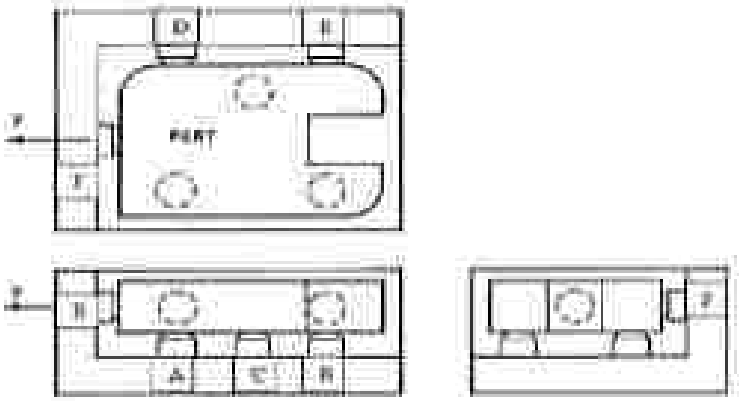
6.4 Describe the methods of location with respect to 3-2-1-point location of rectangular jig:

- The 3-2-1 principle of location (six-point location principle) is used to constrain the movement of work piece along the three axes XX, YY, ZZ.
- This is achieved by providing six locating points, 3 pins in base plate, 2 pins in vertical plane, 1 pin in a plane which is perpendicular to first two planes.
- The work piece is resting on three pins A, B, and C which are inserted in the base of the fixed body.

- The work piece cannot rotate about the axes XX and YY and also cannot move downward.
- In this way, the five degrees of freedom 1,2,3,4 and 5 have been arrested.
- Two pins D and E are inserted in the fixed body, in a plane perpendicular to the plane containing pins A, B&C.
- Now the work piece cannot rotate about the X-axis and also it cannot move to the left.
- Hence the addition of pins D and E restrict three more degrees of freedom, namely 6,7, and 8.
- Another pin F in the second vertical face of the fixed body, arrests degree of freedom 9.







6.5 List various types of jig and fixtures:

Types of jigs:

- Plain type jig
- Template jig
- Plate jig
- Table jig
- Box jig
- Angle jig
- Channel jig
- Leaf jig
- Indexing jig
- Multi station jig

Types of Fixtures:

- 1.Plate fixture
- 2. Angle plate fixture
- 3. Vice jaw fixture
- 4. Indexing fixture
- 5. Profile fixture
- 6. Multi station fixture

POSSIBLE SHORT TYPE QUESTIONS WITH ANSWER

1. Define jig and fixture. (2017,2019-W/S)

Ans:

Jig

A jig may be defined as a device which holds and locates a workpiece, guides and controls one or more cutting tool.

Fixture

A fixture may be defined as a device which holds and locates a workpiece during inspection.

3. Write the classification of jig.

Ans: 1. Plain type jig

2. Template jig

3. Plate jig

4. Table jig

5. Box jig

4. Write the classification of fixture.

Ans: 1. Plate fixture

2. Angle plate fixture

3. Vice jaw fixture

4. Indexing fixture

5. Profile fixture

5. Jigs and fixture increases the production cycle time (True/false). Justifying your answer. (2020-W)

Ans: Jigs and fixture increases the productivity by eliminating the individual marking, positioning and frequent checking.

6. Why jigs are needed in production process?

Ans: A jig is a type of tool used to guide and control and locate one or more tools. A jigs primary purpose is to provide repeatability, accuracy, interchangeability in the manufacturing of products.

POSSIBLE LONG TYPE QUESTIONS

1. Explain about principle of location. (2016-W, 2019-W)

2. Explain 3-2-1 principle of location with neat sketch. (2017-W, 2018-W,2019-S,2020-W,2022-W)

3. What is meant by locating and clamping a work piece? (2017-W)

4. Compare jigs with fixture. (2020-W)

5. Explain various types of jig.(2018-W)

6. Compare plate fixture with angle plate fixture. (2021-W)

7. Explain briefly the difference between jigs and fixture.(2021-W)