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[B.Tech]

FIRST SEMESTER

Manufacturing Process

(ES-119)

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MANUFACTURING PROCESS

(ES-119)

(For B.Tech First Semester Students of Guru Gobind Singh–Indraprastha University)

AB Publishers

Common Scheme for B.Tech. First Year
From Academic Session 2021-22 Onwards

FIRST SEMESTER					
Group	**Code**	**Paper**	**L**	**P**	**Credits**
Theory Papers					
ES BS	ES101 BS103	*Any one of the following: Programming in 'C' Applied Chemistry	3	–	3
BS	BS105	Applied Physics-I	3	–	3
ES BS	ES107 BS109	*Any one of the following: Electrical Science Environmental Studies	3	–	3
BS	BS111	Applied Mathematics-I	4	–	4
HS	HS113	**Group 1 or Group 2 shall be offered: Group 1: Communications Skills	3	–	3
		Or			
HS HS	HS115 HS117	Group 2: Indian Constitution Human Values and Ethics	2 1	–	2 1
ES	ES119	Manufacturing Process	4		4
SECOND SEMESTER					
Theory Papers					
ES BS	ES102 BS104	*Any one of the following: Programming in 'C' Applied Chemistry	3	–	3
BS	BS106	Applied Physics-II	3	–	3
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BS	BS112	Applied Mathematics-II	4	–	4
HS	HS114	**Group 1 or Group 2 shall be offered: Group 1: Communications Skills	3	–	3
		OR			
HS HS	HS116 HS118	Group 2: Indian Constitution Human Values and Ethics	2 1		2 1
ES	ES114	Engineering Mechanics	3	–	3

*For a particular batch of a programme of study one out of these two papers shall be taught in the first semester while the other shall be taught in the 2nd semester. Students who have to re-appear can only reappear in the odd semester. If originally offered to the student in the 1st semester and similarly for the students who study the paper in the second semester. The institution shall decide which paper to offer in which semester.

**For a particular batch of a programme of study either the paper on "Communications Skills" (Group 1), or Group 2 : papers ("Indian Constitution" and "Human values and ethics") shall be taught in the first semester while the other group shall be taught in the 2nd semester. Students who have to re-appear can only reappear in the odd semester if originally offered to the student in the 1st semester and similarly for the students who study the paper(s) in the second semester. The institution shall decide which paper group to offer in which semester.

SYLLABUS (From Academic Session 2021-22)
Manufacturing Process [ES-119]

Marking Scheme:

(a) Teacher Continuous Evaluation: 25 marks
(b) Term End Theory Examination : 75 marks

UNIT I

Definition of manufacturing, Importance of manufacturing towards technological and social economic development, Classification of manufacturing processes, Properties of materials.

Metal Casting Processes: Sand casting, Sand moulds, Type of patterns, Pattern materials, Pattern allowances, Types of Moulding sand and their Properties, Core making, Elements of gating system. Description and operation of cupola.

Working principle of Special casting process - Shell casting, Pressure die casting, Centrifugal casting, Casting defects. **[10 Hrs.]**

UNIT II

Joining Processes: Welding principles, classification of welding processes, Fusion welding, Gas welding, Equipments used, Filler and Flux materials. Electric arc welding, Gas metal arc welding, Submerged arc welding, Electro slag welding, TIG and MIG welding process, resistance welding, welding defects. **[10 Hrs.]**

UNIT III

Deformation Processes: Hot working and cold working of metals, Forging processes, Open and closed die forging process. Typical forging operations, Rolling of metals, Principle of rod and wire drawing, Tube drawing. Principle of Extrusion, Types of Extrusion, Hot and Cold extrusion.

Sheet metal characteristics: Typical shearing operations, bending and drawing operations, Stretch forming operations, Metal spinning. **[10 Hrs.]**

UNIT IV

Powder Metallurgy: Introduction of powder metallurgy process, powder production, blending, compaction, sintering.

Manufacturing of Plastic Components: Type of plastics, Characteristics of the forming and shaping processes, Moulding of thermoplastics, Injection moulding, Blow moulding, Rotational moulding, Film blowing, Extrusion, Thermoforming. Moulding of thermosets-Compression moulding, Transfer moulding, Bonding of Thermoplastics. **[10 Hrs.]**

SYLLABUS

MANUFACTURING PROCESS ETME

INSTRUCTIONS TO PAPER SETTERS: **MAXIMUM MARKS: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from question no. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 12.5 marks.

UNIT-I

Casting Processes

Principles of metal casting: Pattern materials, types and allowance; Study of moulding, sand moulding, tools, moulding materials, classification of moulds, core, elements of gating system, casting defects, description and operation of cupola: special casting processes e.g. die-casting, permanent mould casting, centrifugal casting, investment casting.

[No. of Hrs. 6]

UNIT - II

Smithy and Forging

Basic operation e.g. upsetting, fullering, flattening, drawing, swaging: tools and appliances: drop forging, press forging.

Bench Work and Fitting

Fitting, sawing, chipping, thread cutting (die), tapping; Study of hand tools, Marking and marking tools.

[No. of Hrs. 6]

UNIT - III

Metal joining:

Welding principles, classification of welding techniques; Oxyacetylene Gas welding, equipment and field of application, Arc-welding, metal arc, Carbon arc, submerged arc and atomic hydrogen welding, Electric resistance welding: spot, seam, butt, and percussion welding; Flux: composition, properties and function; Electrodes, Types of joints and edge preparation, Brazing and soldering.

[No. of Hrs. 6]

UNIT - IV

Sheet Metal Work:

Common processes, tools and equipments; metals used for sheets, standard specification for sheets, spinning, bending, embossing and coining.

[No. of Hrs. 5]

UNIT-I

Define Manufacturing Processes

The process of producing the desired object from the raw material is called manufacturing process. Most of the metals used in industry are available in the form of rough casting called ingots. These ingots are further subjected to various processes to convert these into usable products. The processes which are used for changing the ingots into usable products are discussed below

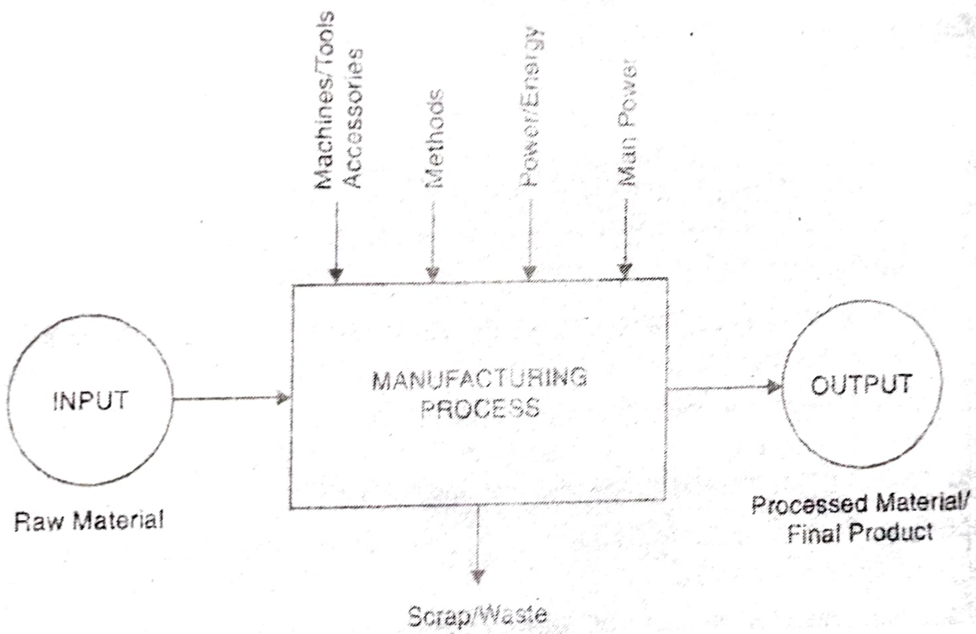


Fig. 1 Manufacturing Process.

Importance of Manufacturing Towards Technological & Social Economic Development

Industrialisation has a major role to economic development of under developed countries. Industrialisation is the period of social and economic change that transforms a human group from an agrarian society into an industrial one. Industrialization is thus inseparable from substantial, sustained economic development, because it is both a consequence of higher incomes and a means of higher productivity.

Unless agriculture is modernised substantially, industrial expansion is likely to proceed at a slow speed due to lack of purchasing power in the hands of the bulk of population.

Historically, Industrial development, has proceeded in three stages. In first stage the industry is concerned with the processing of primary products, the second stage comprises of the transformation of materials,, The third stage consist of manufacturing of machines and other capital equipments in order to facilitate the future process of production.

Role of Industry in the Economic Development: The industries in India can be classified into :

- Organised industries
- Unorganised Industries
- Both type of industries are important for large country with a huge size of population and plays an important role in the economy of the country.

Example of Organised and Unorganised Industries: The Orgarilsed industries include:

- Steel and Petroleum industry
- Textiles, Cement, fertilizer industry
- Tea, Sugar Industry
- Playwood Industry
- The Unorganised industries include:
- The small and cottage industry, khadi and village Industry.

Need of Manufacturing

Economic strength of a country is measured, from, the development of manufacturing industries. It is the backbone of our economy.

They reduce the dependence of people on agriculture

Providing jobs.

Export of manufactured goods

Bring foreign, exchange

Eradicates poverty and unemployment.

Countries that transform their raw materials into a wide variety of furnished goods of higher value are prosperous.

Classification of Manufacturing Process

Primary Shaping Processes: The ingots available in the market need remelting in cupola or some-other foundry furnace. The molten metal is then poured into the moulds to obtain the casting or sometimes ingots are converted into useable form by forging or other primary shaping process. Primary shaping processes include:

(a) Casting (b) Forging (c) Smithy (d) Drawing (e) Rolling

(f) Bending (g) Extruston

Machining Processes: Machining operations are performed on various machine tools (e.g. lathe, shaper, milling machines, drilling machines, grinder etc.) Machining processes are needed because sometimes we need complex shapes, profiles, contours etc. These factors need following machining operations:

(a) Shaping (b) Turning (c) Milling (d) Drilling

(e) Grinding (f) Boring

Surface Finishing Processes: These processes are used to provide a good surface finish to the metal surface of the product. In this, either a negligible amount of metal is removed or a small amount of material is added to the surface of the product. Various surface finishing processes are:

(a) Polishing (b) Buffing (c) Electroplating (d) Super Finishing (e) Painting

Joining Processes: These processes are used for joining two or more pieces of metal parts. Joining processes are used to join two or more workparts either temporary or permanent. Permanent joining processes are as follow:

(a) Welding (b) Soldering (c) Brazing (d) Riveting

Properties of Materials: Property of a material is a factor that influences quantitatively or qualitatively mechanical properties the response of a given material to imposed stimuli and constraints.

1. Strength: Strength of a material may be defined as the ability of the material to sustain loads without distortion. The stronger the material, the greater the load it can withstand. So it is the ability of the material to withstand stress (force per unit area) without failure. Material should have adequate strength when subjected to tension, compression, shear, bending or torsion (types of loads).

2. Stiffness: Stiffness is the ability of a material to resist deformation. A material with high value of Young's modulus E is stiffer than the material with the lower value of Young's modulus (ratio of stress to strain is called Young's modulus, strain is the ratio of change in dimension to the original dimension). Modulus of elasticity for aluminium and steel are 70 GPa and 210 GPa respectively so steel is three times more stiffer than aluminium.

3. Elasticity: Elasticity is that property of a material by virtue of which deformation caused by applied load (stress) disappears completely on the removal of the load. **Proportional limit.** It is the maximum limit upto which stress is directly proportional to strain.

Elastic limit. The greatest stress that a material can withstand without taking up some permanent set is called elastic limit. Beyond elastic limit, removal of load does not bring the material in its original form.

4. Plasticity: The plasticity of a material is its ability to undergo some degree of permanent deformation without rupture or failure. Plastic deformation is after the elastic limit and it is reverse of elasticity. Plasticity is important in forming, extruding and many other hot or cold working processes.

5. Ductility: It is the ability of a metal to withstand elongation (deformation in longitudinal direction) under tension without rupture, or Ductility is that property of a material which enables it to draw out into thin wires without rupture.

6. Malleability: It is the ability of a metal to withstand deformation under compression without rupture, or it is the property of a material which enables it to be hammered or rolled into thin sheets without rupture. This property generally increases with the increase of temperature. Common Metals in decreasing order of their Ductility and Malleability (at room temperature).

Ductility	**Malleability**
Gold	Gold
Silver	Silver
Platinum	Copper
Iron	Aluminium
Nickle	Tin
Copper	Platinum
Aluminium	Lead
Zinc	Zinc
Lead	Nickel

7. Toughness: Toughness is a measure of the amount of energy a material can absorb before failure takes place. The toughness of a material is expressed as energy absorbed (Nm) per unit volume of material (m^3) or Nm/m^3. Toughness is related to impact strength i.e. resistance to shock loading.

For example : If a load is suddenly applied to a piece of mild steel and then to a piece of glass, the mild steel will absorb much more energy before failure occurs. So mild steel is tougher than glass.

8. Brittleness: Lack of ductility is brittleness. The brittleness of a material is the property of breaking without much permanent distortion. Brittle materials are glass, cast iron etc., it will not stretch and bend before breaking. An elongation of less than 5% in a 50 mm gauge length is often taken to indicate a brittle material.

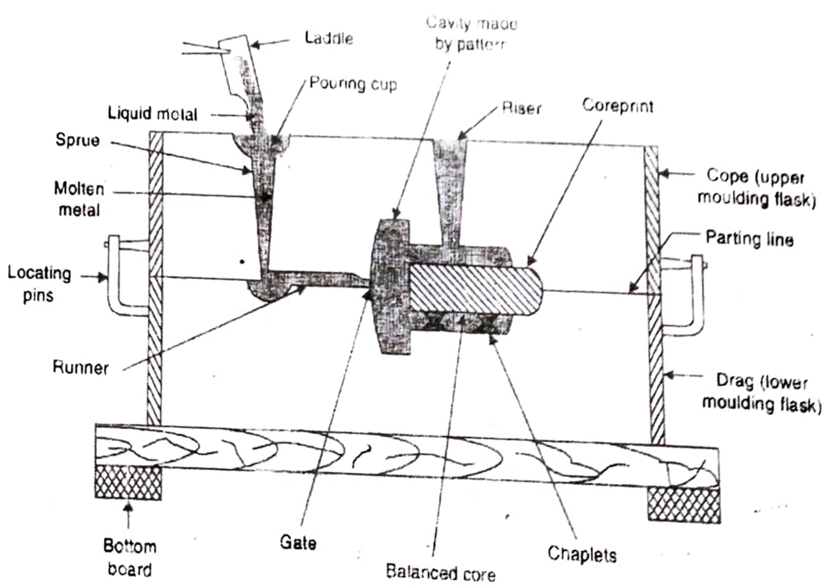
9. Resilience: Resilience is the capacity of a material to absorb energy elastically. On removal of the load, the energy stored is given off exactly as in spring when the load is removed. This property of material is important in the manufacture of shock absorbers, springs etc.

10. Hardness: Hardness is usually defined as resistance of material to penetration. Hard material resist wear and scratches. Diamond is the hardest known material. Hard materials are choosen for the manufacturing of cutting tools.

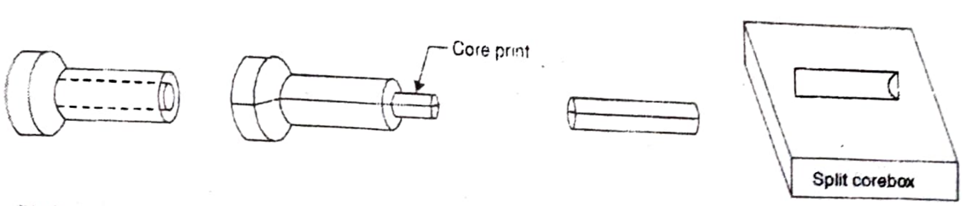
11. Creep: Creep is the slow plastic deformation of metal under constant stresses usually at high temperature. It can take place and lead to failure at static stresses much smaller than those which will fail the specimen by loading it quickly. Metals generally exhibit creep at high temperatures, whereas plastics, rubbers are very temperature sensitive to creep.

12. Machinabiiity: Machinability of a material is the ease with which it can be machined. In general meaning, it signifies how much force and power are required to remove stock from a material.

Casting Process: (Sand Casting)



(a) Two part moulding



(b) Component to be cast (c) Pattern (d) Core (e) Corebox

Fig. 2. Casting processes, (a) Two part mould and its various components, (b) component to be cast, (c) pattern corresponding to that components (d) core for making hole in component (e) corebox for making core.

Steps in Preparing a Casting: Casting process comprise the following steps:

1. Making a pattern: Pattern is the model of the desired product (called casting), constructed in such a way that it can be used for forming an impression called mould (cavity) in damp sand. Various allowances such as shrinkage, machining draft, shaking, distortion etc., are provided. Sometimes core prints are also provided to the patterns to make a core seat in the damp sand.

2. Preparing Moulding Sand: Sand is the principal moulding material in a foundry shop. The quality of the casting depends upon be the selection and mixing of sand, which may be natural or synthetic and is used for mould and core making.

3. Preparing a mould and core making: Moulds are prepared with the help of pattern to produce a cavity of desired shape. Usually the mould is made of sand is used only once. But sometimes permanent metal moulds are also used. For obtaining hollow portions, prepared separately in core boxers. Moulds and cores are baked to impart strength.

4. Melting the Metal: The required quantity of the metal with proper composition is melted in a suitable furnace.

5. Pouring the metal into the mould: When the molten metal attains pouring temperature it is taken into ladles and poured into the moulds.

6. Cooling i.e., Solidification: After pouring the molten metal into the mould cavity it is allowed to cool down so that the metal solidifies.

7. Removing the Solidified casting from the mould: The solidified casting are extracted by breaking the mould and cleaned by removing adhering sand.

Sand Mould: A mould can be described as a void or cavity created in a compact sand mass with the help of pattern which (Mould), when filled with molten metal will produce a casting.

Moulding: The process of making this cavity or mould in the compact sand is called moulding.

Types of Mould Materials

A mould material is one out of which the mould is made.

Casting can be made in

(a) Permanent moulds: These are made up of ferrous metals and alloys (steel, grey cast iron). These are normally employed for casting low melting point materials. The moulds produce small casting with better quality and dimensional accuracy but permanent moulds are costly.

(b) Temporary refractory moulds: These are made up of refractory sands and resin. These are used for casting high melting point materials and bigger objects.

A pattern may be defined as a model of the desired product (called casting), constructed in such a way that it can be used for forming an impression called mould (cavity) in damp sand. When this mould (cavity) is filled with molten metal, it solidifies and produces a casting (desired product). So the pattern is the replica of the casting.

PATTERN MATERIALS

The selection of pattern material depends on factors such as :

* Design of casting.
* Quality of casting.
* Types of moulding process.
* No. of castings.
* Shape (Intricacy) of casting.
* Type of production of castings.

* Moulding material to be used.
* Possibility of design changes
* Chances of repeat orders etc.

To be suitable for use, pattern material should be (Requirements of pattern material).

* Easily worked, shaped and joined.
* Light in weight.
* Strong, hard and durable.
* Available at low cost.
* Resistant to wear and abrasion, to corrosion and to chemical reaction.
* Dimensionally stable and unaffected by variations in temperatures and humidity.
* Such that it can be repaired easily and economically or even re-used.
* Having ability to take a good surface finish.

The following materials are generally used for making patterns :

Wood: Wood is the most common material used for pattern because it satisfies many of the desired requirement. Wood used for pattern making should be properly dried, straight grained, free from knots and free from excessive sap wood. The most common wood used for patterns is teak, mahogany, sal, shisham, pine, deodar etc.

Metals: Metallic patterns are used where repetitive production of casting is required in large quantities. Different metals like cast iron, brass, aluminium alloys and white metal etc. are used for making patterns.

Plaster: Gypsum plaster (plaster of paris) when mixed with a correct quantity of water sets in a given time and forms a hard mass having high compressive strength (upto 300 kg/cm^2).

Plastic Compounds: Both thermosetting and thermoplastic materials are used for pattern work. Generally thermosetting epoxy and polyester resins are used. In the thermoplastic type, polystyrene has become popular.

Waxes: The waxes commonly chosen are paraffin wax, shellac wax, bees wax and cerasin wax. Additives which acts polymerizing agents and stabilizers are also added.

* Their use helps in imparting a high degree of surface finish and dimensional accuracy to castings.

Types of Pattern:

Solid or Single Piece Pattern

* Patterns made without joints, partings or any loose pieces in its construction is called a single piece or solid pattern.
* This pattern is not attached to a frame or plate so it is also called loose pattern.
* These are cheaper

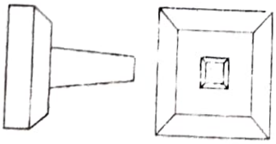


Fig. Solid Pattern

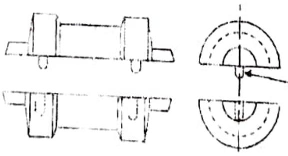


Fig. Split Pattern

Split (Two Piece Pattern)

Sometimes patterns cannot be made in single piece because of the difficulties encountered in moulding or difficulty in withdrawal from the mould. Because of these, patterns are usually made in two pieces called split patterns.

One part will produce the lower half of the mould and the other part will produce the upper half of the mould.

Spindles, cylinders, steam valve bodies, water stop cocks and taps are few examples of split patterns.

Multipiece Pattern: Sometimes the patterns are made in more than two parts if the shape is complex. Then these patterns are called multipiece pattern which may consist of 3, 4 or more number of parts depending upon their design.

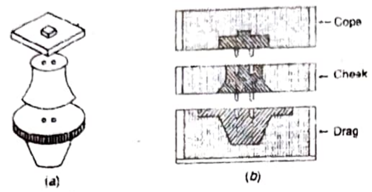


Fig. Multipiece Pattern

Match Plate Pattern: When split patterns are mounted with one half on one side of a plate (Match plate) and the other half directly opposite to the other side of the plate, the pattern is called a match plate pattern.

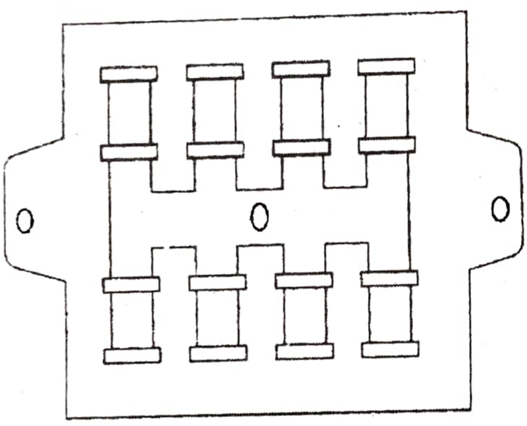


Fig. 14.4. Match Plate Pattern.

Gated Pattern: To produce good casting, it is necessary to ensure that full supply of molten metal flows into every part of the mould. Provision for easy passage of the flowing metal in the mould is called gating and is provided in the gated patterns.

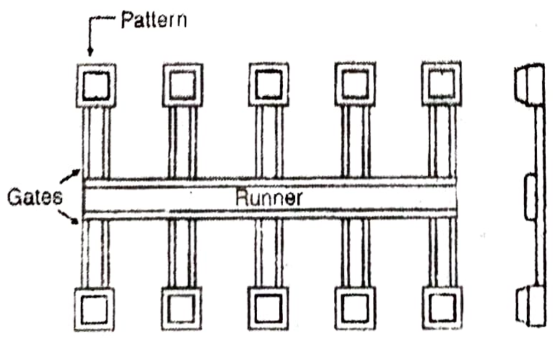
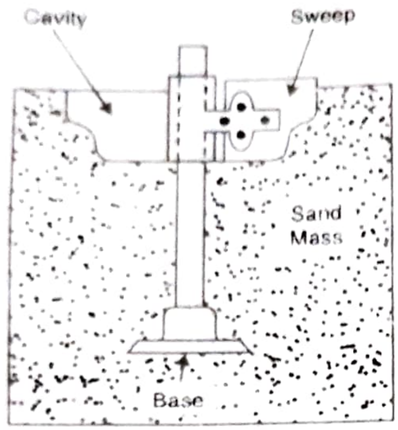
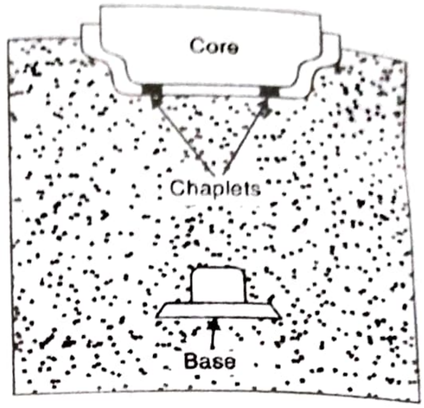


Fig. Gated Pattern

Sweep Pattern: Sweep pattern is just a from made on a wooden board which sweeps the shape of the casting into sand all round the circumference. The sweep pattern rotates about the post.



(a) A sweep pattern in action



(b) Mould ready with core in position

Fig. Sweep Pattern

* The moulds of large size and symmetrical in shape particularly of circular section can be easily prepared by using a sweep instead of a full pattern.

Pattern with Loose Pieces: Certain patterns cannot be withdrawn once they are embedded in the moulding sand. Such pattens are usually made with one or more loose pieces for facilitating their removal from the moulding box and are known as loose piece patterns.

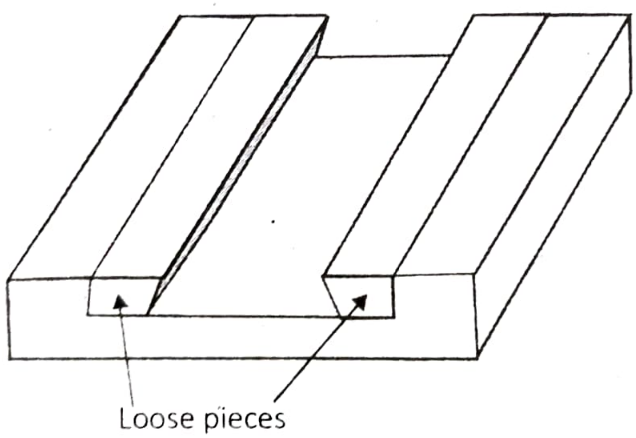


Fig. Pattern with Loose Pieces.

PATTERN ALLOWANCES

Patterns is having different size as compared to casting because it carries certain allowances due to metallurgical and mechanical reasons. The various allowance are:

(a) **Shrinkage or Contraction Allowance**

* As metal solidifies and cools, it shrinks and contracts in size. To compensate for this, a pattern is made larger than a finished casting by means of a shrinkage or contraction allowance.

* Contraction is different for different metals.

* Wood patterns used to make metallic patterns are given double allowance, one for the shrinkage of the metal of the pattern and the other for that of metal to be cast.

* The total contraction is volumetric but the shrinkage allowance is added to the linear dimensions.

(b) Machining or Finish Allowance

* For good surface finish, machining of casting is required. For machining, extra metals are needed. This extra metal is called machining or finish allowance.

* The amount of this allowance varies from 1.6 to 12.5 mm which depends upon the type of casting metal, size and shape of casting, method of casting used, method of machining to be employed and the degree of finish required.

* This allowance is given in addition to shrinkage allowance.

(c) Draft or Taper Allowance: At the time of withdrawing the pattern from the mould, the vertical faces of the pattern are in continual contact with the sand, which may damage the mould cavity. This danger is greatly decreased if the vertical surfaces of a pattern are tapered inward slightly. The slight taper inward on the vertical surface of a pattern is known as the draft.

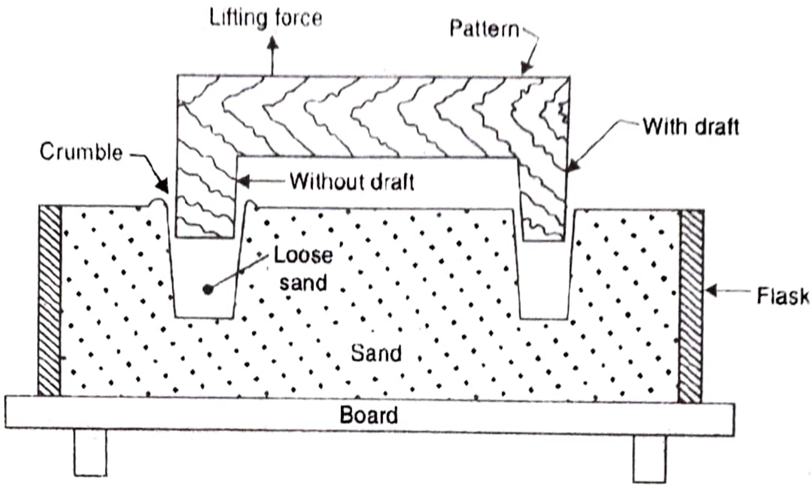


Fig. Draft Allowance

* It may be expressed in millimeters per metre an a side or in degrees.

* It depends upon the length of the vertical side intricacy of the pattern, method of moulding, type of pattern and pattern material.

(d) Distortion or Camber Allowance

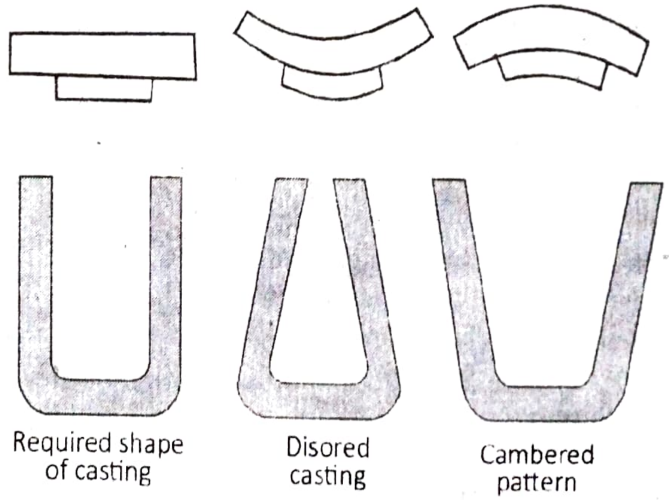


Fig. Distortion Allowance

If the shape of the casting change's that is called distortion of the casting. A casting will distort or warp, if.

* It is of irregular shape.
* All its parts do not shrink uniformly.
* It has long flat casting.
* The arms possess unequal thickness.

CLASSIFICATION OF MOULDING SAND

The moulding sand may be classified generally into the following three different types :

1. Natural Sand (Green sand): These sands are taken from river beds and are dug from pits and purely natural. They possess an appreciable amount of clay (acts as a binder) and moisture.

2. Synthetic Sand: It is an artificial sand obtained by mixing relatively clay free sand, binder and other materials as required. It is a better moulding sand as its properties can be easily controlled by varying the mixture content.

3. Special Sand: It contains the mixtures of inorganic compounds. Cost of these sands are more but they offer high temperature stability, better cast surfaces etc.

* Special sands used are zircon, olivine, chamotte, chromite etc. The moulding sand can be furthur classified as:-

1. Green Sand 2. Dry Sand 3. Loam Sand

PROPERTIES OF MOULDING SAND

Proper moulding sand must possess the following properties :

1. Porosity or Permeability: Molten metal always contains a certain amount of dissolved gases which are evolved when the metal freezes.

* Molten metal also coming in contact with the moist sand, generates steam or water vapours.

2. Flowabiiity (Plasticity): Flowability is the ability of the moulding sand to get compacted to a uniform density.

* Flowability assists moulding sand to flow and pack all around the pattern and take up the required shape.

3. Refractoriness: It is the ability of the moulding sand to withstand high temperature of the molten metal without fusion, cracking or buckling.

* Refractoriness is measured by the sinter point of the sand rather than its melting point.

4. Adhesiveness: It is that property of the sand due to which it adhere or cling to the another body (i.e., sides of the moulding box).

* It is due to this property that the sand mass can be successfully held in a moulding box and it does not fall out of the box when it is tilted (roll over).

5. Cohesiveness: This is the ability of sand particles to stick together. It may be defined as the strength of the moulding sand.

6. Collapsibility: It is that property of the sand due to which the sand mould breaks (collapse) automatically (or with very less forces) after the solidification of the casting occurs.

CORE MAKING

The core making procedure consists of the following steps:

1. Mixing of Core Sand
2. Ramming of Core Sand
3. Venting of Core
4. Reinforcing of Core

5. Baking of Core
6. Finishing of Cores
7. Joining of Cores
8. Setting of Cores

Elements of a Gating System

The various elements connected with a gating system are:

1. Pouring basin or pouring cup
2. Sprue
3. Sprue base well
4. Runner
5. Runner extension
6. Ingate
7. Riser

(Refer Q.2. of first term examination 2017) (Page 2-2017))

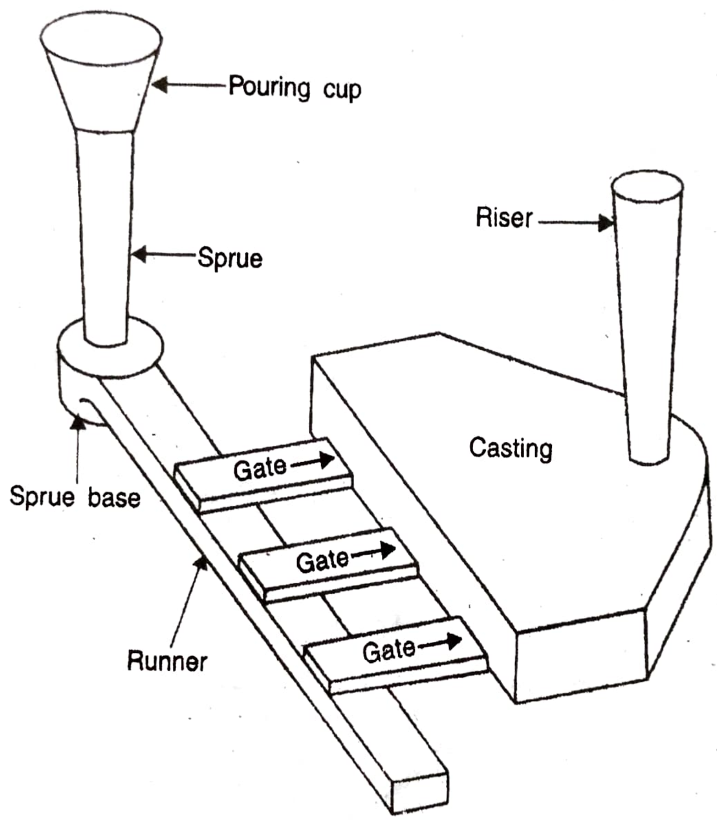


Fig. Gating System

Description and Operating on Cupola

(Refer Q.3 of First Term Examination 2015) (Page 3-2015).

Shell Casting: Shell mold casting is a metal casting process similar to sand casting, in that molten metal is poured into an expendable mold. However, in shell mold casting, the mold is a thin-walled shell created from applying a sand-resin mixture around a pattern. The pattern, a metal piece in the shape of the desired part, is reused to form multiple shell molds. A reusable pattern allows for higher production rates, while the disposable molds enable complex geometries to be cast. Shell mold casting requires the use of a metal pattern, oven, sand-resin mixture, dump box, and molten metal.

Shell mold casting allows the use of both ferrous and non-ferrous metals, most commonly using cast iron, carbon steel, alloy steel, stainless steel, aluminum alloys, and copper alloys. Typical parts are small-to-medium in size and require high accuracy, such as gear housings, cylinder heads, connecting rods, and lever arms.

The shell mold casting process consists of the following steps:

1. Pattern creation - A two-piece metal pattern is created in the shape of the desired part, typically from iron or steel. Other materials are sometimes used, such as aluminum for low volume production or graphite for casting reactive materials.

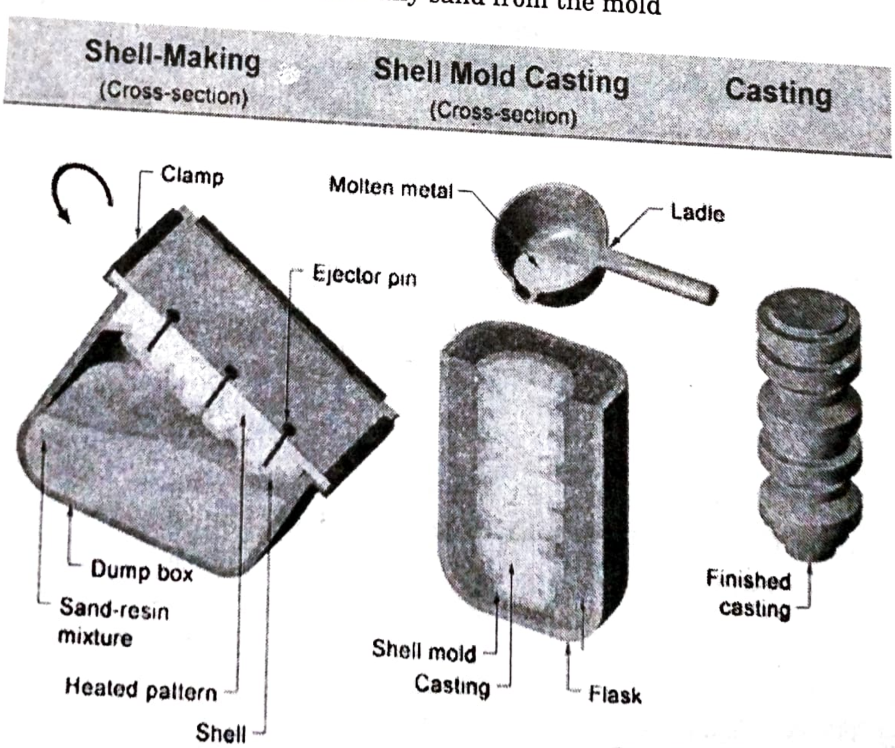
2. Mold creation - First, each pattern half is heated to 175-370°C (350-700°F) and coated with a lubricant to facilitate removal. Next, the heated pattern is clamped to a dump box, which contains a mixture of sand and a resin binder. The dump box is inverted, allowing this sand-resin mixture to coat the pattern. The heated pattern partially cures the mixture, which now forms a shell around the pattern. Each pattern half and surrounding shell is cured to completion in an oven and then the shell is ejected from the pattern.

3. Mold assembly - The two shell halves are joined together and securely clamped to form the complete shell mold. If any cores are required, they are inserted prior to closing the mold. The shell mold is then placed into a flask and supported by a backing material.

4. Pouring - The mold is securely clamped together while the molten metal is poured from a ladle into the gating system and fills the mold cavity.

5. Cooling - After the mold has been filled, the molten metal is allowed to cool and solidify into the shape of the final casting.

6. Casting removal - After the molten metal has cooled, the mold can be broken and the casting removed. Trimming and cleaning processes are required to remove any excess metal from the feed system and any sand from the mold



Working Principle of Special Casting Process

Die Casting: Unlike gravity die casting, in this molten metal is forced into permanent mould (die) cavity under pressure.

* The pressure varies from 20 to 2000 kgf/cm^2 and is maintained till solidification stage is reached. The pressure is generally obtained by compressed air or hydraulically.

Die Casting machines are of two types

(a) Hot Chamber Die Casting

* In hot chamber die casting machines, the melting unit is in the machine itself that is why it is called hot chamber die casting machine.

* The molten metal possesses normal amount of superheat and therefore less pressure is needed to force the liquid metal into die.

* It has further two types of arrangements :

1. Goose neck or air injection type (or direct air pressure).

2. Submerged plunger type

Goose neck or air injection type: In this machine, the goose neck container is operated by a lifting mechanism. Initially it is submerged in the molten metal and is filled by gravity. Then it is raised so as to bring the nozzle in contact with the die opening and is locked in that position. Compressed air then forces the metal into the die and pressure is maintained till solidification. When solidification is complete, the goose neck is lowered down and casting is removed by ejector pins after opening the dies.

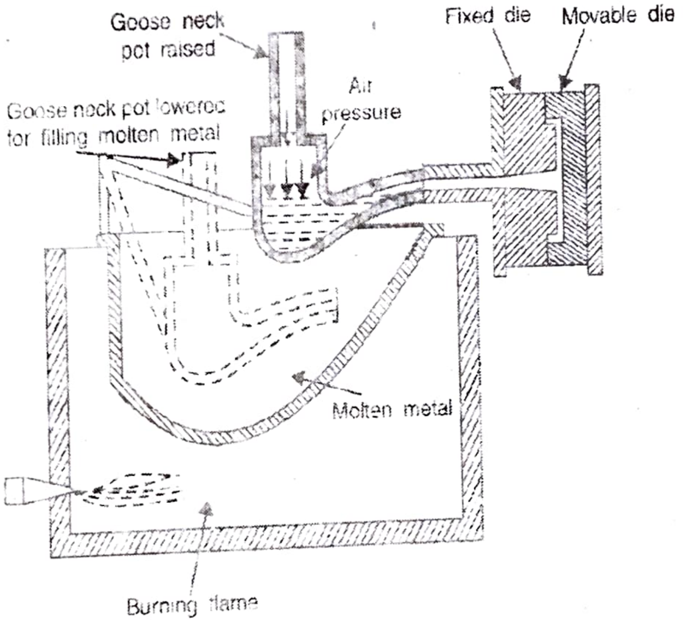


Fig. Air injection Type Hot Chamber Die Casting Machine.

(b) Cold Chamber Die Casting

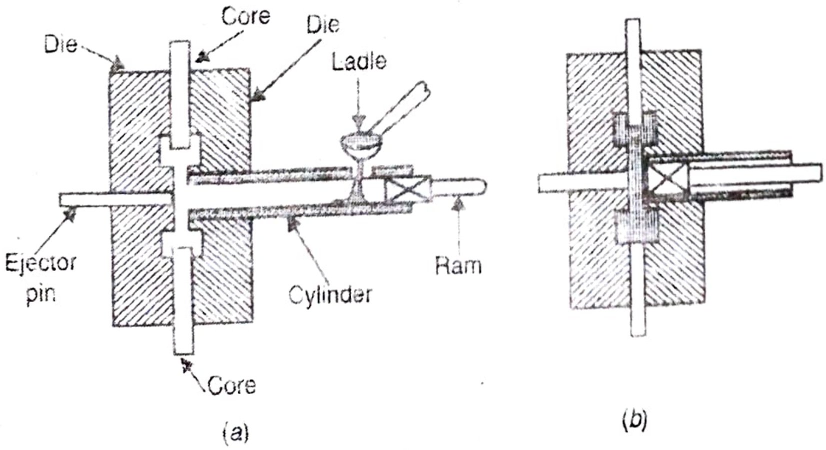


Fig. Cold Chamber Die Casting Machine.

In these machines, the metal is melted separately in a furnace and transferred to these by means of small hand ladle. After closing the die, the molten metal is forced into the die cavity by a hydraulically operated plunger and pressure is maintained till solidification. These machines can either have vertical plunger or horizontal plunger for forcing molten metal into die. These machines are widely used for casting a good number of aluminium alloys and brasses.

CENTRIFUGAL CASTING

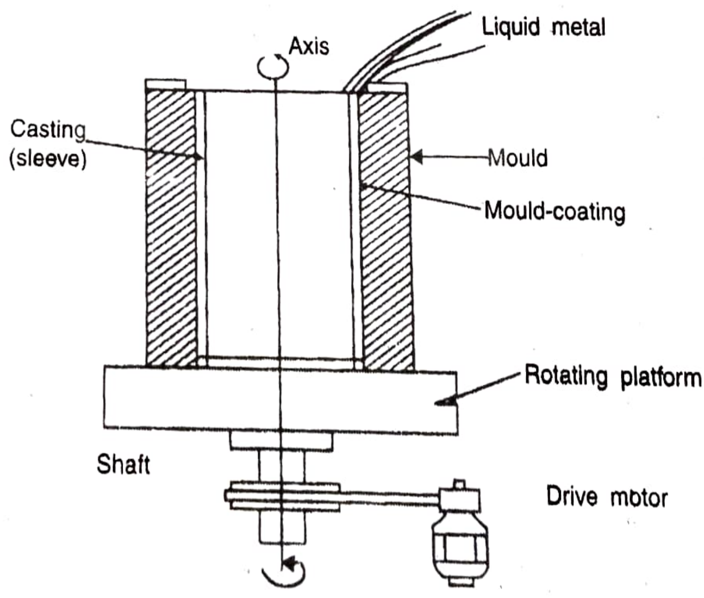
In centrifugal casting, centrifugal force plays a major role in shaping and feeding of the casting. In this process mould is rotated rapidly about its central axis as the metal is poured into it, The centrifugal force is utilized in two ways :

* It is utilised to distribute liquid metal over the outer surface of a mould. Hollow cylinders and other annular shapes are formed in this way.

* Centrifugal force tends the poured metal and the freezing metal to fly outward away from the axis of rotation, and this tendency creates high pressure on the metal of casting while it is freezing the lighter slag, oxides and other inclusions being lighter, gets separated from the metal and segregates towards the centre.

There are three main types of centrifugal casting processes. They are :

* True centrifugal casting. * Semi centrifugal casting.
* Centrifuge casting.



(*b*) Vertical Mould

Fig. True Centrifugal Casting.

Casting Defects: Casting defects are usually not accidents, they occur because some steps in the manufacturing cycle do not get properly controlled and somewhere goes wrong. So close control and standardization of all aspects of manufacturing technique offers the best defense against the occurrence of defects in casting.

BLOW HOLES: They appear as cavities (holes) in a casting.

* Blow holes visible on the surface of a casting are called open blows whereas those occur below the surface of castings and not visible from outside are termed as blow holes.

Causes: Excessive moisture in the moulding sand.

* Low permeability and excessive fine grain sands.

Remedies: Control moisture content.

* Use clean and rust free chills, chaplets and metal insert.

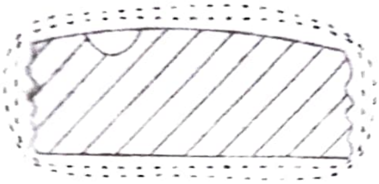


Fig. Blow Holes.

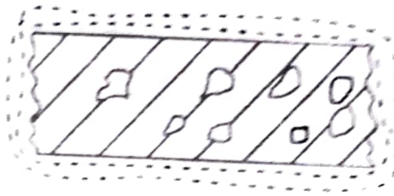


Fig. Porosity.

POROSITY: This defect occurs in the casting in the form of pin hole porosity or gas porosity. Hydrogen is responsible for pin hole porosity. Gases will be absorbed by the liquid metal. When the metal solidifies the solubility decreases and gases will be released and create small voids throughout the called porosity.

Causes : High pouring temperature.

* Gas dissolved in metal charge.

Remedies : Increase flux proportions.

* Ensure effective degassing.

SHRINKAGE: During solidification of metal, there is a volumetric shrinkage. To compensate this, proper feeding of liquid metal is required.

Causes : Faulty gating and risering.

* Improper chilling.

Remedies : Ensure proper directional solidification by modifying gating, risering and chilling.

Misruns and cold sheets: When the metal is unable to fill the mould cavity completely and thus leaving unfilled portion called Misruns. A cold shut is called when two metal streams don't fuse together properly.

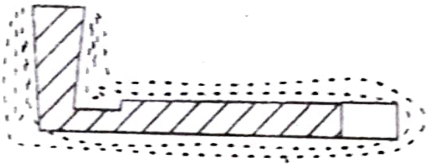


Fig. Mis Runs.

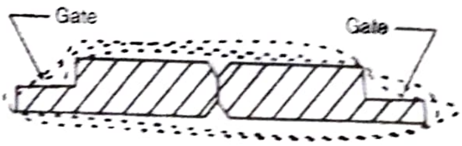


Fig. Cold Shut

Causes : Lack of fluidity in molten metal

* Faulty design.

Remedies : Adjust proper pouring temperature.

* Modify design.

Inclusions : During the melting process, flux is added to remove the undesirable oxides and impurities present on the metal. At the time of tapping, the slag should be properly removed. If it mixes with the molten metal, defect is called inclusion (slag).

Causes : Faulty gating and faulty pouring.

* Inferior moulding or core sand.

Remedies : Improve or modify gating and pouring.

* Use a superior sand.

Hot Tears : Since metal has low strength at higher temperature, any unwanted cooling stress may cause the rupture (tear) of the casting called hot tears.

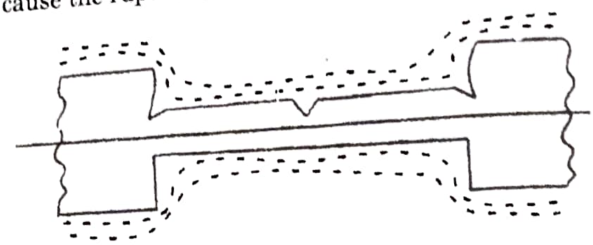


Fig. Hot Tears

Causes: Lack of collapsibility of core and mould.

* Faulty design.

Remedies: Improve collapsibility

* Modify design.

UNIT-II

Welding: The welding is a process of joining two similar or dissimilar metals by fusion, with or without the application of pressure and with or without the use of filter metal. The fusion of metal takes place by means of heat. The heat may be obtained from electric arc, electric resistance, chemical reaction, friction or radiant energy.

CLASSIFICATION OF WELDING

In general, various welding and allied processes are classified as follows:

Gas Welding

* Air-acetylene welding.
* Oxy acetylene welding.
* Oxy-hydrogen welding.

Arc Welding

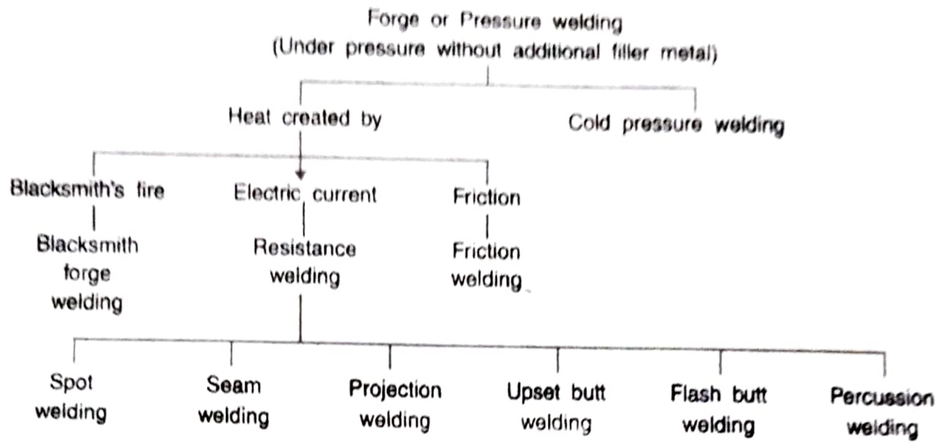
* Carbon arc welding
* Shielded metal arc welding
* Flux cored arc welding
* Submerged arc welding
* TIG (Tungsten Inert Gas) welding. (Gas Tungsten Arc Welding)
* MIG (Metal Inert Gas) or GMAW (Gas Metal Arc Welding)
* Plasma arc welding
* Electroslag welding
* Electrogas arc welding
* Stud arc welding.

Resistance Welding

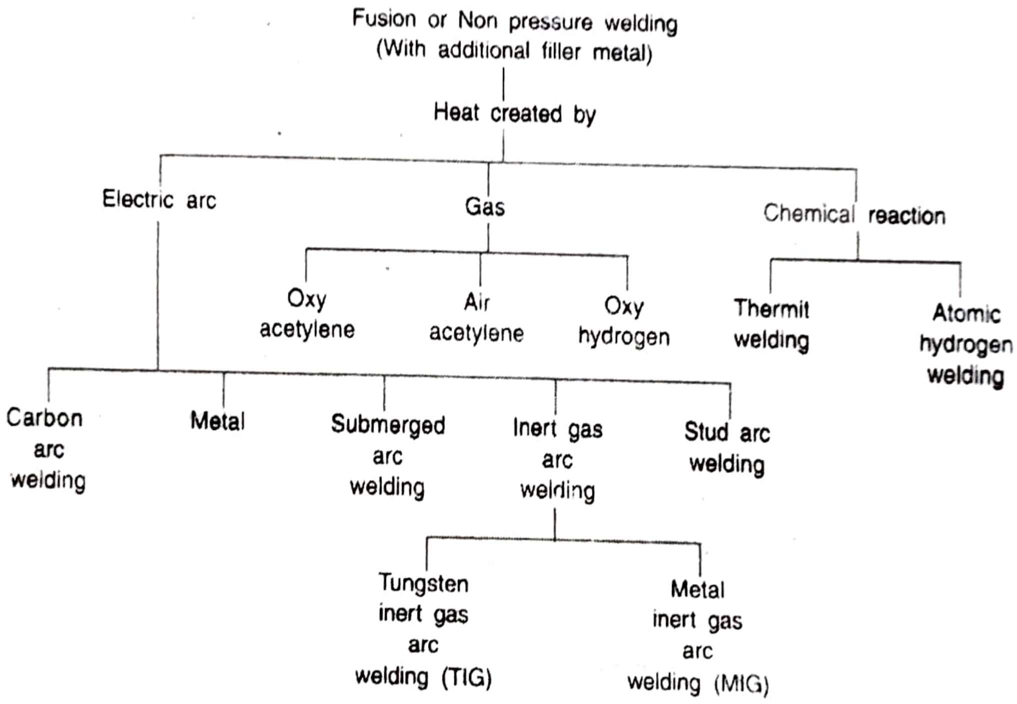
* Spot welding
* Seam welding
* Projection welding
* Resistance butt welding
* Flash butt welding
* Percussion welding
* High frequency resistance welding.

Welding Process can be further divided into the following graps:

1. Forge or Pressure Welding (Plastic Welding): In forge or pressure welding, the workpieces are heated to plastic state and then, the workpieces are joined together by applying external pressure on them.



2. Fusion or Non-pressire Welding: In this welding, the material at the joint is heated to a molten state and then allowed to solidify.



GAS WELDING also called an oxy-fuel gas welding, derives the heat from the combustion of a fuel gas such as acetylene in combination with oxygen. The process is a fusion welding process wherein joint is completely melted to obtained the fusion.

The fuel gas generally used is acetylene because of the high temperature generated in the flame. This process is called oxy-acetylene welding.

Principle of operation: When acetylene is mixed with oxygen in correct proportions in the welding torch and ignited, the flame is produced which is sufficiently hot to melt and join the parent metal. Temperature of flame is about 3100°C. A filler rod is generally added to build up the seam for greater strength.

Oxy-acetylene welding may be classified as:

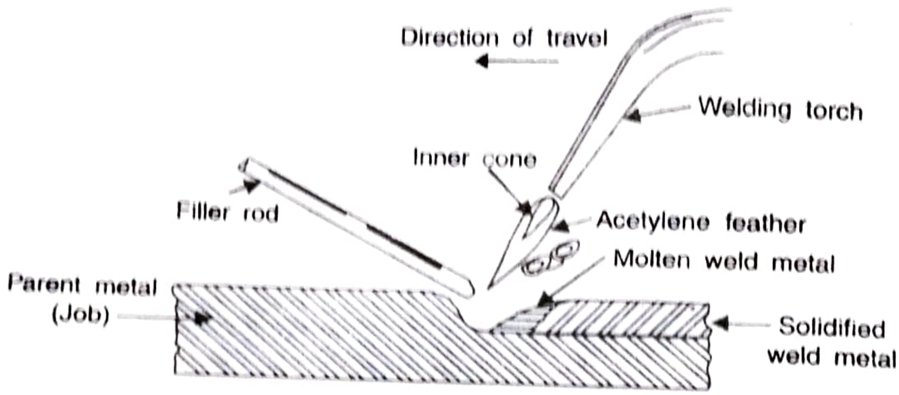
1. High pressure Oxy-acetylene welding.

2. Low pressure Oxy-acetylene welding.

1. High Pressure Oxy-acetylene Welding: In case of high pressure Oxy-acetylene gas welding, the acetylene gas is supplied from the acetylene cylinder in compressed form.

2. Low Pressure Oxy-acetylene Welding: In case of low pressure Oxy-acetylene gas welding, the acetylene gas is supplied from the generator at low pressure. In the generate calcium carbide stone is added in the chamber in which water is already present. Calcium carbide stone reacts with the water and produce acetylene gas. This gas can be easily collected from the top of the water and can be used for welding purpose.

$$CaC_2 + 2H_2O \rightarrow C_2H_2 + Ca(OH)_2$$

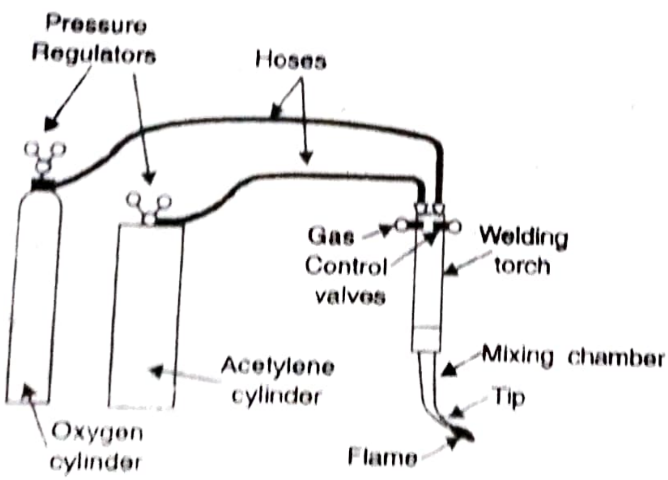


Oxy-Acetylene Welding

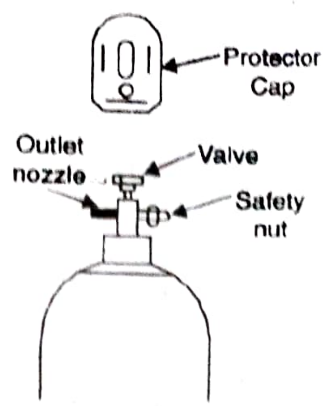
Gas Welding Equipments

1. Oxygen Gas Cylinder: Oxygen cylinders are painted black and valve outlets are screwed right handed.

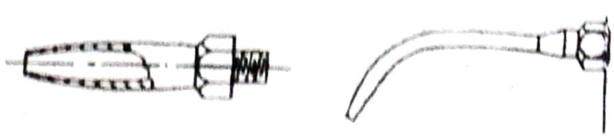
2. Acetylene Gas Cylinder: Acetylene cylinder is painted maroon and the valves are screwed left-handed, to make this easily recognizable, they are chamfered or grooved.



Gas Welding Equipment



Oxygen Cylinder



Welding Nozzles.

3. Oxygen and Acetylene Pressure Regulators

* The pressure of the gases obtained from cylinders/generators is considerably higher than the gas pressure used to operate the welding torch. The purpose of using a gas pressure regulator is, therefore:

* To reduce the high pressure of the gas in the cylinder to a suitable working pressure.

4. Oxygen and Acetylene Gas Hoses and Hose Connections

5. Welding Torch or Blowpipe

6. Trolleys for the transportation of oxygen and acetylene cylinders.

7. Set of keys and spanners.

8. Filler rods and fluxes.

9. Gas lighter.

10. Protective clothing for the welder (e.g. asbestos apron, gloves goggles etc.)

ELECTRODES: The electrodes are used for providing heat input in arc welding. Electrodes can be classified on the following basis :

1. Consumable or Non-consumable. 2. Bare or coated electrodes.

Consumable Electrodes: When the arc is obtained with a consumable electrodes, the weld metal and the tip of the electrode also gets melted under the arc. The molten metal from the electrode and the base metal gets mixed under the arc and provides the necessary joint. So in this process, once the arc is initiated, the electrode is continuously consumed.

Bare Electrode: If the electrode is not located with flux, it is called the have electrode.

FLUX: During welding if the metal is heated/melted in air, oxygen from the air combines with the metal to form oxides which results in poor quality, low strength welds and in some cases, may even make welding impossible. Sometimes the flux will be added separately. Covering of the coated electrode is also called flux. Sometimes the purpose of flux is also solved by inert or active gas (TIG, MIG, and MAG). The materials used for flux coating are termed as components.

ELECTROSLAG WELDING

In welding process, welding heat is produced by the molten slag, which melts the filler metal the surfaces of the work to be welded.

Operation: Electroslag welding is initiated by starting an arc between the filler metal/electrode and the work. This arc heats the flux and melts it to form the slag. The arc is then extinguished and the slag (conductive) is maintained in molten condition by its resistance to the flow of electric current between the electrode and the work. The temperature of this molten slag pool is approx. 1650° at the surface and 1950°C inside, under the surface. This much heat is sufficient to weld thick sections or joints its in a single pass. Several electrodes are used for long welds so that the heat is more uniformly spread.

Water-cooled shoe or dam plate fastened to the sides of the workpiece prevents the molten metal from running off. These plates also assist the solidification process by removing heat and as the weld progress.

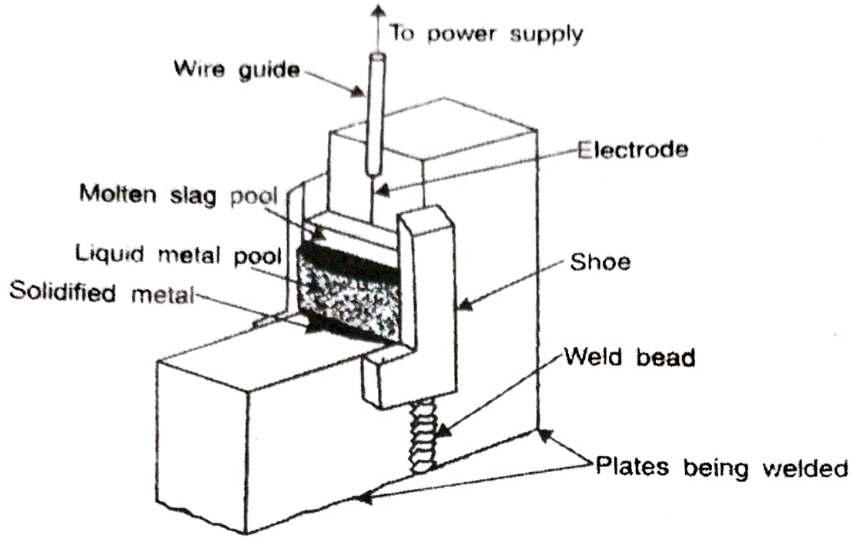


Fig. Electroslag Welding

METAL INERT GAS (MIG) OR GAS METAL ARC WELDING (GMAW)

In this welding process, welding heat is produced from an electric arc established between the continuously fed metal electrode and the job. Argon, helium, carbon dioxide or a gas mixture shields the arc and molten metal from atmospheric contamination.

Gas metal arc welding (GMAW), sometimes referred to by its subtypes **metal inert gas (MIG)** and **metal active gas (MAG)** is a welding process in which an electric arc forms between a consumable MIG wire electrode and the workpiece metal(s), which heats the workpiece metal(s), causing them to fuse (melt and join). Along with the wire electrode, a shielding gas feeds through the welding gun, which shields the process from atmospheric contamination.

The process can be semi-automatic or automatic. A constant voltage, direct current power source is most commonly used with GMAW, but constant current systems, as well as alternating current, can be used.

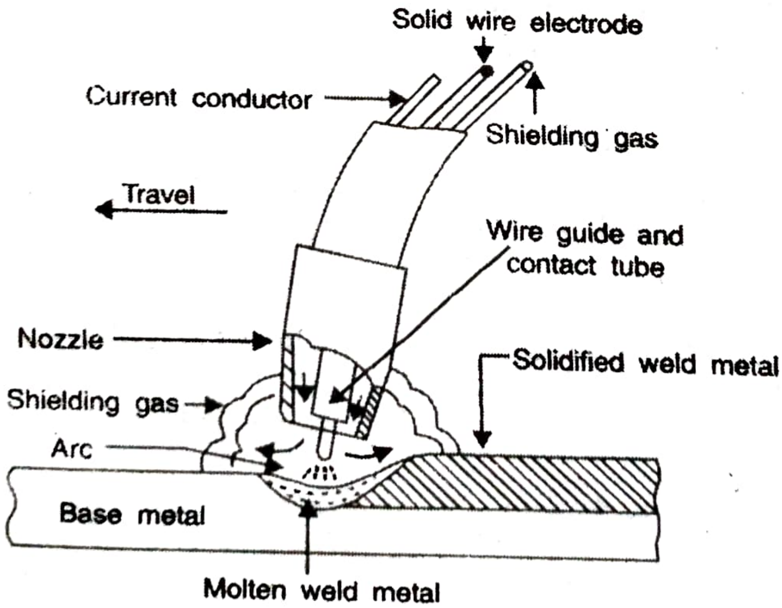


Fig. Principle of Metal Inert Gas Welding (MIG).

Operation: The consumable electrode is in the form of a wire reel, which is fed at a constant rate, through the feed rollers. The welding torch is connected to the gas supply cylinder, which provides the necessary inert gas. The electrode and the workpieces are connected to the welding power supply. The power supplies are generally of the constant voltage type only. The current from the welding machine is changed by changing the rate of feeding of the electrode wire.

Welding Defects: Refer Q.1 (d) (Pg 8-2016)

Flux Material: Refer Q.1 (d) (Pg 7-2017)

Electric are Welding: Refer Q.6 (b) (Pg 19-2018)

Submerged are Welding: Refer Q.4 (Pg 16-2017)

TIG: (Refer Q.1 (e) of (9-2016))

Refer Q.3 (Pg 10-2014)

Resistance Welding: Refer Q.4 (Pg 2017-19)

UNIT-III

Hot Working & Cold Working of Metals: Refer Q.1(c) of End Term Examination (Page 6-2018)

Forging Process: Refer Q.1(g) of First Term Examination (Page 2-2017)

Refer Q.3 of End Term Examination (Page 12-2017)

(a) Drop forging: Drop forging differs from smith forging in the manner that here closed impression dies are used as compared to flat or open face dies. Drop forging die consists of two halves shown in Fig. The lower half is fixed to anvil and upper half is fixed to movable ram. The heated stock is kept in lower die. Forging is produced by blows of ram, which compels the hot metal to flow and take the shape of the cavity. To ensure complete 'filling of cavity normally an excess amount of material is provided. The numbers of blows required varies according to the shape and size of part, forging qualities of metal and tolerances required. When the product geometry is complicated a set of dies may be necessary to obtain the final shape.

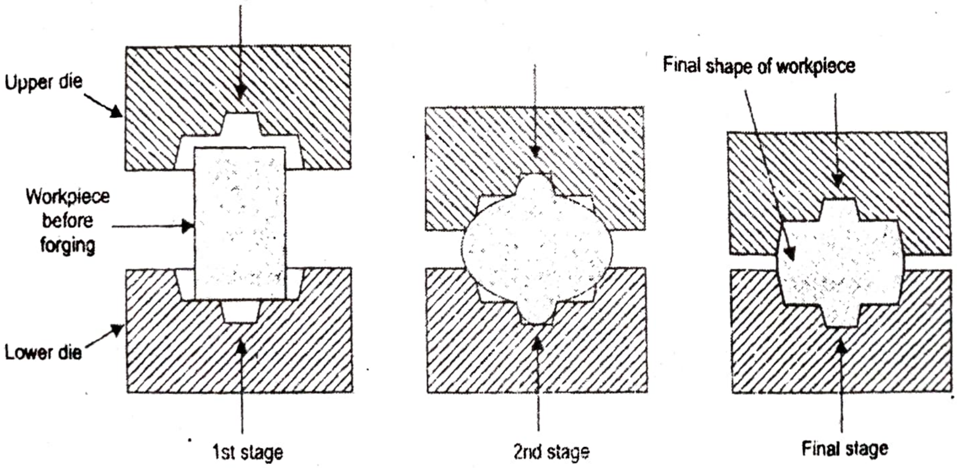


Fig. Closed impression dies

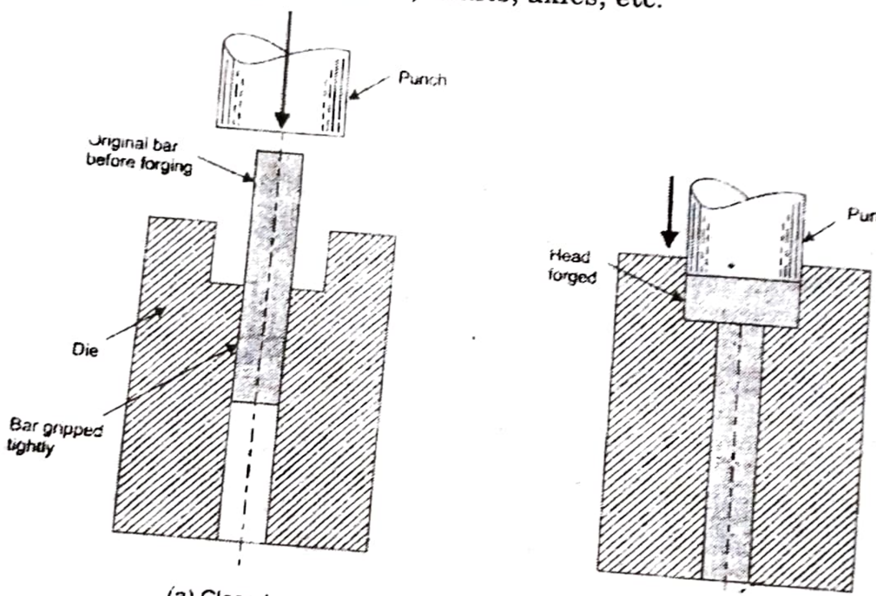
(b) Press forging: Like drop forging, press forging uses closed impression dies. In press forging instead of repeated impact blows a continuous squeezing action is employed. The operation is completed in single stroke and squeezing is obtained by means of mechanically or hydraulically operated presses. Depending upon the complexity of the job a set of dies may be required to obtain final product.

Press forging has got certain **advantages** over the drop forging which are as follows:

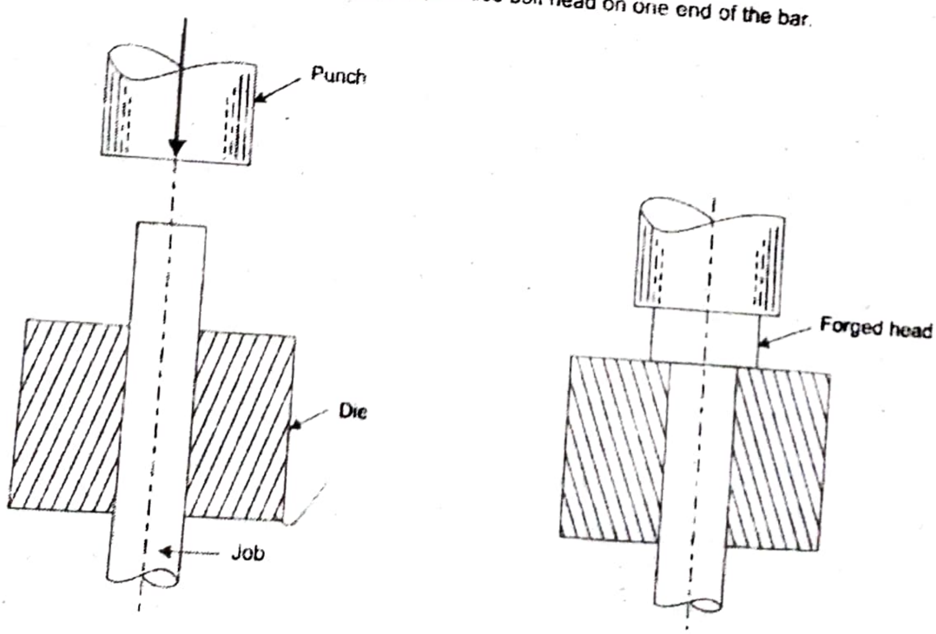
1. Press forging are normally faster than drop forging as only one squeeze is needed.
2. It is preferable to squeeze metal slowly rather than to hammer it rapidly, as the material gets uniformly deformed throughout the entire depth.
3. The surfaces produced by press forging are smooth and provide closer tolerances as compared to drop forging.
4. Alignment of two die half during forging can be more easily obtained.
5. Draft angles used in press forging are less than those used in drop forging.

However, many parts or irregular and complicated shapes can be forged more economically by drop forging.

(c) Upset forging: Upset forging involves upsetting operation. Originally this process was developed to form heads on bolts but now a days it is widely used to produce variety of useful forging e.g. gear blanks, shafts, axles, etc.



(a) Closed upsetting to produce bolt head on one end of the bar.



(b) Open upsetting operation

Fig. Upsetting Operation

Typical Forging Operations:

Drawing Down and Fullering: Drawing down is the process of increasing the length of and workpiece, while cross-sectional area is reduced. It is also known as drawing out. For this operation the workpiece is heated up to the plastic stage and placed on the anvil and the metal is beaten down by a sledge hammer.

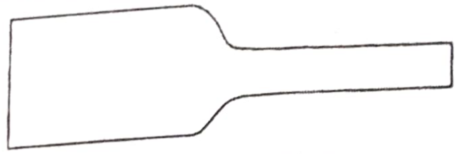
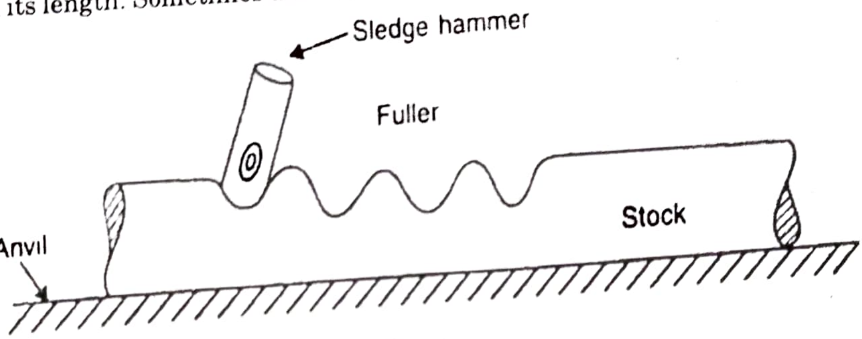


Fig. Drawing Down

Fullering: It is a forging operation carried out to increase the width of the workpiece rather than its length. Sometimes the sectional shape of the round stock is also changed.



Fullering

Cutting (Chiselling): Cutting out is an operation in which long piece of stock is cut into desired lengths by chisels. The metal may be hot or cold while chiselling with appropriate chisels.

Jumping or Upsetting: In this operation the thickness of the bar or section is increased at the expense of the length. If the end of the bar is required to be upset, its end is heated and hammering is done while holding the bar vertically on an anvil. The process is repeated till the required shape is obtained.

Bending: To carry out bending operation the bar stock is heated to dark red heat and then bending operation is carried out over the anvil edge or on the beak or on the swage block.

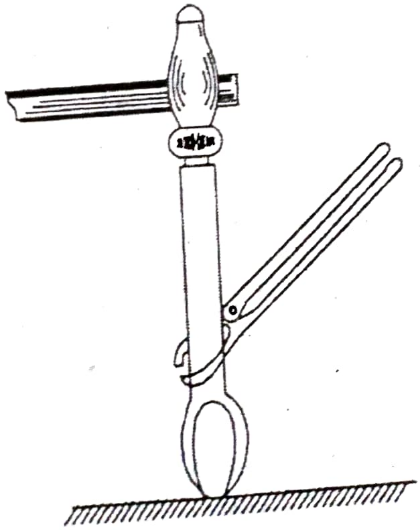


Fig. Jumping or Upsetting

HOT ROLLING (Rolling of Metals)

* Hot rolling is the process of reducing the thickness of a long workpiece by compressive force applied through a set of rolls. The desired thickness is obtained by maintaining the gap between the rolls. The forming of bars, plates, sheets, beams and other structural sections are made by hot rolling.

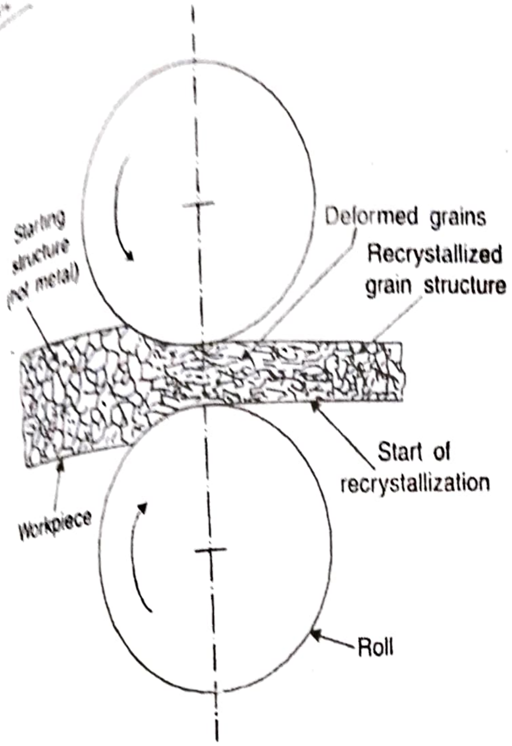


Fig. Hot Rolling Process

Roll force can be reduced by the following means:

* Reducing friction.
* Using smaller diameter rolls to reduce the contact area.
* Taking smaller reductions per pass.
* Roiling at elevated temperature, to lower the strength of the material.

The material commonly hot rolled are aluminium, magnesium, copper etc.

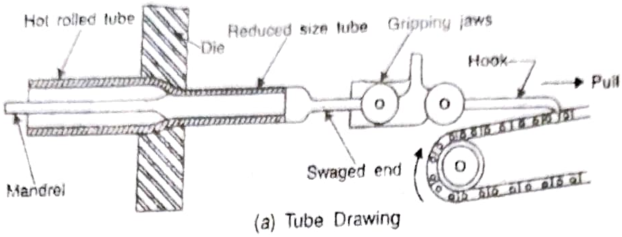
Principal of Rod and Wire Drawing

Rod Drawing: A draw bench is employed for bar drawing. The roller bars obtaned from hot rolling mills are first placed in the bath of dilute sulphuric acid (pickling) and then washed and dried. Then one end of the bar is reduced in diameter or made pointed, so that it can pass through die of somewhat smaller cross-section mounted on the draw bench. After passing this end through the die, it is then placed in grips or jaws from where the bar is pulled with the help of carriage, hook and chain drive. The length of the bars, which can be drawn, is limited by the maximum travel of the carriage, which may be from 15 metres to 25 metres.

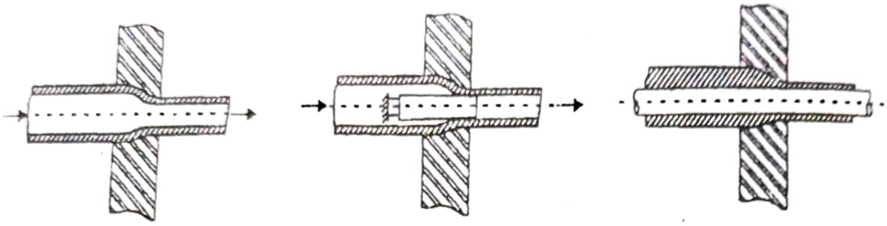
Wire Drawing: Refer Q.5(a)(ii) of End term Examination 2014 (Page 18-2014)

Refer Q.4(a) of End term Examination 2015 (Page 16-2015)

Tube Drawing: Tube drawing is similar to bar drawing but since tubes are hollow so in this case mandrels are used inside the tubes to retain the through hole.



(a) Tube Drawing



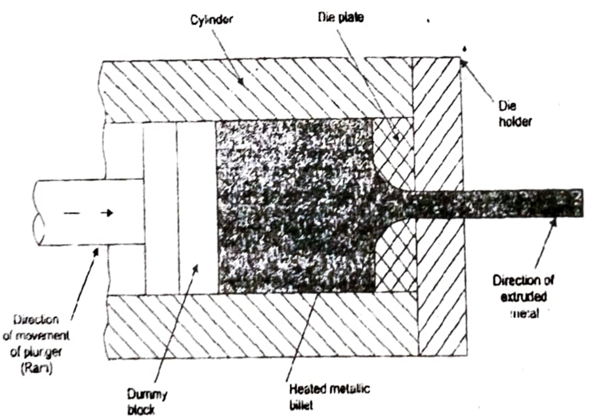
(b) Simplest Type of Tube Drawing

(c) Tube Drawing using a Fixed Plug

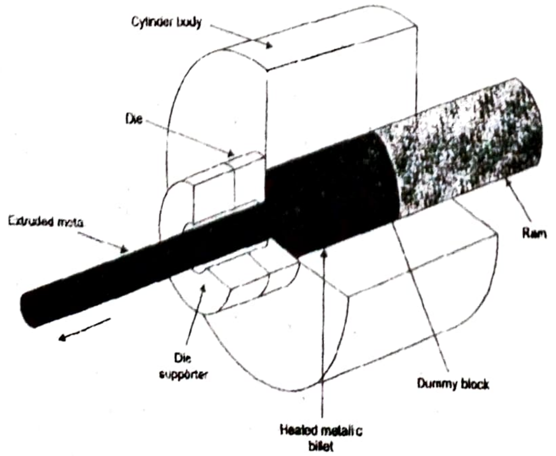
(d) Tube Drawing using a Removable Mandrel

Fig. 28.24. *Tube Drawing.*

Extrusion: Extrusion is the process of confining the metal in closed cavity and then forcing it to flow from one opening (die), so that metal will take the shape of the opening. The operation of extrusion is similar to the squeezing of tooth paste out of toothpaste tube. The paste inside the tooth paste has no shape, when the toothpaste tube is squeezed the paste flows out of the circular opening taking the shape of the opening.



(a)



(b)

Fig. Extrusion Process (forward extrusion)

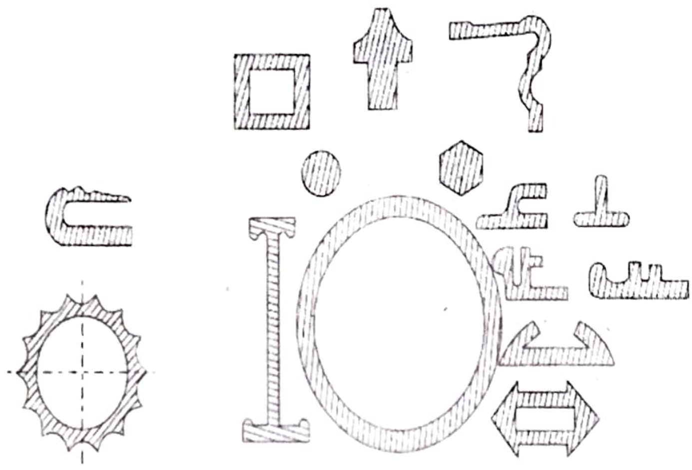


Fig. Example of some extruded components

Extruded Shapes: Rods, tubes, structural shapes, spined shafts, and bars of different cross sections are the typical applications of extrusion process. Almost unlimited length of cross section can be produced with extrusion process. However, only shapes with constant cross section can be produced in this process. Some of the extruded shapes are shown in fig.

Advantages of the extrusion process are as follows:

1. Extrusion is a single pass process unlike rolling.
2. Dies are easy to manufacture.
3. Variety of shapes of high strength, good accuracy and surface finish can be obtained.
4. High production rate with "relatively low die cost.

Classification of Extrusion Processes

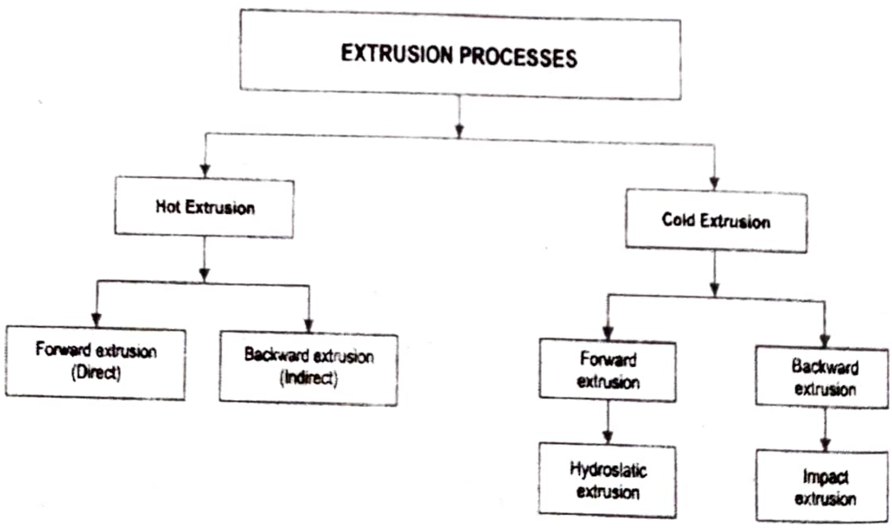


Fig. Classification of Extrusion process

Hot Extrusion

(a) Forward Extrusion: Forward extrusion is shown in fig. In this case the flow of metal is in the direction of movement of ram or plunger. Here the problem of friction is predominant because of relative motion between heated metallic billet and cylindric walls. To reduce friction lubricants are used. But at high temperature the lubricants get compounded. Molten glass is generally used as lubricant and thermal insulator for extruding steels.

(b) Backward Extrusion:

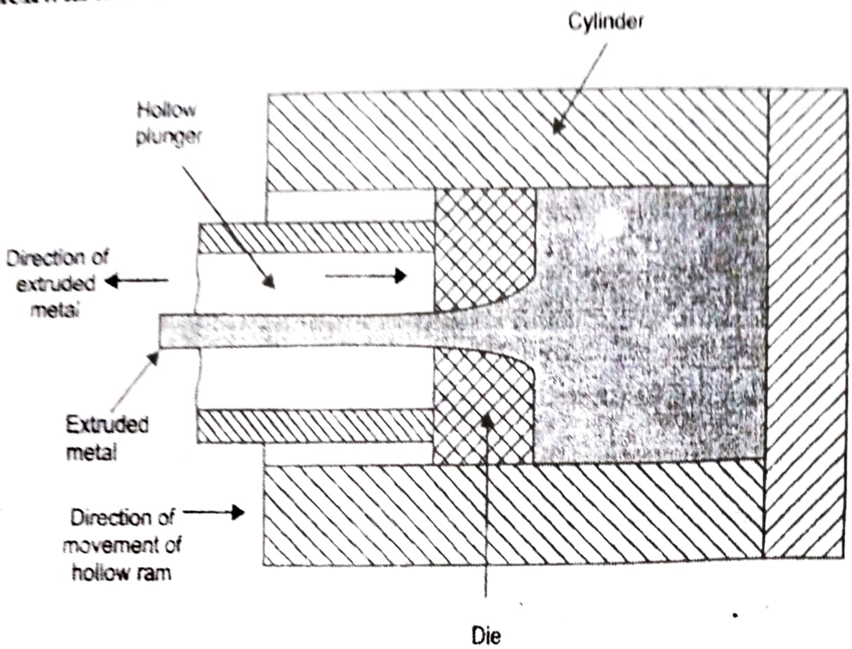


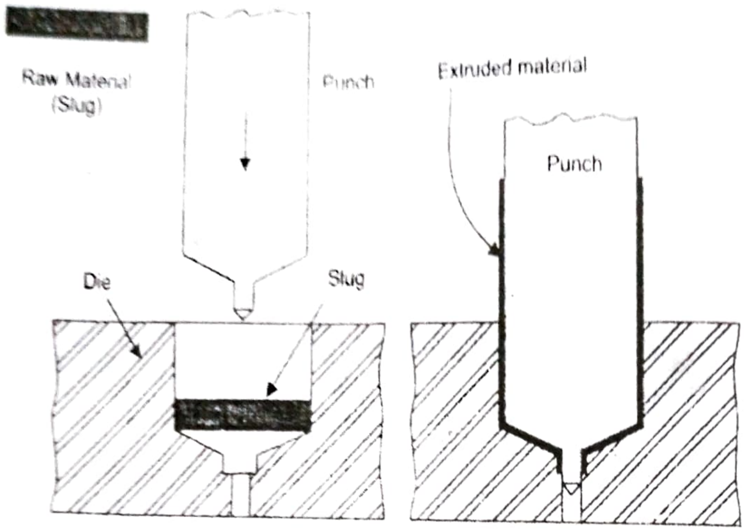
Fig. Backward hot extrusion process

In this case the problem of friction is eliminated as billet does not move in cylinder or container. A hollow ram compresses the metal against container, forcing it to flow backward through the die in hollow plunger. Less force is required in this method. Since there is no frictional force between metallic billet and container. The limitations of the process are the weakening of ram because it is hollow and difficulty of providing proper support for the extruded metal. The process is shown in fig.

Cold Extrusion

(a) Forward cold extrusion: The forward cold extrusion is similar to forward hot extrusion (as shown is Fig.) except that temperature is comparatively lower and extrusion pressures are higher than hot extrusion. It is usually used for simple shapes. The cold extruded products have better surface finish and improved mechanical properties. The common applications of cold extrusion are aluminium brackets, tubes, shock absorber cylinders etc. Now a days cold extrusion has also been used for forming mild steel parts often in combination with cold forging.

(b) Impact extrusion: Impact extrusion is used for manufacturing collapsible tubes for shaving cream, toothpaste and thin walled cans. The process is limited to soft and ductile materials such as aluminium and its alloys. The set up consists of die and punch as shown in Fig. A slug of metal of suitable thickness is kept on the die. The outside dia of tube is same as that of diameter of hole in die. Punch strikes a single blow causing the metal to flow through the annular space between the punch and die. The metal is extruded in the direction opposite to punch movement because of impact force. The process is conducted at room temperature. In recent years the process has been developed and now also applied to production of components for air craft, cars and domestic appliances of Al, copper alloy and steels.



Impact extrusion

Fig. Impact extrusion

Impact extrusion

Sheet metal characteristics:

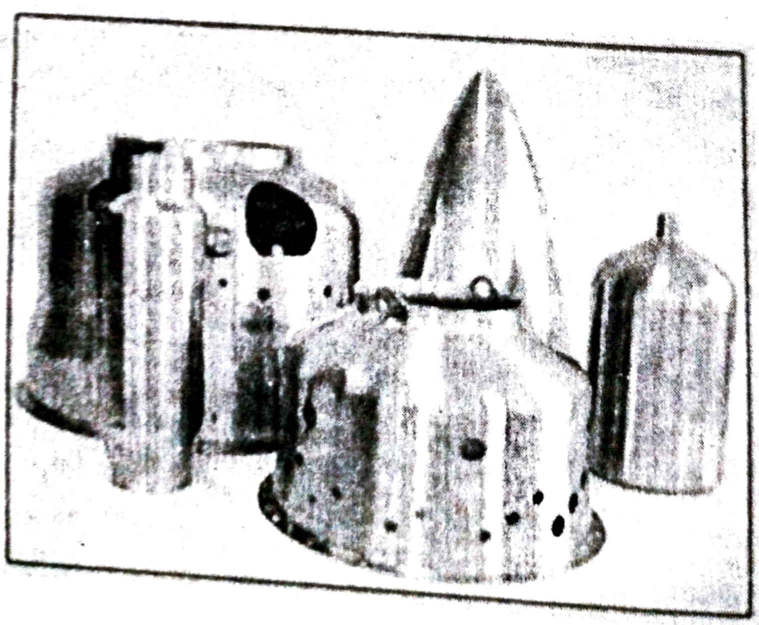
Refer Q.8(b) of End Term Examination 2018 (Page 21-2018)

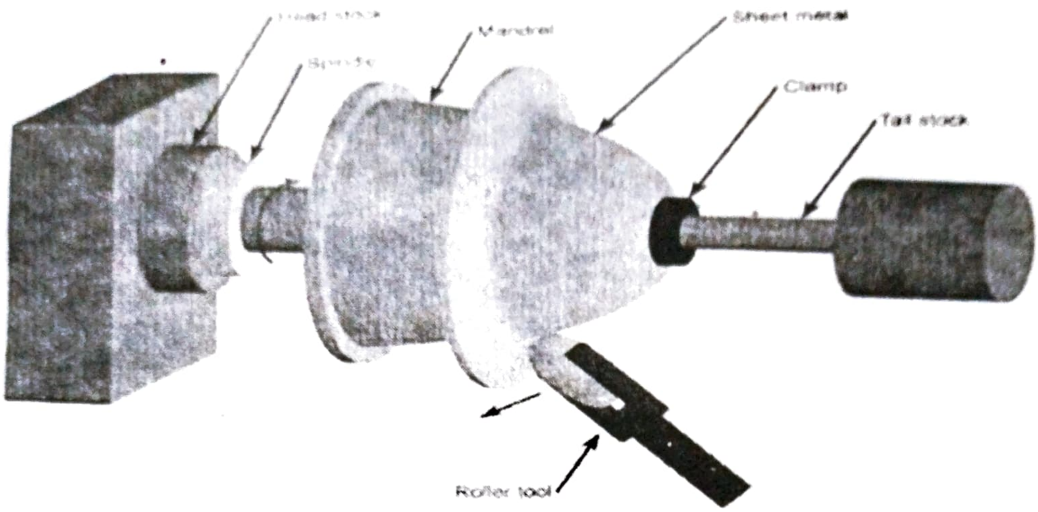
Refer Q.8(a) of End Term Examination 2016 (Page 2-2016)

Stretch forming operations:

Refer Q.9(b) of End Term Examination 2018 (Page 2-2018)

Metal spining process ia cold forming process in which the blank metal appears to flow some what like a place of clay on a potter's wheel.





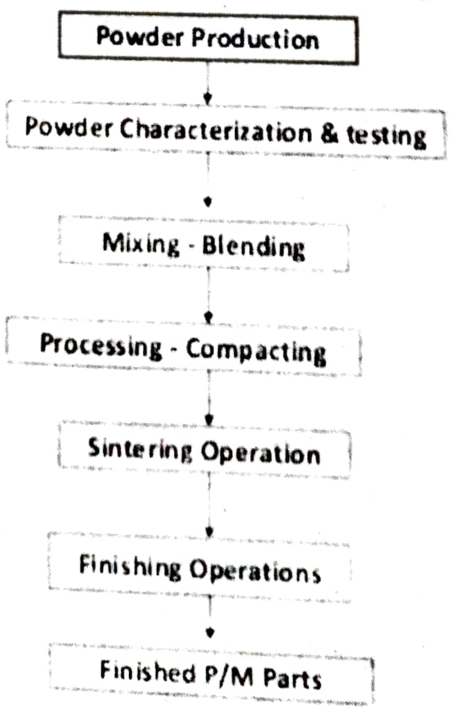
Here, we basically have a metal **disk or cylinder,** rotated at high **speed on CNC lathe** or on hand and hy using specially designed tools, we get **axially symmetric** products.

- to manufacture low cost, rapid prototypes in metals.
- bell shaped curves are ideal for spinning as metals can deform smoothly around them.
- easy to create concentric ribs to strengthen parts.
- Almost all metal in sheet form can be spun
- Specially used when the product requires mirror sheen

UNIT-IV

Powder Metallergy: Refer Q.5(b) of End Term Examination 2017 (Page 23-2017)

Process of Powder Metallurgy



Plastic Product Manufacturing: Plastics manufacturing is the process of making plastic into semi-products or products with practical value. Plastics manufacturing usually includes primary processing and secondary processing of plastics.

Charactersitc forming and shaping process

Process	Characteristics
Extrusion	Long, uniform, solid or hollow complex cross-sections, high production rates; low tooling costs; wide tolerances.
Injection molding	Complex shapes of various sizes, eliminating assembly; high production rates; costly tooling; good dimensional accuracy.
Structural foam molding	Large parts with high stiffness-to-weight ratio; less expensive tooling than in injection molding; low production rates.
Blow molding	Hollow thin-walled parts of various sizes; high production rates and low cost for making containers.
Rotational molding	Large hollow shapes of relatively simple shape; low tooling cost; low production rates.
Thermoforming	Shallow or relatively deep cavities; low tooling costs; medium production rates.
Compression molding	Parts similar to impression-die forging; relatively inexpensive tooling; medium production rates.
Transfer molding	More complex parts than compression molding and higher production rates; some scrap loss; medium tooling cost.
Casting	Simple or intricate shapes made with flexible molds; low production rates
Processing of composite materials	Long cycle times; tolerances and tooling cost depend on process.

Types of plastic

(1) Polyethylene Terephthalate (PET or PETE)

This is one of the most commonly used plastics. It's lightweight, strong, typically transparent and is often used in food packaging and fabrics (polyester).

Examples: Beverage bottles, Food bottles/jars (salad dressing, peanut butter, honey, etc.) and polyester clothing or rope.

(2) High-Density Polyethylene (HDPE)

Collectively, Polyethylene is the most common plastics in the world, but it's classified into three types: High-Density, Low-Density and Linear Low-Density. High-Density Polyethylene is strong and resistant to moisture and chemicals, which makes it ideal for cartons, containers, pipes and other building materials.

Examples: Milk cartons, detergent bottles, cereal box liners, toys, buckets, park benches and rigid pipes.

(3) Polyvinyl Chloride (PVC or Vinyl)

This hard and rigid plastic is resistant to chemicals and weathering, making it desired for building and construction applications; while the fact that it doesn't conduct electricity makes it common for high-tech applications, such as wires and cable.

Examples: Plumbing pipes, credit cards, human and pet toys etc.

(4) Low-Density Polyethylene (LDPE)

A softer, clearer, and more flexible version of HDPE. It's often used as a liner inside beverage cartons, and in corrosion-resistant work surfaces and other products.

Examples: Plastic/cling wrap, sandwich and bread bags, bubble wrap, garbage bags, grocery bags and beverage cups.

(5) Polypropylene (PP)

This is one of the most durable types of plastic. It is more heat resistant than some others, which makes it ideal for such things as food packaging and food storage that's made to hold hot items or be heated itself.

Examples: Straws, bottle caps, prescription bottles, hot food containers, packaging tape, disposable diapers and DVD/CD boxes.

(6) Polystyrene (PS or Styrofoam)

Better known as Styrofoam, this rigid plastic is low-cost and insulates very well, which has made it a staple in the food, packaging and construction industries. Like PVC, polystyrene is considered to be a dangerous plastic.

Examples: Cups, takeout food containers, shipping and product packaging, egg cartons, cutlery and building insulation.

What is thermoplastic molding?

Thermoplastic molding is a reversible molding process by which pellets of plastic are melted, forced into a mold to assume their final shape and then quickly cooled to harden.

Thermoset molding is the reverse process of thermoplastic. Thermoset molding in an irreversible process in which a chemical change takes place in the material, instead of a physical one .Thermoset material is injected into a hot mold and then cooled to maintain the final shape of the part.

Bonding of thermoplastic

Solvent bonding is a common technique used for joining injection molded components, especially injection molded components of amorphous thermoplastics. When the components are bonded with this technique, the solvent dissolves the surfaces of the two components and allows the material to flow together.

There are using of many different types of techniques to welding of thermoplastic material like **spot welding, hot plate welding, friction welding, laser/IR welding, extrusion welding**-etc. It can be used for adhesive bonding techniques to easily welded to thermoplastic to metal joining.

Primay Processing Technology Types:

1. Injection Moulding: Thermoplastic or Thermoset plasticated at control temperature inside the screw pump (a combination of screw & barrel), then forced under pressure through a nozzle into sprue, runners, gates and cavities of mould.

Types of products: Spools, bobbin, bottle caps, automotive parts, gem clips, crates, buckets etc.

Types of Injection Moulding Machineare

(i) Hand injection moulding;

(ii) Semi-auto (Plunger type) Injection moulding;

(iii) Fully-auto (Screw type) Injection moulding;

(iv) Advanced injection moulding;

2. Blow Moulding: An extruded parison tube of heated thermoplastics is positioned between two halves of an open split mould and inflated against the sides of the closed mould using air pressure.

Types of Products: Bottles, Containers, Air ducts, Panels, Portable toilets, Arm rests, tanks, gas tanks.

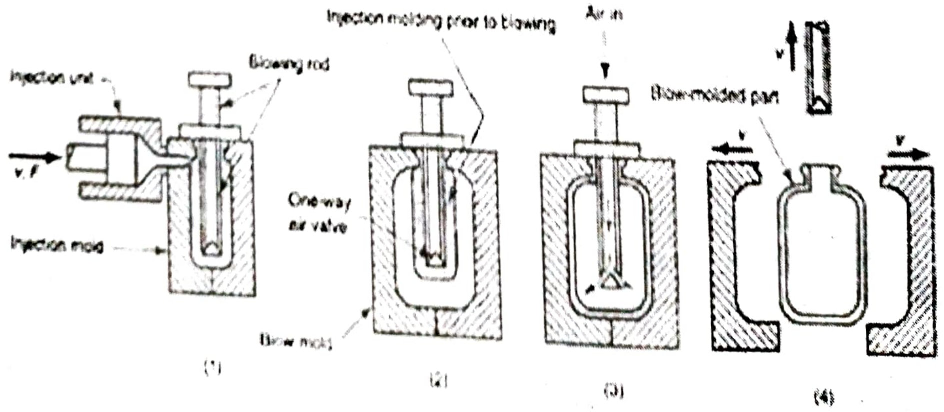
Types of Blow moulding machine:

1. Extrusion Blow moulding, 2. Injection Blow moulding, 3. Stretch Blow moulding

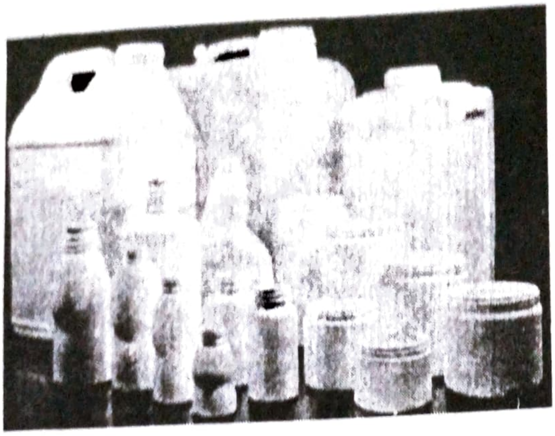
1. Extrusion Blow moulding: In extrusion blow molding (EBM), plastic is melted and extruded into a hollow tube (a parison). This parison is then captured by closing it into a cooled metal mold. Air is then blown into the parison, inflating it into the shape of the hollow bottle, container or part. After the plastic has cooled sufficiently, the mold is opened and the part is ejected.

(Product)

2. Injection Blow moulding: The process of injection blow molding (IBM) is used for the production of hollow glass and plastic objects in large quantities. The blow molding process begins with melting down the plastic and forming it into a parison or in the case of injection. The parison is a tube-like piece of plastic with a hole in one end through which compressed air can pass.



(Process)



(Product)

3. Stretch Blow moulding: In the stretch blow molding (SBM) process, the plastic is first molded into a "preform" using the injection molding process. the preforms are heated (typically using infrared heaters) above their glass transition temperature, then blown using high pressure air into bottles using metal blow molds.

4. Extrusion Process: It is continues Process. Thermoplastic moulding compound/ material is fed from a hopper to a screw pump where it is to plasticated then pumped out through the shaping orifice (die) to achieve desired cross section.

Types of products: Films, Pipes, Strapping, Sheets, Multilayer films, Profiles etc.

5. Compression Moulding: Thermoset compound, usually preformed, is positioned in a heated mould cavity; the mould is closed with the application of heat and pressure the material flows and fills the mould cavity. Heat completes polymerization and identification the part of ejected.

Types of Products: Plugs, sockets, handles, Engine Casing switches, cistern etc.

6. Transfer Moulding: Thermoset moulding compound is fed into transfer chamber where it is then heated to plasticated; it is then fed by a plunge through sprue, runners, and gates into a closed mould where it cures; mould is opened and part ejected.

Types of Products: Plugs, Sockets, Handles, Engine Casing Switches, Cistern etc.

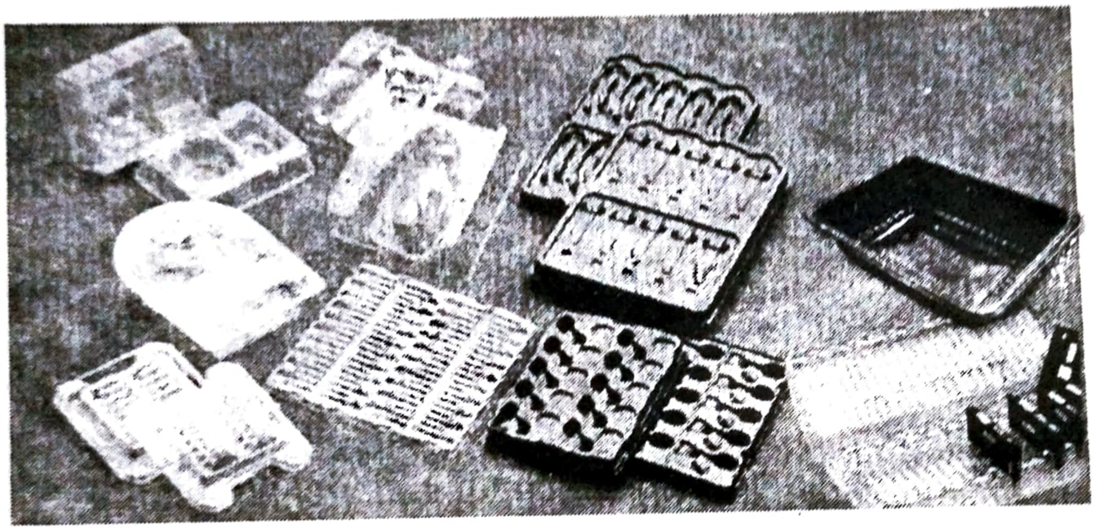
Secondary Processing Technology Types are:

(a) Rotation Moulding: A predetermined amount of powdered thermoplastic material is poured into mould; mould is closed, heated, and rotated in the axis of two planes until contents have fused to the inner walls of mould; mould is then opened and part is removed.

(Product)

(b) Thermoforming Moulding: Heat-softened thermoplastic sheet is positioned over male or female mould; air is evacuated between sheet and mould, forcing sheet to conform to contour of mould.

Types of Products: House wares, Ducts, Toys, Refrigerator panels, Boat windshields etc.



(Product)

FIRST SEMESTER [B.TECH]
FIRST TERM EXAMINATION [2014]
MANUFACTURING PROCESS [ETME-105]

Time 1.30 hrs M. M. 30

Note: Q.No. 1 is Compulsory. Attempt any two more questions from the rest.

Q.1. Explain the following terms related to manufacturing process. (1 × 10 = 10)

(a) Strength (b) Toughness (c) Stiffness (d) Ductility (e) Chaplets (f) Annealing (g) Quenching (h) Core Print (i) Bronze (j) Duralumin

Ans. (a) Strength: The capacity of an object or substance to withstand great force or pressure.

(b) Toughness: Toughness is the ability of a material to absorb energy and plastically deform without fracturing.

(c) Stiffness: Stiffness is the rigidity of an object - the extent to which it resists deformation in response to an applied force. The complementary concept is flexibility or pliability.

(d) Ductility: Ductility is a solid material's ability to deform under tensile stress; this is often characterized by the material's ability to be stretched into a wire.

(e) Chaplets: Cores are usually supported by two core prints in the mold. However, there are situations where a core only uses one core print so other means are required to support the cantilevered end. These are usually supplied in the form of chaplets. These are small metal supports that bridge the gap between the mold surface and the core, but because of this become part of the casting. As such, the chaplets must be of the same or similar material as the metal being cast.

(f) Annealing: Annealing is a rather generalized term. Annealing consists of heating a metal to a specific temperature and then cooling at a rate that will produce a refined microstructure. The rate of cooling is generally slow. Annealing is most often used to soften a metal for cold working, to improve machinability, or to enhance properties like electrical conductivity

(g) Quenching: Quenching is a process of cooling a metal at a rapid rate. This is most often done to produce a marten site transformation. In ferrous alloys, this will often produce a harder metal, while non-ferrous alloys will usually become softer than normal.

(h) Core Print: A core is a device used in casting and molding processes to produce internal cavities and reentrant angles. The core is normally a disposable item that is destroyed to get it out of the piece. They are most commonly used in sand casting, but are also used in injection molding. A Projection made in the Pattern is called core print. It is used to form a core seat in the mould. The core is correctly seated in this seat.

An intriguing example of the use of cores is in the casting of engine blocks. For example, one of the GM V-8 engines requires 5 dry-sand cores for every casting.

Cores are usually supported by two core prints in the mold. However, there are situations where a core only uses one core print so other means are required to support the cantilevered end. These are usually supplied in the form of chaplets. These are small metal supports that bridge the gap between the mold surface and the core, but because of this become part of the casting. As such, the chaplets must be of the same or similar material as the metal being cast.

(*i*) **Bronze:** Bronze is an alloy of copper which can vary widely in its composition. It is often used where a material harder than copper is required, where strength and corrosion resistance is required.

(*j*) **Duralumin:** is the trade name of one of the earliest types of age-hardenable aluminium alloys. Its use as a trade name is obsolete, and today the term is mainly used to describe aluminium-copper alloy.

Q.2. (*a*) Define Manufacturing Process. Also classify and briefly explain the different types of manufacturing process.

Ans. Manufacturing Process:- Manufacturing processes are the steps through which raw materials are transformed into a final product. The manufacturing process begins with the creation of the materials from which the design is made. These materials are then modified through manufacturing processes to become the required part. Various types are

Casting, Molding, Forming, Machining, Joining etc.

Casting: Casting is a manufacturing process by which a liquid material is usually poured into a mold, 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 mold to complete the process. Casting materials are usually metals or various *cold setting* materials that cure after mixing two or more components together; examples are epoxy, concrete, plaster and clay. Casting is most often used for making complex shapes that would be otherwise difficult or uneconomical to make by other methods.

(*b*) **Mould:** A **mold** or **mould** is a hollowed-out block that is filled with a liquid like plastic, glass, metal, or ceramic raw materials. The liquid hardens or sets inside the mold, adopting its shape. A mold is the counterpart to a cast. The manufacturer who makes the molds is called the moldmaker. A release agent is typically used to make removal of the hardened/set substance from the mold easier. Typical uses for molded plastics include molded furniture, molded household goods, molded cases, and structural materials.

(*c*) **Forming:** Forming, or metal forming, is the metalworking process of fashioning metal parts and objects through mechanical deformation; the work piece is reshaped without adding or removing material, and its mass remains unchanged.

(*d*) **Machining:** Machining is any of various processes in which a piece of raw material is cut into a desired final shape and size by a controlled material-removal process.

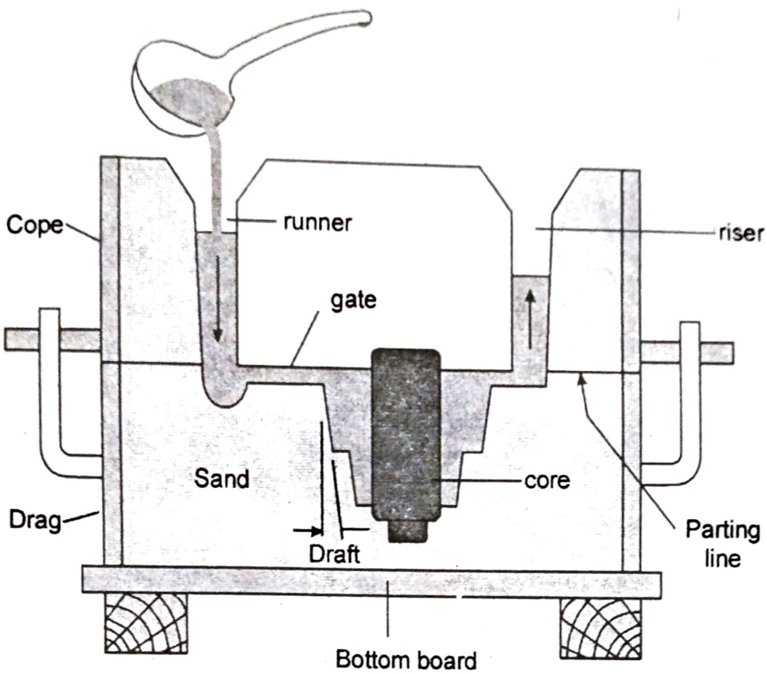
(*e*) **Joining:** Joining is the process in which two similar or different materials are joined toughter with or without pressure.

Q.2. (*b*) Explain the gating system in casting with the help of neat sketch. **(5)**

Ans. Components of gating system: Pouring basin : This is otherwise called as bush or cup. It is circular or rectangular in shape. It collects the molten metal, which is poured, from the ladle.

Sprue : It is circular in cross section. It leads the molten metal from the pouring basin to the sprue well.

Sprue Well : It changes the direction of flow of the molten metal to right angle and passes it to the runner.



Runner: The runner takes the molten metal from sprue to the casting. In gate: This is the final stage where the molten metal moves from the runner to the mold cavity.

Slag trap : It filters the slag when the molten metal moves from the runner and in gate. It is also placed in the runner.

Q.3. Explain the constructional details and working of Cupola with the help of neat sketch. Also mention the different zones in cupola.

Ans. Melting Furnances for cast Iron:

Cupola furnace: This is secondary furnoce for refining pig iron into cost iron.

Description: Cupola is mainly made of a vertical cylindrical shell made of steel plates mesuring 10 to 15 nm thick, welded together. The inside of shell is lined with fireclay or refractory bricks measuring 2 mm thick. The top of shell is provided with a cap where purpose is to fold, to safeguard the burning against rain and to reflect a good amount of heat into furnace by restricting escape of burning gases.

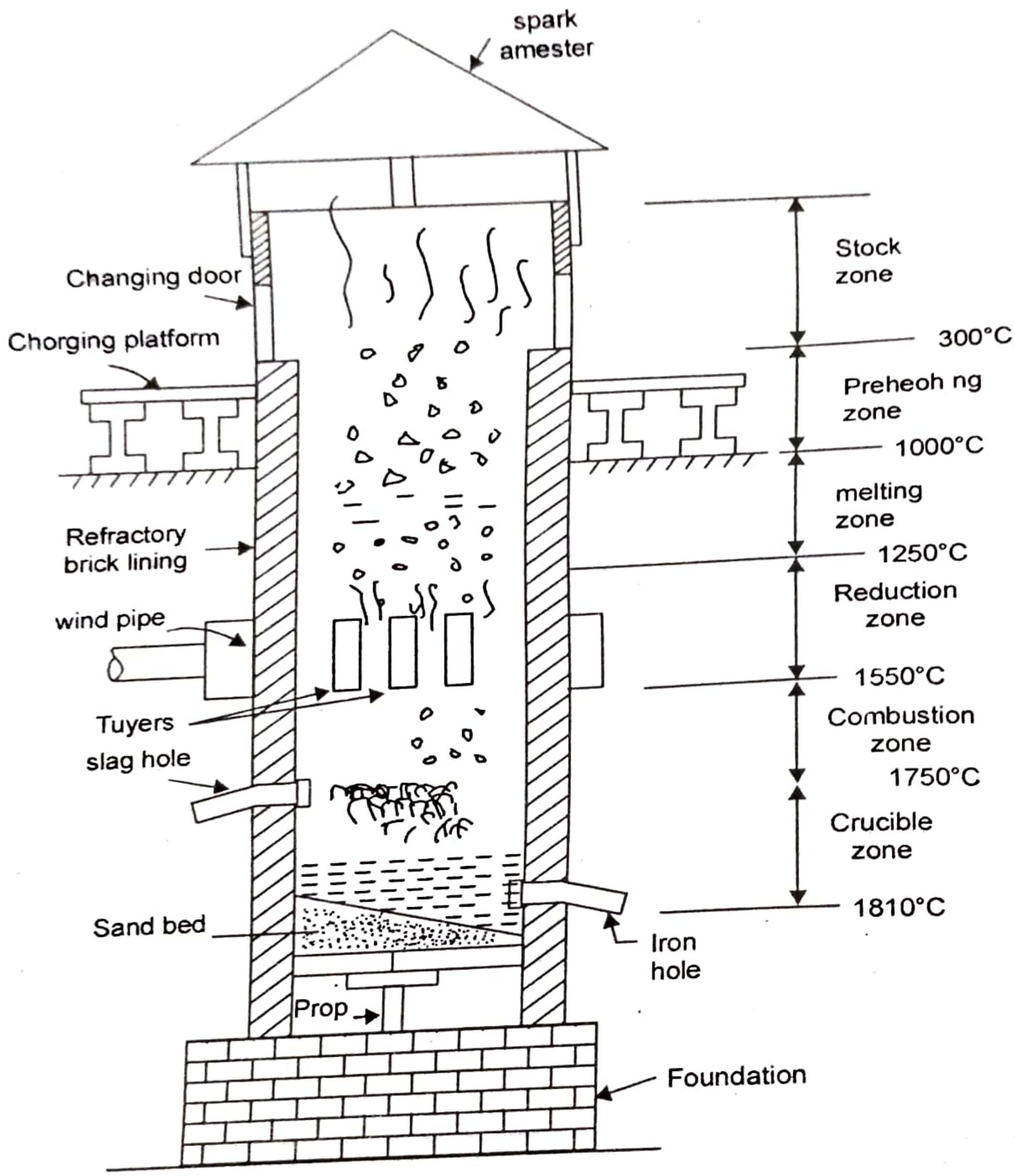
Upper part of the shell is provided with a charging a and below charging door there is a charging plate around the shell. In middle part of shell, there is wind pipe in which the compressed air circulates and from which it can enter the shell through openings known as tuyers which may number four or more. Below the tuyers, there is provision of slag hole and iron tap hole on either side of furnance. The whole structure stands on steel reinforced concrete legs errected over the shop floor. The structure measures 1 to 2 meter dia and 4 times of its dia as height, that is 4 to 8 meter.

Operation: The cupola charge consists of following element where ratio is:

Pig iron scrap – 1010N

Hard coke as fuel – 110 N

Lime stone as fusx – 40N



For getting 1000N or one tonnes of CI First of all drop down bottom is brought to position and a sand bed is prepared over soft wood and coke is placed through iron tapping hole and fire is lit. After this charge, having layers of pig iron, hard coke and flux is slowly dropped from charging door. This charging usually done manually, however conveyer belt syitem is also used in these days. Simultaneously while dropping charge over plates of tuyers are opened so that compressed air from wind pipe enters the furnace and help in burning. As fuel burning picks up temp. of pig iron rises leading to its nelting Molten pig iron trickles down travelling through reduction and combustion zones and lastly it collects in crucible zone. The crucible zone is also called as well, or sufficient quantity of iron collects there over the sand bed.

Zones of Cupola furnace

1. Stack Zone: This is zone above charging door, through which hot gases riser up to escape from furnace.

2. Preheating Zone: This contains alternote layers of pig iron coke and flux. The charge gets sufficient heat here and gets preheated in temp. range of 1000 to 1150°C.

3. Melting Zone: In this zone metal melting starts and so the molten metal travels down. The temp. being 1150 to 1250°C. Chemical reaction.

$$3Fe + 2Co \longrightarrow Fe_3C + CO_2$$

4. Reduction Zone: In this zone oxygen burning takes place giving rise to good amount of heat temp. rise from 1250 to 1550°C.

5. Combustion Zone: This is between reduction and crucible zone above and below tuyers. Here burning of various elements associated with pig iron takes place. Ultimately resulting in refining of pig iron into CI. The temp. being 1550°C to 1750°C

Chemical reaction

$$Si + O_2 \longrightarrow SiO_2 + Heat$$

$$Mn + O \longrightarrow MnO + Heat$$

$$\left.\begin{matrix} \\ \\ \end{matrix}\right\} \text{slag}$$

$$\{P + O_2 \longrightarrow P_2O_5$$

$$Mn + S \longrightarrow MnS$$

6. Crucible zone or well: Molten metal collects here. The temp being 1750° to 1810°C. There is no chemical reaction. The fisating slag is removed trough slage hole + then iron is tapped act through iron top hole into lades which are carried to casting action where mould are lying really.

Cupola Specifications: The cupole furnance is specified of giving following parameters.

- Shell plate thickness
- Cylindrical shell dia with and without refeactory brick oning no of tuyers.
- Furnace total height
- Blowers horse power
- Melting capacity of furnace in tonnes/hr.

Cupola Fluxes: The fluxes cupola in copola may be classified in two categories.

1. Primary fluxes: Primary fluxes are limestone, calcite, oyster and other set and dolomite. These fluxes are added in the proportion in to 7% of metal charge depending on (*i*) cupola dia (*ii*) ash content in coke. (*iii*) impurities present in charge.

2. Secondary fluxes: These are used in small quantities usually from 0.2 to 2.1. of metal charge, acc. to composition and nature of charge materials, of sodium carbonate, calcium carbide are used as fluxex.

Merits of Cupola:

- Its continuous operation
- Low cost of operational melting.
- Composition of melt can be controlled.
- Easy to operate.
- Temp of melt can be controlled.
- Floor area requirement for installation of furnace is less.
- Operational maintanance is less.

Demerits of Cupola

- Charge is in airect controst fueld
- Considerable amount of impurity.
- Direct without of anotehr metal with carbon, themical composition of iron difficult to control
- **Law carbon iron** . below about 2.8% C are difficult to atain because of dire contact of molten iron and corbonaceous fuel.
- Some alloying elements such as chromium, molybdenum are in part lost oxidation in copola.

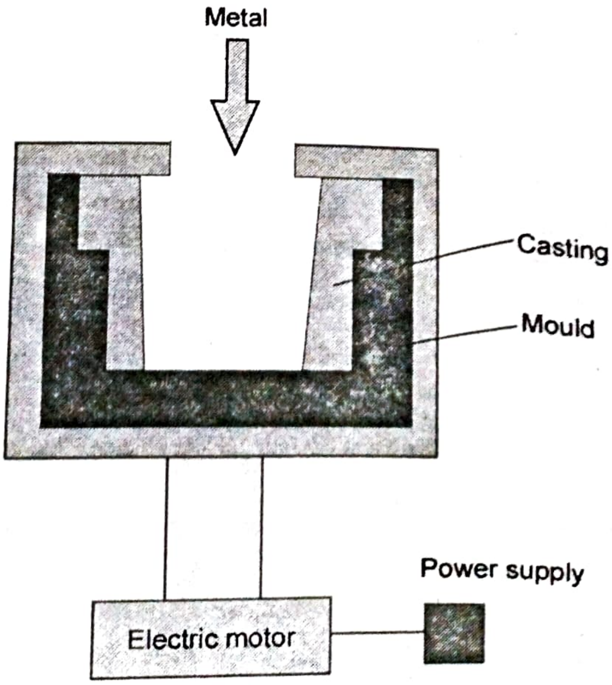
Q.4. (*a*) With the help of neat sketches describe the working principle Centrifugal casting.

Ans. Centrifugal casting: In centrifugal casting, a permanent mold is rotat continuously about its axis at high speeds (300 to 3000 rpm) as the molten metal poured. The molten metal is centrifugally thrown towards the inside mold wall, whe it solidifies after cooling. The casting is usually a fine-grained casting with a very fin grained outer diameter, owing to chilling against the mould surface. Impurities an inclusions are thrown to the surface of the inside diameter, which can be machine away. Casting machines may be either horizontal or vertical-axis.

Advantages of centrifugal casting over sand casting;

1. Improved physical properties,
2. Parts made from centrifugals, with the castings' finer grained,
3. As the molten metal is poured, centrifugal forces distribute the molten met against the walls of the mold with tremendous force.

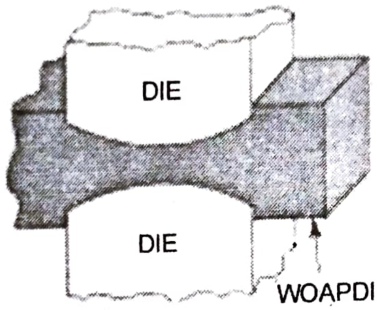
Type of centrifugal casting with diagram: The true centrifugal method of castin is used to produce hollow castings with a round hole. The characteristic feature this process is that the hole is produced by the centrifugal force alone and no cores ar used.



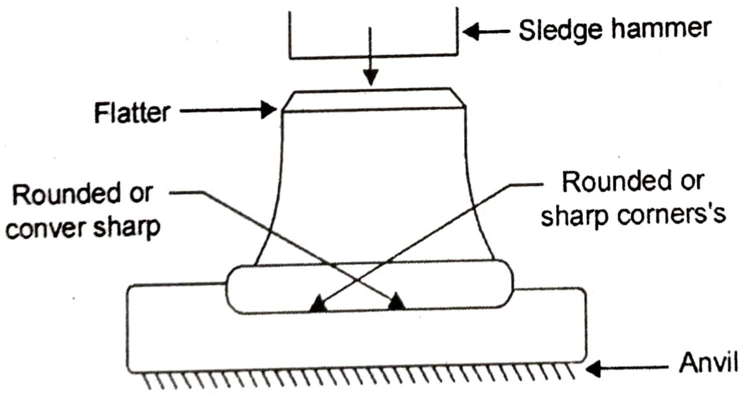
Q.4. (b) With the help of neat sketches describe the following forging operation.

(i) Upsetting (ii) Flattering.

Ans. (i) Upsetting: Upsetting is a forging process in which plastic deformation of a preheated blank is used to reduce the height and increase the cross-sectional area of the blank. Upsetting is used as a preliminary to drawing in order to improve the structural properties of the casting and to increase forge ability. It is also used as a preliminary operation before broaching or forging.



(ii) Flattering: Flatting and setting down Fullering leaves a corrugated surface on the job. Even after a job is forged into shape with a hammer, the marks of the hammer sketches remains on the upper surface of the job. To remove hammer marks and corrugation and in order to obtain a smooth surface on the job, a flatter or set hammer is used.



FIRST SEMESTER [B.TECH]
SECOND TERM EXAMINATION [2014]
MANUFACTURING PROCESS [ETME-105]

Time 1.30 hrs **M. M. 30**

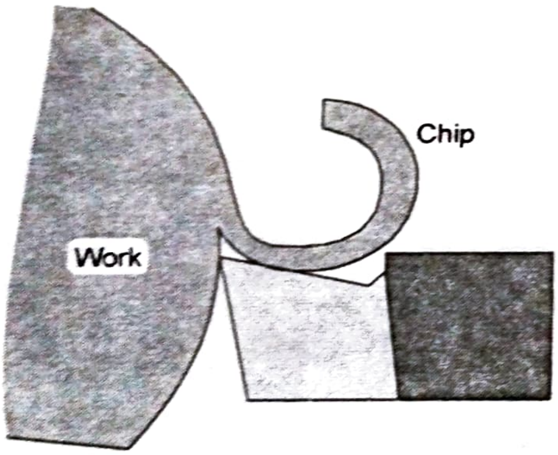
Note: *Q.No. 1 is Compulsory. Attempt any Two more questions from the rest.*

Q.1. (a) Explain the following. **(2 × 5 = 10)**

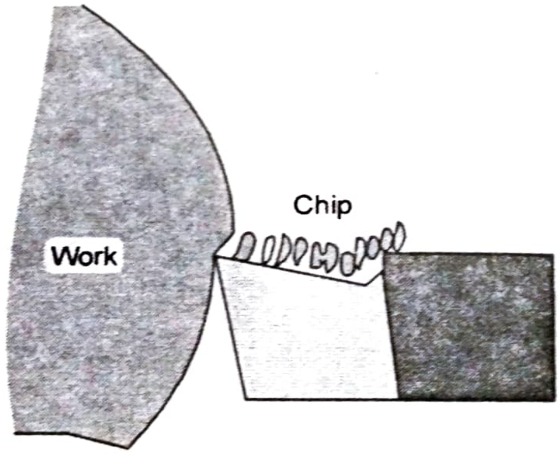
Ans. Filling operation: Filing is a material removal process in manufacturing. Similar, depending on use, to both sawing and grinding in effect, it is functionally versatile, but used mostly for finishing operations, namely in debarring operations. Filing operations can be used on a wide range of materials as a finishing operation. Filing helps achieve work piece function by removing some excess material and debarring the surface. Sandpaper may be used as a filing tool for other materials, such as glass.

Q.1. (b) Chipping Operation

Ans. Chipping: The type of chip produced depends on the material being machined and the cutting conditions at the time. These conditions include the type of tool used tool, rate of cutting condition of the machine and the use or absence of a cutting fluid. There are two types of chips Continuous chipping and Dis continuous chipping



Continuous chipping



Dis continuous chipping

Q.1. (c) Extrusion process

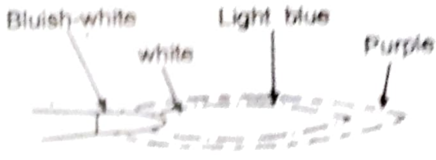
Ans. Extrusion Process: Extrusion is a process used to create objects of a fixed cross-sectional profile. A material is pushed or pulled through a die of the desired cross-section. The two main advantages of this process over other manufacturing processes are its ability to create very complex cross-sections, and to work materials that are brittle, because the material only encounters compressive and shear stresses. It also forms parts with an excellent surface finish.

Q.1. (d) Flames in gas welding

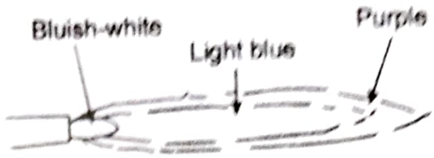
Ans. Different flames used in Gas Welding: There are three of flames which are used in Gas Welding.

1. Reducing Flame
2. Neutral Flame
3. Oxidizing Flame

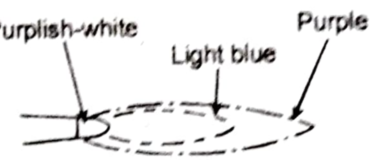
The diagram and Temperature range are given below.



Reducing flame
5700° F



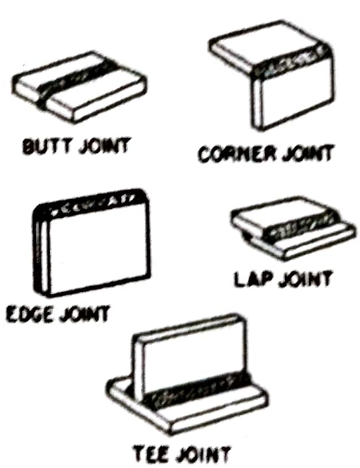
Neutral flame
5850 °F



Oxidizing flame
6300° F

Q.1. (*e*) Welding defects.

Ans. Welding joints: There are five types of welding joints which are given below.



The defects in the weld can be defined as irregularities in the weld metal produced due to incorrect welding parameters or wrong welding procedures or wrong combination of filler metal and parent metal Weld defect may be in the form of variations from the intended weld bead shape, size and desired quality. Defects may be on the surface or inside the weld metal. Certain defects such as cracks are never tolerated but other defects may be acceptable within permissible limits. Welding defects may result.

Common Welding Defects

- Prosity
- Slag Inclusions
- Excess Penetration
- Incomplete Fusion
- Under Cut
- Inadequate Joint Penetration
- Cracking
- Welding Debries

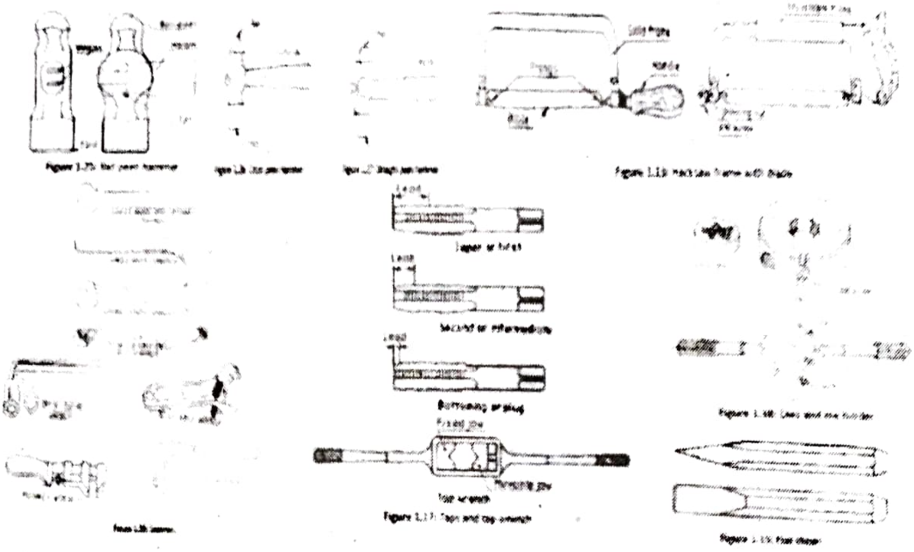
Q.2. With the neat sketch explain the different Measuring Tools, Marking tools and their operation used in bench work and fitting. (10)

Ans. Measuring Tools & Marking Tools:

Marking Tools: Marking is the process of layout of sizes on work place. The following tools are used in marking out operations.

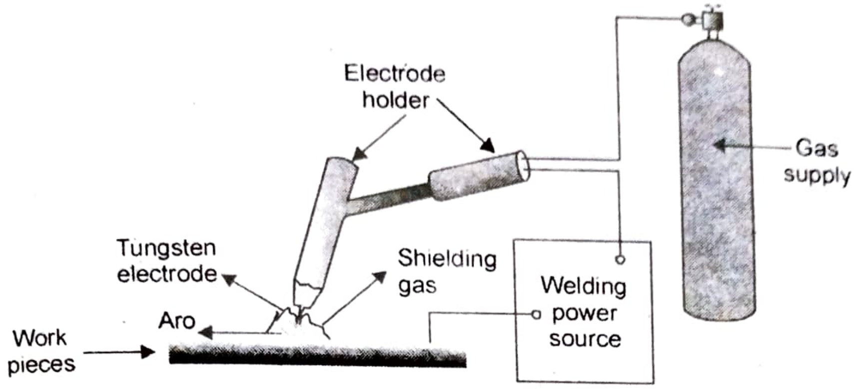
1. Scriber
2. divider
3. Jenny caliper
4. Scribing block
5. Angle plate
6. V-block
7. Punch
8. Try-square
9. Surface plate
10. Straight edge.

Measuring Tools Used in Fitting



Q.3. With the help of neat sketch explain the working principle of TIG Welding. Also state the area of applications, advantages, disadvantages and their limitations. (10)

Ans. Tig Welding: Gas tungsten arc welding (GTAW), also known as tungsten inert gas (TIG) welding, is an arc welding process that uses a non-consumable tungsten electrode to produce the weld. The weld area is protected from atmospheric contamination by an inert shielding gas (argon or helium), and a filler metal is normally used, though some welds, known as auto genius welds, do not require it. A constant-current welding power supply produces electrical energy, which is conducted across the arc through a column of highly ionized gas and metal vapors known as a plasma.



Application: For example, when joining pipes for offshore applications, TIG might be specified for the root weld then MIG for subsequent runs. This gives the high integrity that is essential at the root, in conjunction with the speed and quality of MIG for the rest of the joint.

Advantages of Tungsten Inert Gas Welding (TIG Welding):

Tungsten Inert Gas Welding produces high quality welds.

The weld is automatically protected by the inert gas during the welding process.

No slag is produced.

TIG Welding can be done in any position.

Disadvantages of Tungsten Inert Gas Welding:

Tungsten inert gas welding is a slow process.

Highly skilled labour is needed.

Welder is exposed to huge intensities of light.

TIG welding is more expensive when compared to MIG welding

Q.4. (a) What are the various types of electrode used in welding? Explain with their characteristics and specification. (5)

Ans. The factors which govern the selection of an electrode are:

Selection of electrode is very important to obtain a sound welded joint of proper strength. The various factors affecting the selection of electrodes are:

1. Power source, AC or DC
2. Composition of base metal or work piece which is to be welded.
3. Thickness of workpiece or base metal
4. Welding positions.
5. Welding current conditions.
6. Mechanical properties desired in the joint.
7. Extent of penetration required in welding.

The diameters of electrode, current and voltage requirement depend upon thickness of the metal to be joined. The below table is a good guide for proper electrode selection:

Types of Specifications:

Metal thickness	Electrode dia, mm	Electrode dia (SW_4)	Current range, A	Voltage across arc,
upto 1.5	2.0	14	50–70	15
1.5 – 3	2.5	12	70–100	15
3 – 6	3.15	10	85–120	20
6–10	4.0	8	140–180	20
10–20	5.0	6	180–230	25

Q.4. (b) Discuss the function, properties and composition of flux used in welding. (5)

Ans. Flux: It a material used to prevent, dissolve or facilitate removal of oxides and other undesirable surface substances.

The major Functions/Properties of fluxes are:

1. It act as good insulator and concentrate heat with in a relatively small welding zone; thus it improves fusion of molten metal from welding electrode and parent material.

2. It acts as cleaner for the weld metal, absorb impurites and add alloying elements such as manganese and silicon.

3. Owing to flux, the weld metal is not only clean but it also more dense and hence has excellent physical properties.

4. The blanket of flux improves the process efficiency by reducing spatter, burning losses, which are vanavoidable by an ordinary arc.

5. That position of flux which melt, floats as lizuid blanket over the molten metal, protect it from the deleteroius effects of surrounding atmosphere their by reduces the pickup of oxygen and nitrogen.

Alloy Composition are

1. Cadmium 1% copper 99%

2. Chromium 0.8% copper 9.2%

3. Berlium 0.5%, Nickel 1.6%, Cobalt 1.0%, Copper 97.5%.

FIRST SEMESTER [B.TECH]
END TERM EXAMINATION [2014]
MANUFACTURING PROCESS [ETME-105]

M. M. 75

Time 3 hrs

Note: *Attempt any five questions including Q.No. 1 which is compulsory. Select one question from each unit.*

Q.1. (a) What are the functions of flux in the wedding process? With example.

Ans. Function of Flux: In metallurgy, a flux is a chemical cleaning agent, flowing agent, or purifying agent. Fluxes may have more than one function at a time. They are used in both extractive metallurgy and metal joining.

Flux: It a material used to prevent, dissolve or facilitate removal of oxides and other undesirable surface substances.

The major functions of fluxes are:

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5. That position of flux which melt, floats as lizuid blanket over the molten metal, protect it from the deleteroius effects of surrounding atmosphere their by reduces the pickup of oxygen and nitrogen.

Q.1. (b) What is Strain hardening?

Ans. Strain hardening is generally defined as heating at a relatively low temperature after cold-working. During strain hardening the strength of the metal is increased and ductility decreased. To go a step further in explaining, if a low-carbon steel is cold-worked, or strained passed the yield point, then aged for several days at room temperature, it will have a higher yield stress after the aging. This happens because during the aging carbon or nitrogen atoms diffuse to dislocations, reechoing them.

Q.1. (c) Define sintering.

Ans. It involves raising the temperature of the green compact, (pressed powder part), to a certain level and keeping it at that temperature for a certain amount of time. The sintering temperature is usually between 70% and 90% of the melting point of the powder metal. This will cause bonding mechanisms to occur between powders particles pressed together in the compact.

Q.1. (d) Define Stiffness.

Ans. Stiffness: Stiffness is the rigidity of an object - the extent to which it resists deformation in response to an applied force. The complementary concept is flexibility or pliability.

Q.1. (e) Differentiate between Wrought Iron and Cast Iron.

Ans. Wrought iron has very small carbon content. It is tough, malleable, and ductile can be easily welded.

Cast iron has 2% to 3.5% carbon; it is strong under compression but brittle and weak under tension. Wrought iron has been worked with tools and cast iron has been put in a mould.

Q.1. (f) Define Non-Pressure Welding, also give example.

Ans. Non pressure welding: The material at the joint is heated to a molten state and allowed to solidify. In this process the Joining operation involves melting and solidification and any external Forces applied to the system do not play an active role in producing coalescence. Usually fusion welding uses a filler material to ensure that the joint is filled. All fusion welding processes have three requirements: Heat, Shielding and Filler material.

Q.1. (g) Why sprue size reduces downwards? What is ideal shape of sprue? and why?

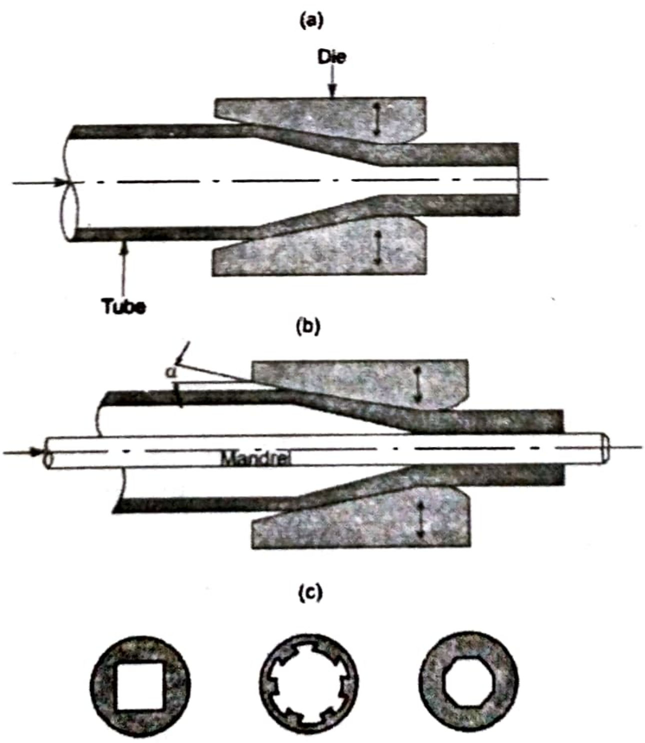
Ans. A sprue is the passage through which liquid material is introduced into a mold. During casting or molding, the material in the sprue will solidify and need to be removed from the finished part. This excess material is also called a sprue. The jedal shape of spur is upto 20 mm diameter. Because the sprue has as minimum surface expossed to cooling and after the lowest resistance to flows the metal.

Q.1. (h) Why cleaning of joints are important before welding?

Ans. One of the most effective ways to save money in the welding business is to increase efficiency and to eliminate any tasks that don't need to be done. There are certain situations where a welder can save some time by skipping the sanding and grinding preparation for a weld joint, How you prepare a weld joint depends on a number of factors

Q.1. (i) What do you mean by Swaging? When Swaging is used?

Ans. Swaging: Swaging is a forging process in which the dimensions of an item are altered using dies, into which the item is forced. Swaging is usually a cold working process; however, it is sometimes done as a hot working process.



Q.1. (j) What is the principle of arc generation in arc welding?

Ans. Principle of Arc Generation: Any arc welding method is based on an electric circuit consisting of the following parts:

- Power supply (AC or DC);
- Welding electrode;
- Work piece;
- Welding leads (electric cables) connecting the electrode and work piece to the power supply.

Electric arc between the electrode and work piece closes the electric circuit. The arc temperature may reach 10000°F (5500°C), which is sufficient for fusion the work piece edges and joining them. When a long join is required the arc is moved along the joint line.

UNIT-1

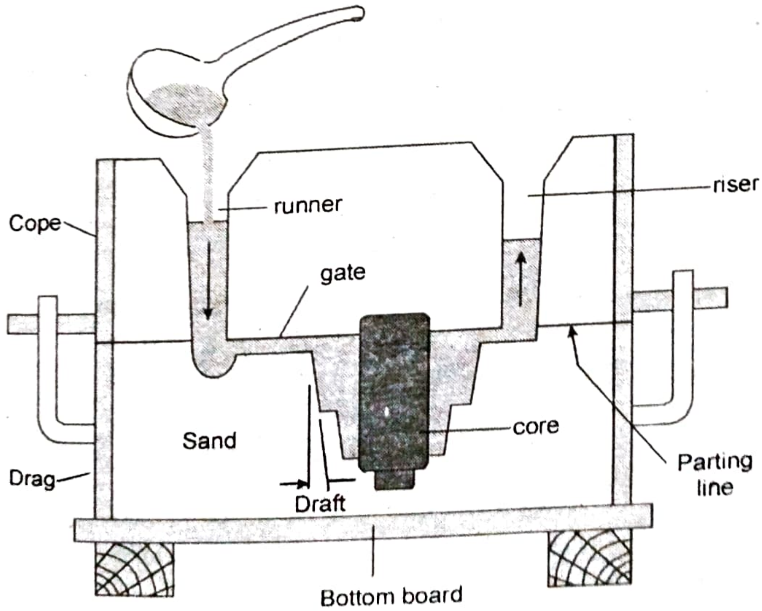
Q.2. (a) Differentiate between Spheroidise Annealing & Diffusion Annealing. What changes in property will occur by Spheroidise Annealing process on Stainless Steel. (6.5)

Ans. Annealing is a heat treatment procedure involving heating the alloy and holding it at a certain temperature (annealing temperature), followed by controlled cooling. Annealing results in relief of internal stresses, softening, chemical homogenizing and transformation of the grain structure into more stable state. Annealing increases an extent of equilibrium of the metal structure resulting in softening and high ductility. Annealing temperature and the control cooling rate depend on the alloy composition and the type of the annealing treatment. The spheroidise annealing is that the steel is heated to the temperature of 735°C to ± 10°C. The spheroidise the maching is good as compose to diffusion. The High carbon the % of carbon is between 2.1 to 3%. In HCS the carbusising is used as heat treatment because it gives better strength.

Q.2. (b) What is Gating Ratio? Explain with neat sketch elements of gating system in casting. (6)

Ans. Gating Ratio: Gating Ratio is define as the Ratio of sprue area to total runner area to total gate area i.e. sprue Area/Runner Area/Gate Area.

Components of gating system: Pouring basin : This is otherwise called as bush or cup. It is circular or rectangular in shape. It collects the molten metal, which is poured, from the ladle.



Sprue : It is circular in cross section. It leads the molten metal from the pouring basin to the sprue well.

Sprue Well : It changes the direction of flow of the molten metal to right angle and passes it to the runner.

Runner: The runner takes the molten metal from sprue to the casting. In gate This is the final stage where the molten metal moves from the runner to the mold cavity.

Slag trap : It filters the slag when the molten metal moves from the runner and in gate. It is also placed in the runner.

Q.3. (*a*) Explain composition of high carbon steel & Tool steel. Which heat treatment is provided on tool steel & why? (6.5)

Ans. Tool steel refers to a variety of carbon and alloy steels that are particularly well-suited to be made into tools. Their suitability comes from their distinctive hardness, resistance to abrasion and deformation and their ability to hold a cutting edge at elevated temperatures. As a result tool steels are suited for their use in the shaping of other materials. With carbon content between 0.5% and 1.5%, tool steels are manufactured under carefully controlled conditions to produce the required quality.

Q.3. (*b*) What is Master pattern, give example? If casting of gray cast iron is to be done then explain allowances of Master pattern. (6)

Ans. Master Pattern models from Precision Pattern can be used for a variety of manufacturing operations, including sand casting, rubber-plaster molding, epoxy tooling, hybrid tooling, RTV molding, and vacuum forming. Depending on the application, Precision Pattern can add texture and embossed or raised lettering to produce a production quality Master Pattern model. Precision Pattern produces Master Pattern models using SLA, and CNC technologies, depending on the specific requirements. Master Pattern models can be produced in as little as 3 working days. Precision Pattern customers use Master Pattern models to:

Produce silicone (RTV) molds for prototype production

Produce epoxy or composite tooling for low-volume molding

Produce vacuum formed prototypes and production parts

The allowences of master pattern is 3 mn to 10 mn because 3 mm is for mediam casting and 10 mm for large casting in cost iron in steel its value in between 12 mm to 45 mm.

UNIT-II

Q.4. (*a*) Explain with neat sketch seven forging defects with femedies. (6.5)

Ans. Forging defects: Though forging process give generally prior quality product compared other manufacturing processes. There are some defects that are lightly to come a proper care is not taken in forging process design. A brief description of such defects and their remedial method is given below.

(*a*) Unfilled Section: In this some section of the die cavity are not completely filled by the flowing metal. The causes of these defects are improper design of the forging die or using forging techniques.

(*b*) Cold Shut: This appears as small cracks at the corners of the forging. This is caused manly by the improper design of die. Where in the corner and the fillet radii are small as a result of which metal does not flow properly into the corner and the ends up as a cold shut.

(c) **Scale Pits:** This is seen as irregular depurations on the surface of the forging. This is primarily caused because of improper cleaning of the stock used for forging. The oxide and scale gets embedded into the finish forging surface. When the forging is cleaned by pickling, these are seen as depurations on the forging surface.

(d) **Die Shift:** This is caused by the miss alignment of the die halve, making the two halve of the forging to be improper shape.

(e) **Flakes:** These are basically internal ruptures caused by the improper cooling of the large forging. Rapid cooling causes the exterior to cool quickly causing internal fractures. This can be remedied by following proper cooling practices.

(f) **Cracks:** The cracks are longitudinal or transverse in nature and occur on the forging surface. It is due to the poor quality of metal, improper heating, incorrect cooling and low temperature of the forging.

(g) **Fins and rags:** These are small projections or pieces of loose metal driven into the forging surface. It can be controlled by proper die design and workmanship.

Q.4. (b) Explain with neat sketch marking tools.

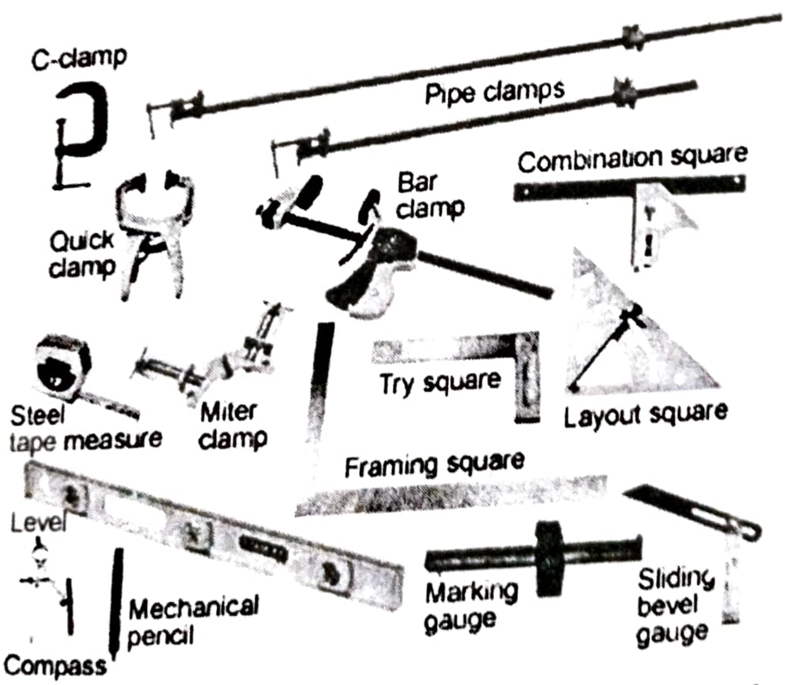
Ans. The Different Types of marking tools are:

The C-clamp's are bascily used to hot the Jobs fightly and rightly.

These types of clamps are used to

1. Pipe Clamps: Support bigger tools and jobs like Pipes etc.

2. Try Square: Try square are used to measure the length and angle that the jobs is in 90° to the stone.



3. Mechanical Pencil: Pencil are used to make or draw or write on the job.

4. Marking Gauge: Marking guage are used to mark the impression on jobs.

5 Level: The level is used to the take the level of the surface.

6. Steal tape measure: Steel measuring tape are used tape are used to measure the length and height of job and tool.

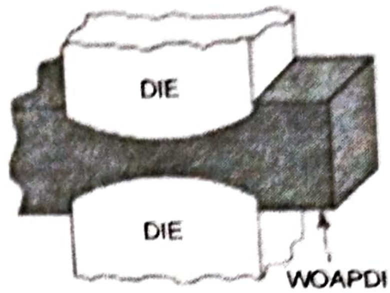
7. C-Clamp: The c-clamp's are basically used to hold the jobs tightly and rigidly.

Q.5. (a) Explain with neat sketch: **(3 + 3.5 = 6.5)**

(i) Upsetting operation.

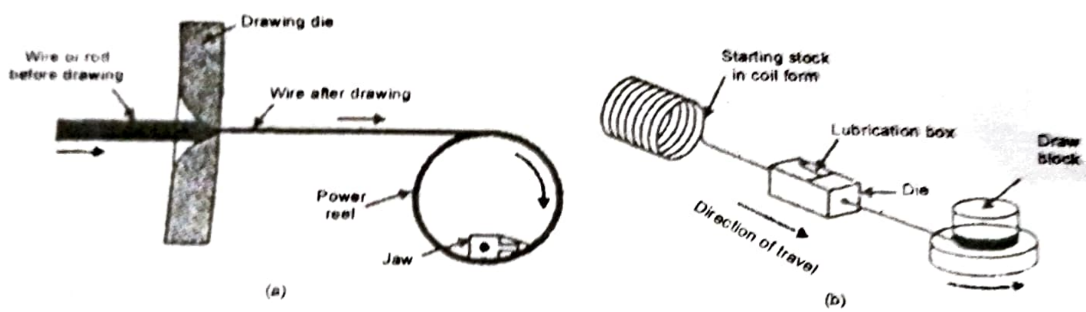
(ii) Wire drawing operation.

Ans. (i) **Upsetting:** When a piece of stock is worked in such a way that its length is shortened and either or both its thickness and width (or diameter of a circular stock) increased, the piece is said to be upset and the operations is known as upsetting.



Refer Q. 4(b) (i) of First Term 2014.

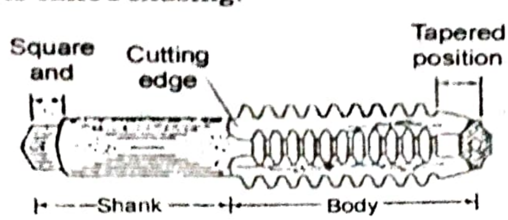
(ii) **Wire Drawing operation** Wire drawing is a metalworking process used to reduce the cross-section of a wire by pulling the wire through a single, or series of, drawing die(s). There are many applications for wire drawing, including electrical wiring, cables, tension-loaded structural components, springs, paper clips, spokes for wheels, and stringed musical instruments. Although similar in process, drawing is different from extrusion, because in drawing the wire is pulled, rather than pushed, through the die. Drawing is usually performed at room temperature, thus classified as a cold working process, but it may be performed at elevated temperatures for large wires to reduce forces.



Wire drawing machine

Q.5. (b) (i) Differentiate between die and tapping operation with diagram. **(3)**

Ans. Taps and dies are tools used to create screw threads, which is called threading. Many are cutting tools; others are forming tools. A tap is used to cut or form the female portion of the mating pair (e.g., a nut). A die is used to cut or form the male portion of the mating pair (e.g., a bolt). The process of cutting or forming threads using a tap is called tapping, whereas the process using a die is called threading. Both tools can be used to clean up a thread, which is called chasing.



Q.5. (ii) Explain with neat sketch major tools used in fitting shop. **(3)**

Ans. Tools in fitting Shop:

Fitting tools the tools used in fitting shop may be classified into following groups.

Measuring: Steel Rule, Inside Caliper, Outside Caliper and Vernier

Holding: All types of vices

Cutting: Chisel, Hacksaw and Files

Striking: All types of Hammers

Drilling: Various types of Drills

Threading: Tap and Dies

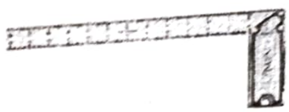
Marking: Scriber, Divider and Center Punch

Fixing: Spanner, Wrenches, Keys and Screw Driver

Checking: All types of Gauges

Steel Rule

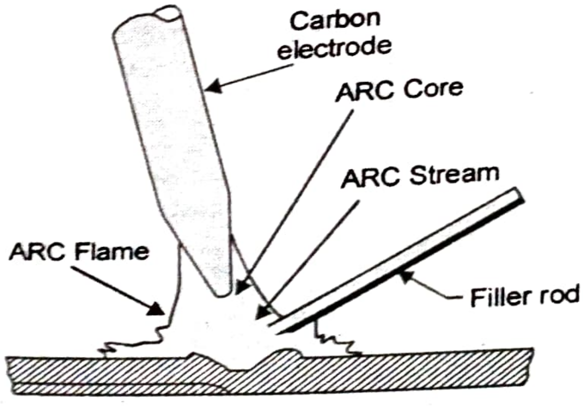
It is a cliff straight steel strip having all faces machined true. One of flat face graduation mark and in inches and also in centimeters. It is used to set out dimensions.



UNIT-3

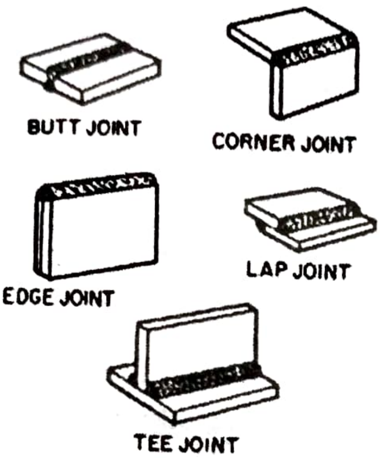
Q.6. (a) Explain with neat sketch carbon arc welding and its applications. Which polarity system is used in fusion welding process? **(6.5)**

Ans. Carbon Arc Welding: Carbon arc welding (CAW) is a process which produces coalescence of metals by heating them with an arc between a non consumable carbon (graphite) electrode and the work-piece. It was the first arc-welding process ever developed but is not used for many applications today, having been replaced by twin-carbon-arc welding and other variations. The purpose of arc welding is to form a bond between separate metals. In carbon-arc welding a carbon electrode is used to produce an electric arc between the electrode and the materials being bonded. This arc produces extreme temperatures in excess of 3,000°C. At this temperature the separate metals form a bond and become welded together.



Q.6. (b) Explain different welding joints and its five defects with diagram. (6)

Ans. Welding joints: There are five types of welding joints which are given below.



The defects in the weld can be defined as irregularities in the weld metal produced due to incorrect welding parameters or wrong welding procedures or wrong combination of filler metal and parent metal Weld defect may be in the form of variations from the intended weld bead shape, size and desired quality. Defects may be on the surface or inside the weld metal. Certain defects such as cracks are never tolerated but other defects may be acceptable within permissible limits. Welding defects may result

Common Welding Defects

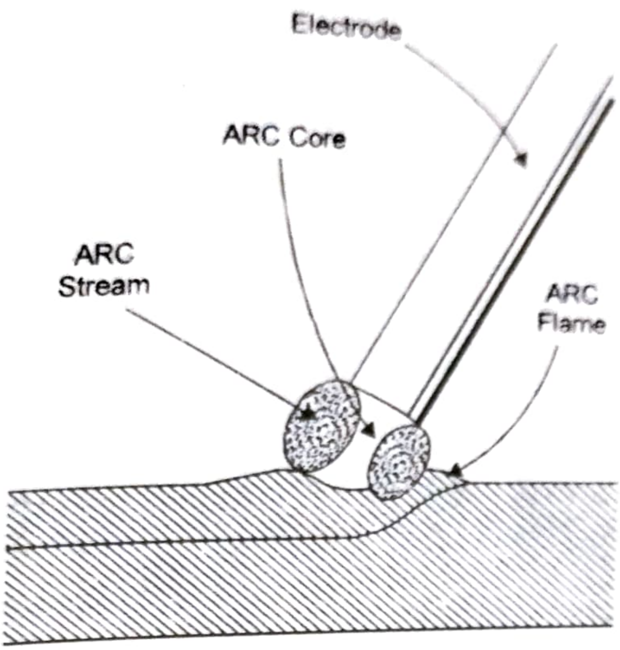
- Prosity
- Slag Inclusions
- Excess Penetration
- Incomplete Fusion
- Under Cut
- Inadequate Joint Penetration
- Cracking
- Welding Debries

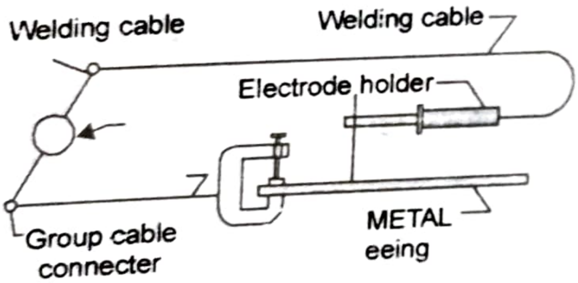
Q.7. (a) What are the defference between arc welding and submerged arc welding process? List along with block diagram of these processes. (6.5)

Ans. Difference between Arc welding And SAW:

Submerged arc welding (SAW) is a common arc welding process. The first patent on the submerged-arc welding (SAW) process was taken out in 1935 and covered an electric arc beneath a bed of granulated flux. Originally developed and patented by Jones, Kennedy and Rothermund, the process requires a continuously fed consumable solid or tubular (metal cored) electrode. The molten weld and the arc zone are protected from atmospheric contamination by being "submerged" under a blanket of granular fusible flux consisting of lime, silica, manganese oxide, calcium fluoride, and other compounds. When molten, the flux becomes conductive, and provides a current path between the electrode and the work.

Arc welding is a type of welding that uses a welding power supply to create an electric arc between an electrode and the base material to melt the metals at the welding point.





They can use either direct (DC) or alternating (AC) current, and consumable or non-consumable electrodes. The welding region is usually protected by some type of shielding gas, vapor, or slag. Arc welding processes may be manual, semi-automatic, or fully automated. First developed in the late part of the 19th century, arc welding became commercially important in shipbuilding during the Second World War.

Q.7. (*b*) What is Flux? Give its composition and properties. **(6)**

Ans. Function of Flux: In metallurgy, a flux is a chemical cleaning agent, flowing agent, or purifying agent. Fluxes may have more than one function at a time. They are used in both extractive metallurgy and metal joining.

Flux: It a material used to prevent, dissolve or facilitate removal of oxides and other undesirable surface substances.

The major functions of fluxes are:

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3. Owing to flux, the weld metal is not only clean but it also more dense and hence has excellent physical properties.

4. The blanket of flux improves the process efficiency by reducing spatter, burning losses, which are vanavoidable by an ordinary arc.

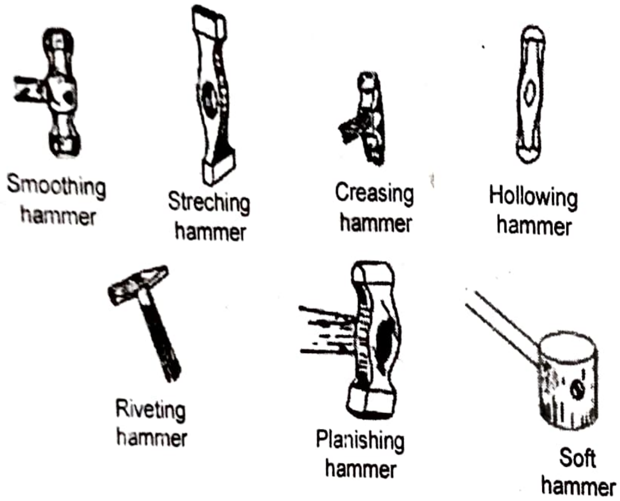
5. That position of flux which melt, floats as lizuid blanket over the molten metal, protect it from the deleteroius effects of surrounding atmosphere their by reduces the pickup of oxygen and nitrogen.

Refer Q. 4 (*b*) Second Term 2014.

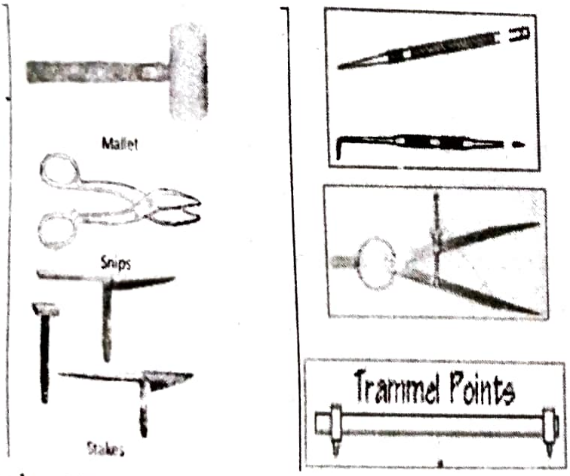
UNIT-IV

Q.8. (*a*) Descirbe various tools & equipments with neat sketch used in sheet metal work. **(6.5)**

Ans. Tools and Equipments used in Sheet Metal:



Sheet Metal Hand Tools



1. Mallet: Used to strike a light and soft blow on metal. This is soft hammer made of rubber, copper, brass, wood etc.

2. Snips of Shears: Used to cut thin sheets.

3. Stakes: Sheet metal worker's anvils, i.e., supporting tool.

4. Scriber: also known as metal worker's pencil. It has one hardened sharp pointed edge to scratch line on sheet metal.

5. Dividers: Used for drawing circle, arc on sheet metal and also used to mark a desired distance between two points.

6. Trammel Points: Consist of a bar with two movable heads. It is used to draw large circles or arcs that are beyond the limit of the dividers.

Q.8. (b) Explain mechanical Pulverization. What are different characteristic of metal powder?

Ans. Mechanical Pulverization: Since power metallurgy is all about working with metallic powders, the first question that would arise in the mind of the reader is that where does this powder come from, or how is it manufactured? There are several methods for preparation of the powder and some of them are listed as follows

Pulverization: as you would expect a simple method of creating metal powders is to crush or pulverize solid metal pieces. But remember we are not talking about a solid piece of salt but metals hence this method requires the application of a lot of force and is only suitable for brittle materials such as Antimony.

Characteristics:

(i) **Particle Shape:** The particle shape depends largely on method of powder manufacture. The shape may be special modular, irregular, angular and dentritic.

(ii) **Particle Size:** The particle size influences the control of porosity, compressibility and amount of shrinkage.

(iii) **Particle Size distribution:** It is specified in term of a sieve analysis, the amount of powder passing through 100, 200 etc, mess sieves. It influences the packing of powder and its behaviour during moulding and sintering.

(iv) **Flow rate:** It is the ability of powder to flow readily and confirm to the mould cavity. It determines the rate of production.

(v) **Compressibility:** It is defined as volume of initial powder to the volume of compact powder. It depends on particle size, distribution and shape.

(vi) **Apparent Density:** It depends on particle size and is defined as the ratio of volume to weight of loosely filled mixture.

(vii) **Purity:** Metal powder should be free from impurities as the impurities reducs the life of dies and effect sintering process.

Q.9. (a) What is Drawing? How is it different from Deep Drawing'? What is Strain Hardening? Is it problem in Deep Drawing? If so, what is the solution? (6.5)

Ans. Drawing: Drawing is a metalworking process which uses tensile forces to stretch metal. As the metal is drawn (pulled), it stretches thinner, into a desired shape and thickness. Drawing is classified in two types: sheet metal drawing and wire, bar, and tube drawing.

Deep drawing is a sheet metal forming process in which a sheet metal blank is radically drawn into a forming die by the mechanical action of a punch. It is thus a shape transformation process with material retention. The process is considered "deep" drawing when the depth of the drawn part exceeds its diameter. This is achieved by redrawing the part through a series of dies. The flange region (sheet metal in the die shoulder area) experiences a radial drawing stress and a tangential compressive stress due to the material retention property.

Strain Harding is also known as work hardning. It is the process of a metal by plastic deformation. This occurs dillocation movement and dislocation generation with in the crystal structure of material. Yes it is occurs in deep drawing because they are chracterised shaping the work piece at atamp. below its recrystalization temperature.

Q.9. (b) What are differences between primary & secondary process w.r.t. Powder Metallurgy? Differentiate between pre-sintering and sintering process. (6)

Ans. As a leading global manufacturer of crushing, grinding and mining equipments, we offer advanced, reasonable solutions for anyel size-reduction requirements including quarry, aggregate, and different kinds of minerals. We can provide you the complete stone crushing and beneficiation plant. We also supply stand-alone crushers, mills and beneficiation machines as well as their spare par.

Primary Process:

1. Primary process, such as blending or mixing, briquetting or compacting, pre-sintering and sintering.

2. Many parts manufactured through powder metallurgy are suitable for use directly using primary processes.

3. Primary processes are not the finishing processes in powder metallurgy.

Secondary Process

1. Secondary processes, such as sizing, coining, machining, impregnation infiltration, plating and heat treatment.

2. When better surface finish and close tolerances are desired then secondary processes are used.

3. While secondary processes are called finishing processes in powder metallurgy.

Difference Between pre sintering and sintering process:

Sintering is the process of compacting and forming a solid mass of material by heat and/or pressure without melting it to the point of liquefaction.

Sintering happens naturally in mineral deposits or as a manufacturing process used with metals, ceramics, plastics, and other materials. The atoms in the materials diffuse across the boundaries of the particles, fusing the particles together and creating one solid piece. Because the sintering temperature does not have to reach the melting point of the material, sintering is often chosen as the shaping process for materials with extremely high melting points such as tungsten and molybdenum. The study of sintering in metallurgy powder-related processes is known as powder metallurgy. An example of sintering can be observed when ice cubes in a glass of water adhere to each other, which is driven by the temperature difference between the water and the ice.

Strain Marding is also known as work having Straing Hordening. It is the process of a metal by Plastic deformation. This occurs disbeation movement and dislocation generation with in the crystal etc vector of meterial. Yes it is recurs in deep drawing because they are chracterized by shaping the work piece at a tamp. Gelcro its recrystalization temp.

FIRST TERM EXAMINATION [SEPT. 2015]
FIRST SEMESTER [B.TECH]
MANUFACTURING PROCESS [ETME-105]

Time : 1 Hours. **M.M. : 30**

Note: *Q.1. is compulsory. Attempt any two more questions from the rest.*

Q.1. (*i*) Write any two functions of Riser. **(1)**

Ans. The effect of absence of riser on the casting canbe adverse suice it performs important functions solely as under:

1. It feeds metal to the soldifying casting so that shrinkage cavities are got rid of, otherwise shrinkage casting defect occurs.

2. A riser full of molten metal indicates that the mold cavity is being filled with the molten metal.

3. A casting solidifying under the liquid metal pressure of riser is compartively sound.

4. Riser promotes directional solidification.

Q.1. (*ii*) In a——— the molten metal is poured and allowed to so lidify while the mould is revolving. **(1)**

(*a*) Die Casting method

(*b*) Slush casting method

(*c*) Permanent mould casting method

(*d*) Centrifugal casting method

Ans. (*d*) Centrifugal Casting Method

Q.1. (*iii*) What are core prints and chaplets?

Ans. A core is a device used in casting and molding processes to produce internal cavities and reentrant angles. The core is normally a disposable item that is destroyed to get it out of the piece. They are most commonly used in sand casting, but are also used in injection molding.

An intriguing example of the use of cores is in the casting of engine blocks. For example, one of the GM V-8 engines requires 5 dry-sand cores for every casting.

Cores are usually supported by two core prints in the mold. However, there are situations where a core only uses one core print so other means are required to support the cantilevered end. These are usually supplied in the form of *chaplets*. These are small metal supports that bridge the gap between the mold surface and the core, but because of this become part of the casting. As such, the chaplets must be of the same or similar material as the metal being cast.

Q.1. (*iv*) What is a pattern? Name different types of pattern. **(1)**

Ans. Pattern: It is defined as the replica of desired casting which we want to produce or it can be defined as replica of the object to be made by casting process.

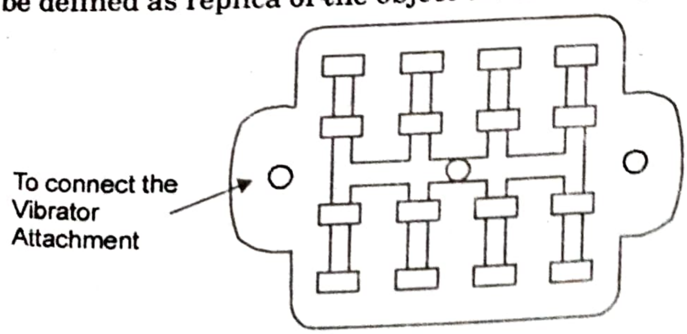


Fig. Match Plate Pattern

The various types of pattern are:

(*i*) Single piece pattern

(*ii*) Match plate pattern

(*iii*) Gated pattern

(*iv*) Cope and drag pattern

(*v*) Split pattern or two piece pattern (*vi*) Sweep pattern
(*vii*) Follow board pattern (*viii*) Skeleton pattern

Q.1. (*v*) The adhesiveness is the property of a sand due to which (1)

(*a*) It evolves a great amount of steam and other gases

(*b*) The sand grains stick together

(*c*) It cling to the sides of a moulding box

(*d*) None of these

Ans. (*b*) The sand grains stick together

Q.1. (*vi*) What are the desirable properties of moulding sand? (1)

Ans. Characteristics of Moulding Sand: The properties that are generally required in moulding material are:

(*i*) Refractoriness **(*ii*) Permeability**

Q.1. (*vii*) What is annealing? (1)

Ans. Annealing is a hest process whereby a metal is heated to a specific temperature /colour and then llowed to cools slowly. This softens the metal which means it can be cut and shaped more easily. Mild steel, is heated to a red heat and allowed to cool slowely.

Q.1. (*viii*) Distinguish between ductility and malleability. (1)

Ans. Ductility & malleability: Ductility is said to be the property of a material to stretch without getting damaged. Metals having ductile property can be stretched into wires. An example is copper wire.

Malleability is said to be the property of a material to deform under compression. The metals having malleable property can be rolled or beaten into sheets. An example is aluminum foil.

Q.(*ix*). Distinguish between Hot working and Cold working. (1)

Ans.

Hot Working	Cold Working
1. It is done at a temperature above recrystallisation but below its melting point	1. It is done at temperature below recrystallisation temperature.
2. Hardening due to plastic deformation is completely eliminated by recovery and recrytallisation.	2. Hardening is not eliminated since working is done at a temperature below recrystallisation.
3. Some mechanical properties such as elongation, reduction of area and impact values are improved.	3. Cold working decreases elongation reduction of area and increases ultimate tensile strength, yield point and Hardness.
4. Surface finish of hot worked metal is not good.	4. Surface finish obtained is better.
5. Refinement of crystals occurs. Grains are only elongated.	5. Crystallisation does not occur.
6. Cracks and blow holes are welded up due to recrystallisation temperature.	6. Possibility of crack formation and propagation is increased.
7. Internal or residual stresses are not developed in the metal	7. Internal and residual stresses are developed in the metal.
8. Oxide forms rapidly on metal surface.	8. Cold part posses less ductility.
9. Less force is required.	9. Higher forces are required for deformation.
10. Equipment used in hot working is light.	10. More powerful and heavier equipments are required for cold working.
11. Handling and maintenance of hot metal is difficult and troublesome.	11. Easier to handle cold parts.

Q.(x). The machining allowance provided on patterns depends upon
(a) Types of casting metal **(b) Size and shape of metal**
(c) Method of casting used **(d) All of these.**

Ans. All of these.

Q.2. Write the principle of casting and Explain the Gating system in detail with neat sketch. (10)

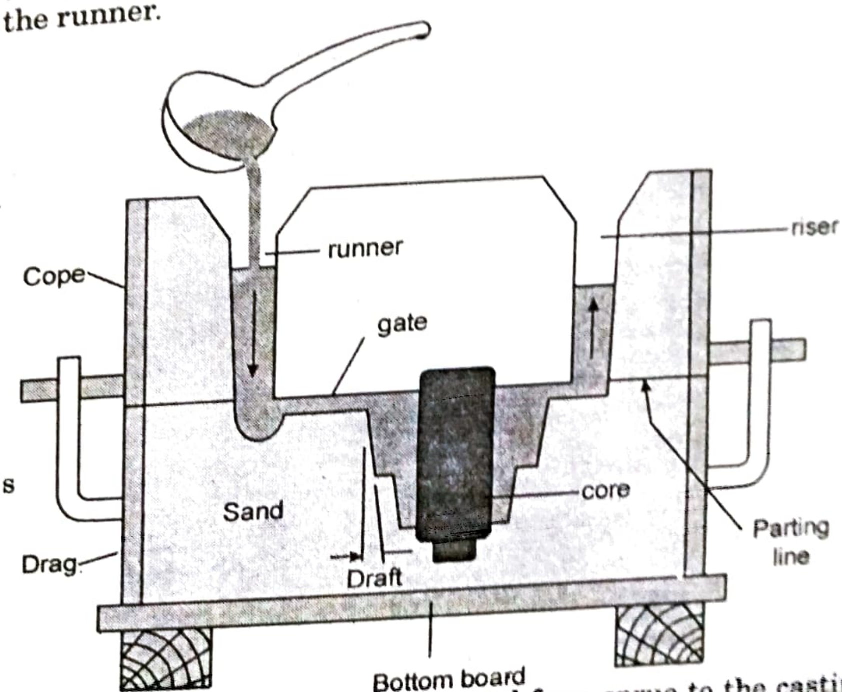
Ans. (a) Casting: Casting is a manufacturing process by which a liquid material is usually poured into a mold, which contains a hollow cavity of the desired shape, and then allowed to solidify. The solidified part is also known as a casting, which is ejected or broken out of the mold to complete the process. Casting materials are usually metals or various *cold setting* materials that cure after mixing two or more components together; examples are epoxy, concrete, plaster and clay. Casting is most often used for making complex shapes that would be otherwise difficult or uneconomical to make by other methods.

Components of gating system:

Pouring basin: This is otherwise called as bush or cup. It is circular or rectangular in shape. It collects the molten metal, which is poured, from the ladle.

Sprue : It is circular in cross section. It leads the molten metal from the pouring basin to the sprue well.

Sprue Wells: It changes the direction of flow of the molten metal to right angle and passes it to the runner.



Runner: The runner takes the molten metal from sprue to the casting. In gate: This is the final stage where the molten metal moves from the runner to the mold cavity.

Slag trap : It filters the slag when the molten metal moves from the runner and in gate. It is also placed in the runner.

Q.3. Explain the working of cupola furnace with neat sketch. Also mention different reactions. (10)

Ans. Melting Furnances for cast Iron:

Cupola furnace: This is secondary furnoce for refining pig iron into cost iron.

Description: Cupola is mainly made of a vertical cylindrical shell made of steel plates mesuring 10 to 15 nm thick, welded together. The inside of shell is lined with fireclay or refractory bricks measuring 2 mm thick. The top of shell is provided with a cap where purpose is to fold, to safeguard the burning against rain and to reflect a good amount of heat into furnace by restricting escape of burning gases.

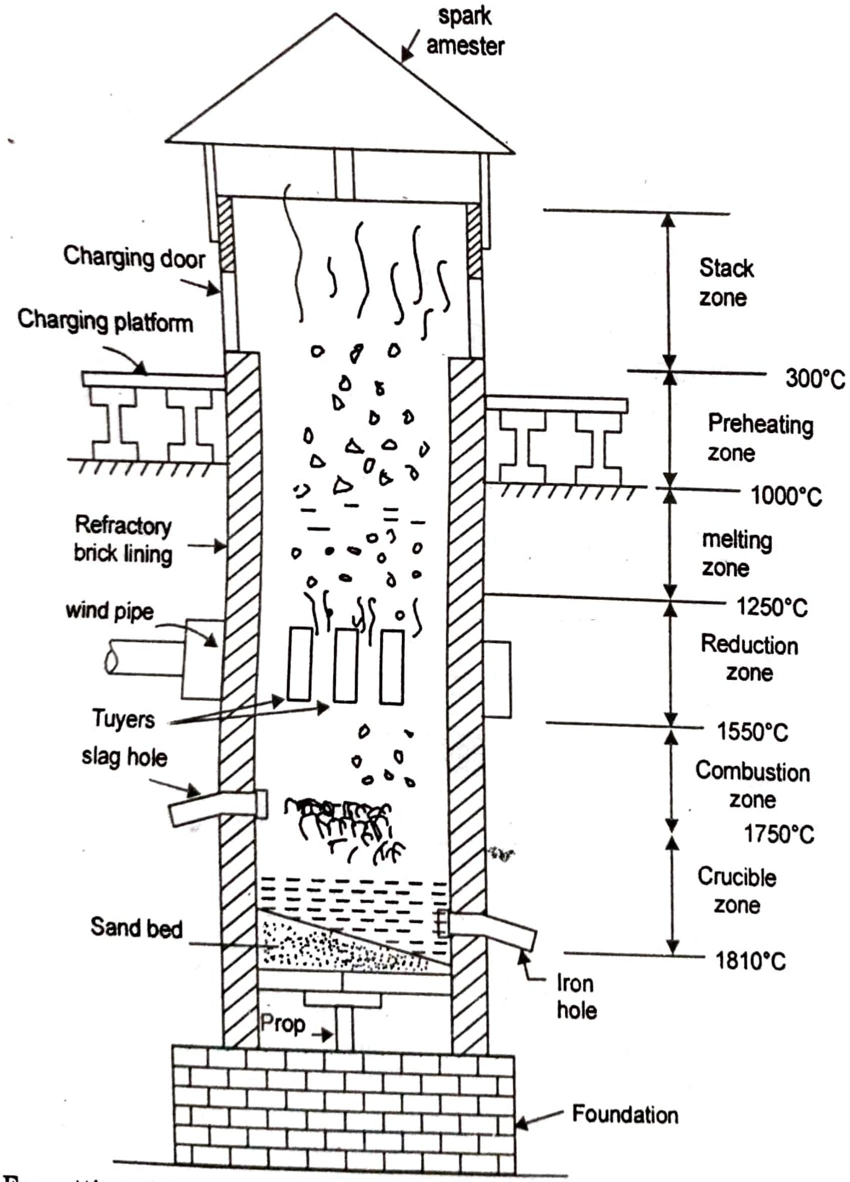
Upper part of the shell is provided with a charging a and below charging door there is a charging plate around the shell. In middle part of shell, there is wind pipe in which the compressed air circulates and from which it can enter the shell through openings known as tuyers which may number four or more. Below the tuyers, there is provision of slag hole and iron tap hole on either side of furnance. The whole structure stands on steel reinforced concrete legs errected over the shop floor. The structure measures 1 to 2 meter dia and 4 times of its dia as height, that is 4 to 8 meter.

Operation: The cupola charge consists of following element where ratio is:

Pig iron scrap – 1010N

Hard coke as fuel – 110 N

Lime stone as fusx – 40N



For getting 1000N or one tonnes of CI First of all drop down bottom is brought to position and a sand bed is prepared over soft wood and coke is placed through iron tapping hole and fire is lit. After this charge, having layers of pig iron, hard coke and flux is slowly dropped from charging door. This charging usually done manually, however conveyer belt syitem is also used in these days. Simultaneously while dropping charge over plates of tuyers are opened so that compressed air from wind pipe enters the furnace and help in burning. As fuel burning picks up temp. of pig iron rises leading to its melting Molten pig iron trickles down travelling through reduction and combustion zones and lastly it collects in crucible zone. The crucible zone is also called as well, or sufficiently quantity of iron collects there over the sand bed.

Zones of Cupola furnace:

1. Stack Zone: This is zone above charging door, through which hot gases riser up to escape from furnace.

2. Preheating Zone: This contains alternate layers of pig iron coke and flux. The charge gets sufficient heat here and gets preheated in temp. range of 1000 to 1150°C.

3. Melting Zone: In this zone metal melting starts and so the molten metal travels down. The temp. being 1150 to 1250°C. Chemical reaction.

$$3Fe + 2Co \longrightarrow Fe_3C + CO_2$$

4. Reduction Zone: In this zone oxygen burning takes place giving rise to good amount of heat temp. rise from 1250 to 1550°C.

5. Combustion Zone: This is between reduction and crucible zone above and below tuyers. Here burning of various elements associated with pig iron takes place. Ultimately resulting in refining of pig iron into CI. The temp. being 1550°C to 1750°C

Chemical reaction

$$Si + O_2 \longrightarrow SiO_2 + Heat$$
$$Mn + O \longrightarrow MnO + Heat$$
$$\left.\begin{array}{l} P + O_2 \longrightarrow P_2O_5 \\ Mn + S \longrightarrow MnS \end{array}\right\} \text{slag}$$

6. Crucible zone or well: Molten metal collects here. The temp being 1750° to 1810°C. There is no chemical reaction. The fisating slag is removed trough slage hole + then iron is tapped act through iron top hole into lades which are carried to casting action where mould are lying really.

Cupola Specifications: The cupole furnance is specified of giving following parameters.

- Shell plate thickness
- Cylindrical shell dia with and without refeactory brick oning no of tuyers.
- Furnace total height
- Blowers horse power
- Melting capacity of furnace in tonnes/hr.

Cupola Fluxes: The fluxes cupola in copola may be classified in two categories.

1. Primary fluxes: Primary fluxes are limestone, calcite, oyster and other set and dolomite. These fluxes are added in the proportion in to 7% of metal charge depending on (*i*) cupola dia (*ii*) ash content in coke. (*iii*) impurities present in charge.

2. Secondary fluxes: These are used in small quantities usually from 0.2 to 2.1. of metal charge, according. to composition and nature of charge materials, of sodium carbonate, calcium carbide are used as fluxex.

Merits of Cupola:

- Its continuous operation
- Low cost of operational melting.
- Composition of melt can be controlled.
- Easy to operate.
- Temperature of melt can be controlled.
- Floor area requirement for installation of furnace is less.
- Operational maintanance is less.

Demerits of Cupola

- Charge is in airect controst fueld
- Considerable amount of impurity.
- Direct without of another metal with carbon, Chemical composition of iron is difficult to control

• **Law carbon iron** . below about 2.8% C are difficult to attain because of direct contact of molten iron and corbonaceous fuel.

• Some alloying elements such as chromium, molybdenum are in part lost by oxidation in cupola.

Q.4. Explain various types of surface hardening or case hardening processes. **(10)**

Ans. Surface Hardening or Case Hardening

In many engineering applications, it is required that a steel being used should have a hard surface so that it can resist wear and tear. At the same time it should have soft and tough interior so that steel is able to absorb any shocks etc. This is possible only when the surface is hard while rest of the metal is left as such. This type of treatment is called surface hardening or case hardening and is applied to gears, ball bearings, railway wheels etc.

Various types of surface hardening or case hardening processes are :

1 . Carburising 2. Cyaniding 3. Nitriding *4.* Induction hardening 5. Flame hardening 6. Laser beam hardening 7. Electron beam hardening.

Carburising

The process of inducing carbon to low carbon steels in order to give it a hard surface is known as carburising. The surface is made hard only upto a certain depth. Following three methods are generally used for carburising.

1. Pack or solid carburising 2. Liquid carburising 3. Gas carburising.

1. Pack or Solid Carburising

In this process, the article to be carburized is placed in a carburising box of proper design and surrounded by solid carbonaceous materials — usually a mixture of charcoal and barium carbonate. The boxes are sealed with clay to exclude air and are placed in an oven or furnace where they are heated to a temperature between 900-950°C for several days depending upon the extent of carburising action desired. In this way, carbon from the carburising compound soaks into the surface of the hot steel. After carburising, steel is reheated to a temperature just above its critical point followed by quenching in water, brine or oil. This hardens the skin and at the same time refines the core. This steel is also given a second heat treatment at a lower temperature range *i.e.* 750-770°C, in order to improve the ductility and impact resistance of the core and case.

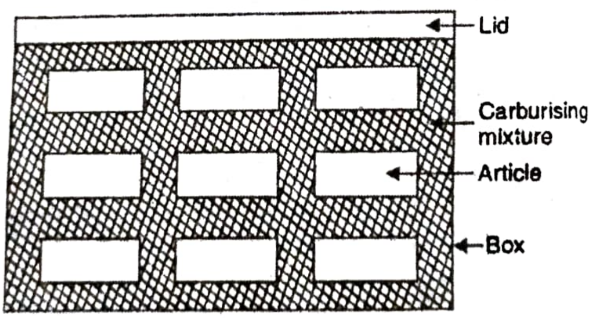


Fig. Pack or solid Carburising

2. Liquid Carburising: In this process, carburising is done by a container filled with a molten salt, such as sodium cyanide. This bath is heated by electrical immersion elements or by a gas burner. Stirring is done to ensure uniform temperature. If only selected portions of the components are to be carburised, then the remaining portions are covered by copper plating.

Heat treatment following liquid bath carburising is almost same as that used after pack hardening :

Advantages:

(i) Very little deformation of artical

(ii) Time saving process.

(iii) Greater depth of penetration possible.

(iv) Selective carburising is possible if needed.

(v) Ease of carburising a wider range of products.

(vi) Uniform heating.

(vii) Parts leave the bath with a clean and bright finish. There is no scale as there in pack hardening.

3. Gas Carburising

In gas carburising, the article is surrounded by a hydrocarbon gas in the furnace. The common carburising gases are methane, ethane, propane, butane and carbon monoxide.

Steel components are quenched in oil after carburising and then heated again to form fine grain sized austenite and then quenched in water to form martensite in surface layers. This gives maximum toughness of the core and hardness of the surface.

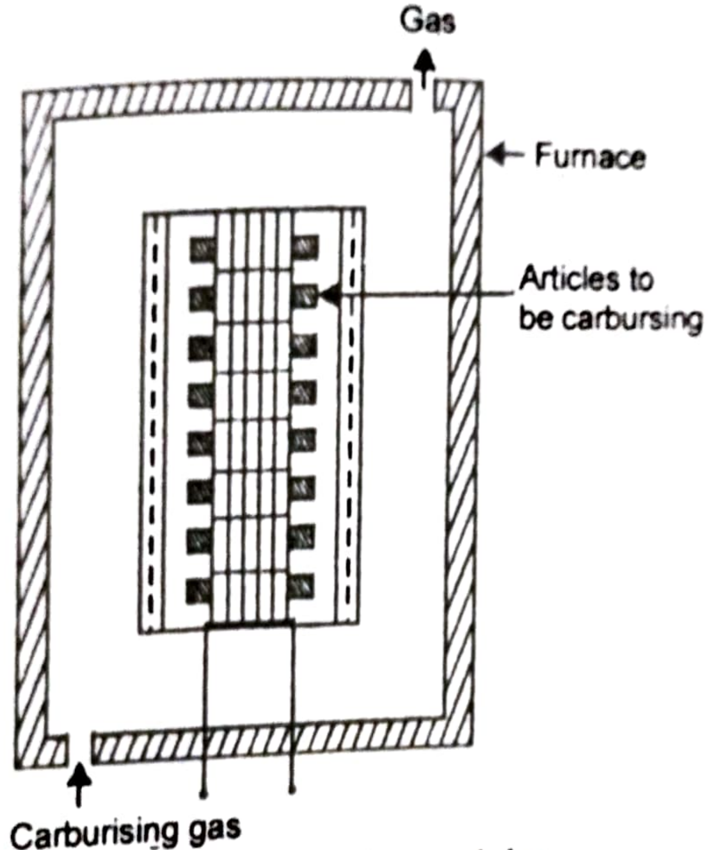


Fig. Gas Carburising

END TERM EXAMINATION [DEC. 2015]
FIRST SEMESTER [B. TECH]
MANUFACTURING PROCESS [ETME–105]

Time: 3 Hrs. **MM : 75**

Note: *Attempt any five questions including Q.no.1 which is compulsory. Selelct one question from each unit.*

Q.1. (a) What is case hardening and when it is required? (2.5)

Ans. Case Hardening: Case hardening is specified by hardness and case depth. The case depth can be specified in two ways: total case depth or effective case depth. The total case depth is the true depth of the case. The effective case depth is the depth of the case that has a hardness equivalent of HRC50; this is checked on a Tukon micro hardness tester. This value can be reoughly approximated as 65% of the total case depth; however the chemical composition and harden ability can effect this approximation. If neither type of case depth is specified the total case depth is assumed.

Q.1. (b) What shrinkage does the Riser take care of and where it should be located in mould? (2.5)

Ans. Shrinkage allowances : All metals usually contracts after solidification in the mould, and the pattern must therefore be made larger than the casting by an amount known as *patternmaker's* contraction. Generally, the patternmaker is equipped with the patternmaker's contraction rule, which is used to compensate for the shrinkage value.

To compensate for shrinkage, the graduations are oversized by a proportionate amount, e.g., on a 1-mm or 1% scale, each 100 cm is longer by 1 cm. The rates of contraction for important cast metals are listed in Table.

Table: Rates of contraction for important cast metals

Cast Metal	Dimension (MM)	Contraction (MM/M)	Remarks
Cast iron	up to 600	10.5	
	600–1200	8.5	
	over 1200	7.0	
Cast steel	up to 600	21	
	600–1800	16	
	over 1800	13	
Aluminium	up to 1200	13	1.5 mm less for cored construction
	1200–1800	12	
magnesium	up to 1200	14.5	1.5 mm less for cored construction
	over 1200	13.0	

The value of contraction as obtained from Table is only a guideline because the actual contraction taking place while the metal solidifies depends on several factors such as (*i*) composition of metal, and impurities and constituents present; (*ii*) method of moulding used, mould design, mould material, and resistance offered by the mould to shrinkage; (*iii*) pouring temperature; and (*iv*) design and intricacy of the casting, its bulk and size., In case of precision casting work, it is not enough to depend on the use of contraction rule, as the actual shrinkage occuring in the casting may be at variance with the one provided on the pattern through a contraction rule. The shrinkage may even vary within the same casting from one dimension to other. Therefore, in such cases it is necessary to calculate the actual dimensions of the pattern considering the shrinkage that is going to occur.

Q.1. (c) Write the chemical reaction taking place in Combustion zone and reducing zone in a Cupola Furnace? (2.5)

Ans. Refer Q.3. of First Term Examination 2014.

Q.1. (d) What are 'Cold shut' and 'Mismatch' defects in a casted products and what are reasons for their occurrence? (2.5)

Ans. When the metal is unable to fill the mould cavity completely and thus leaving unfilled portion called Misruns. A cold shut is called when two metal streams don't fuse together properly.

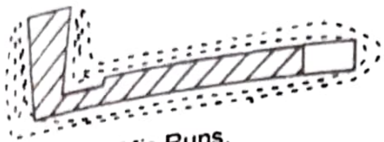


Fig. Mis Runs.

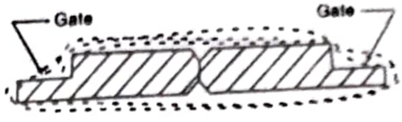


Fig. Cold Shut

Causes:

• Lack of fluidity in molten metal • Faulty design • Fauly gating.

Remedies:

• Adjust proper pouring temperature • Modify design • Modify gating system.

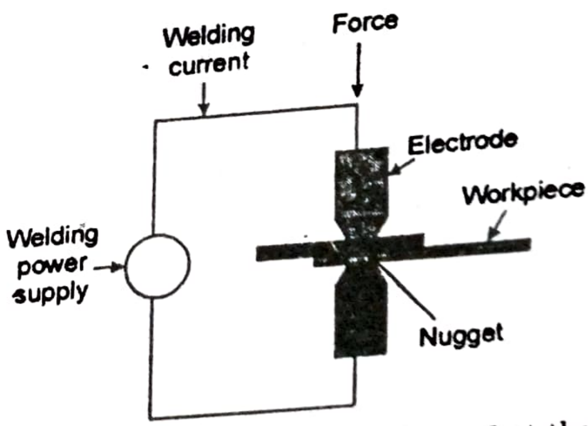
Q.1. (e) What are the functions of V Block and Try Square' used in fitting shop? (2.5)

Ans. Try Square: It is used for checking squareness of two surface. It consists of a blade mode up of steel which is attached to a base at 90°. The base is made up cast iron or steel. Try square is also used for marking right angles and masuring strainghtness of surface. It is an instrument used to draw straight lines at right angle to a true surface.

V-Block: V-Bloks are precision metal working jigs typically used to hold round metal rods or pipes for perfoming drilling or milling operations. Thys consists of a rectangular steel or cast iron block with a 90-degree channel rotated 45-degrees form the sides, forming a V-shaped channel in the top. A small groove is cut in the bottom of the "V". They of ten come with screw clamps to hold the work. There are also versions with internal magnet for magnetic work holding V blocks are usually sold in pairs.

Q.1. (f) What is the principle of Resistance welding and what is the order of current in this process? (2.5)

Ans. Resistance Welding: Electric resistance welding (ERW) refers to a group of welding processes such as spot and seam welding that produce coalescence of faying surfaces where heat to form the weld is generated by the electrical resistance of material combined with the time and the force used to hold the materials together during welding. Some factors influencing heat or welding temperatures are the proportions of the work pieces, the metal coating or the lack of coating, the electrode materials, electrode geometry, electrode pressing force, electrical current and length of welding time. Small pools of molten metal are formed at the point of most electrical resistance (the connecting or "faying" surfaces) as an electrical current (100-100,000 A) is passed through the metal.



Reverse Polarity: When the electrode is given positive potential and the work piece is given negative potential, the weld formed is shallow and wide, this method is called 'Direct Current Reverse Polarity' (DCRP) welding procedure.

Straight Polarity: AC (Alternating Current) and DC (Direct Current) is used to describe the polarity of the electric current that the welder generates and in what direction it travels. If you use the wrong polarity for a certain welding rod, your weld strength will not be very good.The general terms associated with polarity are reverse polarity and straight polarity. These are common to the welding trade. Another way to describe the two terms is electrode positive and electrode negative. Electrode positive is the same as reverse polarity. Electrode negative is the same as straight polarity. Hence the + and the - written on your welder where the cables connect to it.

Q.1. (g) What is edge preparation in are welding process and under what conditions it becomes necessary? (2.5)

Ans. This type fo edge preparation is used when the thickness of two pieces to be joined is small. As thickness increase it becomes necessary to prepare edge in such a way that heat produced would be able to penetrate the entire depth. If edge preparation is not done then the joint will not be strong one because the two metals can be united throughout the depth.

The various possible edge preparation for butt joint are:square, single V, double V, single U, double U, single bevel and double bevel. Square of straight weld is used for sheet about 1 to 5 mm thick. The distance between faces is kept about 3mm. single V and single U joints are used for sheet of about 5 to 15 mm thickness. The V joint is easier to make as compared to U joint but the filler metal increases greatly with increase in thickness. That is why some time U joint is preferred but this joint is difficult to make. Double U (above 15 mm) joint is preferred for joining very thick material because of less requirement of filler meterial.

Q.1. (h) How Acetylene is stored in a cylinder and the reasons thereof? (2.5)

Ans. Acetylene is not stored safely at pressures higher than 0.1 MPA. It is usually dissolved in acetone. The storage cylinders are filled with around 80% porous filler such as calcium silicate. Acetone is absorbed into the voids in filler material and serves as medium for dissolving the acetone. These cylinders can hold 9 m^3 of gas at the pressure of 1.75 MPa.

Q.1. (i) What difference between punching and piercing in sheet metal. (2.5)

Ans. Punching: The punching is cutting operation by which various shaped holes are made in sheet metal strip. In punching operations sheet with the hole is desired product and material punched out is scrap. Normally punching operation is performed after blanking :

- The punch and die are made of a suitable hard and strong material, such as hardened high carbon steel, high chromium oil hardening steel or tungsten carbide.
- In punching operation the punch size equals the size of hole and die opening size is obtained by adding the clearance to punch size.

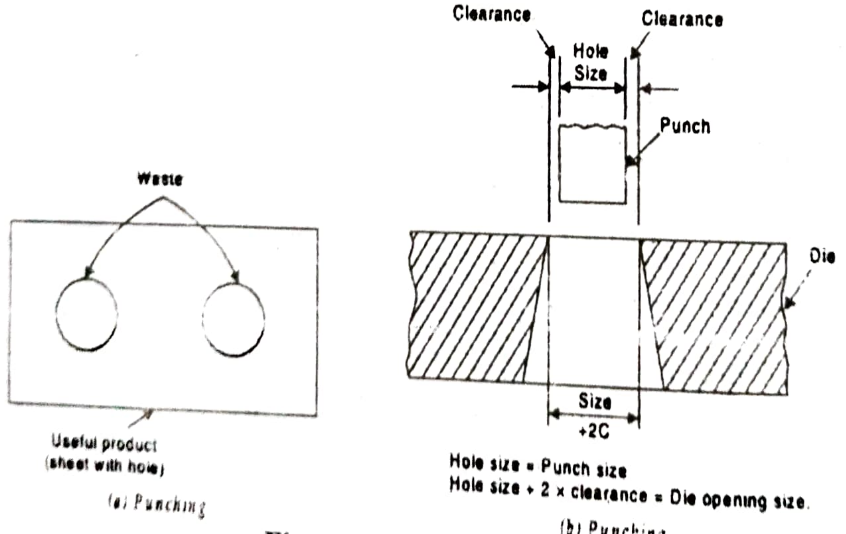
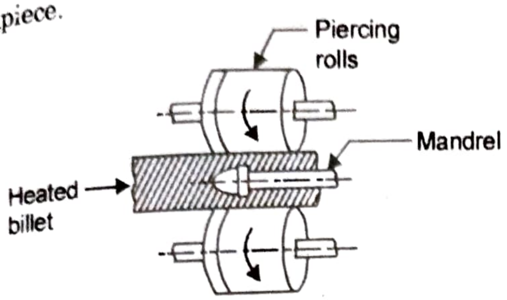


Fig. Punching Operation.

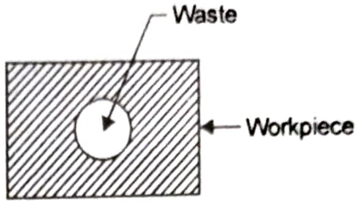
Piercing: It is the proces of generating a hole in the sheet metal, thus the hole generated in the blank is a product. In this obtaining a hole in a blank is a objective. It can be obtained by die and a punch mechanism.

Piercing is employed to produce seamless tubing, which is popular and economical raw stock for machining because it saves drilling and boring of parts. In this process, a heated cylindrical billet (heated to about 1100°C) is passed between too conical-shaped piercing rolls which impart axial as well as rolling movement to the billet. The size and shape is controlled by the piercing mandrel. The first pass makes a rather thick-walled tube which is reduced to required dimensions after further operations. The tube is then passed through a reeling machine which helps in straightening and sizing to the final dimensions.

Piercing differs from blanking in the end result part. In blanking, the piece being punched out becomes the workpiece and the remaining part is treated as waste. But, in piercing the punched out part is considered waste and the remaining part is the workpiece.



Piercing operation



Piercing

Q.1. (j) What is the basic difference between Embossing and Coining Processes? (2.5)

Ans. Embossing:

- It is the operation used in making raised figures on sheets, with corresponding relief on the other side.
- The die set consist of punch and die with desired contours, so that when both meet (die and punch) then clearance between them is same as that of sheet thickness.
- The diagram of Embossing is shown below above

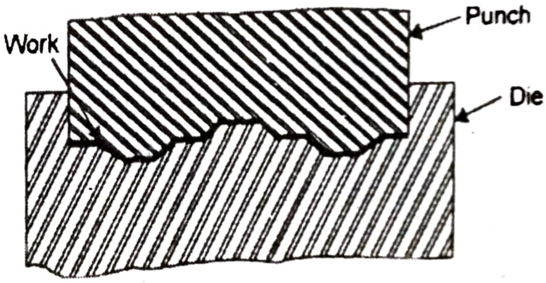


Fig.: (Embossing)

- Embossing is used for providing dimples on sheet to increase their rigidity and for decorative sheet work used for panels in houses.

Coining:

- It is essentially a cold forging operation, here the flow of metals occurs only at the top layers and not the entire volume.
- The coining die consist of punch and die which are engraved with the neccessary details required on both sides of the final object.

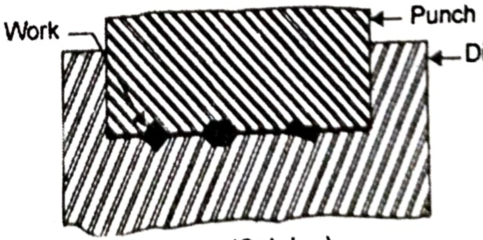


Fig. (Coining)

- The pressure involved in coining are very high of order of 1600 MPa
- The diagram of coining in shown below.
- Coining is used for making coins, medals and similar materials and for imperssions on the decorative terns.

UNIT-I

Q.2. (a) Discuss in detail the process of Normalizing. What properties are improved by this process? (6.5)

Ans. Normalising: Normalising is done for the following purposes:

1. To eliminate coarse grain structure which is produced during forging, rolling etc.
2. To improve machinability.
3. To remove or reduce internal stresses
4. To improve certain mechanical and electrical properties.

The process consists of heating of steel to a point 40 to 50°C above its upper crtical temperature. Hold at that temperature for a short duration and subsequently cooling in still air at room temperature . This is also known as air quenching.

It produces microstructures consisting of ferrite and pearlite for hypoeutectoid steels and pearlite and cementite for hypereutectoid steels.

Normalising raises the yield point, ultimate tensile strength and impact strength values of steel. Normalised steels are harder and storngerbut less ductile than annealed steels with the same composition.

Normalising as Compared with Annealing

1. Normalising requires a heating range which is about 40°C above that of aneealing.
2. Mechanical properties of steel are better produced by normalising as compared to annealing.
3. Heat treatment properties of steels are beteer than produced by annealing.
4. Heat treatment process is of short duratrion due to increased rate of cooling of metal in air.

If improvement of mechanical properties is not the main aim of heat treatment, better machinability and greater removal of internal stresses is possible with annealing than that can be obtained with normalising.

Q.2. (b) Explain the following with neat sketches and their application areas **(6)**

(i) Sweep Pattern **(ii) Multipiece pattern**

Ans. (i) Sweep pattern.

These patterns are used for producing large casting, particularly which are circular in cross-section and are axis symmetrical like bell shape castings or large kettles of cast iron. The main advantage of this pattern is that it eliminates the cost of manufacturing in a three-dimensional pattern.

The equipment consists of a base suitable placed in sand, a vertical spindle and a wooden template called sweep. The sweep consists of flat board and on the one end has the shape corresponding to the shape of desired casting. The sweep is rotated about the spindle to form the mould cavity (like if conical cavity is desired the shape of sweep will be right angle triangular plane. When this plane will rotate about the edge the conical cavity will be formed).

Sweep and spindle are then removed leaving the base in sand. The hole made by removal of spindle is filled up by sand. Hence cavity is prepared. If shape desires then we may place core and chaplets in the cavity.

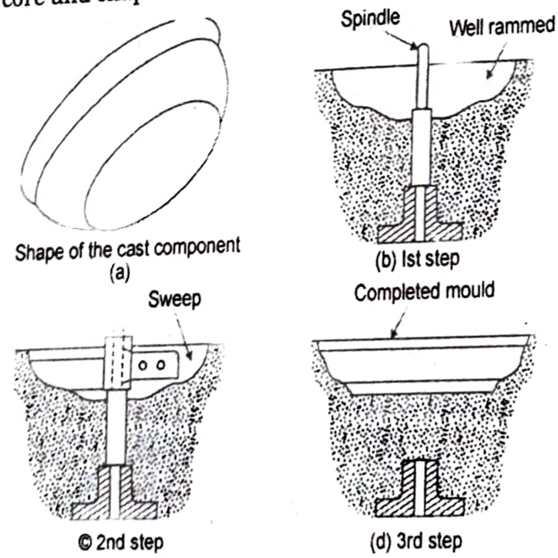


Fig: Sands moulding precess using sweep pattern.

(ii) **Multipiece Pattern:** Sometimes the patterns are made in more than two parts if the shape is complex. Then these patterns are called multipiece pattern which may consist of 3, 4 or more number of parts depending upon their design.

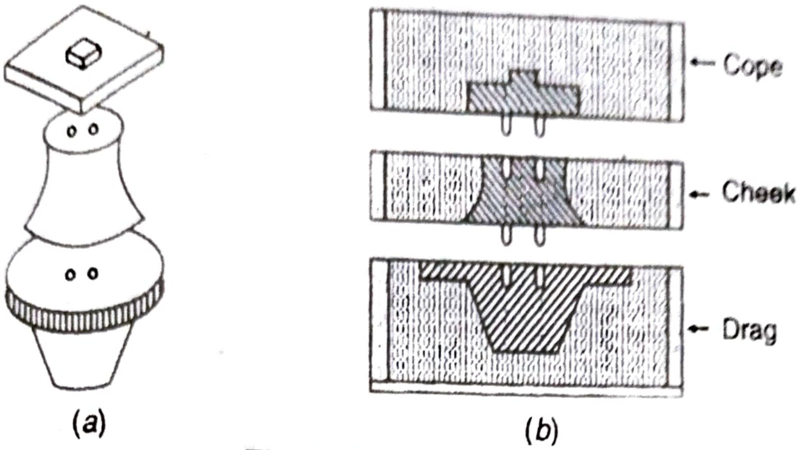


Fig. Multipiece Pattern.

Q.3. (a) Explain the process of investment casting. List its any three applications. (6.5)

Ans. Principal of investment casting is that it forms an expendable pattern of -wax in a die which in turn is employed to form a mold in an investment material After the model of investment material is set, the wax pattern is melted or burned and the molten metal is poured in the cavity thus formed.

It is called as investement casting as the term investment refers to cloak or special covering apparel. Here the clock is refractory mold which surrounds the precoated wax pattern.

The steps involved in investment casting are:

Precision Investment Casting: This is the process where the mould is prepared around an expendable pattern. The various steps in the process are shown in Fig. The first step in this process is the preparation of the pattern for every casting to be made. To do this, molten wax, which is used as the pattern material is injected under pressure of about 2.5 MPa into a metallic die, which has the cavity of the casting to be made as shown . in Step 1 of Fig. The wax when allowed to solidify would produce the pattern. The pattern is ejected from the die as shown in Step 2. Then the cluster of wax patterns are attached to the gating system by applying heat as shown in Step 3.

To make the mould, the prepared pattern is dipped into a slurry made by suspending fine ceramic materials in a liquid such as ethyl silicate or sodium silicate (Step 4). The excess liquid is allowed to drain off from the pattern. Dry refractory grains such as fused silica or zircon are *stuccoed on* this liquid ceramic coating (Step 5). Thus, a small shell is formed around the wax pattern. The shell is cured and then the process of dipping & stuccoing is continued with ceramic slurries of gradually increasing grain sizes. Finally, when a shell thickness of 6 to 15 mm is reached, the mould is ready for further processing. The shell thickness required depends on the casting shape and mass, type of ceramic and the binder used.

The next step in the process is to remove the pattern from the mould, which is done by heating mold to melt the pattern (Step 6). The melted wax is completely drained through the sprue by inverting the mould. Any wax remain in the mould are dissolved with the help of the hot vapour of a solvent, such as trichloro-ethylene.

The moulds are then pre-heated to a temperature of 100 to 1000°C, depending on the size, complexity and the metal of the casting. This is done to reduce any last traces of wax left off cold mould.

The molten metal is poured into the mould under gravity, under slight pressure, by evacuating the min first (Step 7). The method chosen depends on the type of casting.

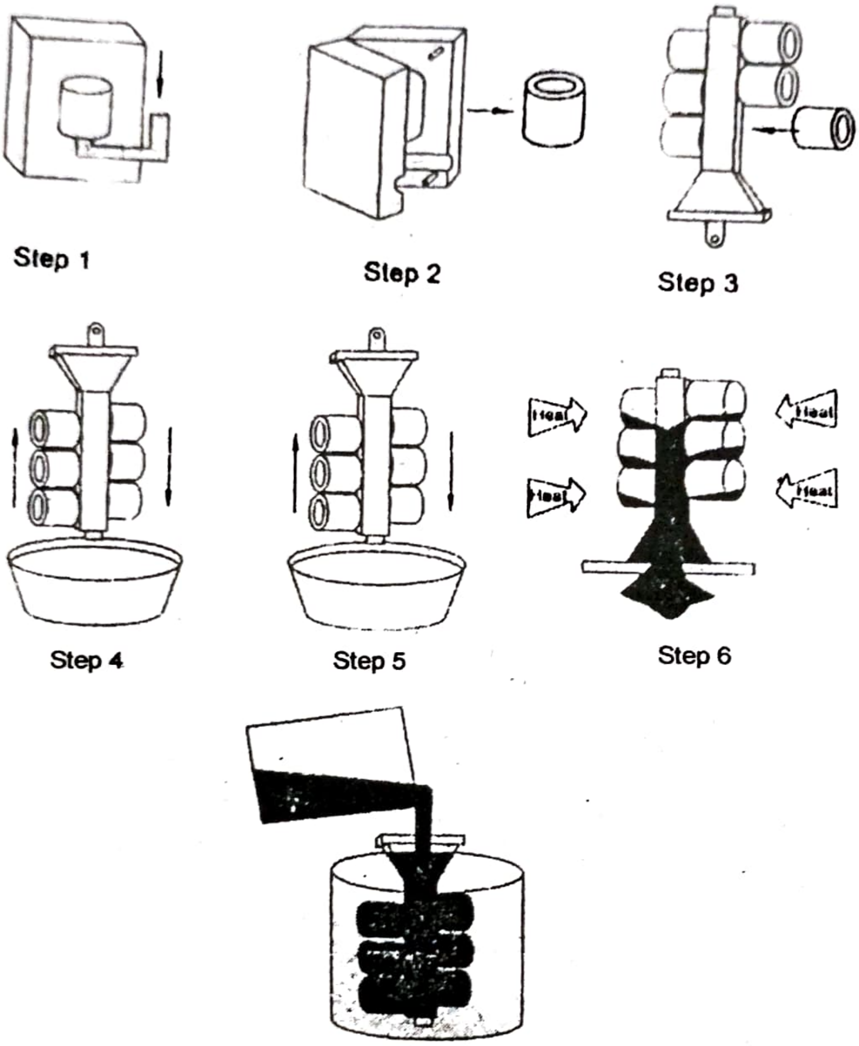


Fig. Steps in the precision investment casting process.

Other pattern materials used are plastics and mercury in place of wax. In the process called *Mercast* the mercury is kept under -57°C where the mercury is frozen. The complete mould preparation is to be under taken at a temperature below -38°C. The main advantage of mercury as a pattern material is that it does not expand when changed from solid to liquid state as wax. But the main disadvantage is keeping the pattern at such low temperature, which is responsible for its diminishing use.

Advantages:

1. Complex shapes which are difficult to produce by any other method are possible since the pattern is withdrawn by melting it.

2. Very fine details and thin sections can be produced by this process because the mould is heated before pouring.

3. Very close tolerances and better surface finish can be produced. This is made possible because of fine grain of sand used next to the mould cavity.

4. Castings produced by this process are ready for use with little or no machining required. This is particularly useful for those hard-to-machine materials such as nimonic alloys.

5. With proper care it is possible to contreol grain size, grain orientation and directional solidification in this process, so that controlled mechanical properties can be obtained.

6. Since there is no parting line, dimensions across it would not vary.

Limitations

1. The process is normally limited by the size and mass of the casting. The upper limit on the mass of the casting may be of the order of 5 kg.

2. This is a more expensive process because of larger naual labour involved in the preparation of the pattern and the mould.

Application: This process was used in the olden days for the preparation of artefacts, jewellery and surgical instruments. Presently, the products made by this process are vanes and blades for gas turbines. Shuttle eyes for weaving, pawls and claws for movie cameras, wave guides for radars, bolts and triggers for fire arms, stainless steels values bodies and impellers for turbo chargers.

Q.3. (*b*) Explian the composition, salient properties and application areas of: **(6)**

(*i*) Duralium **(*ii*) Bronze**

Ans. (*i*) Duralium:

It contains Al = 94%, Cu = 4%; Mg, Mn, Si, Fe = 0.5% each.

Properties:

1. It can be cast, forged and stamped.
2. It has high tensile strength.
3. It has high electrical conductivity.
4. It hardens spontaneously when exposed to room temperature.
5. The alloy is soft enough for a workable period after it has been quenched.
6. It is light in weight as compared to its strength.

Uses:

1. It is used for sheets, tubes, rivets, nuts bolts etc.
2. Because of lighter weight, it is used in automobile and aircraft components.
3. It is also employed in surgical and orthopaedic work for non-magnetic and other instrument parts.

(*ii*) Bronze: Bronze in basically on alloy of copper and tin. various properties of bronzes are:

- The tensile strength of bronze increases gradually with the amount of tin, reaching a maximum when tin is about 20%. But when the tin increases beyond this amount, the tensile strength decreses very rapidly.
- Bronze has higher strength than brasses.
- Bronze has better corrosion resistance than brasses.
- Bronze has antifriction or bearing properties.
- Bronze is costlier than brass.
- Bronze is most ductile when it contains about 5% of tin. As the amount of tin increases about 5%, the ductility gradually decreases and practically it disapperars with about 20% of tin.
- Precence of zince in the bronze increases fluidity of molten metal, strength and ductility.

Various types of modified Bronzes are:

1. Phosphor Bronze

When bronze contains phosphrous, it is called phosphor bronze.

- A common type of phosphor bronze has the following composition:

Copper = 89 to 94%, Tin = 5 to 10% and Phosphorous = 0.1 to 0.3%

- Addition of phosphorus increase the tensile strength, elasitcity and resistance to fatigue.
- Phosphor bronze of proper composition can be forged, drawn, cold rolled and cast.
- It is having good corrostion resistance especially by sea water, so that it is much used for propeller blades.

Uses:

1. Used for bolts, electric contact springs, bearings , bushes, gears.
2. It is also used in the manufacturing of corrosion resistance mine cables, ship sheathing, vave parts, propeller blades etc.

2. Sillicon Bronze

- It generally contains 96% copper, 3% silicon and 1% managanese or zinc.
- It can be cast, rolled, stamped, forged, pressed and can be welded by all the usual methods.

Uses: It is widely for boilers, screws, tubings, pumps, tanks etc.

Aluminium may be alloyed with one or more elements like silicon, managenese, zinc, mannesium and nickel to improve various properties.

UNIT-II

Q.4. (a) Explain with neat sketches the process of wire drawing. **(6.5)**

Ans. The wire obtained from the rolling mills are first pickled, washed and then dried. The end of the wire is then reduced in dimater (swaging) and passed through the die opening. Then this end is attached to the draw block, which pulls the wire. The contact region of the die is generally made up wear resistant tungsten carbide or polycrystalline manufactured diamond. Lubrication is also done to reduce the friction and to prevent the wear of the dies.

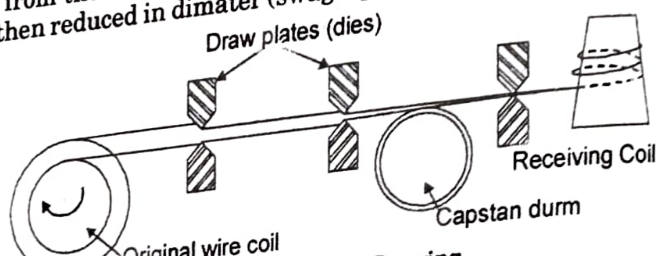


Fig. Wire Drawing.

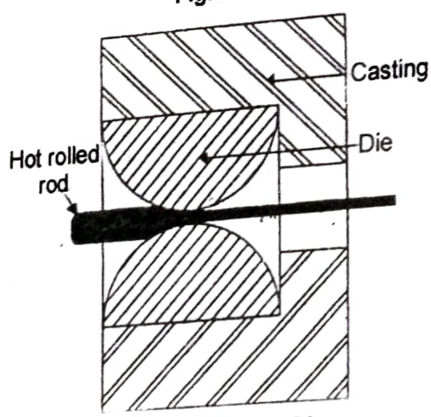


Fig. Wire Drawing Die

If large reduction is needed, then these are passed continoulsy from one station to another. After passing through all the dies in a tandem machine, the material usually requires an intermediate anneal and for maximum ductilty and conductivity, the wire should be annealed in controlled amosphere furnaces after the final draw.

Q.4. (b) Discuss in detail the classification of files in fitting shop on basis of their

***(i)* Shape *(ii)* Cut of teeth *(iii)* finishing capabilities** **(6)**

Ans. Files are used to cut and smoothen the metal surfaces. The file is made of high carbon steel and is hardened and tampered. The file consists of two major parts toothed blade and tang (which is fitted in a wooden handle). The different parts of files are shown in Fig.

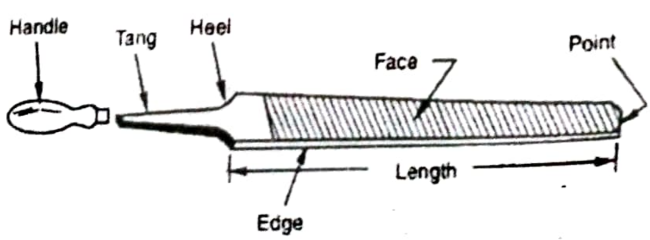


Fig. Various Parts of Single Cut File.

Files may be classified on the basis of cross-section, on the basis of grade and on the basis of type of teeth (Fig.).

The classification of files on the basis of cross-section is shown in Fig. Depending upon the cross-section, these are used for various different applications.

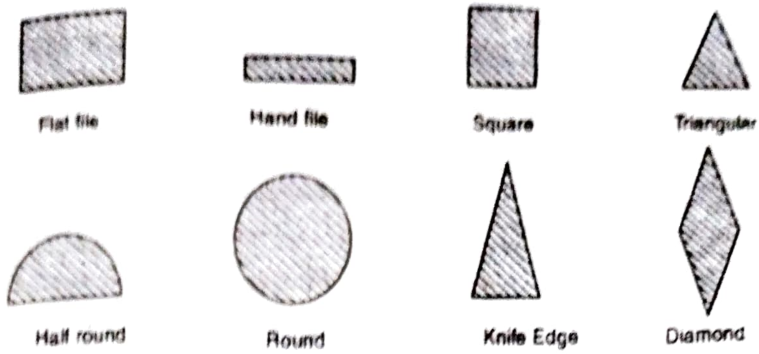


Fig. Classification of files depending upon their cross-section.

Depending upon the number of teeth per cm files are classified as:

Table Files of different grades

Name of file	Pitch (teeth per cm)
Rough files	8 teeth per cm
Bastard file	12 teeth per cm
Second cut files	16 teeth per cm
Smooth files	20 to 24 teeth per cm
Dead smooth file	40 or more teeth per cm

Depending upon the type of teeth files may be classified as single cut file, double cut file.

In single cut files, there is only one series of parallel grooves. The groove may be inclined at 45° to 60°, the file edge as shown in Fig. In double cut file there are two series of grooves, one similar to those of single cut file and other and an angle of 70° to the edges of file blade. In both type of files all the teeth are having negative rake in sloping backward and thus perform cutting operation during forward stroke only.

Fig. Single cut and double cut files

Q.5. (a) Describe 'Fullering' and Swaging' operations in smithy. What is the main difference between them? **(6)**

Ans. Fuller: Fullers are ceed in pairs, the lower one is called bottom fuller which is used to support work piece the upper one is called top fuller which is used to strike work

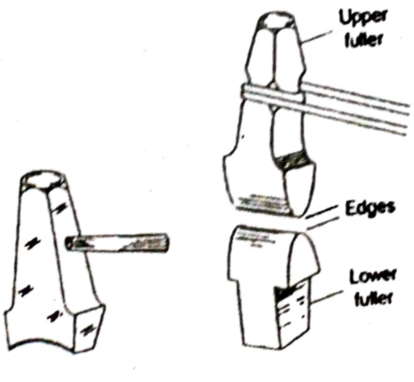


Fig. Fullers

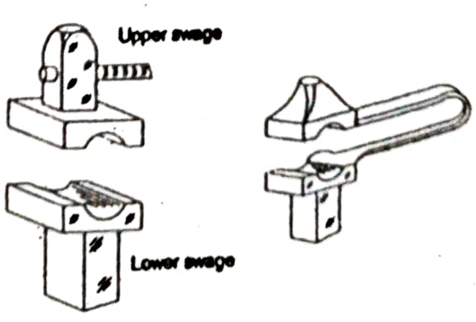


Fig. Swages

piece. Fullers are made of hardened carbon steel. It is used for making slots, finishing the edges and increasing the lengths or width of work piece.

Swages: Swage are also made in pairs like fullers called top swage and bottom swage. These are made of hardened carbon or high carbon steel. Each of the pair of swages consist of circular groove of compatible size. The work piece to be processed is kept in the groove of bottom swage and stroke with top swage. It is used to increase the length of rod and to finish the cylindrical objects.

Q.5. (*b*) Explain the following process used in fitting shop. (6.5)

(i) External thred outing (ii) Screaping.

Ans. External Threads Cutting Dies (Die and Stock): These tools are used for cutting external threads on the outer round surface of bars or lubes. It consist of nut having internal threads (cutting edges).

Sharpening of Cutting Edges: The cutting edges of the nut are hardened and sharpened. This nut is crewed to the bar on which external threads are to be cut. This die cut is carierd and held in die stock. So that it could be easily screwed to the bar. The end of the rod or the bar should be slightly clamfered to allow the nut dies to side properly over the bar.

One or two of the die threads may also be chamfered to facilitate the die nut to start the threading operation. The dies have various form. Most common type of die nuts are solid die nut and loose die nut.

(*ii*) **Scarping** is a practice that has lost its custer for many machine builders. Because of the associated costs in time and maintaining skilled labour, it's an art that has largely been abandoned Many industry experts feel that there's no substitute, for hand scraping when it comes to maintaining high levels of CNC machining accuracy in a long life machine tool.

UNIT III

Q.6. (*a*) Discuss the process, advantages and limitation of Resistance spot Welding. (6.5)

Ans. Resistance Spot Welding: Resistance spot welding is the most common resistance welding process. It is essentially done to join sheet metal jobs in lap joint. The workpieces are clampled between two water cooled copper cylindrical electrodes. On the passage of high transient current, the interface melts over a spot and forms the weld. The high current is needed for a fraction of second to complete the weld. The cooling at the electrode limits the siexe of spot.

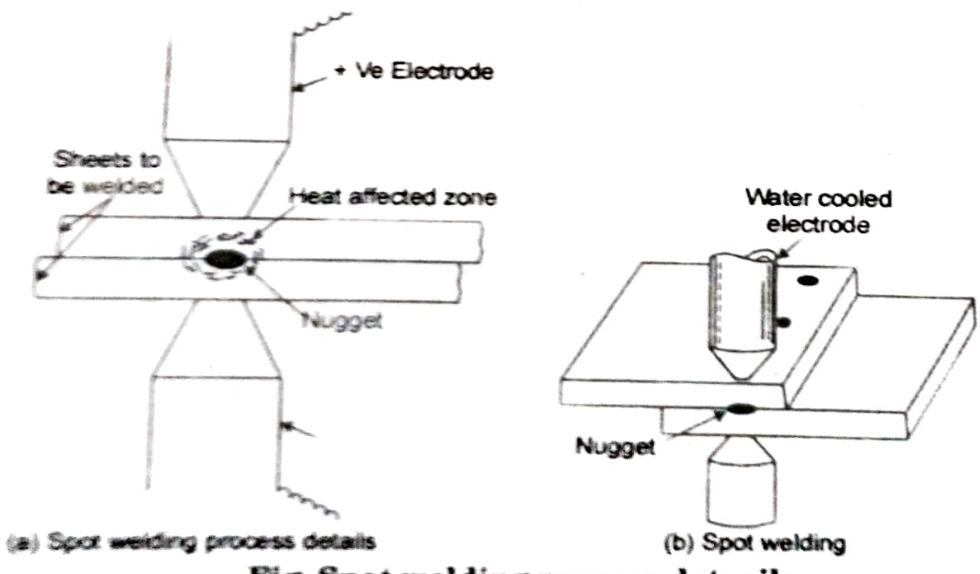


Fig. Spot welding process deteails

Q.6. (*b*) Discuss in the detail how gas welding process is different from brazing. (6)

Ans. Gas welding, also called as oxy-fuel welding obtains the heat for welding by the combustion of a fuel gases. The process is fusion welding process where the joint is completely melted and no pressure is used. Filler metal may or may not be used. The fuel gas most widely used is acetylene (C_2H_2). When *mixed* with *oxygen* acetylene burns to produce temperature of the range of 3100°C Hydrogen or some other gas may also be used but the temperatures obtained are lower than that of *oxy* acetylene flame. *Oxy* hydrogen welding may be used for, welding low melting temperature metals and for welding thin pieces of steel.

Oxy-Acetylene Welding: This is the most common of all oxy-fuel gas welding process. As mentioned earlier in this case acetylene ($C_2 H_2$), which is produced by chemical reaction between water and calcium carbide (CaC_2) mixes with pure oxygen to produce welding heat. The combustion of acetylene with pure oxygen takes place in two stages.

In the first stage acetylene and oxygen react to produce carbon mono oxide and hydrogen and releasing intense heat which is present as small inner white cone close to welding torch tip.

$$C_2 H_2 + O_2 \rightarrow 2Co + H_2 + 448 \text{ KJ/ mol.}$$

In second stage carbon mono-oxide and hydrogen produced in first stage further react with atmospheric oxygen and give rise to outer blusih flame.

$$4CO + 2H_2 + 3O_2 \rightarrow 4Co_2\ 2H_2o + 812 \text{ KJ/mol.}$$

Though higher amount of heat is produced in second stage but it is not concentrated and is distributed over a larger area. The temperature achived is of the order of 1200-2000°C. This blue flame may be used to preheat the metal and at the same time provide shielding from oxidation. The temperature of inner white cone is around 3100°C which is used to directly melat the steel joint.

Brazing: Brazing is the method of joining similar or dissimilar metals with the help of molten filler materials whose melting point is above 450°C and less than the melting point of the parent metals. The filler metal is copper alloy (copper zinc and copper silver alloys) and distributed between the surfaces of parent metals by capillary action. Joint strength is largely determined by the strength of filler metal used. Almost all the similar and dissimilar metals can be joined by brazing except Al and Mg, which are not easily joined by brazing. Like soldered joints brazed joints are also not suitable for high temperature service.

Brazing process also involves proper joint designing and

(*i*) pre-cleaning, (*ii*) fluxing, (*iii*) heating.

(*i*) Pre-cleaning: Joint is properly pre-cleaned using proper solvents. Scales and oxides are removed by acid pickling. Cleaning is essential because the oil, dirt or grease prevent the flow of filler metal.

(*ii*) Fluxing: Fluxes are added to the brazed joint to remove any of oxides present and to prevent the formation of oxides in base metal and filler metal. The fluxes generally used are combination of borax, boric acid, chlorides and fluorides. For ferrous metals fluxes used are mixture of borax and boric acid in powder form.

(*iii*) Heating: Heat sources used for brazing are electrical resistance heating, molten bath of brazing filler material oxy-acetylene torch induction heating, controlled atmosphere furnaces etc.

First joint are pre-cleaned and properly prepared. Then fluxes are applied by spraying brushing or with the help of pressurised applicator. Now joint is heated to bring it to the melting temperature of filler metal and then filler material is applied so that it flows in thw joint by capillary action. The filler metal after solidification gives necessary strength.

Q.7. (*a*) Discuss the process, advantage and limitations of Atomic Hydrogen Welding. **(6.5)**

Ans. Atomic hydrogen welding is a gas shielded metal arc welding using non-consumable electrode In this process arc is maintained between two tungsten electrode rather than between electrode and workpiece (please note that in TIG, MIG and SMAW are is maintained between electrode and workpiece). The two tungsten electrode arc held in special atomic hydrogen torch. The shielding gas used is hydrogen which is reactive in nature compared to argon. As the hydrogen is made to pass through high arc produced between two electrode hydrogen gets dissociated in single atoms (H^+) from H_2 molecules. The single hydrogens atoms have strong tendency to reunite when they approach relatively cool surface of workpiece. When hydrogen atoms reunite, intense heat is released producing the temperature of about *3500°C and* joint is melted.

Following are the salient features of the the process :

(1) Because of the strong reactivity of hydrogen atom, it is able to break oxide on the base metal and clean weld is obtained.

(2) As arc is independent of workpiece, heat input to the welding zone can be controlled by varying the distances between electrodes.

(3) The normal process voltage ranges between 50 to 80 V and current varies from 15 to 1500 amperes.

(4) The process is used for flat positions only because of generation of high temperature.

(5) The process is applicable to all the materials which are welded by non-consumable electrode inert gas are welding process. In addition process is also used for repairing of steel moulds, dies and tools.

(6) AC power supply is used to reduce the wear of particular electrode.

(7) If the process is followed properly , atomic hydrogen welding gives extremely clean weld with dense metal deposition and it is also free from porosity and inclusions

Non-Consumable Electrode: When non-consumable electrodes are used, separate filler metals rods are used. We may say that in case of welding processes using non-consumable electrodes heat source and filler metal deposition can be separately controlled. For all processes using non-consumable electrodes it is better to connect the electrode to the negative terminal (straight polarity) to keep the heat losses minimum. However, in case of welding aluminium and magnesium it is preferable to use AC power supply.

Non-consumable electrodes are usually made of ungsten, graphite or carbon. When non consumable electrodes are used processes are naned after the electrode material like tungsten arc welding (tungsten is used as electrode) *x* carbon arc welding (carbon is used, as electrode).

Q.7. (*b*) What is Carbon arc welding and under what conditions it is necessary? (6)

Ans. Carbon Electrode Arc Welding: The first method of arc welding was carbon electrode arc welding which employed non consumable carbon or graphite electrodes. Separate filler rod is used in the process to deposit filler metal. The twin carbon arc method is one of the first methods. Where arc is generated between the two electrodes and not between the workpiece and electrode. In this process the arc is held about 6.5 to 9.5 mm above the work and best results are obtained with welding in flat position.

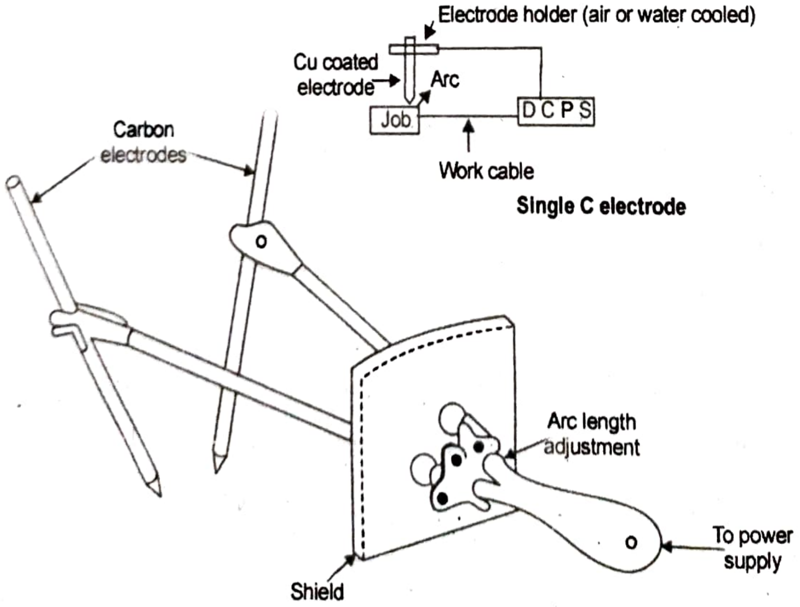


Fig. Carbon Electrode Arc Weld (Twin electrode)

Another process utilizing the single carbon electrode is considerably simpler. The arc is created between carbon electrode and work piece and filler metal is supplied by a separ aterod. Such an arc is easy to start as electrode does not stick to the metal. Straight polarity must be used because carbon becomses unstable under reverse polarity. Straight polarity also minimises the heat generation near the electrode side and so life of carbon electrode is increased.

Twin electrode carbon arc welding. Here arc is generated between two carbon electrodes.

UNIT IV

Q.8. (a) Discuss with neat sketches the process of Deep Drawing. (6.5)

Ans. Drawing is define as process of making cup shaped parts from sheet metal blank (heated) by putting it into die with the help of punch.

The set up for drawing is similar to blanking except that the punch and die are provided with the necessary rounding at the corners to allow for smooth flow of metal during drawing.

When the cup height is more than half the diameter it is termed as deep drawing. In deep drawing blank holder is normally provided to prevent excess wrinkling of the edges.

For long thinned cylinders or tubes, repeated heating and drawing operation are carried out. Drawing operation is performed in various stages, and die material for drawing is usually tool steels and carbides. Proper lubrication is necessary in order to improve die life, reduce drawing force and to improve surface finish. Various lubricants used are oils, soap or sometimes coating of soft metals.

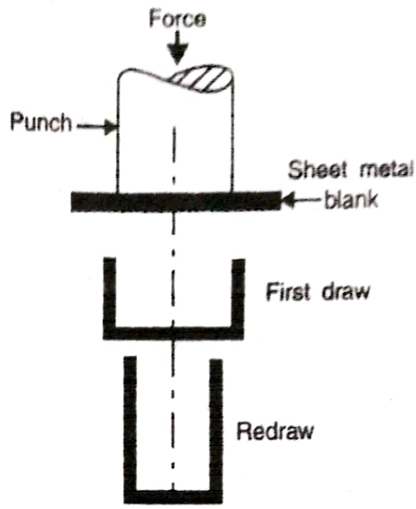


Fig. Hot Drawing

Q.8. (b) Explain how the powers used in powder metallurgy process. (6)

Ans. The particle shape depends largely on the method of powder manufacture, It spheroidal, nodular/irregular, angular, lamellar, acicular and dendritic. Spheroidal particles have excellent sintering properties. However, irregularly shaped particles are superior for practical moulding and achieving good green strength of the part because they will interlock on compacting.

Particle size or fineness is expressed by the diameter of the spheriodal particles and by the average diameter of the other particles. It is determined by passing the powder through standard sieves or by microscopic measurement. Particle size should neither be too large nor too small Too large particles may not display the required structure for the P/M route and may not result in high densities. On the other hand, it is difficult to handle fine particles and they may tend to agglomerate. Also, their large surface area-to-volume ratio may introduce large quantities of undesirable adsorbed substances and on metals, also oxides. However, finer powders have excellent sintering qualities and are particularly important for 'Slip Casting'. The usual size of powders used in P/M varies from 4 to 200 microns, with 100 microns being the most used size.

Particle size distribution refers to the quantity of each standard particle size in the mix (powder). It influences apparent density, compressibility, flowability, final porosity and the strength of the part. For a given material, the strength of the part will be proportional to its final density after pressing. Theoretically, a powder containing varying particle sizes will result in greater density, because smaller particles will fill up the interspaces between the large particles. However, when mixing, the finer particles have the tendency to separate and segregate. Due to this reason, many users prefer uniform size particles and rely on the compacting pressure to get the final density required.

The ISO has defined the following qualitative particle shape classification as per ISO-3252:

1. Spherical : Nominally spherical, three dimensional.
   Produced by : atomization, carbonyl (Fe), precipitation from a liquid

2.	Rounded or Nodular	:	Rounded, irregular shape (3D). *Produced by* : atomization, chemical decomposition.
3.	Angular	:	Roughly polyhedral with sharp edges (3D). Produced by: Mechanical disintegration, Carbonyl (Ni).
4.	Acicular	:	Needle shaped (1D) Produced by : Chemical decompostion
5.	Dendritic	:	Branched, crystalline shape (2D). produced by Electrylytic Process.
6.	Irregular	:	Lacking any symmetry (3D). *Produced by:* Chemical decomposition, Mechanical comminution.
7.	Granular	:	Irregular but approximately equidimensional, (3D). Produced by: reduction of oxides.
8.	Flaky	:	Plate like (2D) Produced by: Mechanical Communution.
9.	Fibrous	:	Regularly or irregularly thread like (1D). Produced by chemical decomposition, mechanical communution.

These shapes have been illustrated in Fig.

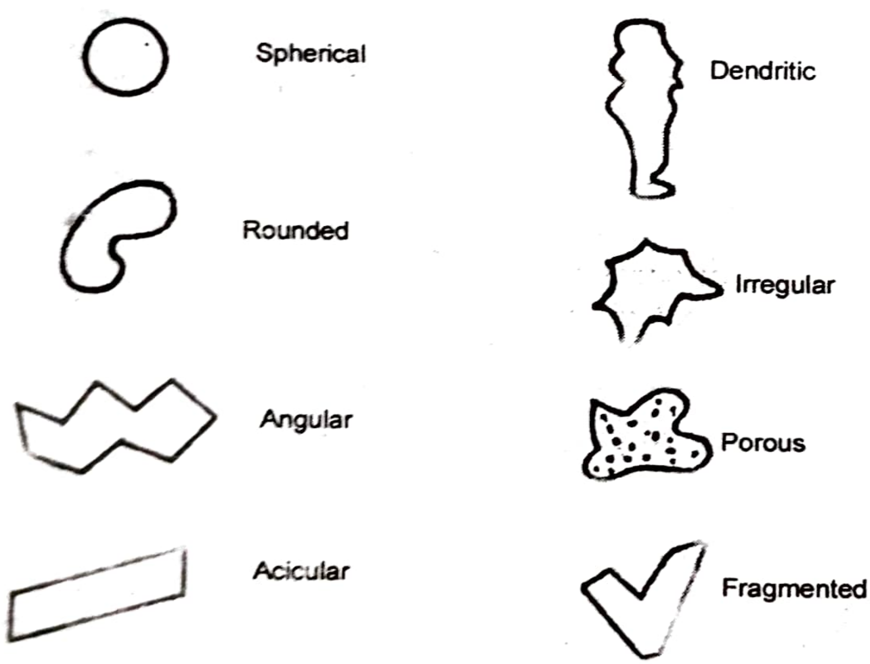
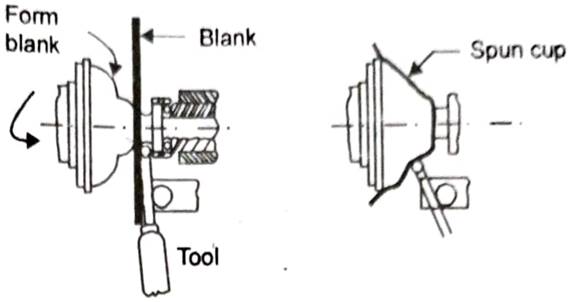


Fig. Particle Shapes.

Q.9. (a) Discuss with neat sketches the process of spining and stretch forming. (6.5)

Ans. Spinning: Spinning is the used for making cup-shaped articles which are axi-symmertical. The process of spinning consists of rotating the blank, fixed against the form block and then applying a gradually moving force on the blank so that the blank takes the shape of the form block. A typical set-up is shown is Fig.

The set-up essentially consists of a machine similar to a centre lathe. In the head stock of the spinning machine, a hard wood form block that has the shape of the desired part is fixed. The blank is held against the form block by means of the freely rotating wooden block from the tail stock. After proper clamping, the blank is rotated to its operating speed. Then the hard wood or roller-type metallic tool is pressed and moved gradully on the blank so that it conforms to the shape of the form block. The manipulation

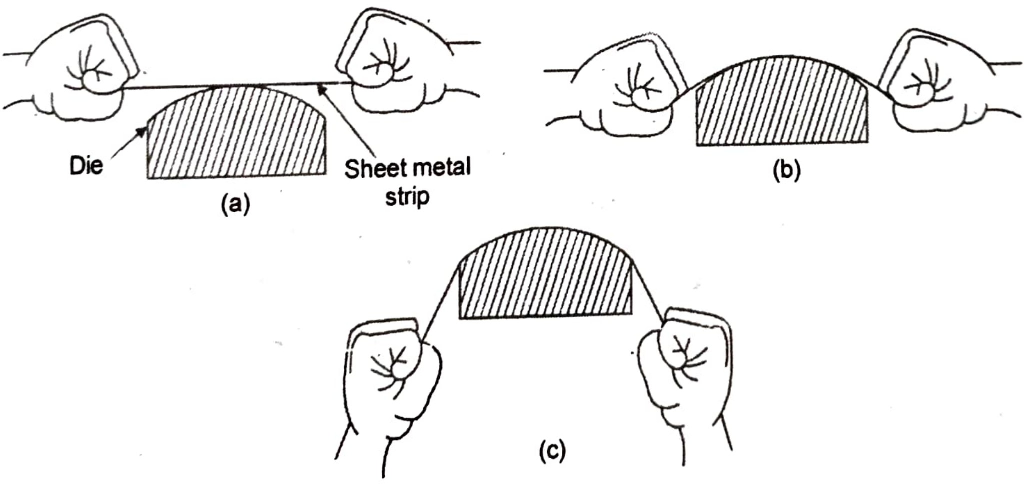


of spinning tools is a highly skilled art. The tool is to be moved back and forth on the blank so that no thinning takes place anywhere on the blank.

Spinning is comparable to drawing for making cylindrical-shaped parts. Because of the simple tools used in spinning, it is economical for smaller lots. But the time required for making a cup is more in spinning and also more skill is required in the process. Thus, it is not suitable for large-scale production. Complicated shapes and re-entrant shapes are not feasible by drawing, but can be made by spinning using the sectional and collapsible form blocks. Large parts are much more easily made in spinning than by drawing. When sheet thickness is more, for example, in making the dished ends of pressure vessels, cold spinning is not sufficient. Then the blank is heated to the forging temperature and so the process is called *hot spinning*. Also in hot spinning, the tools are mechanically manipulated because of the higher magnitudes of forces required.

Stretch Forming: Stretch forming is an attractive way of producing the large sheet metal parts in limited or low quantities. In this process the sheet of metal is gripped by two or more sets of jaws that stretch it and wrap it around a single form die block. This process of simultaneously stretching and bending is called stretch forming.

• In stretch forming most of the deformation is induced by the tensile stretching, therefore, forces on the die are far less than those normally present in bending or forming because forces are so low that the dies can often be made of wood, low melting point metal or even plastic.



Various steps to illustrate the process of stretch forming. It is also shown the how metal is subjected to stretching and bending in stretch forming.

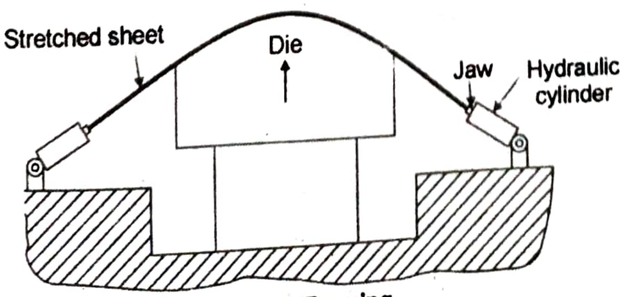


Fig. Stretch Forming

• As in this process deformation is carried out in plastic region there is very little spring back and work piece closely conforms to the shape of tool.

• In stretch forming we can have component either single or double *curved surfaces*. The sheet should have uniform thickness otherwise the thinner portions be over stretched. Also if the sheet is having any holes *before the* stretch forming they are likely to be enlarged.

Q.9. (*b*) Explain **(6)**

(*i*) Sintering (*ii*) Compacting related to Poweder Metallurgy.

Ans. (*i*) Sintering: Green compact as obtained after compacting operation is not very strong and is very britlle and can't be used as it is. In order that it becomes a usable powder metal product it must undergo the sintering operation. The green compact is placed in a furnace and is soaked in heat until the indivudual powder particles are no longer discernible. So, sintering can be defined as the bonding of adjacent surfaes of particles in a mass of metal powder, by heating. The time of exposure the temperature and the rate of cooling are closely controlled.

The first stage in the sintering operation is the purging or drying or drying stage. The compact is heated at low temperatures to drive off liquid constituents (lubricants, water etc.) The heating should be gradual since, fast heating will cause sudden vaporization and could result in the disintegration of the compact. The time for drying increases with increasing wall thickness of the compact. Vacuum accelerates drying. If organic binders are to be burnt off, sufficient oxygen must be available for thier combustion.

After the first stage, the actual sintering operation starts at an elevated temperaure. The sintering temperature is normally below the melting points of all powder consituents. However in certain cases, the sintering temperature may be above the melting point of one the powders. The sintering temperature for a powder varies over a range (0.7 to 0.9 times the melting point), but there is usually an optimum maximum sintering temperature for a given set.

(*ii*) Compacting (Briquetting): The powders are compacted in moulds by the application of pressure to form a so called green comapct (a compact without permanent bonding). The compacting pressure may range from 80 to 1600 MPa with more commonly used pressures being 320 to 800 MPa. The density, hardness and also the strength increase with pressure. However, for every metal powder, there is an optimum compacting pressure beyond which there is little improvement in properties. The die cost and press capacity and hence the production cost will increase with increased compacting pressure

(*a*) For soft powders such as brass, bronze and aluminium, the compacting pressure may range from 100 to 350 MPa.

(*b*) For iron, steel and Ni alloys, the range in 400 to 700 MPa.

(*c*) The pressure range is still higher for harder materials such as WC.

During compacting, the green strength of a compact is achieved due to the following factors:

1. Sliding combined with pressure promotes adhesion and even cold welding with some powders.

2. Mechanical interlocking of particles, especially with particles of irregular shape. So green strength is lower for more spherical powders even through they pack more closely.

3. By the addition of bonding agents which evaporate during sintering. Of course, the green strength is lower when lubricants are added to the powders.

FIRST TERM EXAMINATION [SEPT. 2016]
FIRST SEMESTER [B.TECH]
MANUFACTURING PROCESS [ETME–105]

Time : 1½ hrs. M.M. : 30

Note: *Attempt any three questions. Question No. 1 is compulsory.*

Q. 1. Attempt the following parts: **(2.5×4)**

Q. 1. (a) What is Heat Treatment? Explain the purpose of heat treatment.

Ans. Heat treating is a group of industrial and metal working processes used to alter the physical, and sometimes chemical properties of a material. **Heat treatment** involves the use of heating or chilling, normally to extreme temperatures to achieve a desired result such as hardening or softening of a material.

We heat treat metals in an attempt to optimise the mechanical and physical properties for a given application. Heat treatment is considered as a **process** for hardening metal. There are also ageing **processes** designed to increase the strength of some non ferrous metals and precipitation hardening steels.

Q. 1. (b) Define the terms: Toughness, Stiffness, Tempering, Annealing.

Ans. Toughness is the ability of a material to absorb energy and plastically deform without fracturing. One definition of material toughness is the amount of **energy** per unit volume that a material can absorb before rupturing. It is also defined as a materials resistance of **fracture** when **stressed**.

Stifness is the rigidity of an object-the extent to which it resists deformation in response to an applied **force**. The complementary concept is **flexibility** or pliability; the more flexible an object is, the less stiff it is.

Tempering is a process of heat treating, which is used to increase the **toughness** of **iron-based alloys**. Tempering is usually performed after **hardening**, to reduce some of excess **hardness**, and is done by heating the metal to some temperature below the **critical point** for a certain period of time, then allowing it to cool in still air. The exact temperature determines the amount of hardness removed and depends on both the specific composition of the alloy and on the desired properties in the finished product For instance, very hard **tools** are often tempered at low temperature, while **springs** are tempered to much higher temperature.

Annealing, in **metasllurgy** and **materials science**, is a **heat treatment** that alters the physical and sometimes chemical properties of a material to increase its **ductility** and reduce its **hardness**, making it more workable it involves heating a material to above its **recrystalization temperature**, maintaining a suitable temperature, and then cooling.

Q. 1. (c) What are the various purposes of Riser in Gating system?

Ans. A riser, also known as a feeder is a reservoir built into a metal casting mold to prevent cavities due to shrinkage. Most metals are less dense as a liquid than as a solid so castings shrink upon cooling, which can leave a void at the last point to solidify

Q. 1. (d) Explain the properties and applications of Wrought Iron and Stainless steel.

Ans. Wrought Iron–

It is soft, ductile, magnetic and has, high elasticity and tensile strength. It can be heated and reheated and worked into various shapes. Although wrought iron exhibits properties that are not found in other forms of ferrous metal it lacks the carbon content necessary for hardening through heat treatment.

Historical uses during the seventeenth and eighteenth centuries were typically decorative and included

- Fences, gates and railings
- Balconies
- Porches and verandas
- Canopies
- Roof cresting
- Lamps
- Grilles
- Hardware

Historical uses during the nineteenth century were more structural and included.

- Nails
- Iron cramps (*i.e.* to secure masonry veneer building frames).
- Structural members in tension such as tie rods, bulb-tees and I-beams. The standard sections of wrought iron included bar iron, angle irons, T irons, channel iron (half H iron), rolled girder iron (rolled joist iron, beam iron, I iron, or H iron), various special sections (sash bar, beading iron, cross iron, quadrant iron), iron bars, rivet iron, chainiron, horseshoe iron, nail iron, plate iron, coated iron (tin or lead), corrugated sheet iron (generally galvanized)

Characteristics of Stainless Steel Contains iron and a minimum of 10 percent chromium. Marketed for its corrosion resistance, sanitary qualities and modern appearance. Capable of being polished using an electropolishing methods.

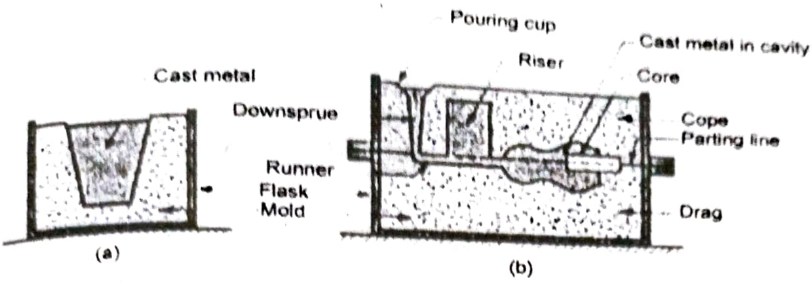
Typical historical and current uses for stainless steel include.

- Martensitic stainless steel (Iron-chromium alloys contaning 1 percent chromium and 35 percent carbon) was orginally used for cutlery and munitions in the early 1900s.
- Ferritic stainless steel (iron-chromium alloys with a low carbon content) was used for the electric light bulb filament, also common for turbine blades in the early 1900s.
- Austenitic stainless steel (iron-chromium-nickel and iron-chromium-nickel-manganese alloys containing 18 percent chromium and 8 percent nickel) were developed between 1909 and 1912 and are commonly used as formed sheets in architectural construction.
- Precipitation-hardening stainless steel (titanium, boron or beryllium added to iron-chromium-nickel alloys as hardeners) was introduced in the late 1920s.
- Manufactured in Great Britain for cutlery, stoves, and motor cars.

Q. 2. Explain the various elements of gating system with neat sketch. Explain any four casting defects with neat sketch. (10)

Ans. The main elements needed for the gating system are as follows:

- Pouring basin or bush.
- Spur or downs pure.
- Sprue Well
- Runner
- Ingate
- Ladle
- Slag trap or filter.



The characteristics of each element are mentioned below:

Pouring basin: This is otherwise called as bush or cup. It is circular or rectangular in shape. It collects the molten metal, which is poured, from the ladle.

Sprue: It is circular in cross section. It leads the molten metal from the pouring basin to the sprue well.

Sprue Well: It changes the direction of flow of the molten metal to right angle and passes it to the runner.

Runner: The runner takes the molten metal from sprue to the casting.

Ingate: This is the final stage where the molten metal moves from the runner to the mold cavity.

Slag trap: It filters the slag when the molten metal moves from the runner and ingate. It is also placed in the runner.

The major casting defects are as follows:

(i) **Blow:** It is a fairly large, well-rounded cavity produced by the gases which displace the molten metal at the cope surface of a casting. Blows usually occur on a convex casting surface and can be avoided by having a proper venting and an adequate permeability. A controlled content of moisture and volatile constituents in the sand-mix also helps in avoiding the blow holes.

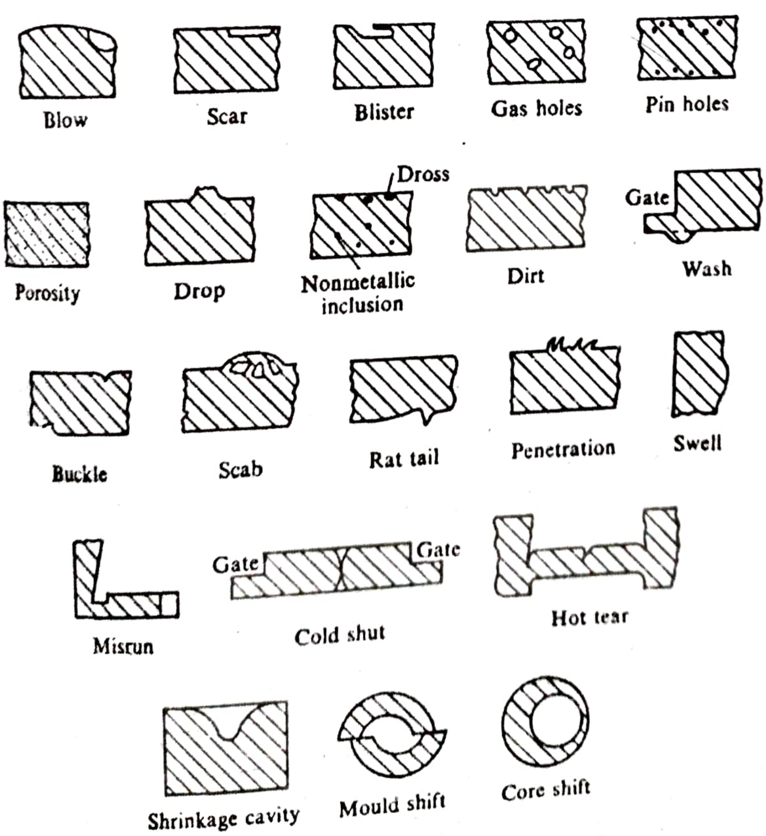


Fig.: Common casting defects.

(*ii*) **Scar :** A shallow blow, usually found on a flat casting surface, is referred to as a scar.

(*iii*) **Blister :** This is a scar covered by the thin layers of a metal.

(*iv*) **Gas holes :** These refer to the entrapped gas bubbles having a nearly spherical shape, and occur when an excessive amount of gases is dissolved in the liquid metal.

(*v*) **Pin holes :** These are nothing but tiny blow holes, and occur either at or just below the casting surface. Normally, these are found in large numbers and are almost uniformly distributed in the entire casting surface.

(*vi*) **Porosity :** This indicates very small holes uniformly dispersed throughout a casting. It arises when there is a decease in gas solubility during solidificaiton.

(*vii*) **Drop :** An irregularly-shaped projection on the cope surface of a casting is called a drop. This is caused by dropping of sand from the cope or other overhanging projections into the mould. An adequate strength of the sand and the use of gaggers can help in avoiding the drops.

(*viii*) **Inclusion :** It refers to a nonmetallic particle in the metal matrix. It becomes highly undesirable when segregated.

(*ix*) **Dross :** Lighter impurities appearing on the top surface of a casting are called dross. It can be taken care of at the pouring stage by using items such as a strainer and a skim bob.

Q. 3. Describe the zones of cupola furnace with neat diagram and also write equations. (10)

Ans. Refer Q.3. of First term exam 2015

Q. 4. Explain the following: (5x2)

Q. 4. (*a*) Investment casting

Ans. Principal of investment casting is that it forms an expendable pattern of wax in a die which in turn is employed to form a mold in an investment material. After the model of investment material is set, the wax pattern is melted or burned and the molten metal is poured in the cavity thus formed.

It is called as investement casting as the term investment refers to cloak or special covering apparel. Here the clock is refractory mold which surrounds the precoated wax pattern.

The steps involved in investment casting are:

Precision Investment Casting: This is the process where the mould is prepared around an expendable pattern. The various steps in the process are shown in Fig. The first step in this process is the preparation of the pattern for every casting to be made. To do this, molten wax, which is used as the pattern material is injected under pressure of about 2.5 MPa into a metallic die, which has the cavity of the casting to be made as shown in Step 1 of Fig. The wax when allowed to solidify would produce the pattern. The pattern is ejected from the die as shown in Step 2. Then the cluster of wax patterns are attached to the gating system by applying heat as shown in Step 3.

To make the mould, the prepared pattern is dipped into a slurry made by suspending fine ceramic materials in a liquid such as ethyl silicate or sodium silicate (Step 4). The excess liquid is allowed to drain off from the pattern. Dry refractory grains such as fused silica or zircon are *stuccoed on this* liquid ceramic coating (Step 5). Thus, a small shell is formed around the wax pattern. The shell is cured and then the process of dipping & stuccoing is continued with ceramic slurries of gradually increasing grain sizes. Finally, when a shell thickness of 6 to 15 mm is reached, the mould is ready for further processing. The shell thickness required depends on the casting shape and mass, type of ceramic and the binder used.

The next step in the process is to remove the pattern from the mould, which is done by heating mold to melt the pattern (Step 6). The melted wax is completely drained through the sprue by inverting the mould. Any wax remain in the mould are dissolved with the help of the hot vapour of a solvent, such as trichloro-ethylene.

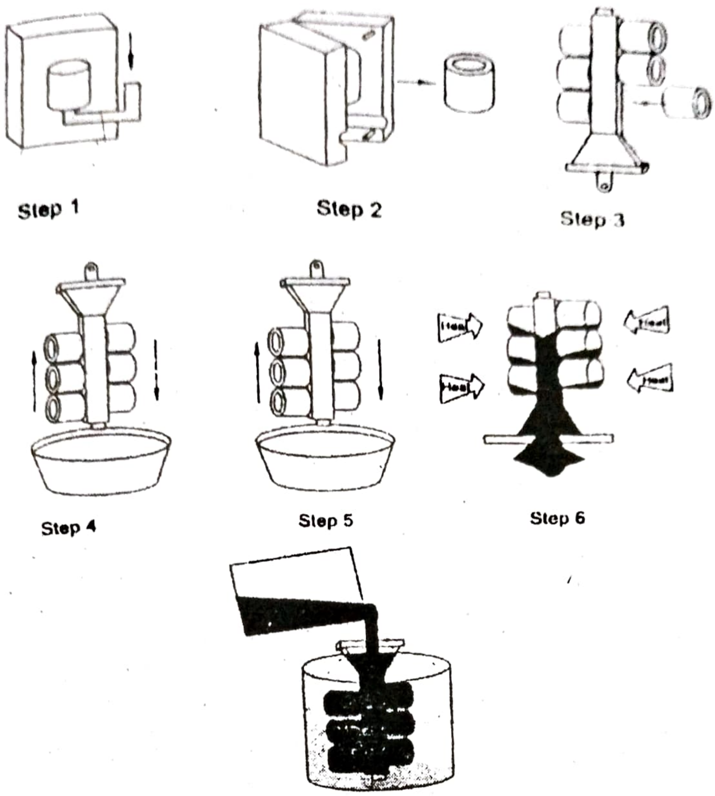


Fig. Steps in the precision investment casting process.

The moulds are then pre-heated to a temperature of 100 to 1000°C, depending on the size, complexity and the metal of the casting. This is done to reduce any last traces of wax left off cold mould.

The molten metal is poured into the mould under gravity, under slight pressure, by evacuating the min first (Step 7). The method chosen depends on the type of casting.

Other pattern materials used are plastics and mercury in place of wax. In the process called *Mercast* the mercury is kept under –57°C where the mercury is frozen. The complete mould preparation is to be under taken at a temperature below –38°C. The main advantage of mercury as a pattern material is that it does not expand when changed from solid to liquid state as wax. But the main disadvantage is keeping the pattern at such low temperature, which is responsible for its diminishing use.

Advantages

1. Complex shapes which are difficult to produce by any other method are possible since the pattern is withdrawn by melting it.

2. Very fine details and thin sections can be produced by this process because the mould is heated before pouring.

3. Very close tolerances and better surface finish can be produced. This is made possible because of fine grain of sand used next to the mould cavity.

4. Castings produced by this process are ready for use with little or no machining required. This is particularly useful for those hard-to-machine materials such as nimonic alloys.

5. With proper care it is possible to control grain size, grain orientation and directional solidification in this process, so that controlled mechanical properties can be obtained.

6. Since there is no parting line, dimensions across it would not vary.

Limitations

1. The process is normally limited by the size and mass of the casting. The upper limit on the mass of the casting may be of the order to 5 kg.

2. This is a more expensive process because of larger manual labour involved in the preparation of the pattern and the mould.

Applications: This process was used in the olden days for the preparation of artefacts, jewellery and surgical instruments. Presently, the products made by this process are vanes and blades for gas turbines, shuttle eyes for weaving, pawls and claws for movie cameras, wave guides for radars, bolts and triggers for fire arms, stainless steel valve bodies and impellers for turbo chargers.

Q. 4. (b) Centrifugal Casting

Ans. Centrifugal casting: In centrifugal casting, a permanent mold is rotated continuously about its axis at high speeds (300 to 3000 rpm) as the molten metal is poured. The molten metal is centrifugally thrown towards the inside mold wall, where it solidifies after cooling. The casting is usually a fine-grained casting with a very fine-grained outer diameter, owing to chilling against the mould surface. Impurities and inclusions are thrown to the surface of the inside diameter, which can be machined away. Casting machines may be either horizontal or vertical-axis.

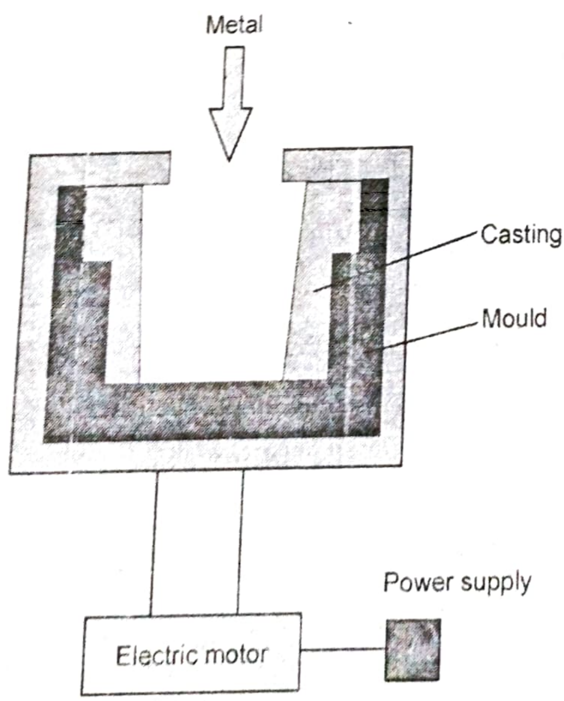
Advantages of centrifugal casting over sand casting;

1. Improved physical properties,

2. Parts made from centrifugals, with the castings finer grained,

3. As the molten metal is poured, centrifugal forces distribute the molten metal against the walls of the mold with tremendous force.

Type of centrifugal casting with diagram: The true centrifugal method of casting is used to produce hollow castings with a round hole. The characteristic feature of this process is that the hole is produced by the centrifugal force alone and no cores are used.



END TERM EXAMINATION [DEC. 2016]
FIRST SEMESTER [B.TECH]
MANUFACTURING PROCESS [ETME-105]

Time : 3 hrs. **M.M. : 75**

Note: *Attempt any five questions including Q.No. 1 which is compulsory. Select one question from each unit.*

Q. 1. Answer questions: **(5×5=25)**

Q. 1. (a) Describe Properties of materials: strength, elasticity, stiffness, malleability and hardness?

Ans. Elasticity is the tendency of soild materials to return to their original shape after forces are applied on them. When the forcess are removed, the object will returns to its initial shape and size if the material is elastic.

Stiffness: Rigidity of an object, the extent to which it exists deformation in response to an applied force.

Strength: The capacity to resists attack, strain or stress.

Malleability: It is said to be the property of a material to deform under compression. The metals having malleable property can be rolled or beaten into sheets. An example is aluminum foil.

Hardness: In materials science, hardness in the characteristic of a solid material expressing its resistance to permanent deformation. Hardness can be measured on the Mohr scale or various other scales.

Q. 1. (b) Explain in brief all the elements of gating system.

Ans. Refer Q.2. of First Term Exam 2016

Q. 1. (c) Compare Hot working and Cold working process.

Ans.

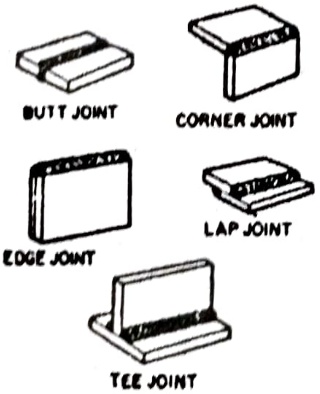
Hot Working	Cold Working
1. It is done at a temperature above recrystallisation but below its melting point	1. It is done at temperature below recrystallisation temperature.
2. Hardening due to plastic deformation is completely eliminated by recovery and recrytallisation.	2. Hardening is not eliminated since working is done at a temperature below recrystallisation.
3. Some mechanical properties such as elongation, reduction of area and impact values are improved.	3. Cold working decreases elongation reduction of area and increases ultimate tensile strength, yield point and Hardness.
4. Surface finish of hot worked metal is not good.	4. Surface finish obtained is better.
5. Refinement of crystals occurs. Grains are only elongated.	5. Crystallisation does not occur.
6. Cracks and blow holes are welded up due to recrystallisation temperature.	6. Possibility of crack formation and propagation is increased.

7. Internal or residual stresses are not developed in the metal.	7. Internal and residual stresses are developed in the metal.
8. Oxide forms rapidly on metal surface.	8. Cold part posses less ductility.
9. Less force is required.	9. Higher forces are required for deformation.
10. Equipment used in hot working is light.	10. More powerful and heavier equipments are required for cold working.
11. Handling and maintenance of hot metal is difficult and troublesome.	11. Easier to handle cold parts.

Q. 1. (*d*) Describe any five welding defects with proper nomenclature.

Ans. Welding joints: There are five types of welding joints which are given below.

The defects in the weld can be defined as irregularities in the weld metal produced due to incorrect welding parameters or wrong welding procedures or wrong combination filler metal and parent metal Weld defect may be in the form of variations from the intended weld bead shape, size and desired quality. Defects may be on the surface or inside the weld metal. Certain defects such as cracks are never tolerated but other defects may be acceptable within permissible limits. Welding defects may result.



Common Welding Defects

- Prosity
- Slag Inclusions
- Excess Penetration
- Incomplete Fusion
- Under Cut
- Inadequate Joint Penetration
- Cracking
- Welding Debries

Common weld defects include:

(*i*) Lack of fusion

(*ii*) Lack of penetration or excess penetration

(*iii*) Porosity

(*iv*) Inclusions

(*v*) Cracking

(*vi*) Undercut

Types of Defects:

(i and ii) - To achieve a good quality join it is essential that the fusion zone extends the full thickness of the sheets being joined. Thin sheet material can be joined with a single pass and a clean square edge will be a satisfactory basis for a join. However thicker material will normally need edges cut at a V angle and may need several passes to fill the V with weld metal. Where both sides are accessible one or more passes may be made along the reverse side to ensure the joint extends the full thickness of the metal.

Lack of fusion results from too little heat input and / or too rapid traverse of the welding torch (gas or electric).

Excess penetration arises from to high a heat input and / or too slow transverse of the welding torch (gas or electric). Excess penetration - burning through - is more of a problem with thin sheet as a higher level of skill is needed to balance heat input and torch traverse when welding thin metal.

(iii) **Porosity** - This occurs when gases are trapped in the solidifying weld metal. These may arise from damp consumables or metal or, from dirt, particularly oil or grease, on the metal in the vicinity of the weld. This can be avoided by ensuring all consumables are stored in dry conditions and work is carefully cleaned and degreased prior to welding.

(iv) **Inclusions** - These can occur when several runs are made along a V join when joining thick plate using flux cored or flux coated rods and the slag covering a run is not totally removed after every run before the following run.

(v) **Cracking** - This can occur due just to thermal shrinkage or due to a combination of strain accompanying phase change and thermal shrinkage.

In the case of welded stiff frames, a combination of poor design and inappropriate procedure may result in high residual stresses and cracking.

Where alloy steels or steels with a carbon content greater than about 0.2% are being welded, self cooling may be rapid enough to cause some (brittle) martensite to form. This will easily develop cracks.

To prevent these problems a process of pre-heating in stages may be needed and after welding a slow controlled post cooling in stages will be required. This can greatly increase the cost of welded joins, but for high strength steels, such as those used in petrochemical plant and piping, there may well be no alternative.

Q. 1. (*e*) Compare TIG and MIG welding in detail. What are their applications?

Ans.

MIG WELDING	TIG WELDING
1. This welding is known as metal inert gas welding.	1. This is known as tungsten inert gas welding.
2. Metal rod is used as electrode and work piece used as another electrode.	2. Tungsten rod is used as electrode.
3. It is gas shielded metal arc welding.	3. It is gas shielded tungsten arc welding.
4. Continuous feed electrode wire is used which are fast feeding.	4. Welding rods are used which are slow feeding.

5. The welding area is flooded with a gas which will not combine with the metal.	5. Gas is used to protect the welded area from atmosphere.
6. MIG can weld materials such as mild steel, stainless steel and aluminum. A range of material thicknesses can be welded from thin gauge sheet metal right up to heavier structure plates.	6. TIG weld things like kitchen sinks and tool boxes. Pipe welding and other heavier tasks can also be performed, you just need to have a unit that is capable of putting out the amount of power that you need.
7. MIG requires consumable metalic electrode	7. It used non consumable tungsten electrode
8. Electrode is feeded continuously from a wire reel.	8. It does not require electrode feed.
9. DC with reverse polarity is used.	9. It can use both A.C. and D.C.
10. Filler metal is compulsory used.	10. Filler metal may or not be used.
11. It can weld up to 40 mm thick metal sheet.	11. Metal thickness is limited about 5 mm.
12. MIG is comparatively faster than TIG.	12. TIG is a slow welding process.

Applications: TIG is most commonly used to weld thin sections of stainless steel and ferrous metals such as aluminium, magnesium and copper alloys. The aerospace industry is one of the primary users of gas tungsten arc welding. It is also frequently employed to weld small diameter, thin wall tubing such as those used in bicycle industry. TIG is often used in piping various sizes.

TIG in aerospace industry: Aerospace industry uses lite metals (Alumium and its alloys) thin sheet and need high quality welding. So TIG is more suitable for it.

Application of MIG

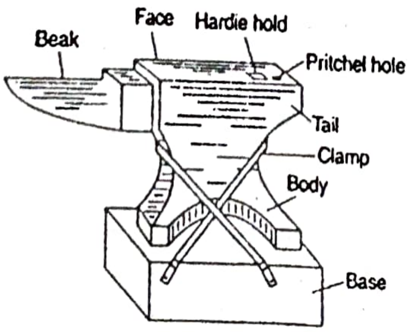
1. The most common application is automobile repair.
2. Special welding equipment can be used to weld pipes
3. It can be used to reinforce the surface of a worn of road rail track.
4. Because of its high economy and utility it is widely used in various industries.

Q. 1. (f) Elaborate on any five fitting shop tools with proper diagrams.

Ans. The common hand tools used in sheet metal work are:

1. Anvil	2. Stakes	3. Swages	4. Flatter
5. Fullers	6. Snips	7. Hammer	8. Set hammer

1. Anvil: Anvil is main supporting tool widely used in metal working shop. It is made of cast iron. Anvil consists of beak, Face, hardie hole, pritchel hole, tail, body, clamp, base. Each pair have its own importance due to exclusive functions.



Base: It is made of cast iron, wood or concrete used to provide a strong and rigid support and foundation to it.

Body: Body is the middle portion of anvil which decides the height of it and transmission the blows to its foundation.

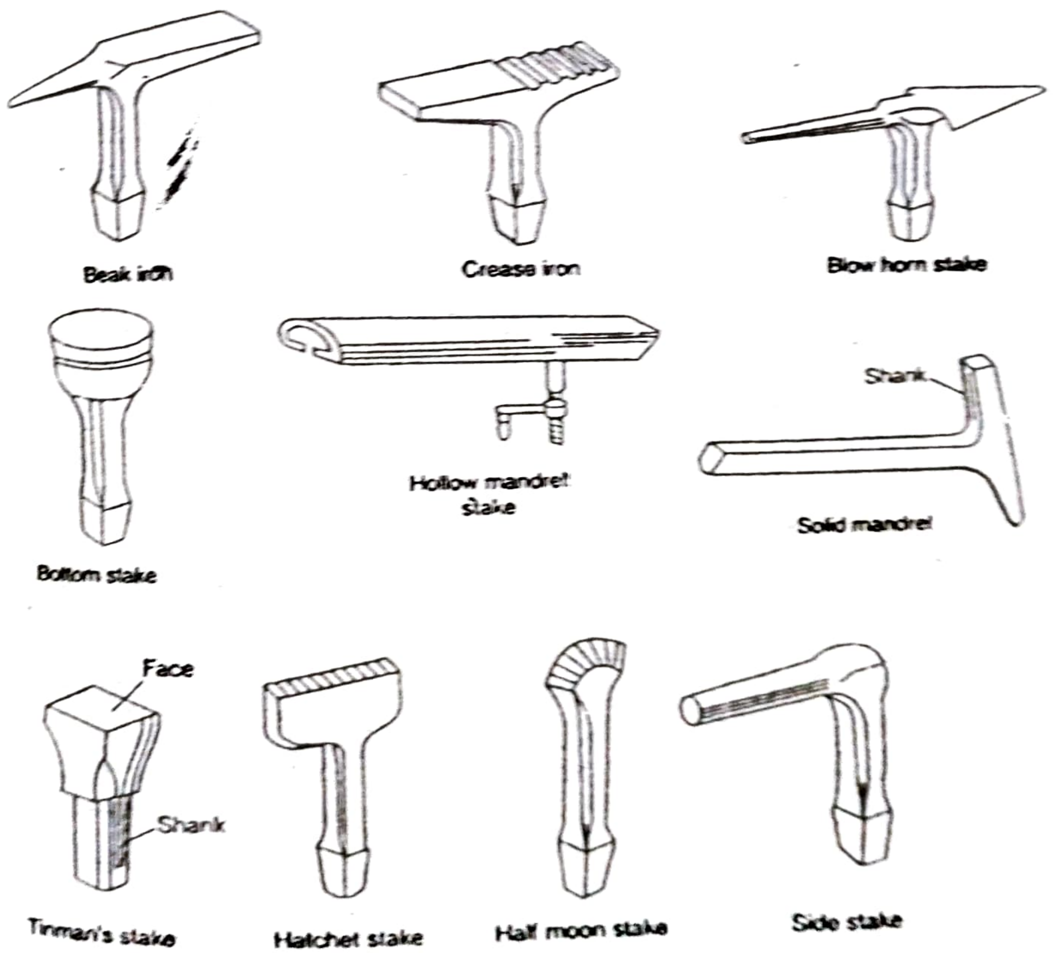
Beak: Beak is tapered convex. Extended part at the front used to give a shape to work piece. It is used in bending operation.

Clamp: Face is top and flat surface of anvil which provides support to work piece when it is processed. Face is made of high conductivity hard material to facilitate hot working of metal.

Hardie Hole: It is a square hole at the tail of anvil to hold grip the rectangular objects.

Pritchel Hole: It is a circular hole used to grip the round object to process them.

2. Stakes: Stake is a supporting tool used in sheet metal working. It provides support to sheet metal to do work upon it. It is made of cast steel or forged steel. It is used for bending, riveting and making seam joint in sheet metal.



Stakes are classified into different types depending upon the shape of their upper face.

3. Hammer: Some heavy duty hammers are said hammer. They are further classified on the basis of shape, of their peen like straight peen, cross peen, ball peen, double face hammer.

Sledge Hammer

4. Set Hammer: Set hammer consists of a flat surface used to strike on the surface of sheet metal to flatten it. It is recommended to work in narrow space and to fold the edges of sheet metal at 90°.

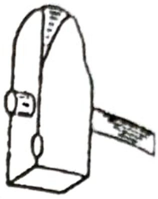


Fig. Set Hammer

5. Fuller: Fullers are ceed in pairs, the lower one is called bottom fuller which is used to support work piece the upper one is called top fuller which is used to strike work piece. Fullers are made of hardened carbon steel. It is used for making slots, finishing the edges and increasing the lengths or width of work piece.

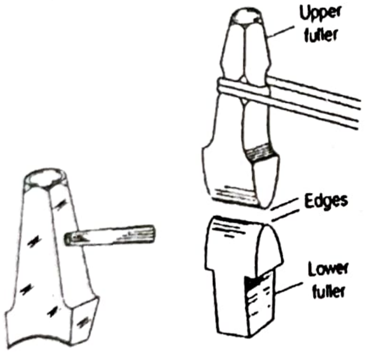


Fig. Fullers

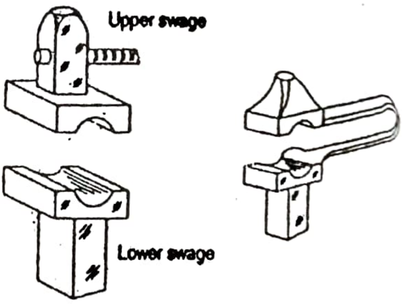
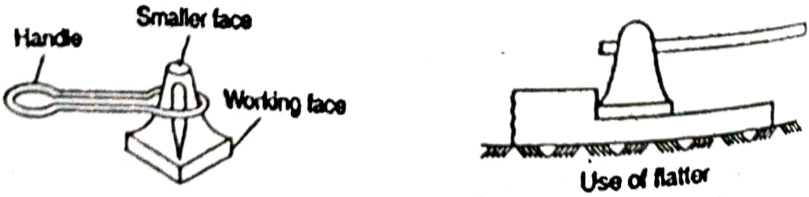


Fig. Swages

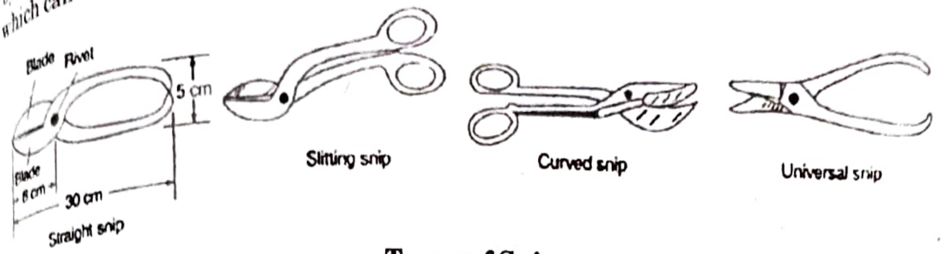
6. Swages: Swage are also made in pairs like fullers called top swage and bottom swage. These are made of hardened carbon or high carbon steel. Each of the pair of swages consist of circular groove of compatible size. The work piece to be processed is kept in the groove of bottom swage and stroke with top swage. It is used to increase the length of rod and to finish the cylindrical objects.

7. Flatter: It is made of hardened, high carbon steel and used for flattering the surface. It consist of one end flat with rectangular cross-section and other end smaller. The working face of flatter is flat end.



Flatter and its use

8. SNIPS: It is also called shears. It is a shearing tool used to cut the sheet metal by shearing action. It consists of two movable jaws with sharp edge on each of then which can be brought closer to cut the metal.



Types of Snips

UNIT-I

Q. 2. (a) What are Carbon steels? How they are classified based on % of carbon? Describe their properties and applications. (8)

Ans. Carbon steel is an alloy consisting of iron and carbon. Several other elements are allowed in carbon steel, with low maximum percenatges. These elements are manganese, with a 1.65% maximum, silicon, with a 0.60% maximum, and copper, with a 0.60% maximum.

Classification: Any steel in the 0.35 to 1.86 percent carbon content range can be hardened using a heat-quench-temper cycle. Most commerical steels are classified into one of three groups.

1. Plain carbon steels
2. Low-alloy steels
3. High-alloy steels

Plain carbon steels are further subdivided into four groups:

1. Low
2. Medium
3. High
4. Very high

Low-allowy Steels

When these steels are designed for welded applications, their carbon content is usually below 0.25 percent and often below 0.15 percent. Typical alloys include nickel, chromium, molydenum, manganese, and silicon, which add strength at room temperature and increase low-temperature notch toughness.

High-alloy Steels: For the most part, we're talking about stainless steel here, the most important commerical high-alloy steel. Stainless steels are at least 12 percent chromium and many have high nickel contents. The three basic types of stainless are

1. Austenitic
2. Ferritic
3. Martensitic

The high carbon steel has good wear resistance, and unit recently was used for railways. It is also used for cutting tools, such as chisels and high strength wires. These applications requires a much finer microstructure, which improves the toughness.

Q. 2. (*b*) Elaborate on composition and properties of moulding sand. **(4.5)**

Ans. Compositions:

The main constituents of molding sand involve silica sand, binder, moisture content and additives.

Silica Sand: Silica sand in form of granular quarts is the main constituent of molding sand having enough refractoriness which can impart strength stability and permeability to molding and core sand. But along with silica small amounts of iron oxide, alumina, lime stone ($CaCo_3$), magnesia, soda and potash are present as impurities. The chemical composition of silica sand gives an idea of the impurities like lime, magnesia, alkalis etc. present. The presence of excessive amounts of iron oxide, alkali oxides and lime can lower the fusion point to a considerable extent which is undesirable. The silica sand can be specified according to the sand grain size and the shape (angular, subangular and rounded) of the sand.

Binder: Binders can be either inorganic or organic substance. Binders included in the inorganic group are clay sodium silicate and port land cement etc. In foundry shop, the clay acts as binder which may be Kaolinite, Ball Clay, Fire Clay, Limonite, Fuller's earth and Bentonite. Binders included in the organic group are dextrin, molasses, cereal binders. Linseed oil and resins like phenol formaldehyde, urea formaldehyde etc. Binders of organic group are mostly used for core making. Among all the above binders, the bentonite variety of clay is the most commonly used. However, this clay alone can't develop bonds among sand grins without the presence of moisture content in molding sand and core sand.

Moisture: The amount of moisture content in the molding sand varies from 2 to 8%. This amount is added to the mixture of clay and silica sand for developing bonds. This is the amount of water required to fill the pores between the particles of clay without separating them. This amount of water is held rigidly by the clay and is mainly responsible for developing the strength in the sand. The effect of clay and water decreases permeability with increasing clay and moisture content. The green compressive strength first increases with the increase in clay content, but after a certain value, it starts decreasing. For increasing the molding sand characteristics some other additional materials besides basic constituents are added which are added which are known as additives.

Additives: Additives are the materials generally added to the molding and core sand mixture to develop some special property in the sand some commonly used additives for enhancing the properties of molding and core sands are coal.

Q. 3. (*a*) What are permanent mould casting and centrifugal casting? Compare. **(4.5)**

Ans. Permanent mold casting is a metal casting process that employs reusable molds("permanent molds"), usually made from metal. The most common process uses gravity of fill the mold, however gas pressure or a vacuum are also used. A variation on the typical gravity casting process, called slush casting, produces hollow castings. Common casting metals are aluminium, magnesium, and copper alloys. Other materials include tin, zinc, and lead alloys and iron and steel are also cast in graphite molds.

Typical products are components such as gears, splines, wheels, gear housing, pipe fitting, fuel injection housings, and automotive engine pistons.

There are four main types of permanent mold casting which are, gravity, slush, low-pressure, and vacuum.

Centrifugal casting or **rotocasting** is a casting technique that is typically used to cast thin-walled cylinders. It is used to cast such materials as metal, glass, and concrete. It is noted for the high quality of the results attainable, particularly for precise control of their metallurgy and crystal structure. Unlike most other casting techniques, centrifugal casting is chiefly used to manufacture stock materials in standard sizes for further machining, rather than shaped parts tailored to a particular end-use.

Typical materials that can be cast with this process are iron, steel, stainless steels, glass, and alloys of aluminum, copper and nickel.

Two materials can be cast together by introducing a second material during the process.

Typical parts made by this process are pipes, flywheels, cylinder liners and other parts that are axi-symmetric. It is notably used to cast cylinder liners and sleeve valves for piston engines, parts which could not be reliably manufactured otherwise.

Features of centrifugal casting

- Castings can be made in almost any length, thickness and diameter.
- Different wall thicknesses can be produced from the same size mold.
- Eliminates the need for cores.
- Resistant to atmospheric corrosion, a typical situation with pipes.

Q. 3. (*b*) What is Pattern? What are pattern materials? Explain all types of patterns in brief. **(4)**

Ans. Pattern: It is defined as the replica of desired casting which we want to produce or it can be defined as replica of the object to be made by casting process.

The various types of pattern are:

(*i*) Single piece pattern

(*ii*) Match plate pattern

(*iii*) Gated pattern

(*iv*) Cope and drag pattern

(*v*) Split pattern or two piece pattern

(*vi*) Sweep pattern

(*vii*) Follow board pattern

(*viii*) Skeleton pattern

The functions of pattern are as follows:

1. A pattern prepares a mold cavity for the purpose of making a casting.

2. Runner, gates and risers (used for introducing molten metal to the mold cavity) may form a part of the pattern.

3. A pattern may contain projections known as core prints if the casting requires a core and used to be made hollow.

4. Patterns establish the parting line and parting surfaces in the mold.

5. Patterns properly made and having finished and smooth surfaces reduces casting defects.

6. Properly constructed patterns minimize overall cost of the castings.

Advantages and Applications

1. High production rate
2. High dimensional accuracy

3. Generally used for small casting.
4. Aluminium is used as pattern material as it is of light weight.

Pattern Material :-

P Wood;

Metals;

Plaster;

Plastics;

Wax;

Follow board pattern :-A follow board is not a pattern but is a device (wooden board) used for various purposes.

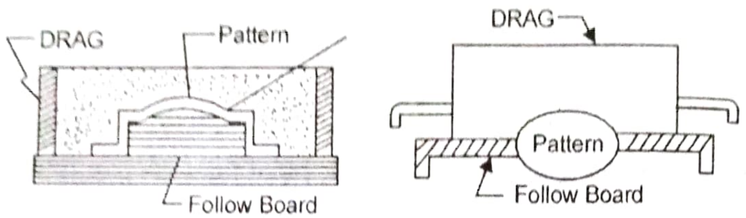


Fig. Follow board pattern

(i) Single piece pattern: This is the simplest type of pattern, exactly like the desired casting. For making a mould, the pattern is accommodated either in cope or drag

(ii) Split pattern: These patterns are split along the parting plane (which may be flat or irregular surface) to facilitate the extraction of the pattern out of the mould before the pouring operation

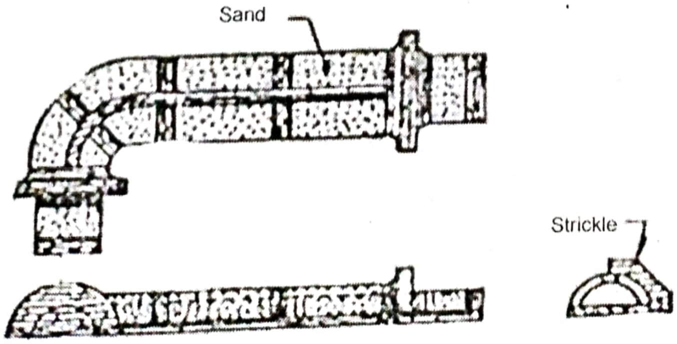
(iii) Loose piece pattern: When a one piece solid pattern has projections or back drafts which lie above or below the parting plane, it is impossible to with draw it from the mould.

(iv) Gated pattern: A gated pattern is simply one or more loose patterns having attached gates and runners.

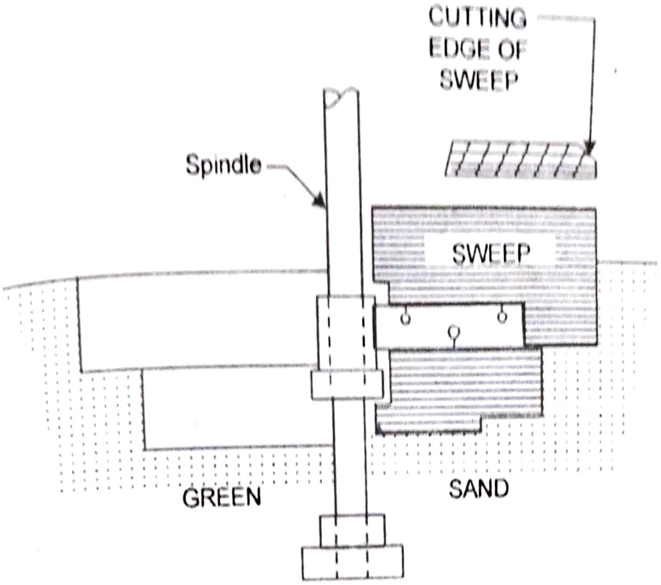
(v) Match plate pattern: A match plate pattern is a split pattern having the cope and drags portions mounted on opposite sides of a plate (usually metallic), called the "match plate" that conforms to the contour of the parting surface.

(vi) Skeleton pattern: For large castings having simple geometrical shapes, skeleton patterns are used. Just like sweep patterns, these are simple wooden frames that outline the shape of the part to be cast and are also used as guides by the molder in the hand shaping of the mould.

This type of pattern is also used in pit or floor molding process.



(vii) Sweep pattern: A sweep is a section or board (wooden) of proper contour that is rotated about one edge to shape mould cavities having shapes of rotational symmetry. This type of pattern is used when a casting of large size is to be produced in a short time. Large kettles of C.I. are made by sweep patterns.



UNIT-II

Q. 4. Explain any four in brief. **(12.5)**

Q. 4. (a) Forging defects

Ans. Forging defects: Though forging process give generally prior quality product compared other manufacturing processes. There are some defects that are lightly to come a proper care is not taken in forging process design. A brief description of such defects and their remedial method is given below.

(a) Unfilled Section: In this some section of the die cavity are not completely filled by the flowing metal. The causes of these defects are improper design of the forging die or using forging techniques.

(b) Cold Shut: This appears as small cracks at the corners of the forging. This is caused mainly by the improper design of die. Where in the corner and the fillet radii are small as a result of which metal does not flow properly into the corner and the ends up as a cold shut.

(c) Scale Pits: This is seen as irregular depurations on the surface of the forging. This is primarily caused because of improper cleaning of the stock used for forging. The oxide and scale gets embedded into the finish forging surface. When the forging is cleaned by pickling, these are seen as depurations on the forging surface.

(d) Die Shift: This is caused by the miss alignment of the die halve, making the two halve of the forging to be improper shape.

(e) Flakes: These are basically internal ruptures caused by the improper cooling of the large forging. Rapid cooling causes the exterior to cool quickly causing internal fractures. This can be remedied by following proper cooling practices.

(i) Cracks: The cracks are longitudinal or transverse in nature and occur on the forging surface. It is due to the poor quality of metal, improper heating, incorrect cooling and low temperature of the forging.

(*g*) **Fins and rags:** These are small projections or pieces of loose metal driven into the forging surface. It can be controlled by proper die design and workmanship.

Q. 4. (*b*) Drop forging

Ans. Drop forging: Drop-hammer forging usually only deforms the surfaces of the work piece in contact with the hammer and anvil; the interior of the work piece will stay relatively unreformed. Another advantage to the process includes the knowledge of the new part's strain rate. We specifically know what kind of strain can be put on the part, because the compression rate of the press forging operation is controlled.

Q. 4. (c) Press forging

Ans. Press Forging: The forging of parts done in presses is called press forging. The forging of parts by presses involves relatively slow squezing instead of delivering heavy blows and penetrotes deeply because, it gives the metal time to flow. Dies may have less draft, and the forgings come nearer to the desired sizes. Pressed forgings are shaped at each impression with a single smooth stroke and they stick to the die impressions more rigidly. Press forging dies require a mechanical means for ejecting the forgings are venting for the escape of air and lubricant. Press forgings are generally more accurate dimensionally than drop forgings.

Two types of presses are used in Press forging

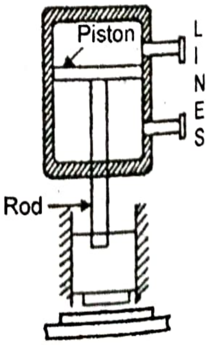
(*a*) Hydraulic presses (*b*) Mechanical presses

The hydraulic presses are used for heavy work and mechanical presses for light work. Mechanical presses operate faster than the hydraulic presses, but hydraulic presses are designed to provide greater squeezing force. Because of the continous action of the hydraulic presses, the material gets uniformly deformed throughout its entire depth. More hammer force is likely to be transmitted to the machine frame in drop forging, whereas in press forging it is absorbed fully by the stock. The impressions obtained in press forging are clean compared to that of the likely in the drop forged components. The press capacity required for deforming is higher and as a result somewhat smaller size components only are press forged in closed impression dies. But there is no such limitation for press forging in open dies.

The capacity of presses range from 500 to 800 tonnes and the speeds from 35 to 90 stroke per meter. In press forging, the speed, pressure and travel of the die are automatically controlled. There are less vibrations and noise than in hammer forging.

The presses are mostly used for in production of rivets, screws and nuts where a high operating speed is desired.

Advantages:



1. The operation is faster because whole operation is carried out in a single squeezing operation instead of several blows by hammers.

2. Deep penetration is obtained because enough times allowed to the metal to flow.

3. More complicated shapes with better dimensional accuracy can be forged.

4. The life of presses and dies is longer than that of hammers.

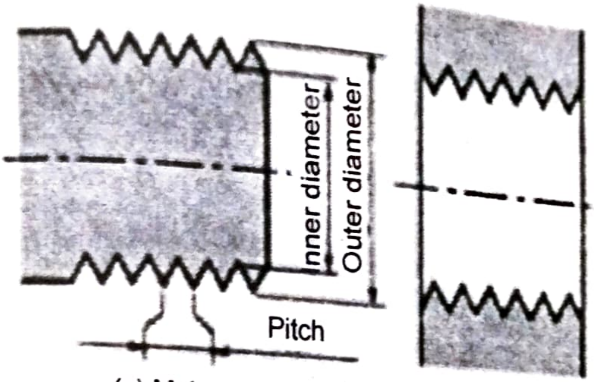
5. The alignment of two die halves to easier to maintain than with hammers.

6. Low susceptibility to failure and simple maintenance.

Q. 4. (d) Bench work and fitting operations

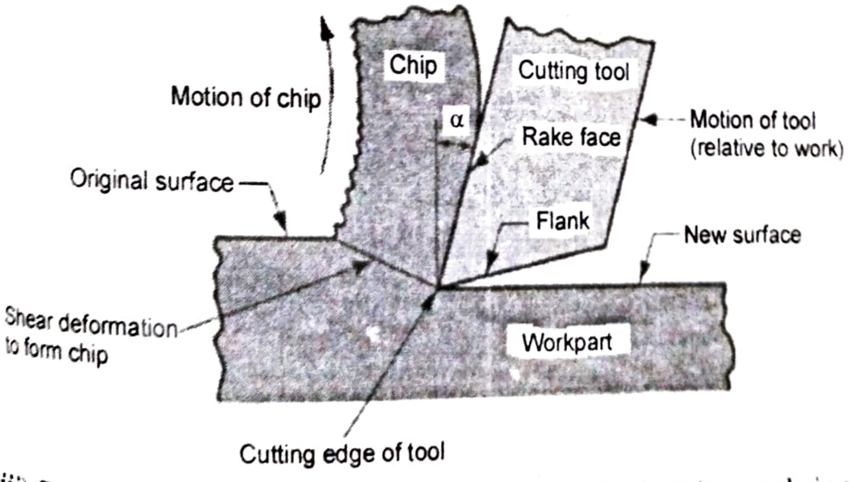
Ans. (i) Thread cutting using dies (ii) Chipping (iii) Fitting (iv) Sawing

(i) Thread cutting using dies: The principles of cutting threads in nuts and bolts that the bolt (male thread) is usually cut from a rod of material which has the same diameter has the intended finished bolt. The nut is made from a larger stock which has hole drilled through it that is slightly larger than that of the rod diameter. A thread of the same pitch is then cut which results in two mating threads. The same principles apply for cutting holes in places and other work pieces.

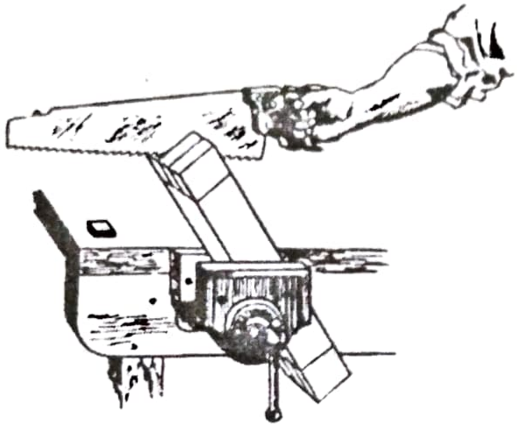


(a) Male thread (b) Female thread

(ii) Chipping: The chips are then screened and those that are oversized may be rechipped, and those that are undersized used as fuel. Stockpiles of several hundred tonnes of chips are maintained. There may be a blending of chips from different sources or timber species to enhance certain properties. For example the highly moisture resistant high density boards that many manufacturers make typically use a eucalypt content of 10%. The chips are washed, and a magnet or other scanner may be passed over to detect impurities.



(iii) Sawing: A saw is a tool consisting of a hard blade, wire, or chain with a toothed edge. It is used to cut through relatively hard material, most often wood. The cut is made by placing the toothed edge against the material and moving it forcefully back and forth. This force may be applied by hand, or powered by steam, water, electricity or other power source. An abrasive saw has a powered circular blade designed to cut through metal.



Q. 4. (*e*) Extrusion and its types

Ans. Extrusion is a process used to create objects of a fixed cross-sectional profile. A material is pushed through a die of the desired cross-section. The two main advantage of this process over other manufacturing processess are its ability to create very complex cross-sections, and to work materials that are brittle, because the material only encounters compressive and shear stresses. It also forms parts with an excellent surface finish.

Direct Extrusion: Direct extrusion, also known as forward extrusion, is the most common extrusion process. It works by placing the billet in a heavy walled container. The billet is pushed through the die by a ram or screw. There is reusable dummy block between the ram and the billet to keep them separated. The major disadvantage of this process is that the force required to extrude the billet is greater than that needed in the indirect extrusion process because of the frictional force introduced by the need for the billet to travel the entire length of the container. Because of this the greatest force required is at the beginning of process and slowly decreases as the billet is used up. At the end of the billet the force greatly increases because the billet is thin and the material must flow radially to exit the die. The end of the billet (called the butt end) is not used for this reason.

Indirect Extrusion: In indirect extrusion, also known as backwards extrusion, the billet and container move together while the die is stationary. The die is held in place by a "stem" which has to be longer than the container length. The maximum length of the extrusion is ultimately dicated by the column strength of the stem.

Q. 4. (*f*) Wire drawing and swaging.

Ans. Wire drawing is a metalworking process used to reduce the cross-section of a wire by pulling the wire through a single, or series of, drawing die(s). There are many applications for wire drawing, including electrical wiring, cables, tension-loaded structural components, spring, paper clips, spokes for wheels, and stringed musical instrucments. Although similar in process, drawing is different from extrusion, because in drawing the wire is pulled, rather than pushed, through the die. Drawing is usually performed at room temperature, thus classified as a cold working process, but it may be performed at elevated temperature for large wires to reduce forces.

Swaging is a forging process in which the dimensions of an item are altered using dies into which the item is forced. Swaging is usually a cold working process, however, it is sometimes done as a hot working process.

The term swage can apply to the process of swaging (verb), or to a die or tool used for swaging.

UNIT-III

Q. 5. (a) Explain Oxyacetylene gas welding its equipment and field of application? (6)

Ans. Oxy-fuel welding (commonly called **oxyacetylene welding, oxy welding,** or **gas welding** in the U.S.) and **oxy-fuel cutting**are processes that use fuel gases and oxygen to weld and cut metals, respectively. French engineers Edmond Fouché and Charles Picard became the first to develop oxygen-acetylene welding in 1903. Pure oxygen, instead of air, is used to increase the flame temperature to allow localized melting of the workpiece material (e.g. steel) in a room environment. A common propane/air flame burns at about 2,250 K (1,980 °C; 3,590 °F), a propane/oxygen flame burns at about 2,526 K (2,253 °C; 4,087 °F), an oxyhydrogen flame burns at 3,073 K (2,800 °C; 5,072 °F), and an acetylene/oxygen flame burns at about 3,773 K (3,500 °C; 6,332 °F).

Oxy-fuel is one of the oldest welding processes, besides forge welding. In recent decades it has been obsolesced in almost all industrial uses due to various arc welding methods offering more consistent mechanical weld properties and faster application. Gas welding is still used for metal-based artwork and in smaller home based shops, as well as situations where accessing electricity (e.g., via an extension cord or portable generator) would present difficulties.

In **oxy-fuel welding,** a welding torch is used to weld metals. Welding metal results when two pieces are heated to a temperature that produces a shared pool of molten metal. The molten pool is generally supplied with additional metal called filler. Filler material depends upon the metals to be welded.

In **oxy-fuel cutting,** a torch is used to heat metal to its kindling temperature. A stream of oxygen is then trained on the metal, burning it into a metal oxide that flows out of the kerf as slag.

Torches that do not mix fuel with oxygen (combining, instead, atmospheric air) are not considered oxy-fuel torches and can typically be identified by a single tank (oxy-fuel cutting requires two isolated supplies, fuel and oxygen). Most metals cannot be melted with a single-tank torch. Consequently, single-tank torches are typically suitable for soldering and brazing but not for welding.

Apparatus: The apparatus used in gas welding consists basically of an oxygen source and a fuel gas source (usually contained in cylinders), two pressure regulators and two flexible hoses (one for each cylinder), and a torch. This sort of torch can also be used for soldering and brazing. The cylinders are often carried in a special wheeled trolley.

There have been examples of oxyhydrogen cutting sets with small (scuba-sized) gas cylinders worn on the user's back in a backpack harness, for rescue work and similar.

There are also examples of pressurized liquid fuel cutting torches, usually using gasoline. These are used for their increased portability.

Regulator

Pressure regulator

The regulator ensures that pressure of the gas from the tanks matches the required pressure in the hose. The flow rate is then adjusted by the operator using needle valves on the torch. Accurate flow control with a needle valves relies on a constant inlet pressure

Most regulators have two stages. The first stage is a fixed-pressure regulator, which releases gas from the cylinder at a constant intermediate pressure, despite the pressure in the cylinder falling as the gas in it is consumed. This is similar to the first stage of a scuba-diving regulator. The adjustable second stage of the regulator controls the pressure reduction from the intermediate pressure to the low outlet pressure. The regulator has two pressure gauges, one indicating cylinder pressure, the other indicating hose pressure. The adjustment knob of the regulator is sometimes roughly calibrated for pressure, but an accurate setting requires observation of the gauge.

Some simpler or cheaper oxygen-fuel regulators have only a single stage regulator, or only a single gauge. A single-stage regulator will tend to allow a reduction in outlet pressure as the cylinder is emptied, requiring manual readjustment. For low-volume users, this is an acceptable simplification. Welding regulators, unlike simpler LPG heating regulators, retain their outlet (hose) pressure gauge and do not rely on the calibration of the adjustment knob. The cheaper single-stage regulators may sometimes omit the cylinder contents gauge, or replace the accurate dial gauge with a cheaper and less precise "rising button" gauge.

Gas hoses: The hoses are designed for use in welding and cutting metal. A double-hose or twinned design can be used, meaning that the oxygen and fuel hoses are joined together. If separate hoses are used, they should be clipped together at intervals approximately 3 feet (1 m) apart, although that is not recommended for cutting applications, because beads of molten metal given off by the process can become lodged between the hoses where they are held together, and burn through, releasing the pressurised gas inside, which in the case of fuel gas usually ignites.

The hoses are color-coded for visual identification. The color of the hoses varies between countries. In the United States, the oxygen hose is green, and the fuel hose is red. In the UK and other countries, the oxygen hose is blue (black hoses may still be found on old equipment), and the acetylene (fuel) hose is red. If liquefied petroleum gas (LPG) fuel, such as propane, is used, the fuel hose should be orange, indicating that it is compatible with LPG. LPG will damage an incompatible hose, including most acetylene hoses.

The threaded connectors on the hoses are handed to avoid accidental mis-connection: the thread on the oxygen hose is right-handed (as normal), while the fuel gas hose has a left-handed thread. The left-handed threads also have an identifying groove cut into their nuts.

Gas-tight connections between the flexible hoses and rigid fittings are made by using crimped hose clips or ferrules, often referred to as 'O' clips, over barbed spigots. The use of worm-drive hose clips or Jubilee clips is specifically forbidden in the UK and other countries.

Non-return valve: Acetylene is not just flammable; in certain conditions it is explosive. Although it has an upper flammability limit in air of 81%, acetylene's explosive decomposition behaviour makes this irrelevant. If a detonation wave enters the acetylene tank, the tank will be blown apart by the decomposition. Ordinary check valves that normally prevent back flow cannot stop a detonation wave because they are not capable of closing before the wave passes around the gate. For that reason a flashback arrestor is needed. It is designed to operate before the detonation wave makes it from the hose side to the supply side.

Between the regulator and hose, and ideally between hose and torch on both oxygen and fuel lines, a flashback arrestor and/or non-return valve (check valve) should be installed to prevent flame or oxygen-fuel mixture being pushed back into either cylinder and damaging the equipment or causing a cylinder to explode.

European practice is to fit flashback arrestors at the regulator and check valves at the torch. US practice is to fit both at the regulator.

The flashback arrestor (not to be confused with a check valve) prevents shock waves from downstream coming back up the hoses and entering the cylinder, possibly rupturing it, as there are quantities of fuel/oxygen mixtures inside parts of the equipment (specifically within the mixer and blowpipe/nozzle) that may explode if the equipment is incorrectly shut down, and acetylene decomposes at excessive pressures or temperatures. In case the pressure wave has created a leak downstream of the flashback arrestor, it will remain switched off until someone resets it.

Check valve: A check valve lets gas flow in one direction only. It is usually a chamber containing a ball that is pressed against one end by a spring. Gas flow one way pushes the ball out of the way, and a lack of flow or a reverse flow allows the spring to push the ball into the inlet, blocking it. Not to be confused with a flashback arrestor, a check valve is not designed to block a shock wave. The shock wave could occur while the ball is so far from the inlet that the wave will get past the ball before it can reach its off position.

Torch: The torch is the tool that the welder holds and manipulates to make the weld. It has a connection and valve for the fuel gas and a connection and valve for the oxygen, a handle for the welder to grasp, and a mixing chamber (set at an angle) where the fuel gas and oxygen mix, with a tip where the flame forms. Two basic types of torches are positive pressure type and low pressure or injector type.

The top torch is a welding torch and the bottom is a cutting torch

Welding torch: A welding torch head is used to weld metals. It can be identified by having only one or two pipes running to the nozzle, no oxygen-blast trigger, and two valve knobs at the bottom of the handle letting the operator adjust the oxygen and fuel flow respectively.

Cutting torch: A cutting torch head is used to cut materials. It is similar to a welding torch, but can be identified by the oxygen blast trigger or lever.

When cutting, the metal is first heated by the flame until it is cherry red. Once this temperature is attained, oxygen is supplied to the heated parts by pressing the oxygen-blast trigger. This oxygen reacts with the metal, forming iron oxide and producing heat. It is the heat that continues the cutting process. The cutting torch only heats the metal to start the process; further heat is provided by the burning metal.

The melting point of the iron oxide is around half that of the metal being cut. As the metal burns, it immediately turns to liquid iron oxide and flows away from the cutting zone. However, some of the iron oxide remains on the workpiece, forming a hard "slag" which can be removed by gentle tapping and/or grinding.

Rose bud torch: A rose bud torch is used to heat metals for bending, straightening, etc. where a large area needs to be heated. It is so-called because the flame at the end looks like a rose bud. A welding torch can also be used to heat small areas such as rusted nuts and bolts.

Uses of Oxy-Fuel Welding:

- Welding metal:

- Cutting metal:

→ Also, oxy-hydrogen flames are used:

- in Stone Work for "flaming" where the stone is heated and a top layer crackles and breaks. A steel circular brush is attached to an angle grinder and used to remove the first layer leaving behind a bumpy surface similar to hammered bronze.
- in the glass industry for "fire polishing".
- in jewellery production for "water welding" using a water torch.
- formerly, to heat lumps of quicklime to obtain a bright white light called limelight,in theatres or optical ("magic") lanterns.
- formerly, in platinum works, as platinum is fusible only in the oxyhydrogen flame and in an electric furnace

Q. 5. (b) Compare Brazing and soldering? How they are used in modern manufacturing process? **(6.5)**

Ans.

Soldering	Brazing
1. In soldering joint is obtained by means of filler material whose melting point is less than 450°C and less than the melting point of base metal.	In brazing the joint is obtained by means of filler material whose melting point is above the 450°C and less than the melting temperature of base metal.
2. The soldered joints are weakest among the soldering, welding and brazing.	The brazed joints are stronger than soldered joint but weaker than welded joints.
3. Essentially filler metals are alloys of lead and tin.	The filler metals are alloys of copper (*e.g.,* copper zinc and copper silver alloys).
4. Soldered joints are not suitable for high temperature service because of lower melting point of the filler metal.	Brazed joints are also not suitable for high temperature service because of lower melting point of filler metal.
5. The process can join dissimilar metals which are insoluble in each other.	The process can join dissimilar metals which are insoluble in each other.
6. Heating of parent metal is negligible to cause any change in their structure and properties.	Heating of parent metal is negligible to cause any change in their structure and properties.
7. Soldering is widely used in joining small assemblies electric and electronics parts.	Brazing is used for joining electrical parts, joining carbide tips to tools, heat exchangers, radiators etc.

Q. 6. (a) Describe butt and percussion welding? Draw suitable diagram to elaborate. Also give its some applications. **(6)**

Ans. Percussion Butt Welding (PEW) : This process uses the heating effect of a high-intensity electric arc produced by a rapid discharge of electric energy, in combination with a percussion blow to forge weld metal pieces together. When the movable clamp is released, it moves rapidly alongwith one of the workpiece (Fig.). When the two parts are about 1.6 mm apart, there is a sudden discharge of electric energy. This causes intense arcing over the surfaces and brings them to high temperature. The arc is extinguished by the percussion blow of the two parts coming together with sufficient force to effect the weld.

Percussion welding makes it possible to weld parts having considerable difference in mass and in thermal and electrical conductivity, for example welding of copper to steels, steel to magnesium alloys and so on.

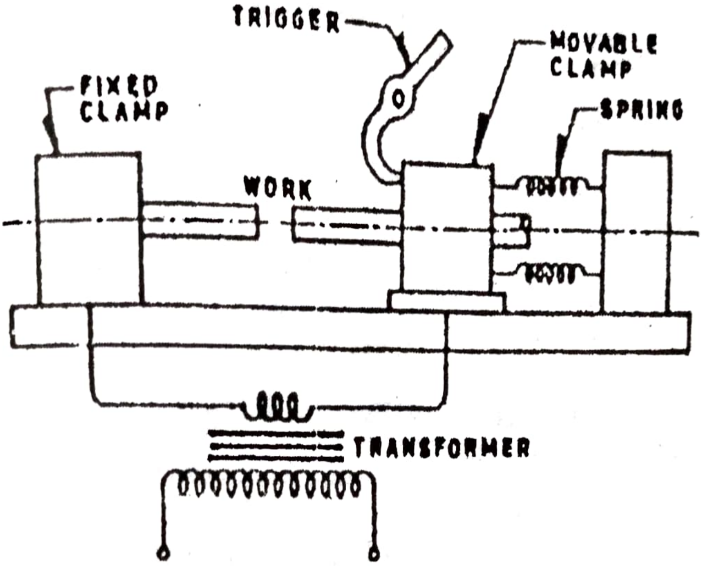


Fig. Percussion Butt Welding.

Percussion welding is used for special joining situations, for example, joining dissimilar metals that can not be welded economically by flash welding. The method is also used to weld pins, studs, bolts, and so on, to other components as well as to join sections of pipe, rod, or tube to each other or to flat sections. Since control of the path of an arc is difficult and also because of the impact required, the method is limited to small pieces (about 150 to 300 mm^2).

Commerical product applications include: Butt welding steel or other metals without flash or upset, joining aluminium rods, tubes or bars to copper, joining corrosion-resistant alloys to steel or non-ferrous pieces, joining of threaded steel studs to aluminium or magnesium alloys or forgings, joining of silver contact tips to copper studs and joining of stellite tips to steel or non-ferrous metals.

Q. 6. (*b*) Discuss Flux, its composition, properties and function? Elaborate in brief. **(6.5)**

Ans. Function of Flux: In metallurgy, a flux is a chemical cleaning agent, flowing agent, or purifying agent. Fluxes may have more than one function at a time. They are used in both extractive metallurgy and metal joining.

Flux: It a material used to prevent, dissolve or facilitate removal of oxides and other undesirable surface substances.

The major functions of fluxes are:

1. It act as good insulator and concentrate heat with in a relatively small welding zone; thus it improves fusion of molten metal from welding electrode and parent material.

2. It acts as cleaner for the weld metal, absorb impurites and add alloying elements such as manganese and silicon.

3. Owing to flux, the weld metal is not only clean but it also more dense and hence has excellent physical properties.

4. The blanket of flux improves the process efficiency by reducing spatter, burning losses, which are anavoidable by an ordinary arc.

5. That position of flux which melt, floats as liquid blanket over the molten metal, protect it from the deleteroius effects of surrounding atmosphere their by reduces the pickup of oxygen and nitrogen.

Alloy composition are:

1. Cadmium 1 % copper 99 %

2. Chromium 0.8 % copper 9.2 %

3. Berlium 0.5% Nickel 1.6 %, Cobalt 1.0%, Copper 97.5%.

UNIT-IV

Q. 7. What is Powder metallurgy? Explain its all process: powder production blending, compaction, sintering? (12.5)

Ans. Powder metallurgy: Powder metallurgy is the process of blending fine powdered materials, pressing them into a desired shape or form (compacting), and then heating the compressed material in a controlled atmosphere to bond the material. The powder metallurgy process generally consists of four basic steps: powder manufacture, powder blending, compacting, and sintering. Compacting is generally performed at room temperature, and the elevated-temperature process of sintering is usually conducted at atmospheric pressure. Optional secondary processing often follows to obtain special properties or enhanced precision.

Two advantages of Powder metallurgy:

1 . The use of powder metal technology bypasses the need to manufacture the resulting products by metal removal processes, thereby reducing costs.

2. Powder metallurgy is also used in "3D printing" of metals.

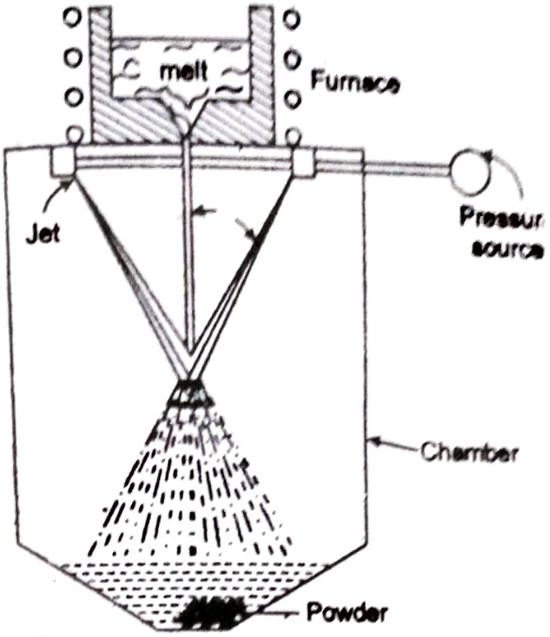
Two applications of powder metallurgy:

1. It can used in making automotive components.

2. Also used in medical implants and tubing or piping.

Methods of Manufacturing metal powders: Powder metallurgy is the process of blending fine powdered materials, pressing them into a desired shape or form (compacting), and then heating the compressed material in a controlled atmosphere to bond the material (sintering). The powder metallurgy process generally consists of four basic steps: powder manufacture, powder blending, compacting, and sintering.

Atomization is the process used commercially to produce the largest tonnage of metal powders in water and gas atomization.



1. Bending: Bending is a manufacturing process that produces a V-shape, U-shape, or channel shape along a straight axis in ductile materials, most commonly sheet metal. Commonly used equipment include brakes and other specialized machine presses.

2. Compaction: The roll compaction process takes finely sized powders, compresses these into a solid shape which can be a flat sheet, corrugated sheet and or in stick form. This is accomplished utilizing a roll compactor. Roll compactors are similar in design to roll briquettes, however higher compaction.

3. Sintering: It involves raising the temperature of the green compact, (pressed powder part), to a certain level and keeping it at that temperature for a certain amount of time. The sintering temperature is usually between 70% and 90% of the melting point of the powder metal. This will cause bonding mechanisms to occur between powders particles pressed together in the compact.

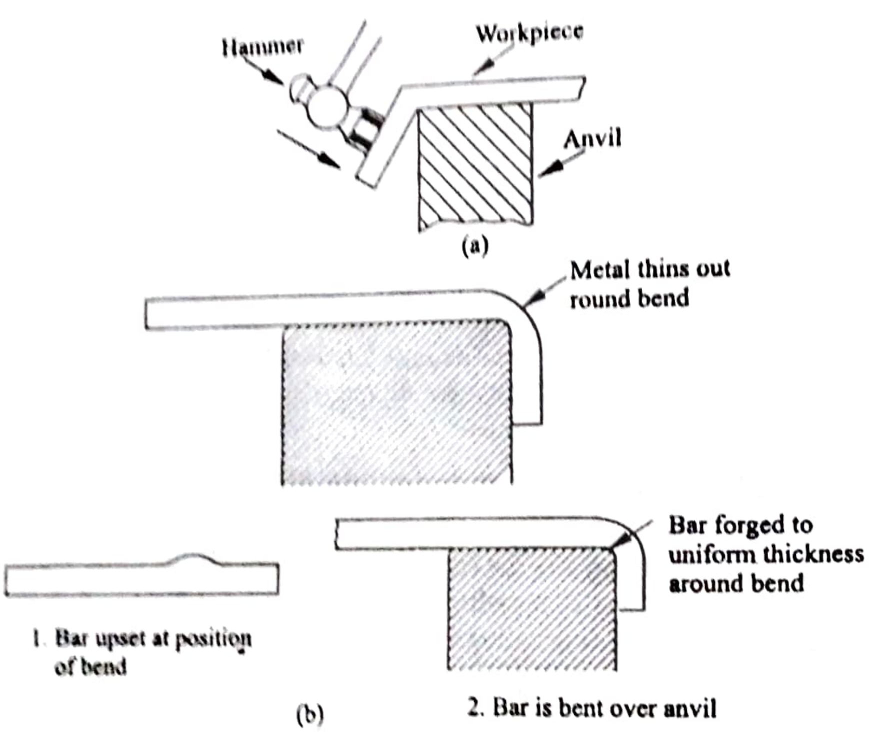
Q. 8. (a) Explain types of sheet metal operations: shearing, drawing and bending. **(8)**

Ans. Shearing, also known as die cutting, is a process which cuts stock without the formation of chips or the use of burning or melting. Strictly speaking, if the cutting blades are straight the process is called shearing; if the cutting blades are curved then they are shearing-type oper3ations. The most commonly sheared materials are the form of sheet metal or plates, however rods can also be sheared. Shearing-type operations include; blanking, piercing, roll sitting, and trimming. It is used in metalworking and also with paper and plastics.

Principle: A punch (or moving blade) is used to push a workpiece aganist the die (or fixed blade), which is fixed. Usually the clearance between the two is 5 to 40% tof the thickness of the material, but dependent on the material. Clearance is defined as the separation between the blades, measured at the point where the cutting action takes place and perpendicular to the direction of blade movement. It affects the finish of the cut (burr) and the machine's power consumption. This causes the material to experience highly localized shear stresses between the punch and die. The material will then fail when the punch has moved 15 to 60% the thickness of the material, because the shear stresses are greater than the shear strength of the material and the remainder of the material is torn. Two distinct sections can be seen on a sheared workpiece, the first part being plastic deformation and the second being fractured. Because of normal inhomogeneities in materials and inconsistencies in clearance between the punch and die, the shearing action does not occur in a uniform manner. The fracture will begin at the weakest point and progress to the next weakest point until the entire workpiece has been sheared; this is what causes the rough edge. The rough edge can be reduced if the workpiece is clamped from the top with a die cushion. Above a certain pressure the fracture zone can be completely eliminated. However, the sheared edge of the workpiece will usually experience workhardening and cracking. If the workpiece has too much clearance, then it may experience roll-over or heavy burring.

Bending

- Bending is a very common forging operation.
- The simplest method of bending a piece of metal in hand forging is to support it on the anvil and to strike its free end with a hammer.
- When bent, the metal of the workpiece thins out round bend causing weakness. This can be overcome by upsetting the bar prior to bending.



Bending operation

Wire Drawing: The wire obtained from the rolling mills are first pickled, washed and then dried. The end of the wire is then reduced in dimater (swaging) and passed through the die opening. Then this end is attached to the draw block, which pulls the wire. The contact region of the die is generally made up wear resistant tungsten carbide or polycrystalline manufactured diamond. Lubrication is also done to reduce the friction and to prevent the wear of the dies.

If large reduction is needed, then these are passed continously from one station to another. After passing through all the dies in a tandem machine, the material usually requires an intermediate anneal and for maximum ductility and conductivity, the wire should be annealed in controlled atmosphere furnaces after the final draw.

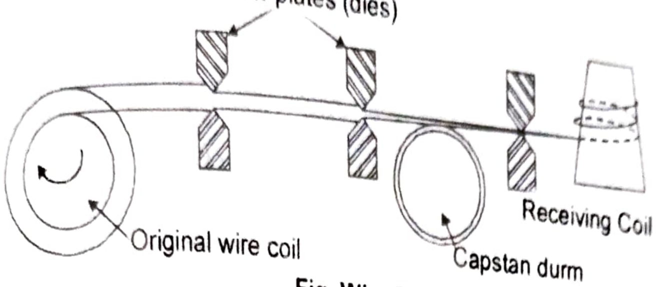


Fig. Wire Drawing.

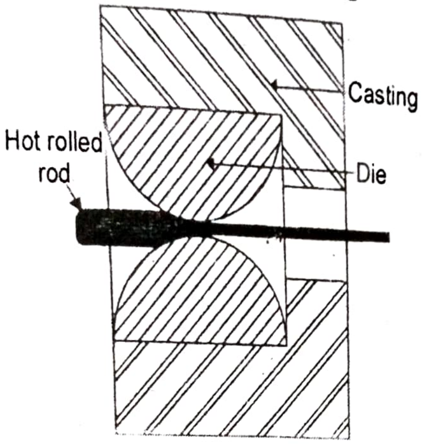


Fig. Wire Drawing Die

Q. 8. (b) Compare embossing and coining with suitable diagram and applications. **(4.5)**

Ans. Embossing:

- It is the operation used in making raised figures on sheets, with corresponding relief on the other side.

- The die set consist of punch and die with desired contours, so that when both meet (die and punch) then clearance between them is same as that of sheet thickness.

- Embossing is used for providing dimples on sheet to increase their rigidity and for decorative sheet work used for panels in houses.

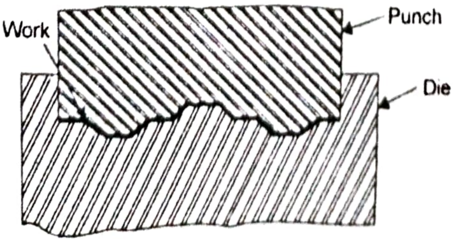


Fig. : (Embossing)

Coining:

• It is essentially a cold forging operation, here the flow of metals occurs only at the top layers and not the entire volume.

• The coining die consist of punch and die which are engraved with the neccessary details required on both sides of the final object.

• The pressure involved in coining are very high of order of 1600 MPa

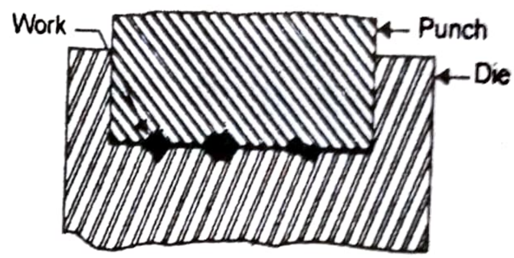


Fig. (Coining)

• Coining is used for making coins, medals and similar materials and for imperssions on the decorative terms.

FIRST TERM EXAMINATION [SEP.2017]
FIRST SEMESTER [B.TECH.]
MAUNFACTURING PROCESS [ETME-105]

Time : 1.30 hrs. M.M. : 30

Note: *Attempt any three question in all and Q.1 is compulsory.*

Q.1. (a) State the functions of a Riser. (1)

Ans. A **riser**, also known as a feeder, is a reservoir built into a metal casting mold to prevent cavities due to shrinkage. Most metals are less dense as a liquid than as a solid so castings shrink upon cooling, which can leave a void at the last point to solidify.

Q.1. (b) The ability of the moulding sand to withstand the heat of melt without showing any sign of softening is called as (1)

a. Strength or cohesiveness

b. Refractiveness

c. Collapsibility

d. Adhesiveness

Ans. Refractiveness

Q.1. What are core prints and chaplets? (1)

Ans. Chaplets - Chaplets are used to support a core from the bottom,or to anchor it from the top to prevent floating.However,it is quite as important to secure it against lateral shifting due to unequal pressure of the metal while pouring.

Core Prints - Core print is an open space provided in the mold for locating, positioning and supporting the core.

The core can't not be suspended inside the cavity without any support. So the space in the mold is needed. The core print is prepared with the help of projections on the pattern. But the problem is, while removing the pattern, the mold will get damaged due to the presence of projections on the pattern. Hence split pattern is used for casting process in which the core is used.

Q.1. (d) What is a pattern? Name different types of pattern. (1)

Ans. Pattern - In casting, a 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. Patterns used in sand casting may be made of wood, metal, plastics or other materials.

Types of Pattern

- Solid or single piece pattern.
- Split pattern or two piece pattern.
- Multi-piece pattern.
- Cope and drag pattern.
- Match plate pattern.
- Gated pattern.
- Skeleton pattern.
- sweep pattern sand casting.

Q.1. (e) Define the Premeability and why it is necessary? (1)

Ans. Permeability is a property of foundry sand with respect to how well the sand can vent, i.e. how well gases pass through the sand. And in other words, permeability is the property by which we can know the ability of material to transmit fluid/gases.

Permeability is a property of foundry sand with respect to how well the sand can vent, i.e. how well gases pass through the sand. And in other words, permeability is the property by which we can know the ability of material to transmit fluid/gases. The permeability is commonly tested to see if it is correct for the casting conditions.

Q.1. (f) What are the desirable properties of moulding sand?

Ans. Properties of Molding sand (1)

- Adhesiveness. ...
- Cohesiveness. ...
- Collapsibility. ...
- Dry strength. ...
- Flowability or plasticity. ...
- Green strength. ...
- Permeability. ...
- Refractoriness.

Q.1. (g) What is forging? (1)

Ans. Forging is a manufacturing process involving the shaping of metalusing localized compressive forces. The blows are delivered with a hammer (often a power hammer) or a die. Forging is often classified according to the temperature at which it is performed: cold forging (a type of cold working), warm forging, or hot forging (a type of hot working).

Q.1. (h) Distinguish between ductility and malleability. (1)

Ans. Ductility is said to be the property of a material to stretch without getting damaged. Metals having ductile property can be stretched into wires. ... Malleability is said to be the property of a material to deform under compression. The metals having **malleable** property can be rolled or beaten into sheets.

Q.1. (i) Distinguish between Hot working and Cold working. (1)

Ans. Difference between Hot Working and Cold Working: When plastic deformation of metal is carried out at temperature above the recrystallization temperature the process, the process is known as hot working. If this deformation is done below the recrystallization temperature the process is known as cold working.

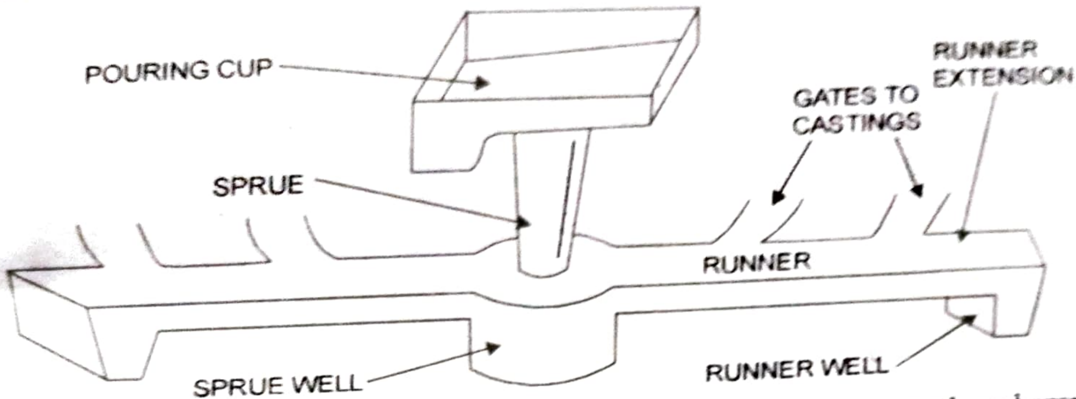
Q.1. (j) Mention any four requirements of a good pattern. (1)

Ans. Typically, materials used for pattern making are wood, metal or plastics. Wax and Plaster of Paris are also used, but only for specialized applications. Mahogany is the most commonly used material for patterns, primarily because it is soft, light, and easy to work, but also once properly cured it is about as stable as any wood available, not subject to warping or curling. Once the pattern is built the foundry does not want it changing shape. The downside is that it wears out fast, and is prone to moisture attack. Metal patterns are more long lasting, and do not succumb to moisture, but they are heavier and difficult to repair once damaged.

Sprues, gates, risers, cores, and chills- these are also the requirements for good designs .

Q. 2. Write the principle of casting and Explain the Gating system in detail with neat sketch. (10)

Ans. Principle Of casting - Casting is a manufacturing process in which a liquid material is usually poured into a mold, 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 mold to complete the process. Casting materials are usually metals or various *cold setting* materials that cure after mixing two or more components together; examples are epoxy, concrete, plaster and clay. Casting is most often used for making complex shapes that would be otherwise difficult or uneconomical to make by other methods.



It is nothing but the basic design, which is needed to construct a smooth and proper filling of the mold cavity of the casting without any discontinuity, voids or solid inclusions. A proper method of gating system is that it leads the pure molten metal to flow through a ladle to the casting cavity, which ensures proper and smooth filling of the cavity. This depends on the layout of the gating channels too, such as the direction and the position of the runner, sprue and ingates.

Objective of the Gating System :

The four main points, which enables a proper gating system, are:

- Clean molten metal.
- Smooth filling of the casting cavity.
- Uniform filling of the casting cavity.
- Complete filling of the casting cavity.

The mold cavity must be filled with a clean metal so that it prevents the entry of slag and inclusions into the mold cavity, which in turn minimizes the surface instability. If the mold has smooth filling then it helps to reduce the bulk turbulence. If it has a uniform filling it means that the casting fill is in a controlled manner. Complete filling of the cavity makes the metal thin with minimum resistance at the end sections.

Procedure :

The main elements needed for the gating system are as follows:

- Pouring basin or bush.
- Sprue or downspure.
- Sprue Well
- Runner
- Ingate
- Ladle
- Slag trap or filter.

The characteristics of each element are mentioned below:

- **Pouring basin :** This is otherwise called as bush or cup. It is circular or rectangular in shape. It collects the molten metal, which is poured, from the ladle

- **Sprue :** It is circular in cross section. It leads the molten metal from the pouring basin to the sprue well.
- **Sprue Well:** It changes the direction of flow of the molten metal to right angle and passes it to the runner.
- **Runner:** The runner takes the molten metal from sprue to the casting. Ingate: This is the final stage where the molten metal moves from the runner to the mold cavity.
- **Slag trap:** It filters the slag when the molten metal moves from the runner and ingate. It is also placed in the runner.

Types of Gating Systems:

The gating system also depends on the direction of the parting plane, which contains the sprue, runner and the ingate. They are as follows:

Horizontal Gating System: This is used most widely. This type is normally applied in ferrous metal's sand casting and gravity die-casting of non-ferrous metals. They are used for flat casting, which are filled under gravity.

Vertical Gating System: This is applied in tall castings were high-pressure sand mold, shell mold and die-casting processes are done. Top Gating System : this is applied in places where the hot metal is poured form the top of the casting. It helps directional solidification of the casting from top to bottom. It suits only flat castings to limit the damage of the metal during the initial filling.

Bottom Gating System: it is used in tall castings where the molten metal enters the casting through the bottom.

Middle Gating System: It has the characteristics of both the top and bottom.

Q. 3. Explain the method of investment casting with neat sketch. Also mention its advantages and disadvantages. **(10)**

Ans. Refer to Q.4. (a) First Term Examination 2016. (Page 4,5,6)

Advantages of Investment casting

1. Many Intricate forms with undercuts can be cast.
2. A very smooth surface is obtained with no parting line.
3. Dimensional accuracy is good.
4. Certain unmachinable parts can be cast to preplanned shape.
5. It may be used to replace die casting where short runs are involved.

Disadvantages of Investment casting

1. This process is expensive, is usually limited to small casting, and presents some difficulties where cores are involved.

2. Holes cannot be smaller than 1/16 in. (1.6 mm) and should be no deeper than about 1.5 times the diameter.

3. Investment castings require very long production-cycle times versus other casting processes.

4. This process is practically infeasible for high-volume manufacturing, due to its high cost and long cycle times.

5. Many of the advantages of the investment casting process can be achieved through other casting techniques if principles of thermal design and control are applied appropriately to existing processes that do not involve the shortcomings of investment castings.

Q. 4. State and explain casting defects and causes with neat diagrams. (10)

Ans. A casting defect is an undesired irregularity in a metal casting process. Some defects can be tolerated while others can be repaired, otherwise they must be eliminated. They are broken down into five main categories: gas porosity, shrinkage defects, mold material defects, pouring metal defects, and metallurgical defects.

Manufacturing Technology

Casting Defects

• There are numerous opportunities in the casting operation for different defects to appear in the cast product. Some of them are common to all casting processes:

• **Misruns:** Casting solidifies before completely fill the mold. Reasons are low pouring temperature, slow pouring or thin cross section of casting.

Cold shut: Two portions flow together but without fusion between them, Causes are similar to those of a misrun.

Cold shots: When splattering occurs during pouring, solid globules of metal are entrapped in the casting. Proper gating system designs could avoid this defect.

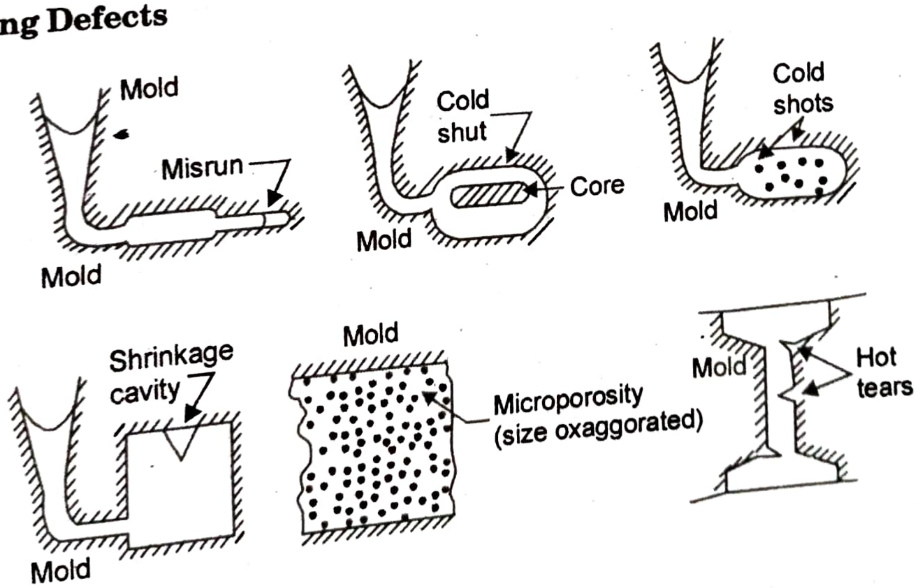
Shrinkage cavity: Voids resulting from shrinkage. The problem can often be solved by proper riser design but may require some changes in the part design as well.

Micro-porosity: Network of small voids distributed throughout the casting. The defect occurs more aften in alloys, because of the manner they solidify.

Hot tearing: Cracks caused by low mold collapsibility. They occurs when the material is restrained from contraction during solidification. A proper mold design can solve this problem.

Manufacturing Technology

Casting Defects



END TERM EXAMINATION [DEC-2017]
FIRST SEMESTER [B.TECH.]
MANUFACTURING PROCESS [ETME-105]

Time : 3 hrs. **M.M. : 75**

Note: *Attempt all questions. Internal choice is indicated.*

Q.1. (a) Write short note on the followings.

Q.1. (a) Pattern, allowances. (5)

Ans. Pattern: A pattern may be defined as a model of desired casting which when moulded in sand forms an impression called mould. The mould when filled with the molten metal forms casting after solidification of the poured metal. The quality and accuracy of casting depends upon the pattern making. The pattern may be made of wood, metal(cast iron, brass, aluminium and alloy steel.), plaster, plastics and wax.

Pattern Allowances: A pattern is always made larger than the required size of the casting considering the various allowances. These are the allowances which are usually provided in a pattern.

1. Shrinkage or contraction allowance: The various metals used for casting contract after solidification in the mould. Since the contraction is different for different materials, therefore it will also differ with the form or type of metal.

2. Draft allowance: It is a taper which is given to all the vertical walls of the pattern for easy and clean withdraw of the pattern from the sand without damaging the mould cavity. It may be expressed in millimeters on a side or in degrees. The amount of taper varies with the type of patterns. The wooden patterns require more taper than metal patterns because of the greater frictional resistance of the wooden surfaces.

3. Finish or machining allowance: The allowance is provided on the pattern if the casting is to be machined. This allowance is given in addition to shrinkage allowance. The amount of this allowance varies from 1.6 to 12.5 mm which depends upon the type of the casting metal, size and the shape of the casting. The ferrous metals require more machining allowance than non ferrous metals.

4. Distortion or camber allowance: This allowance is provided on patterns used for casting of such design in which the contraction is not uniform throughout.

5. Rapping or shaking allowance: This allowance is provided in the pattern to compensate for the rapping of mould because the pattern is to be rapped before removing it from the mould.

Q.1. (b) Classification of carbon steels. (5)

Ans. Carbon steel is an alloy consisting of iron and carbon. Several other elements are allowed in carbon steel, with low maximum percentages. These elements are manganese, with a 1.65% maximum, silicon, with a 0.60% maximum, and copper, with a 0.60% maximum. Other elements may be present in quantities too small to affect its properties.

GRADES OF CARBON AND ALLOY STEEL

There are four types of carbon steel based on the amount of carbon present in the alloy. Lower carbon steels are softer and more easily formed, and steels with a higher carbon content are harder and stronger, but less ductile, and they become more difficult to machine and weld. Below are the properties of the grades of carbon steel:

- **Low Carbon Steel** – Composition of 0.05%-0.25% carbon and up to 0.4% manganese. Also known as mild steel, it is a low-cost material that is easy to shape. While not as hard as higher-carbon steels, carburizing can increase its surface hardness.
- **Medium Carbon Steel** – Composition of 0.29%-0.54% carbon, with 0.60%-1.65% manganese. Medium carbon steel is ductile and strong, with long-wearing properties.
- **High Carbon Steel** – Composition of 0.55%-0.95% carbon, with 0.30%-0.90% manganese. It is very strong and holds shape memory well, making it ideal for springs and wire.
- **Very High Carbon Steel** - Composition of 0.96%-2.1% carbon. Its high carbon content makes it an extremely strong material. Due to its brittleness, this grade requires special handling.

Q.1. (c) Forging defects and their remedies. (5)

Ans. Forging defects

1. Incomplete forging penetration: - Dendritic ingot structure at the interior of forging is not broken. Actual forging takes place only at the surface. - Cause: Use of light rapid hammer blows - **Remedy:** To use forging press for full penetration.

2. Surface Cracking - Cause: Excessive working on the surface and too low temperature. High sulfur in furnace leading to hot shortness - **Remedy:** To increase the work temperature 19

3. Cracking at the flash: - This crack penetrates into the interior after flash is trimmed off. - Cause: Very thin flash - **Remedy:**-Increasing flash thickness, relocating the flash to a less critical region of the forging, hot trimming and stress relieving.

4. Cold shut (Fold) • Two surfaces of metal fold against each other without welding completely • Cause: Sharp corner (less fillet), excessive chilling, high friction • **Remedy:** increase fillet radius on the die

5. Scale pockets and Underfills: • They are loose scale/ lubricant residue which accumulate in deep recesses of the die. • Cause: Incomplete descaling of the work • **Remedy:** Proper decaling of work prior to forging

6. Internal cracks Cause: Secondary tensile stresses developed during forging Remedy: Proper die design Residual stresses in Forging: Causes: Inhomogeneous deformation and improper cooling (quenching) of forging. **Remedy:** Slow cooling of the forging in a furnace or under ash cover over a period of time.

Q.1. (d) Give the necessity of flux and its composition. (5)

Ans. In metallurgy, a flux (derived from Latin *fluxus* meaning "flow") is a chemical cleaning agent, flowing agent, or purifying agent. Fluxes may have more than one function at a time. They are used in both extractive metallurgy and metal joining.

Composition

Organic fluxes typically consist of four major components:

Activators - Chemicals disrupting/dissolving the metal oxides. Their role is to expose unoxidized, easily wettable metal surface and aid soldering by other means, e.g. by exchange reactions with the base metals.

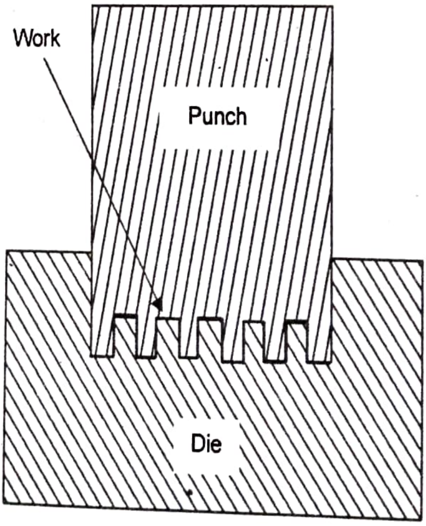
- Highly active fluxes contain chemicals that are corrosive at room temperature. The compounds used include metal halides (most often zinc chloride or ammonium chloride), hydrochloric acid, phosphoric acid, and hydrobromic acid. Salts of mineral acids with amines are also used as aggressive activators. Aggressive fluxes typically facilitate corrosion, require careful removal, and are unsuitable for finer work. Activators for fluxes for soldering and brazing aluminium often contain fluorides.

- Milder activators begin to react with oxides only at elevated temperature. Typical compounds used are carboxylic acids(e.g. fatty acids (most often oleic acid and stearic acid), dicarboxylic acids) and sometimes amino acids. Some milder fluxes also contain halides or organohalides.
- **Vehicles** - High-temperature tolerant chemicals in the form of non-volatile liquids or solids with suitable melting point; they are generally liquid at soldering temperatures. Their role is to act as an oxygen barrier to protect the hot metal surface against oxidation, to dissolve the reaction products of activators and oxides and carry them away from the metal surface, and to facilitate heat transfer. Solid vehicles tend to be based on natural or modified rosin (mostly abietic acid, pimaric acid, and other resin acids) or natural or synthetic resins. Water-soluble organic fluxes tend to contain vehicles based on high-boiling polyols - glycols, diethylene glycol and higher polyglycols, polyglycol-based surfactants and glycerol.
- **Solvents** - Added to facilitate processing and deposition to the joint. Solvents are typically dried out during preheating before the soldering operation; incomplete solvent removal may lead to boiling off and spattering of solder paste particles or molten solder.
- **Additives** - Numerous other chemicals modifying the flux properties. Additives can be surfactants (especially nonionic), corrosion inhibitors, stabilizers and antioxidants, tackifiers, thickeners and other rheological modifiers (especially for solder pastes), plasticizers (especially for flux-cored solders), and dyes.

Q.1. (e) Explain and differentiate embossing and coining giving their uses. (5)

Ans. Embossing: It is a metal forming process for producing raised of sunken designs using matched male and female dies.

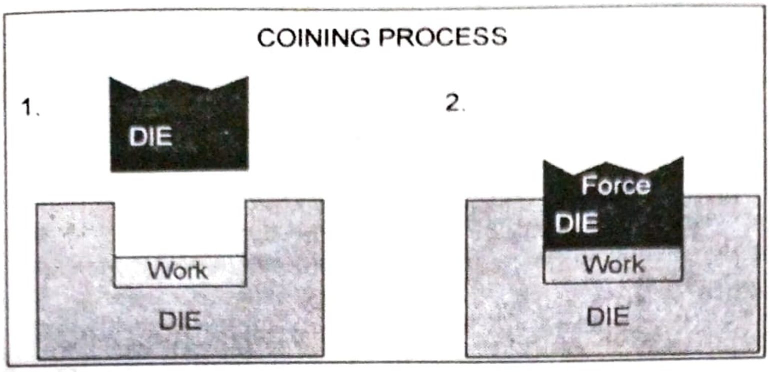
The design is uniform and throughout the thickness of the sheet metal.



Examples : Vehicle number plates, jewellry etc.

Coining: It is a metal squeezing operation where the male and female dies are different (not matching). The flow occurs only and the top and bottom layers of the metal.

The design on the top and bottom are not the same.



Examples: Coins, medals etc.

The main difference between the two operations is the design created, if the metal has same design on both sides (one raised and one depressed) then it is embossing and in case of coining, the design is different on both sides of the metal.

Q.2. What are alloy steels? Discuss various heat treatment processes of carbon steels. (12.5)

Ans. Alloy steel is steel that is alloyed with a variety of elements in total amounts between 1.0% and 50% by weight to improve its mechanical properties. Alloy steels are broken down arbitrarily: Smith and Hashemi define the difference at 4.0%, while Degarmo, et al., define it at 8.0%. Most commonly, the phrase "alloy steel" refers to low-alloy steels.

Strictly speaking, every steel is an alloy, but not all steels are called "alloy steels". The simplest steels are iron (Fe) alloyed with carbon (C) (about 0.1% to 1%, depending on type). However, the term "alloy steel" is the standard term referring to steels with other alloying elements added deliberately in addition to the carbon. Common alloyants include manganese (the most common one), nickel, chromium, molybdenum, vanadium, silicon, and boron. Less common alloyants include aluminum, cobalt, copper, cerium, niobium, titanium, tungsten, tin, zinc, lead, and zirconium.

Heat treating (or **heat treatment**) is a group of industrial and metalworking processes used to alter the physical, and sometimes chemical, properties of a material. The most common application is metallurgical. Heat treatments are also used in the manufacture of many other materials, such as glass. Heat treatment involves the use of heating or chilling, normally to extreme temperatures, to achieve a desired result such as hardening or softening of a material. Heat treatment techniques include annealing, case hardening, precipitation strengthening, tempering, normalizing and quenching.

Various Processes are:

Annealings

Main article: Annealing (metallurgy)

Annealing consists of heating a metal to a specific temperature and then cooling at a rate that will produce a refined microstructure, either fully or partially separating the constituents. The rate of cooling is generally slow. Annealing is most often used to soften a metal for cold working, to improve machinability, or to enhance properties like electrical conductivity.

In ferrous alloys, annealing is usually accomplished by heating the metal beyond the upper critical temperature and then cooling very slowly, resulting in the formation of pearlite. In both pure metals and many alloys that can not be heat treated, annealing is used to remove the hardness caused by cold working. The metal is heated to a temperature where recrystallization can occur, thereby repairing the defects caused by plastic deformation. In these metals, the rate of cooling will usually have little effect. Most non-ferrous alloys that are heat-treatable are also annealed to relieve the hardness of cold working. These may be slowly cooled to allow full precipitation of the constituents and produce a refined microstructure.

Ferrous alloys are usually either "full annealed" or "process annealed." Full annealing requires very slow cooling rates, in order to form coarse pearlite. In process annealing, the cooling rate may be faster; up to, and including normalizing. The main goal of process annealing is to produce a uniform microstructure. Non-ferrous alloys are often subjected to a variety of annealing techniques, including "recrystallization annealing," "partial annealing," "full annealing," and "final annealing." Not all annealing techniques involve recrystallization, such as stress relieving.

Normalizing: Normalizing is a technique used to provide uniformity in grain size and composition (equiaxing) throughout an alloy. The term is often used for ferrous alloys that have been austenized and then cooled in open air. Normalizing not only produces pearlite, but also martensite and sometimes bainite, which gives harder and stronger steel, but with less ductility for the same composition than full annealing.

Stress relieving: Stress relieving is a technique to remove or reduce the internal stresses created in a metal. These stresses may be caused in a number of ways, ranging from cold working to non-uniform cooling. Stress relieving is usually accomplished by heating a metal below the lower critical temperature and then cooling uniformly.[21] Stress relieving is commonly used on items like air tanks, boilers and other pressure vessels, to remove all stresses created during the welding process.

Aging

Main article: Precipitation hardening

Some metals are classified as *precipitation hardening metals*. When a precipitation hardening alloy is quenched, its alloying elements will be trapped in solution, resulting in a soft metal. Aging a "solutionized" metal will allow the alloying elements to diffuse through the microstructure and form intermetallic particles. These intermetallic particles will nucleate and fall out of solution and act as a reinforcing phase, thereby increasing the strength of the alloy. Alloys may age "naturally" meaning that the precipitates form at room temperature, or they may age "artificially" when precipitates only form at elevated temperatures. In some applications, naturally aging alloys may be stored in a freezer to prevent hardening until after further operations - assembly of rivets, for example, may be easier with a softer part.

Examples of precipitation hardening alloys include 2000 series, 6000 series, and 7000 series aluminium alloy, as well as some superalloys and some stainless steels. Steels that harden by aging are typically referred to as maraging steels, from a combination of the term "martensite aging.

Quenching

Main article: Quenching

Quenching is a process of cooling a metal at a rapid rate. This is most often done to produce a martensite transformation. In ferrous alloys, this will often produce a harder metal, while non-ferrous alloys will usually become softer than normal.

To harden by quenching, a metal (usually steel or cast iron) must be heated above the upper critical temperature and then quickly cooled. Depending on the alloy and other considerations (such as concern for maximum hardness vs. cracking and distortion), cooling may be done with forced air or other gases, (such as nitrogen). Liquids may be used, due to their better thermal conductivity, such as oil, water, a polymer dissolved in water, or a brine. Upon being rapidly cooled, a portion of austenite (dependent on alloy composition) will transform to martensite, a hard, brittle crystalline structure. The quenched hardness of a metal depends on its chemical composition and quenching method. Cooling speeds, from fastest to slowest, go from brine, polymer (i.e. mixtures of water + glycol polymers), fresh water, oil, and forced air. However, quenching a certain steel too fast can result in cracking, which is why high-tensile steels such as AISI 4140 should be quenched in oil, tool steels such as ISO 1.2767 or H13 hot work tool steel should be quenched in forced air, and low alloy or medium-tensile steels such as XK1320 or AISI 1040 should be quenched in brine.

Some Beta titanium based alloys have also shown similar trends of increased strength through rapid cooling. However, most non-ferrous metals, like alloys of copper, aluminum, or nickel, and some high alloy steels such as austenitic stainless steel (304, 316), produce an opposite effect when these are quenched: they soften. Austenitic stainless steels must be quenched to become fully corrosion resistant, as they work-harden significantly.

Tempering

Main article: Tempering (metallurgy)

Untempered martensitic steel, while very hard, is too brittle to be useful for most applications. A method for alleviating this problem is called tempering. Most applications require that quenched parts be tempered. Tempering consists of heating steel below the lower critical temperature, (often from 400 to 1105 °F or 205 to 595 °C, depending on the desired results), to impart some toughness. Higher tempering temperatures (may be up to 1,300 °F or 700 °C, depending on the alloy and application) are sometimes used to impart further ductility, although some yield strength is lost.

Tempering may also be performed on normalized steels. Other methods of tempering consist of quenching to a specific temperature, which is above the martensite start temperature, and then holding it there until pure bainite can form or internal stresses can be relieved. These include austempering and martempering.

OR

Q.2. Describe imvestment casting process with neat diagram, its uses and limitations. (12.5)

Ans. Refer to Q. 3. First Term Examination, 2017.

Disadvantages of Investment casting

1. This process is expensive, is usually limited to small casting, and presents some difficulties where cores are involved.

2. Holes cannot be smaller than 1/16 in. (1.6 mm) and should be no deeper than about 1.5 times the diameter.

3. Investment castings require very long production-cycle times versus other casting processes.

4. This process is practically infeasible for high-volume manufacturing, due to its high cost and long cycle times.

5. Many of the advantages of the investment casting process can be achieved through other casting techniques if principles of thermal design and control are applied appropriately to existing processes that do not involve the shortcomings of investment castings.

Applications: Investment casting is used in the aerospace and power generation industries to produce turbine blades with complex shapes or cooling systems. Blades produced by investment casting can include single-crystal (SX), directionally solidified (DS), or conventional equiaxed blades. Investment casting is also widely used by firearms manufacturers to fabricate firearm receivers, triggers, hammers, and other precision parts at low cost. Other industries that use standard investment-cast parts include military, medical, commercial and automotive.

Q.3. Explain various forging process giving the tools required and their uses. (12.5)

Ans. Types of Forging Processes

There are basically three methods (or processes) to make a forged part.

1. Impression Die Forging
2. Cold Forging
3. Open Die Forging
4. Seamless Rolled Ring Forging

There is a wide variety of processes that can be classified under the above definition of forging. This manual will address five: open die, impression die, ring rolling, warm forging and cold forging. Cold forging is performed at or near room temperature, and work hardening occurs. The other processes are performed at elevated temperatures, where work hardening is diminished or the workpiece is not work hardened at all.

Open Die Forging is a hot forming process, which uses standard flat, "V" or swage dies. The hot workpiece temperature improves plastic flow characteristics and reduces the force required to work the metal. The desired shape is systematically formed by a relatively large number of strokes.

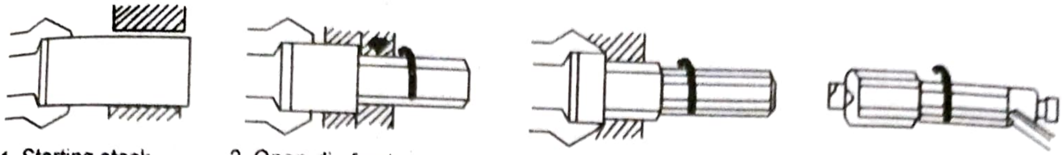
Open die forging is normally used to produce large parts, which are often well beyond the range of impression die processes. It is sometimes used to produce substantially the same shapes as impression die. In these applications it offers no chargeable tooling cost and very short lead time. However, per-piece processing costs are higher, dimensional precision is not as good, and more finish machining operations are required compared with impression die forging. The process is shown schematically in Figure shown

Impression Die Forging utilizes a pair of matched dies with contoured impressions in each die. When the dies close, the impressions form a cavity in the shape of the forging. Often two or more progressive impressions are used, sometimes in conjunction with one or more preforming operations, to form the desired shape. The proper forging temperature improves plastic flow characteristics and reduces the forces on the forging tools. The process is shown schematically in Figure shown

Ring Rolling forms axisymmetric shapes in a hot forming process. The process begins with a "donut" shaped preform, which is made by upsetting and piercing operations. The preform is placed over the idler or mandrel roll in a ring rolling mill. The idler roll is moved toward a drive roll, which rotates to reduce the wall and increase the diameter, while forming the desired shape. The process is shown schematically in Figure shown Cross sections of typical ring rolled shapes are shown in Figure shown.

Process Operations

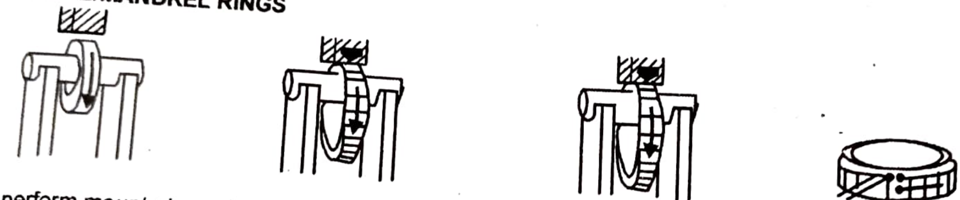
Shafts



1. Starting stock, held manipulator
2. Open-die forging
3. Progressive forging
4. Lathe turning to near net-shape

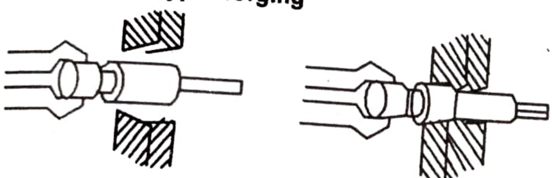
1. Starting stock
2. Preliminary upsetting
3. Progressive upsetting forging to dsc dimensions
4. Pierced for saddle',amdrel ring hollow "sleeve type" preform

SADDLE/MANDREL RINGS



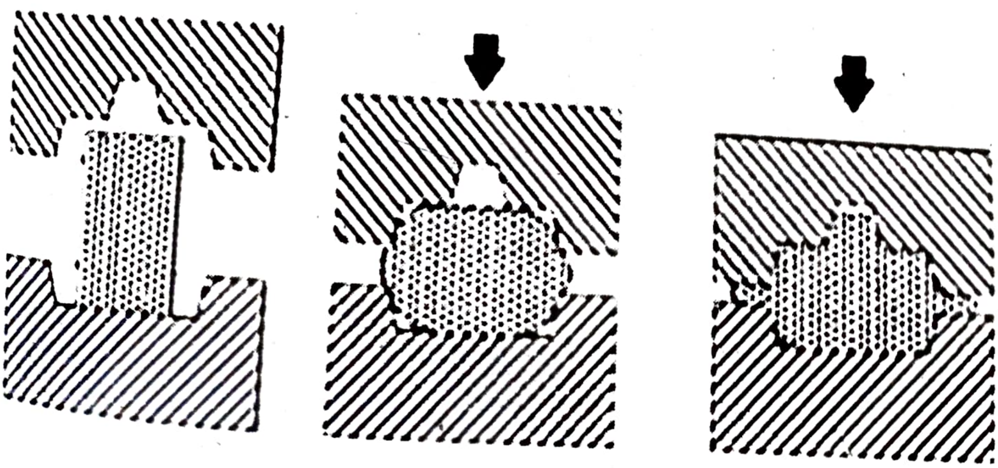
1. perform mounted on saddleimandrel
2. Metal displacement-reduce perform wall thickness to increase demeter
3. Progressive reduction of wal thickness to produce ring dimensions
4. Matching to near net shape

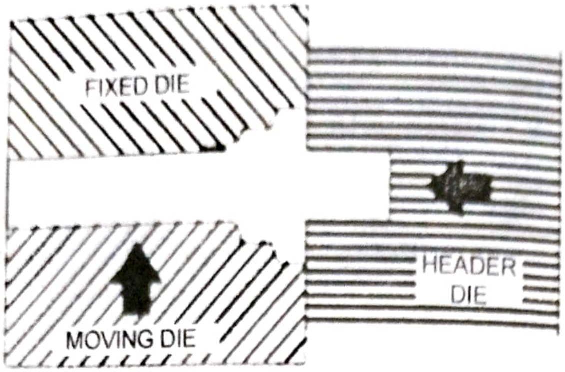
Hollow "Sleeve type" forging



1. Punched or trepanhned disc on tapered draw bar
2. Progressive reduction of outside diameter (inside damater remains constant) increases overall length of sleeve

Process Operation - UPSETTING





Cold Forging employs dies that are sometimes similar to impression dies. The temperature of the workpiece is low enough that scale does not form, but the workpiece work hardens. The lower temperature also promotes greater dimensional accuracy. However, the plastic flow characteristics are not as good at the reduced temperatures, and higher applied forces are required. The three basic cold forging processes are shown in Figure shown.

Warm forging is a modification of the cold forging process where the workpiece is heated to a temperature significantly below the typical hot forging temperature.

Forging offers the designer several basic performance advantages to a degree that sets it above alternate processes.

OR

Q.3. Describe the different tools used in fitting and thread cutting with neat diagram. **(12.5)**

Ans. It is the process of assembling and fitting at a right place, different parts of a machine manufactured by different manufacturing process."

It has been divided two categories:

1. Fitting tools
2. Fitting operations

FITTING SHOP TOOLS:

These are the helping hands while fitting and assembling a machine or a part of it. They can be hand driven or power driven. Some main fitting tools are listed below:

- Measuring tools
- Marking tools
- Holding and supporting tools
- Cutting and sawing tools
- Striking tools
- Drilling tools
- Threading tools
- Loosing and tightening tools

Measuring Tool: These tools are used to measure the basic quantities i.e. length, mass, diameter, radius etc. They are also used to Measure the extent or degrees of something.some basic tools in this respect are:

- **Vernier Calipers:** It is used to measure and calculate the diameter (internal or external), depth, and height, volume of sphere or cylinder. It is the most precise tool. And can calculate up to its least count. It consists of main scale and Vernier scale along with jaws for measuring internal diameter.

• **Internal calipers**: It is also known s inside calliper. It is used to measure the internal diameter. Its edges are turned outwards so that they hold workpiece. It is used to measure the diameter of a hole or width of a slot.

• **Steel ruler:** It is a simple integrated ruler of considerable long length. It is used to measure the length of workpiece .but it is not the accurate or precise way. It is used to integrate on workpiece before cutting or adjusting the length of hole for drilling. It is also used with callipers. It has two types:

• Flexible steel ruler

• Fixed steel ruler

Marking Tools: Marking refers to the process of mark something on workpiece to trace back to it. Marking out is the preliminary work of providing guide lines and centre before cutting or drilling.

Marking tools are described below:-

• **Scriber:** It is used to scratching a line or marking a point on workpiece before doing any operation on it. It is made up of hard material e.g. steel and has a sharp, pointed edge.

• **Divider:** It can be used for various purposes. Its basic purpose is to make a circle of required diameter on workpiece. Along with this, it can be used to measure the diameter of that circle and for measuring length. it has pointed legs.

• **Tri-scale:** It is used for marking at 90 degree. It is also used to check whether the workpiece has cutted at right angle or not. It is made up of metal blade fit at right angle to the straight wooden handle.

Cutting Tools: These tools help in removing or cutting the unwanted pieces of workpiece. They are used to re-size or adjust them according to required measurements.

• **Hand hacksaw:** It is used to cut the undesired part of wood or metal by using it's to and fro motion .its blades are sharp and tethered. It is made of high carbon steel. Blade is inside the frame adjusted by nuts. Various types of blades are available in market. The teeth are generally in forward direction. It must be used in straight direction otherwise blade will get damage.

• **Files:** Files are rubbed or slide against the work piece to get desired length. It is a multi-tooth tool. They are available in number of sizes, pitches and degree of corrosiveness. It is of various types as explained below:-

• **Rough file:** It is used for large cutting and hence workpiece length can b shortened to a considerable distance. It has 20 teeth per inch.

• **Smooth file:** It is used for less cutting and work piece length cannot b shortened to a large distance. It has 50-60 teeth per inch.

• **Square file:** It is square in shape and tapered towards the tip and usually double cut on all four sides. It is used in rectangular slots or groves.

Threading is the process of creating a screw thread. More screw threads are produced each year than any other machine element. There are many methods of generating threads, including subtractive methods (many kinds of thread cutting and grinding, as detailed below); deformative or transformative methods (rolling and forming; molding and casting); additivemethods (such as 3D printing); or combinations thereof.

TOOLS USED IN FITTING

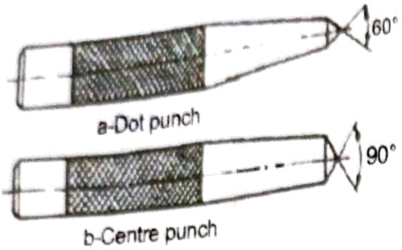


Fig. Punches

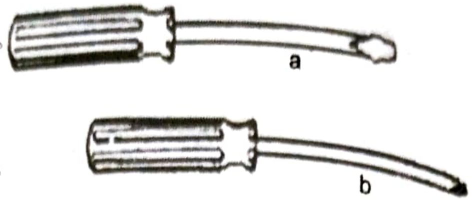


Fig. Screw drivers

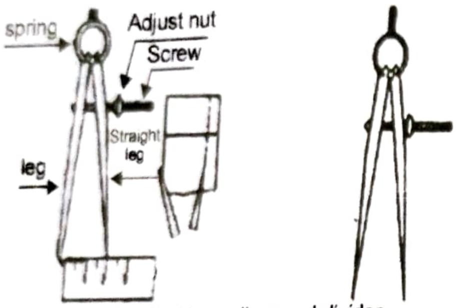
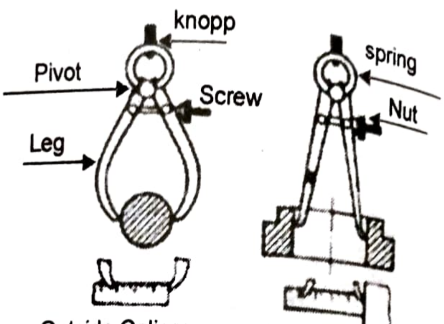


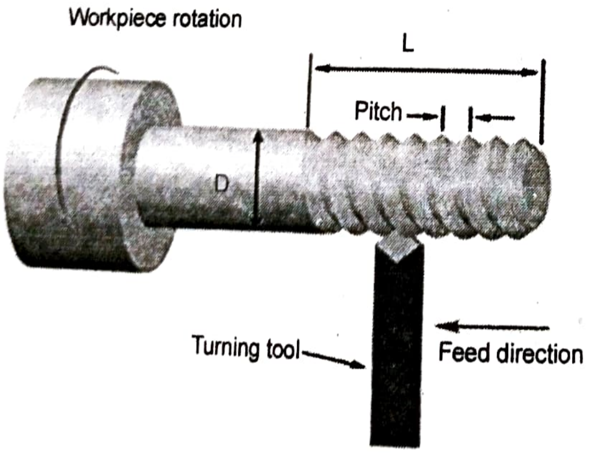
Fig. Odd leg caliper and divider



a-Outside Caliper

b-Inside Caliper

Threading is the process of creating a screw thread. More screw threads are produced each year than any other machine element.[1] There are many methods of generating threads, including subtractive methods (many kinds of thread cutting and grinding, as detailed below); deformative or transformative methods (rolling and forming; molding and casting); additivemethods (such as 3D printing); or combinations thereof.



Q.4. Give the classification of the welding processess and explain submerged arc welding with neat diagram. **(12.5)**

Ans. Welding is a process of joining two metal pieces as a result of significant diffusion of the atoms of the welded pieces into the joint (weld) region. Welding is carried out by heating the joined pieces to melting point and fusing them together (with or without filler material) or by applying pressure to the pieces in cold or heated state.

Advantages of welding:

- Strong and tight joining;
- Cost effectiveness;
- Simplicity of welded structures design;
- Welding processes may be mechanized and automated.

Disadvantages of welding:

- Internal stresses, distortions and changes of micro-structure in the weld region;
- Harmful effects: light, ultra violate radiation, fumes, high temperature.

Applications of welding:

- Buildings and bridges structures;
- Automotive, ship and aircraft constructions;
- Pipe lines;
- Tanks and vessels;
- Rairoads;
- Machinery elements.

Welding processes

→ Arc welding

- Carbon Arc Welding;
- Shielded Metal Arc Welding (SMAW);
- Submerged Arc Welding (SAW);
- Metal Inert Gas Welding (MIG, GMAW);
- Tungsten Inert Gas Arc Welding (TIG, GTAW);
- Electroslag Welding (ESW);
- Plasma Arc Welding (PAW);

→ Resistance Welding (RW);

- Spot Welding (RSW);
- Flash Welding (FW);
- Resistance Butt Welding (UW) ;
- Seam Welding (RSEW);

→ Gas Welding (GW);

- Oxyacetylene Welding (OAW);
- Oxyhydrogen Welding (OHW);
- Pressure Gas Welding (PGW);

→ Solid State Welding (SSW);

- Forge Welding (FOW);

- Cold Welding (CW);
- Friction Welding (FRW);
- Explosive Welding (EXW);
- Diffusion Welding (DFW);
- Ultrasonic Welding (USW);

→ Thermit Welding (TW);

→ Electron Beam Welding (EBW);

→ Laser Welding (LW).

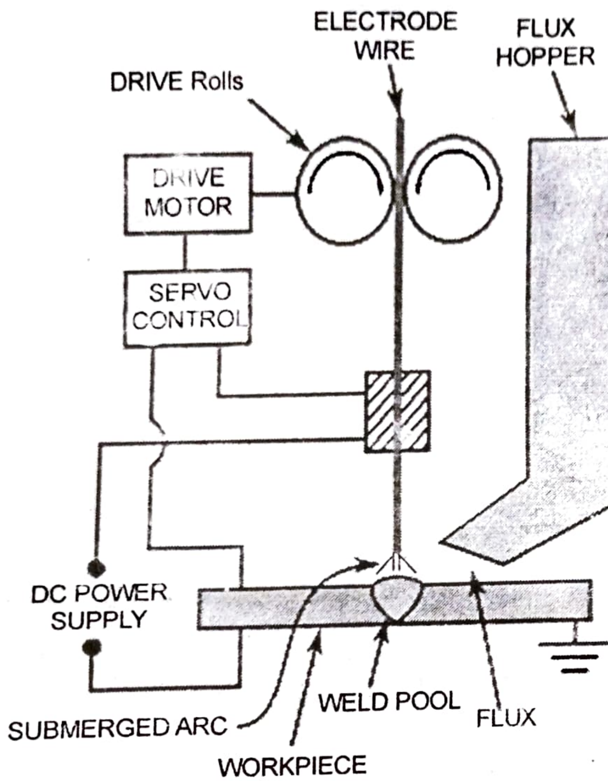
Submerged arc welding (SAW) is a common arc welding process. The first patent on the submerged-arc welding (SAW) process was taken out in 1935 and covered an electric arc beneath a bed of granulated flux. Originally developed and patented by Jones, Kennedy and Rothermund, the process requires a continuously fed consumable solid or tubular (metal cored) electrode. The molten weld and the arc zone are protected from atmospheric contamination by being "submerged" under a blanket of granular fusible flux consisting of lime, silica, manganese oxide, calcium fluoride, and other compounds. When molten, the flux becomes conductive, and provides a current path between the electrode and the work. This thick layer of flux completely covers the molten metal thus preventing spatter and sparks as well as suppressing the intense ultraviolet radiation and fumes that are a part of the shielded metal arc welding (SMAW) process.

Welding Operation: The flux starts depositing on the joint to be welded. Since the flux when cold is non-conductor of electricity, the arc may be struck either by touching the electrode with the work piece or by placing steel wool between electrode and job before switching on the welding current or by using a high frequency unit. In all cases the arc is struck under a cover of flux. Flux otherwise is an insulator but once it melts due to heat of the arc, it becomes highly conductive and hence the current flow is maintained between the electrode and the workpiece through the molten flux. The upper portion of the flux, in contact with atmosphere, which is visible remains granular (unchanged) and can be reused. The lower, melted flux becomes slag, which is waste material and must be removed after welding.

The electrode at a predetermined speed is continuously fed to the joint to be welded. In semi-automatic welding sets the welding head is moved manually along the joint. In automatic welding a separate drive moves either the welding head over the stationary job or the job moves/rotates under the stationary welding head.

The arc length is kept constant by using the principle of a self-adjusting arc. If the arc length decreases, arc voltage will increase, arc current and therefore burn-off rate will increase thereby causing the arc to lengthen. The reverse occurs if the arc length increases more than the normal.

A backing plate of steel or copper may be used to control penetration and to support large amounts of molten metal associated with the process.



OR

Q.4. Describe different electric resistance welding processes giving their uses. (12.5)

Ans. Resistance Welding – Spot, Seam, Projection and Flash Welding:

Principle: All resistance welding like spot welding, seam welding, projection welding etc. are worked on same principle of heat generation due to electric resistance. When a current passes through electric resistance, it produces heat. This is same principle which is used in electric coil. The amount of heat produced is depends on resistance of material, surface conditions, current supplied, time duration of current supplied etc. This heat generation takes place due to conversion of electric energy into thermal energy. The heat generation formula is

$$H = IxIRT$$

Where

H = Heat generated in joule

I = Electric current in ampere

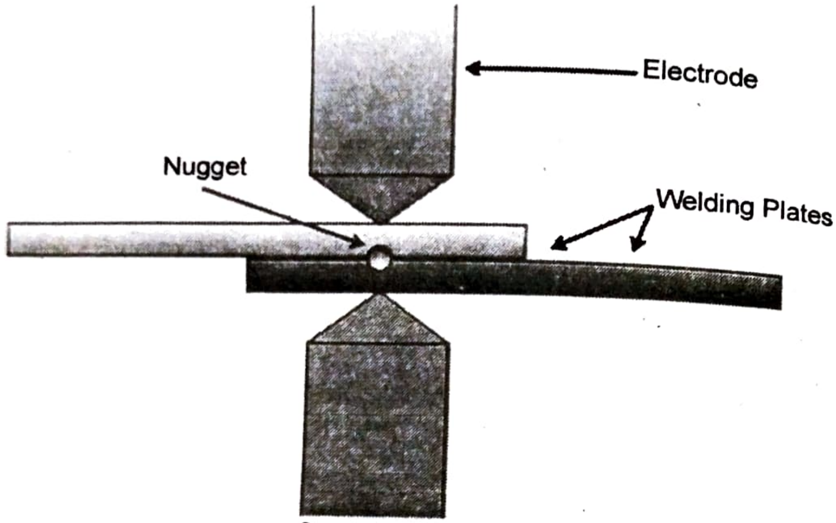
R = Electric resistance in Ohm

T = Time of current flow in second

This heat is used to melt the interface metal to form a strong weld joint by fusion. This process produces weld without application of any filler material, flux and shielding gases.

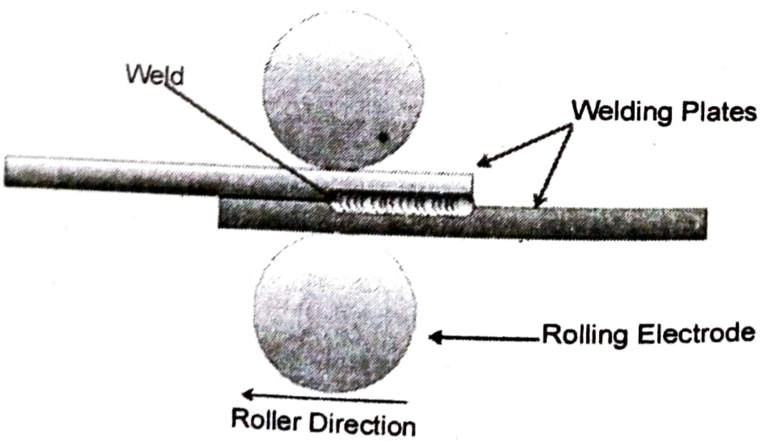
Types: There are four main type of resistance welding. These are

Spot Welding: It is simplest type of resistance welding in which the work pieces are held together under pressure of anvil face. The copper electrodes are brought in contact with work piece and current start to flow through it. The work piece material applies some resistance in flow of current which cause local heat generation. At the interface surfaces the resistance is high due to air gap. The current start to flow though it which melt down the interface surface. The amount of current supply and time should be sufficient for proper melting of interface surfaces. Now the current stopped to flow but the pressure applied by electrode maintained for a fraction of second, while the weld rapidly cooled. After it, the electrodes remove and brought to contact at other spot. It will create a circular nugget. The nugget size depends on size of electrode. It is generally about diameter 4-7 mm.



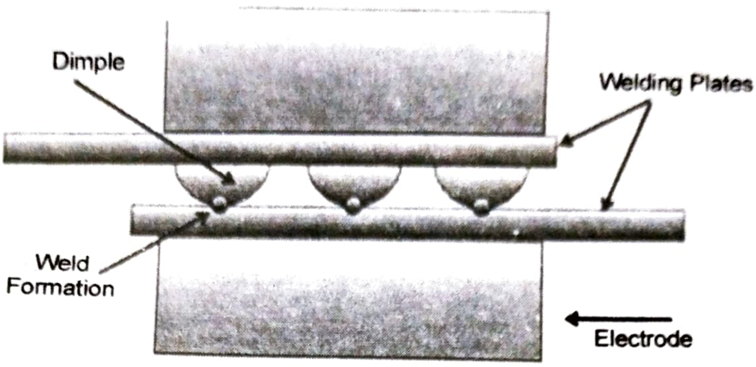
Spot Welding

Seam Welding: Seam welding is also called continuous spot welding in which a roller type electrode is used to flow current through work pieces. First the rollers are brought in contact with work piece. A high ampere current is passed through these rollers. This will melt the interface surfaces and form a weld joint. Now the rollers start rolling at work plates. This will create a continuous weld joint. The timing of the weld and movement of electrode is controlled to assure that the weld overlap and work piece does not get too hot. The welding speed is about 60 in/min in seam welding. It is used to create air tight joints.



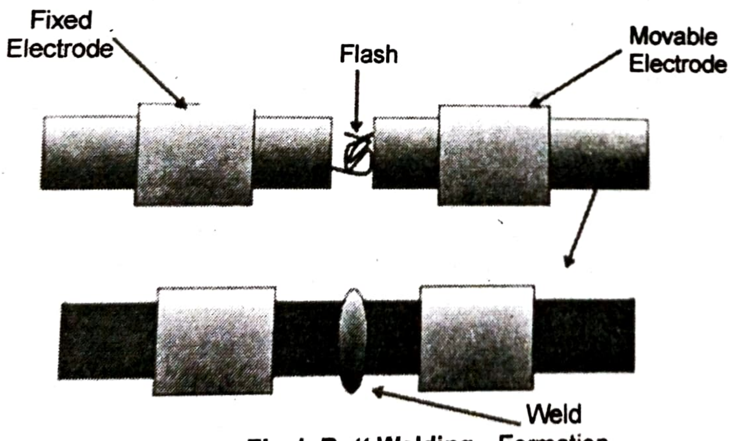
Seam Welding

Projection Welding: Projection welding is same as spot welding except a dimple is produced on work pieces at the location where weld is desired. Now the work pieces held between electrode and a large amount of current pass through it. A small amount of pressure is applied through electrode on welding plates. The current pass through dimple which melt down it and the pressure causes the dimple flatten and form a weld.



Projection Welding

Flash butt Welding: It is another type of resistance welding which is used to weld tubes and rods in steel industries. In this process, two work pieces which are to be welded will be clamped in the electrode holders and a high pulsed current in the range of 100000 ampere is supplied to the work piece material. In this two electrode holders are used in which one is fixed and other is movable. Initially the current is supplied and movable clamp is forced against the fixed clamp due to contact of these two work pieces at high current, flash will be produced. When the interface surface comes into plastic form, the current is stopped and axial pressure is increased to make joint. In this process weld is formed due to plastic deformation.



Flash Butt Welding

Application:

Resistance welding is widely used in automotive industries.

Projection welding is widely used in production of nut and bolt.

Seam welding is used to produce leak prove joint required in small tanks, boilers etc.

Flash welding is used to welding pipes and tubes.

22-2017

Q.5. Describe the different sheet metal work processes and tools used for them giving their limitations. **(12.5)**

Ans. SHEET METAL SHOP

It deals with working of thin sheets with hand tools and simple machines into various cutting forms by:

1. Cutting
2. Forming into shapes
3. Joining

Examples: Making of canisters, boxes, funnels, pipes, bends cans etc.

SHEET METAL HAND TOOLS

1. **Measuring tools** i. Steel rule ii. Folding rule iii. Circumference rule iv. Vernier Caliper v. Micrometer vi. Thickness Gauge vii. Sheet Metal Gauge	2. Straight Edge 3. Steel Square 4. Scriber 5. Divider 6. Trammel Points 7. Punches 8. Chisel	9. Hammers 10. Snips or shears 11. Pliers 12. Stakes 13. Groovers 14. Rivet Set 15. Soldering Iron

2. Straight Edge: is a flat graduated steel bar with one longitudinal edge bevelled. It is useful for scribing long straight lines Fig. 1.

3. Steel Square: made of hardened steel. It is used for marking in the perpendicul direction to any base line Fig. 2.

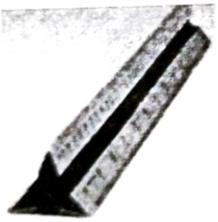


Fig .1

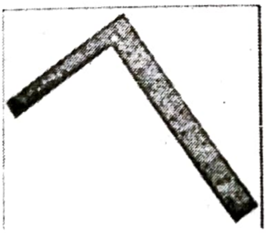


Fig .2

4. Scriber: also known as metal worker's pencil. It has one hardened sharp pointed edge to scratch line on sheet metal. Fig. 3.

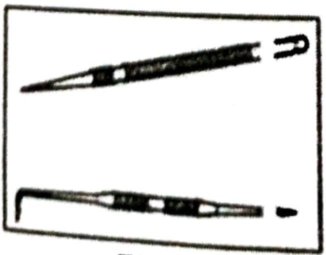


Fig. 3.

5. Dividers: used for drawing circles , arc on sheet metal and also used to mark a desired distance between two points Fig. 4.

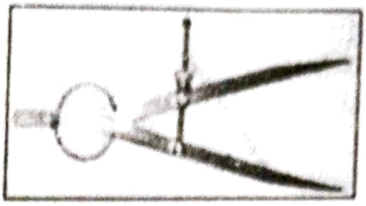


Fig. 4.

6. Trammel Points: consist of a bar with two movable heads. It is used to draw large circles or arcs that are beyond the limit of the dividers Fig. 5.

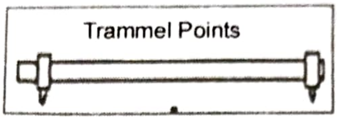


Fig. 5.

7. Punch: used for marking out work, locating centers etc Fig. 6.

Prick punches is used to make small marks on layout lines.

Centre punch is used to make prick punch markers larger at the centre holes that are to be drilled

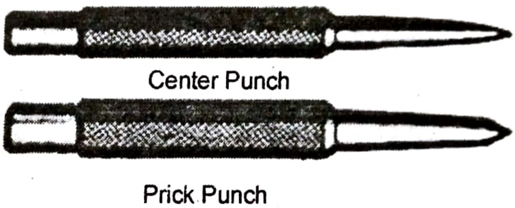


Fig. 6.

Hand lever punch is used for marking holes with a punch and die incorporated in the tool when a large number of holes are to be punched.

OR

Q.5. (b) What is powder metallurgy? Explain the processes of pulverization compaction and sintering. (12.5)

Ans. Powder metallurgy: Powder metallurgy is the process of blending fine powdered materials, pressing them into a desired shape or form (compacting), and then heating the compressed material in a controlled atmosphere to bond the material. The powder metallurgy process generally consists of four basic steps: powder manufacture powder blending, compacting, and sintering. Compacting is generally performed at room temperature, and the elevated-temperature process of sintering is usually conducted at atmospheric pressure. Optional secondary processing often follows to obtain special properties or enhanced precision.

Two advantages of Powder metallurgy:

1. The use of powder metal technology bypasses the need to manufacture the resulting products by metal removal processes, thereby reducing costs.

2. Powder metallurgy is also used in "3D printing" of metals.

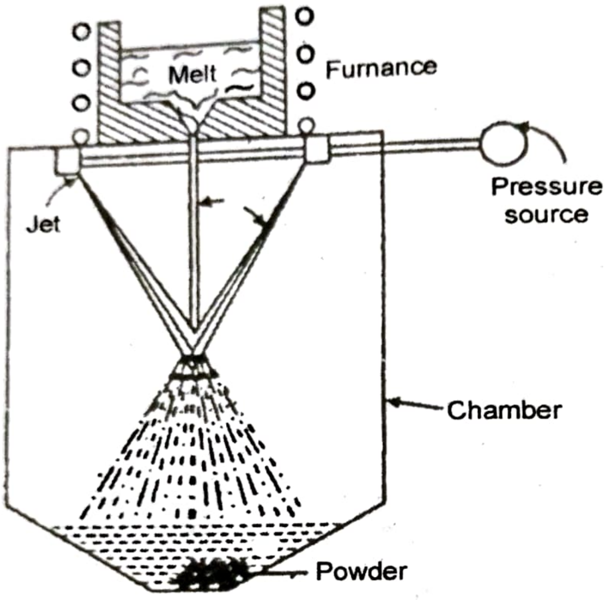
Two applications of powder metallurgy:

1. It can used in making automotive components.

2. Also used in medical implants and tubing or piping.

Methods of Manufacturing metal powders: Powder metallurgy is the process of blending fine powdered materials, pressing them into a desired shape or form (compacting), and then heating the compressed material in a controlled atmosphere to bond the material (sintering). The powder metallurgy process generally consists of four basic steps: powder manufacture, powder blending, compacting, and sintering.

Atomization is the process used commercially to produce the largest tonnage of metal powders in water and gas atomization.



1. Bending: Bending is a manufacturing process that produces a V-shape, U-shape, or channel shape along *a* straight axis in ductile materials, most commonly sheet metal. Commonly used equipment include brakes and other specialized machine presses.

2. Compaction: The roll compaction process takes finely sized powders, compresses these into a solid shape which can be a flat sheet, corrugated sheet and or in stick form. This is accomplished utilizing a roll compactor. Roll compactors are similar in design to roll briquettes, however higher compaction.

3. Sintering: It involves raising the temperature of the green compact, (pressed powder part), to a certain level and keeping it at that temperature for a certain amount of time. The sintering temperature is usually between 70% and 90% of the melting loint of the powder metal. This will cause bonding mechanisms to occur between powders particles pressed together in the compact.

FIRST TERM EXAMINATION [SEPT. 2018]
FIRST SEMESTER [B.TECH]
MANUFACTURING PROCESS [ETME–105]

Time : 1.5 hrs. **M.M. : 30**

Note: *Q. No. 1 is compulsory. Attempt any two more Questions from the rest.*

Q.1. (a) Define heat treatment. Explain the need or purpose of heat treatment process. (2.5)

Ans. Heat Treatment

Heat treatment is defined as an operation or combination of operations, involving heating and cooling of a metal or alloy in the solid state with the purpose of changing the properties of the material.

Heat treatment consists of three phases (i) Heating of the metal (ii) Soaking of the metal (iii) Cooling of the metal.

Purpose of heat treatment

1. To improve machinability.
2. To improve mechanical properties, e.g., tensile strength, ductility, hardness, shock resistance, resistance to corrosion etc.
3. To relieve the stresses induced during hot or cold working.
4. To change or refine grain size.
5. To improve magnetic and electrical properties.
6. To improve heat resistance, wear resistance.
7. To improve weldability.

Q. 1. (b) Write down the effects of constituent elements on cast iron. (2.5)

Ans. Effect of Consituent Elements on Cast Iron

1. Carbon (C). Carbon is one of the important element in cast iron. It reduces the melting point. Pure iron has a melting point of about 1500°C but iron with 3.5% carbon has a melting point of about 1350°C.

When carbon is in free form i.e. as graphite form, the resulting cast iron is known as grey cast iron. On the other hand, when the iron and carbon are chemicaly combined in the form of cementite, the cast iron will be hard and known as white cast iron.

2. Silicon (Si). The presence of silicon promotes the decomposition of cementite in free iron and graphite. it also helps to reduce the shrinkage in cast iron. Shrinkage is less when carbon is changed to graphite forms.

3. Manganese (Mn). It reduces the harmful effects of the sulphur by forming the compound magnese sulphide which is not soluble in cast iron. Manganese will also help the carbon to remain in the combined form.

4. Phosphorus (P). Phosphorus has no effect on the carbon in the cast iron, but affects the fluidity as well as the shrinkage. It increases the brittleness and reduces the strength of the cast iron when the content is above 0.3%.

5. Sulphur (S). It is often responsible for the troubles of foundry men. It will harden cast iron thereby counteracting the softening influences of silicon. It decreases strength, fluidity and increases brittleness. It also promotes oxidation of cast iron. Hence it is desired to keep the sulphur content as low as possible.

Q. 1. (c) List out the various types of pattern and pattern allowances. **(2.5)**

Ans. Types of Patterns

The following types of patterns are commonly used:

- Solid or single piece pattern
- Split (Two piece) pattern
- Multipiece pattern
- Match plate pattern
- Gated pattern
- Skeleton pattern
- Sweep pattern
- Pattern with loose pieces
- Cope and drag patten
- Follow board pattern
- Segmental pattern

Pattern allowances

1. Shrinkage or Contraction
2. Draft allowance
3. Finish or Machining allowance
4. Distortion or camber allowance
5. Rapping or shaking allowance.

Q. 1. (d) Define the following. **(2.5)**

***(i)* Fatigue *(ii)* Creep *(iii)* Toughness *(iv)* Resilience *(v)* Stiffness**

Ans. *(i)* Fatigue: When subjected to fluctuating or repeated loads, a material tend to develop a characteristic behaviour which is different from that (of the materials) under steady loads. Fatique is the phenomenon that leads to fracture under such conditions.

Or

The fatigue properties of a material determine its behaviour when subjected to thousands or even millions of cyclic load aplications in which the maximum stress developed in each cycle is well within the elastic range of the material. Under these conditions, failure may occur when the material continue to give service indefinitely.

Bridges, many components of high speed aero and turbine engines are failed because of fatigue.

(ii) Creep: Creep is the slow plastic deformation of metal under constant stresses usually at high temperature. It can take place and lead to failure at static stresses much smaller then those which will fail the specimen by loading it quickly. Metals generally exhibit creep at high temperatures, whereas plastics, rubbers are very temperature sensitive to creep.

(iii) Toughness: Toughness is a measure of the amount of energy a material can absorb before failure takes place. The toughness of a material is expressed as energy absorbed (Nm) per unit volume of material (m^3) or Nm/m^3. Toughness is related to impact strength i.e. resistance to shock loading.

For example: If a load is suddenly applied to a piece of mild steel and then to a piece of glass, the mild steel will absorb much more energy before failure occurs. So mild steel is tougher than glass.

(iv) Resilience.: Resilience is the capacity of a material to absorb energy elastically. On removal of the load, the energy stored is given off exactly as in spring when the load is removed. This property of material is important in the manufacture of shock absorbers, springs etc.

(v) Stiffness: Stiffness is the ability of a material to resist deformation. A material with high value of Young's modulus E is stiffer than the material with the value of Young's modulus (ratio of stress to strain is called Young's modulus, strain is the ratio of change in dimension to the original dimension).

Modulus of elasticity for aluminium and steel are 70 GPa and 210 GPa respectively so steel is three times more stiffer than aluminium.

Q. 2. (a) Explain the different types of zones in a cupola furnace. **(6)**

Ans. Zones in Cupola

The entire section of the cupola is divided into the following zones:

Crucible Zone: It is between top of the sand bed and bottom of the tuyers. The molten metal accumulates here. It is also called the 'well'.

Combustion or Oxidizing Zone: It is situated normally 150 to 300 mm above the top of the tuyers. Heat is evolved in this zone because of the following oxidation reactions.

$$C + O_2 \longrightarrow CO_2 + \text{Heat}$$
$$Si + O_2 \longrightarrow SiO_2 + \text{Heat}$$
$$2Mn + O_2 \longrightarrow 2\,MnO + \text{Heat}$$
$$Fe + O \longrightarrow FeO + \text{Heat}$$

Reducing Zone: This zone starts from the top of the combustion zone and extends upto the top of the coke bed. In this zone, the reduction of CO_2 to CO occurs and temperature drops to about 1200°C.

$$CO_2 + C\,(\text{coke}) \longrightarrow 2CO - \text{Heat}$$

Melting Zone: The zone starts from the top of the coke bed extends upto a height of 900 mm. The temperature in this zone is highest approx. equal to 1600°C.

$$3\,Fe + 2CO \longrightarrow Fe_3C + CO_2$$

Preheating Zone or Charging Zone: It starts from the top of the melting zone and extends upto the charging door. Charging materials are fed in this zone and get preheated.

Stack Zone: It starts from the charging zone and extends upto top of the cupola. The gases generated within the furnace are carried to the atmosphere by this zone.

Q. 2. (b) What is the requirement of good gating system? **(4)**

Ans. Requirements of a Gating System

An ideal gating system is expected to meet the following requirements:

1. The velocity of molten metal entering into the mould cavity should be as low as possible, so that there is no erosion of mould.

2. Gating system should ensures the complete filling of the mould cavity.

3. Gating system should prevent the motten metal from absorbing air or other gases while flowing through it.

4. Gating system should prevent the formation of oxides.

5. Gating system should prevent the entry of oxides, slag, dross etc.

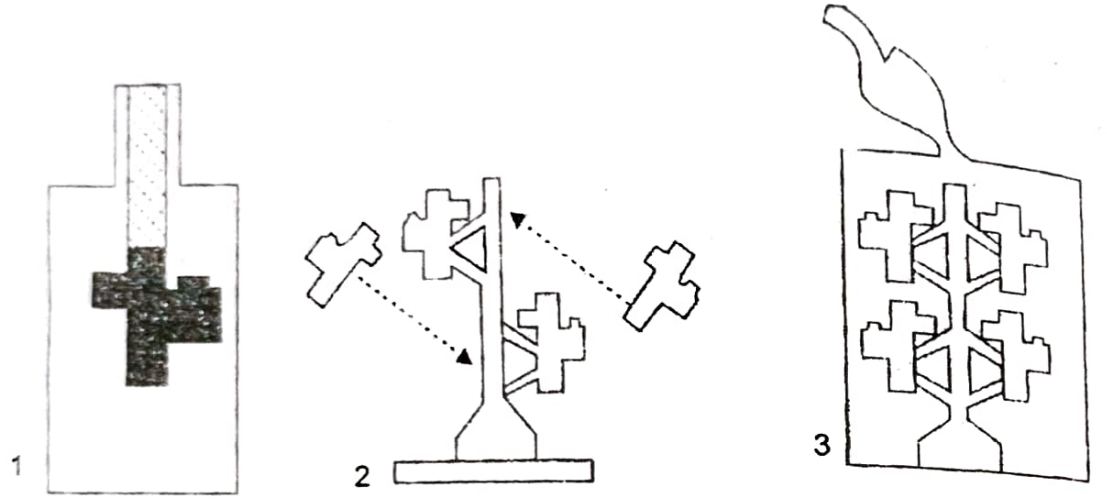
6. Gating system should assist in directional solidification of the casting.

7. Gating system design should be practicable and economical.

Q. 3. Sketch and explain the complete procedure of investment casting. (10)

Ans. Investment Casting or Lost Wax Process or Precision Casting

This process uses wax pattern which is subsequently melted from the mould, leaving a cavity having all the details of the original pattern (required casting).



• Wax pattern assembly is next, sprinkled with 40 to 50 AFS (American Foundary Society) silica sand and is permitted to dry.

Investing the wax pattern assembly for the production of moulds

• This is done by inverting the wax assembly on the bottom board, surrounding it with a paper lined steel flask and pouring the investment moulding mixture around the pattern. The mould material settles by gravity and completely surround the pattern as the work table is vibrated.

• The moulds are then allowed to dry in air for 2 to 3 hours.

Removal of wax pattern

• The wax pattern can be removed from the mould by two methods:

(i) Place the mould in a furnace in an inverted position i.e. the sprue downwards. The wax is melted out due to heat and collected for reuse.

(ii) In other method, mould is placed in a bath of trichloromethylene vapours which also enable the recovery of wax for reuse.

Pouring and casting

• The mould is again heated at the rate of 40 °C to 70 °C per hour from about 150 °C to 1000 °C for ferrous alloys and 650 °C aluminium alloys.

• Preheating is done.

→ To remove the wax if any.

→ It helps the metal to flow easily and fill up properly.

→ It causes expansion of the mould.

After preheating, the metal is poured into the investment mould under simple gravitational force or under the force of applied air pressure or by centrifugal force.

Cleaning, finishing and inspection

• Each casting is separated from the assembly and the gates, runner etc. are removed.

• Finishing and inspection of casting is done.

Q. 4. Explain the various casting defects with its causes and remedies. (10)

Ans. Blow Holes

• They appear as cavities (holes) in a casting.

Causes:

• Low strength of mould and core.

• Lack of binders in facing and core sand.

• Faulty gating.

Blow

Remedies:

• Improve collapsibility.

• Modify design.

• Provide softy ramming.

2. Metal Penetration

If the molten metal enters into the spaces between the sand grains and holds some of the sand tightly with it even after fettling, defect is known as metal penetration.

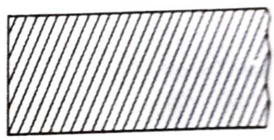
Causes:

• Large grain size of sand and used sand.

• Soft ramming.

• Moulding sand or core have low strength.

• Pouring temperature of metal two high.



Penetration

Remedies:

• Use sand having finer grain size.

• Provide harder ramming.

• Increase the strength of sand.

• Adjust the proper pouring temperature.

3. Drop

If a portion of the sand breaks away from the mould and drops in the molten metal, that is called drop defect.

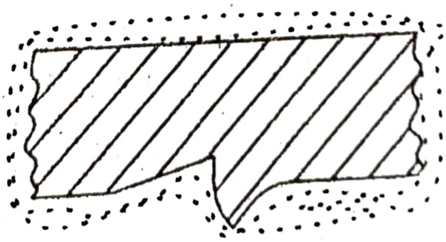


Fig. Drop

Causes:

• Low green strength in moulding sand and core.

• Too soft raming.

• Inadequate reinforcement of sand projections and core.

END TERM EXAMINATION [NOV-DEC. 2018]
FIRST SEMESTER [B.TECH]
MANUFACTURING PROCESS [ETME-105]

Time : 3 hrs. **M.M. : 75**

Note: *Attempt five questions in all including Q. No. 1 which is compulsory. Select one question from each unit. Assume suitable missing data, if any.*

Q.1. Answer the questions:

Q. 1. (a) Classify carbon steel on the basis of % carbon. **(2.5)**

Ans. Carbon steels are classified according to their carbon content as follows.

1. Dead mild steel – % of carbon having 0.05 – 0.15
2. Mild steel – % of carbon having 0.15 to 0.3%
3. Medium carbon steel – % of carbon having 0.3 to 0.8%
4. High carbon steel – % of carbon having 0.8 to 1.5%.

Q. 1. (b) Write important properties of green sand used in foundry shop. **(2.5)**

Ans. Green sand must posses the following properties

(a) Porosity or permeability

(b) Flowability

(c) Pefactoriness

(d) Adhesiveness

(e) Cohesiveness.

Q. 1. (c) Differentiate between hot working and cold working processes. (2.5)

Ans.

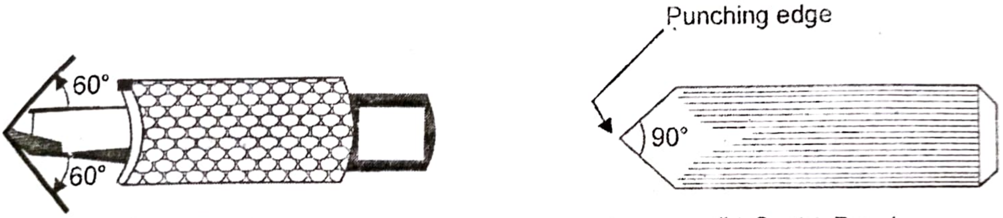
	Hot Working		Cold Working
1.	It is done at a temperature above recrystallisation but below its melting point	1.	It is done at temperature below recrystallisation temperature.
2.	Hardening due to plastic deformation is completely eliminated by recovery and recrytallisation.	2.	Hardening is not eliminated since working is done at a temperature below recrystallisation.
3.	Some mechanical properties such as elongation, reduction of area and impact values are improved.	3.	Cold working decreases elongation reduction of area and increases ultimate tensile strength, yield point and Hardness.
4.	Surface finish of hot worked metal is not good.	4.	Surface finish obtained is better.
5.	Refinement of crystals occurs. Grains are only elongated.	5.	Crystallisation does not occur.
6.	Cracks and blow holes are welded up due to recrystallisation temperature.	6.	Possibility of crack formation and propagation is increased.
7.	Internal or residual stresses are	7.	Internal and residual stresses are developed in the metal.

8.	Oxide forms rapidly on metal surface.	8.	Cold part posses less ductility.
9.	Less force is required.	9.	Higher forces are required for deformation.
10	Equipment used in hot working is light.	10.	More powerful and heavier equipments are required for cold working.
11.	Handling and maintenance of hot metal is difficult and troublesome.	11.	Easier to handle cold parts.

Q. 1. (d) With the help of neat sketch, describe any marking tool used in fitting shop. (2.5)

Ans. Marking Tool

Punches are used for marking purposes. Dot punches are used for marking dotted line and centre punch is used to mark the centre of hole before drilling. Punches are made up of high carbon steel or high speed steels. One end is sharpened. Hammering is done on the second end while working. For dot punch, angle of the punching end is 60 degree while in centre punch , angle of punching end is 90 degree.



(a) Dot Punch (b) Centre Punch

Fig. Punches

Q. 1. (e) With the help of sketch, describe all the three oxyacetylene flames. (2.5)

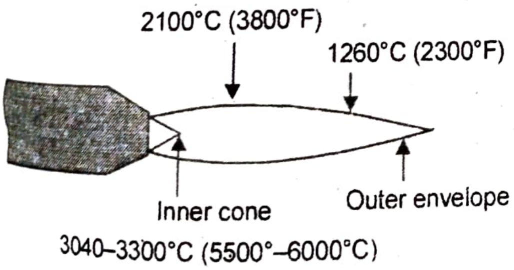
Ans. Types of flame

1. Neutral flame

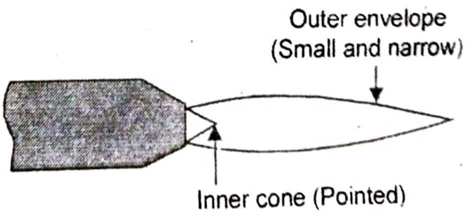
A neutral flame is produced when oxygen to acetylene ratio is 1.1 to 1.

→ The temperature is of the order of about 5900°F (3200°C).

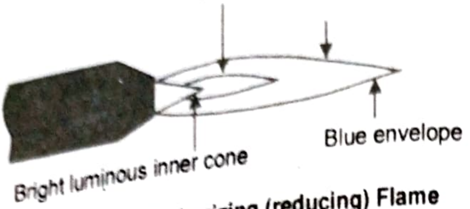
→ The flame has nicely defined inner cone (light blue in colour) and is surrounded by outer envelope which is dark blue in colour than the inner cone.



(a) Neutral Flame



(b) Oxidizing Flame



(c) Carburizing (reducing) Flame

Fig. Types of Flames.

- It is called neutral because it will not oxidize or carburise the metal.
- It is used for welding of:
  - Mild steel
  - Stainless Steel
  - Copper
  - Cast iron
  - Aluminium

2. Oxidizing flame

• After the neutral flame, if the supply of oxygen is further increased, the result will be an oxidizing flame.

• Its inner cone is more pointed, outer flame envelope is much shorter.

• It burns with a loud roar.

• The temperature is of the order of about 6300°F (because of exess O_2 so complete combustion takes place).

• This flame is harmful for steels, because it oxidizes the steels.

• Only in the welding of copper and copper based alloys, oxidizing flame is desirable, because in those cases a thin protective layer of slag forms over the molten metal.

Reducing flame

If the volume of oxygen supplied to the neutral flame is reduced, the resulting flame will be a carburising or reducing flame i.e., rich in acetylene.

• In this flame, acetylene feather exists between the inner cone and outer envelop.

• Temperature is of the order of about 5500 °F (less because it does not completely consume the available carbon).

• Metals that tend to absorb carbon should not be welded with reducing flame.

• Carburizing flame contains more acetylene than a reducing flame.

• Carburizing flame is used for the welding of lead and for carburizing (surface hardening) purposes.

• Reducing flame is used with low-alloy steel rod for welding high carbon steel.

Q. 1. (f) Enumerate the limitations of spot welding. (2.5)

Ans. Limitation of spot welding.

(a) Difficulty for maintenance or repair

(b) Intial cost of equipment is high

(c) Low tensile and Fatigue strength.

(d) Produces unfavorable line power demands

Q. 1. (g) Define blanking and punching processes in sheet metal work. (2.5)

Ans. Blanking: This means cutting a whole piece from sheet metal. Around this piece, there is enough scrap left all around this piece. The piece which is cut from the sheet metal is our objective. The size of the blank (cutting part) is our requirement and the remaining sheet is scrap.

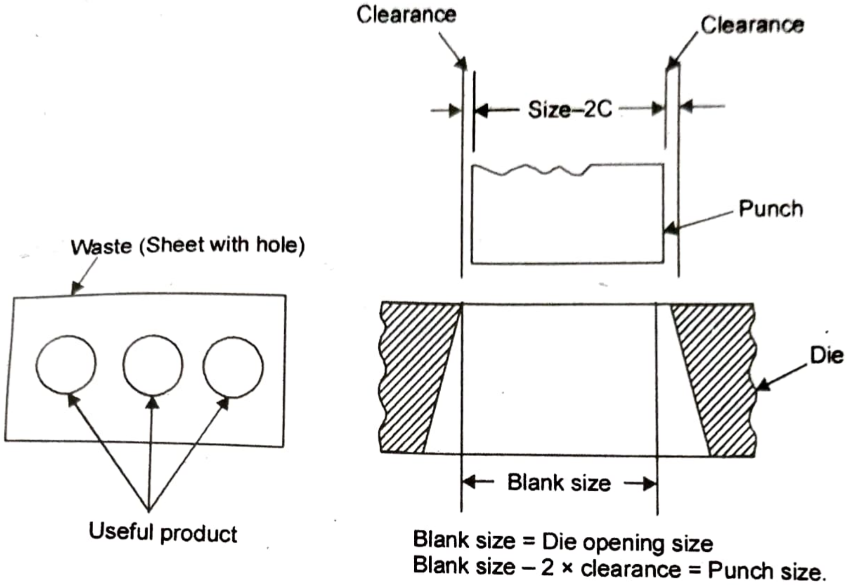


Fig. Blanking operation.

Blank is then further processed to produce desired part. In blanking operation clearance is given to the punch whereas die opening size equals the blank size.

- Punching

Punching is the operation of producing circular holes on a sheet metal by a punch and die.

The material punched out (small circular sheet) is removed as waste and the sheet, which is having holes, is our objective or our requirement.

In punching operation, clearance is given to the die and punch size equals the size of the hole.

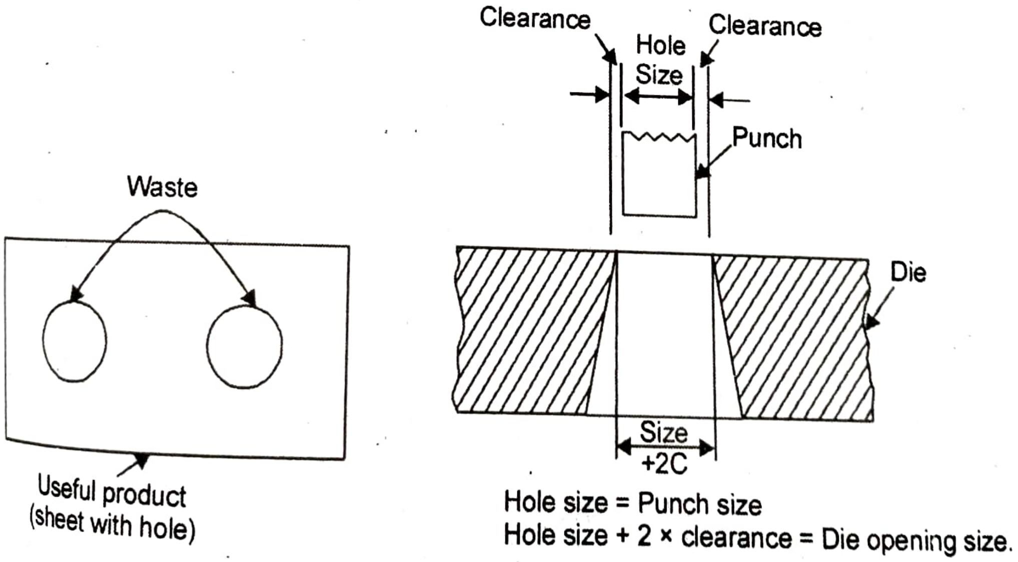
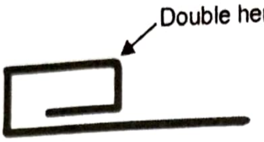


Fig. Punching Operation.

Q. 1. (h) Desribe single hem and double hem and write their purpose in sheet metal joint. (2.5)

Ans. Single hem: Single hem is made by the turning the edge over the hatchet stake and them it is completed by mallet.

Double hem: The double hem is made by turning the edge over the hatchet stake and them it is completed by a mallet.



Q. 1. (i) Define stiffness and toughness of the material. (2.5)

Ans. Refer Q. 1. (d) First Term 2018.

Q. 1. (j) Differentiate between cold and hot isostatic pressings. (2.5)

Ans. Cold isostatic pressing is used to compact green parts at ambient temp, while HTP in used to fully consolidate parts at elevated temp by solid state diffusion HIP can also be used to eliminate residual prosily from a sintered PM part.

UNIT-I

Q. 2. (a) Write short notes on alloying metals for aluminium alloys. (6)

Ans. Aluminium

The main source of aluminium is bauxite. Bauxite is hydrated aluminium oxide ($Al_2O_3.2H_2O$). The chief impurities are oxide, silica, clay and titanium oxide. It is found in districts of Bihar, Chennai and Madhya Pradesh.

Manufacture: The bauxite is first purified and then dissolved in fused cryolite (double fluoride of aluminium and sodium). The aluminium is then separated from this solution by electrolysis at about 910°C.

Properties:

1. Pure aluminium has silvery colour and lusture.
2. It has a very high resistance to corrosion than the ordinary steel.
3. It is ductile and malleable.
4. It is a good conductor of heat and electricity.
5. Its specific gravity is 2.7.
6. Melting point = 658°C, boiling point = 2055°C.
7. Its tensile strength varies from 95 to 157 MN/m^2.
8. It may be blanked, formed, drawn, turned, cast, forged and die cast.
9. In proportion to its weight it is quite strong.
10. It forms useful alloys with iron, copper, zinc and other metals.

Uses:

1. It is used in furniture, rail road, trolley cars, automobile bodies and pistons, electric cables, rivets, kitchen utensiles and collapsible tubes for pastes.
2. In a finely divided flake form, aluminium is employed as a pigment in paint.
3. Aluminium metal of high purity has got high reflecting power in the form of sheets and is, therefore, widely used for reflectors, mirrors and telescopes.

4. Aluminium foil is used as silver paper for food packing etc.

5. It is useful metal for cooking utensiles.

Q. 2. (b) Describe five types of pattern allowances considered n casting. (6.5)

Ans. Pattern Allowances

Pattern is having different size as compared to casting because it carries certain allowances due to metallurgical and mechanical reasons. The various allowances are:

- Shrinkage or contraction allowance.
- Machining or finish allowance.
- Draft or taper allowance.
- Distortion or camber allowance.
- Shake or rapping allowance.

Shrinkage or Contraction Allowance

- As metal solidifies and cools, it shrinks and contracts in size. To compensate for this, a pattern is made larger than a finished casting by means of a shrinkage or contraction allowance.
- Contraction is different for different metals.
- Wood patterns used to make metallic patterns are given double allowance, one for the shrinkage of the metal of the pattern and the other for that of metal to be cast.
- The total contraction is volumetric but the shrinkage allowance is added to the linear dimensions.

Shrinkage allowances for various metals.

Material	Shrinakge metals mm/mm
Grey cast iron	0.0105
White cast iron	0.0160 to 0.0230
Aluminium	0.0130
Brass	0.0155
Copper	0.0160
Lead	0.0260
Magnesium	0.0130

Machining or Finish Allowance

- For good surface finish, machining of casting is required. For machining, extra metals are needed. This extra metal is called machining or finish allowance.
- The amount of this allowance varies from 1.6 to 12.5 mm which depends upon the type of casting metal, size and shape of casting, method of casting used, method of machining to be employed and the degree of finish required.
- This allowance is given in addition to shrinkage allowance.

Draft or Taper Allowance

- At the time of withdrawing the pattern from the mould, the vertical faces of the pattern are in continual contact with the sand, which may damage the mould cavity. This danger is greatly decreased if the vertical surfaces of a pattern are tapered inward silightly. The slight taper inward on the vertical surface of a pattern is known as the draft.

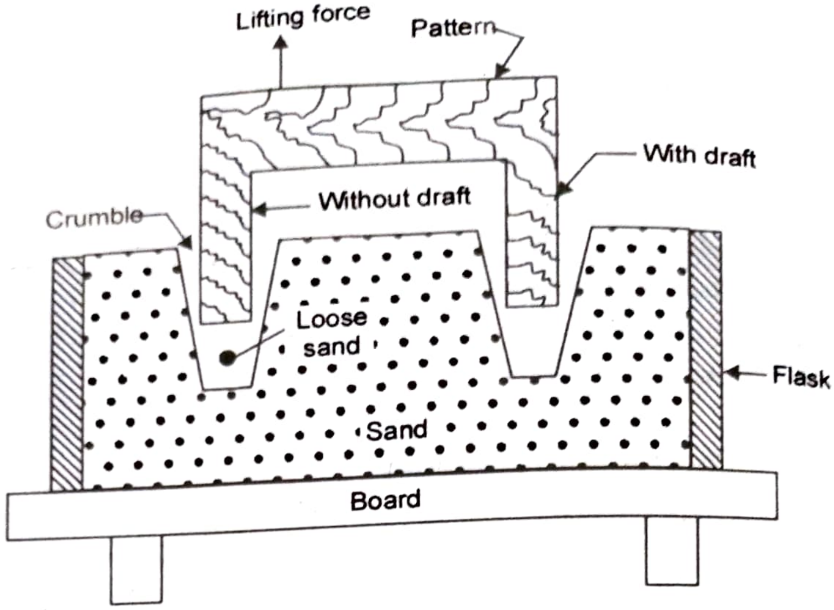


Fig. Draft Allowance.

- It may be expressed in millimeters per metre on a side or in degrees.
- It depends upon the length of the vertical side, intricacy of the pattern, method of moulding, type of pattern and pattern material.
- The taper on the inner surfaces must be greater than on the outside surfaces.
- The amount of taper varies from 1/2 to $1\frac{1}{2}$ degrees. It may be reduced to less than 1/2 degree for larger castings.

Distortion or Camber Allowance

If the shape of the casting changes that is called distortion of the casting. A casting will distort or warp, if.

- It is of irregular shape.
- All its parts do not shrink uniformly.
- It has long flat casting.
- The arms possess unequal thickness.

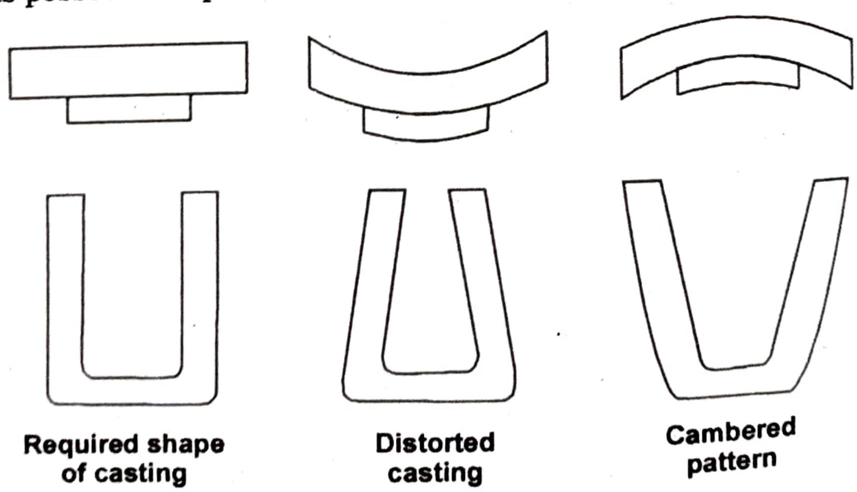


Fig. Distortion Allowance

Distortion can be practically eliminated by providing an allowance and contructing the pattern initially distorted. e.g., For U shape casting, legs will diverge so we make the pattern having legs converging so that after casting, the product is having legs parallel.

Shake or Rapping Allowance

- When a pattern is rapped (shaped) in the mould before it is withdrawn, the cavity in the mould is slightly increased. So in order to compensate this, pattern is made slightly smaller than the actual. This allowance is called shaking or rapping.
- All allowance except shake or rapping allowance are positive but rapping allowance is negative.
- The magnitude of shake allowance can be reduced by increasing the taper.

Q. 3. (a) Briefly explain (i) cyaniding (ii) nitriding and (iii) induction hardening. State their advantages and limitations. (6)

Ans. (i) Cyaniding: Cyanide may also be used to case harden steel. It is used to give a very thin but hard outer case. Sodium cyanide or potassium cyanide may be used as the hardening medium. The cyanide is heated until it becomes liquid. When the steel is placed in the cyanide bath (temperature ranging between 700°C to 820°C) both carbon and nitrogen are added to the outer surface resulting a surface harder than that produced by the carburising process. After soaking for the required period at proper temperature, the steel piece is removed from the bath and quenched in water, brine or oil.

Application: This process is mainly applied to the low carbon steel parts of automobiles (sleeves, brake cam, speed box gears, drive worm screws, oil pump gears etc), motor cycle parts (gears, shaft, pins etc) and agriculture machinery.

(ii) Nitriding: Nitriding is a case hardening process in which nitrogen instead of carbon, is added to the skin of the steel. This process is used for those alloys which are susceptible to the formation of chemical nitrides. The article to be nitride is placed in a container (made of high nickel chromium steel). Container is having inlet and outlet tubes through which ammonia gas is circulated. Ammonia gas is used as the nitrogen producing material. Process is carried out in electric furnace where the temperature in the range 450°C to 550°C is maintained. No scaling occurs, because the steel is not exposed to air at elevated temperatures.

Application: This process is used for the parts which require high wear resistance at elevated temperatures such as automobile and air plane valves and valve parts, piston pins, crankshafts, cylinder liners etc. It is also used in ball and roller bearing parts, die casting dies, wire drawing dies etc.

(iii) Induction Hardening: Induction hardening is done by placing the part in a high frequency alternating magnetic field. Heat is generated by the rapid reversals of polarity. The primary current is carried by a water cooled copper tube and is induced into the surfacew layers of the work piece. This walled sections required high frequencies and thicker sections must require low frequencies for adequate penetration of the electrical energy. The heating effects is due to induced eddy currents and hysteresis losses in the surface material. The surface of the part is heated above the hardening temperature and is then quenched to obtain martensite.

Advantages

(i) Operation is very fast

(ii) Comparatively large parts can be processed in a minimum time.

(iii) A minimum distortion or oxidation is encountered because of the short cycle time.

Application: It is widely used for hardening surfaces of crankshafts, cam shafts, gears, automobile components, spline shafts, spindles, brake drums etc.

Q. 3. (b) Describe step by step the process of investment casting. (6.5)

Ans. Refer Q. 3. First Term Exam 2018.

UNIT-II

Q. 4. (a) With the help of neat sketch, describe the machine forging. (6.5)

Ans. Upset Forging: Machine or upset forging consists of gripping heated bar stock between two dies and striking the protruding end with another die. This is also called hot heading operation. This process is employed in the forging of pinion gear blanks, flanges on axles, valve system etc. where larger volume of metal is needed in the end.

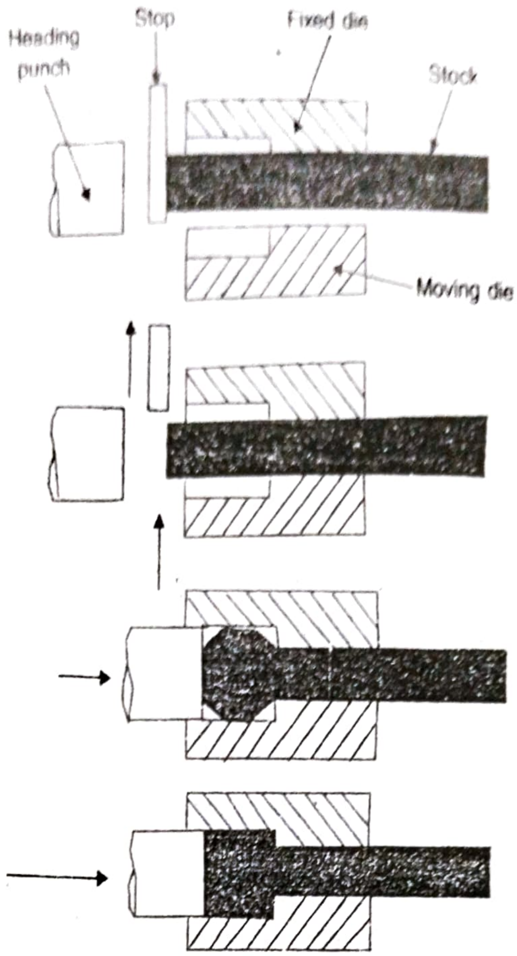


Fig. Upset Forging

The complete operation is performed in several stages. The dies carry no draft, and no flash is produced on the parts. Better dimensional accuracy is also obtained.

Q. 4. (b) With the help of neat sketches, explain the various types of files used in fitting shop. (6)

Ans. Files: Files are multi points cutting tools. It is used to remove the material by rubbing it on the metals. Files are available in a number of sizes, shapes and degree of coarseness.

Types of files

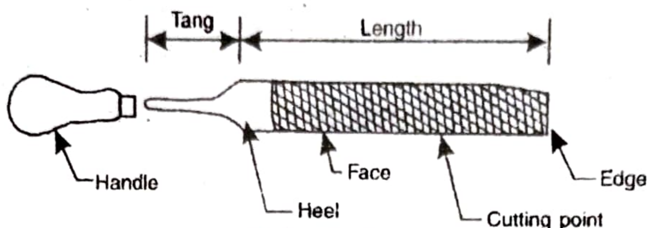
On the basis of grade

- Rough (20 teeth per inch)
- Bastard (30 teeth per inch)
- Second cut (40 teeth per inch)
- Smooth file (50 teeth per inch)
- Dead smooth (100 teeth per inch)

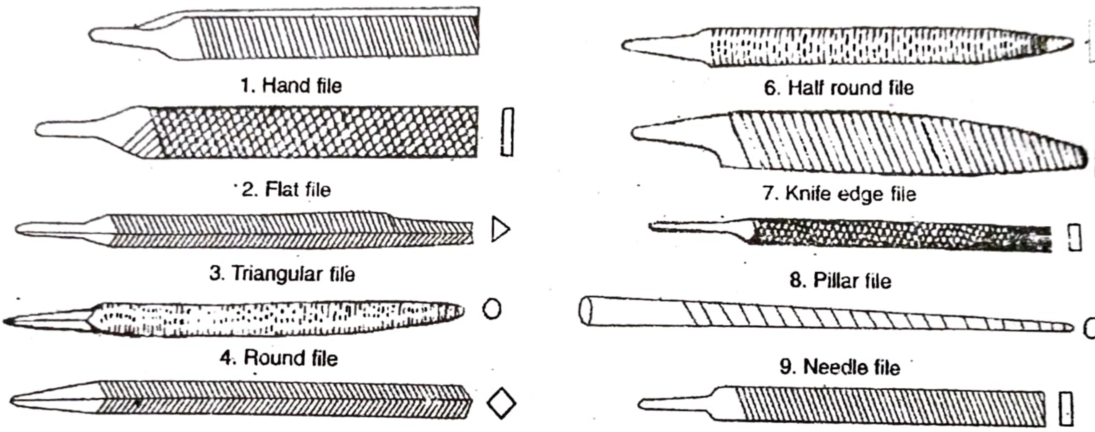
Rough and bastard files are the big cut files. When the material removal is more these files are used. These files have bigger cut but the surface produced is rough.

Dead smooth and smooth files have smaller teeth and used for finishing work. Second cut file has degree of finish in between bastard and smooth file.

On the basis of shape and size: The length of the files varies from 4" to 14". The various shapes of cross-section available are hand file, flat file, triangular, round, square, half round, knife-edge, pillar, needle and mill file.

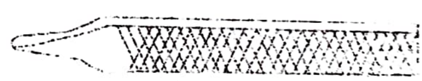


Nomenclature of a File

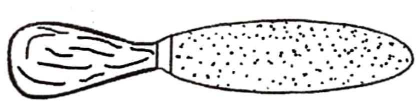


Types of Files on the Basis of Shape

(a) Single cut file



(b) Double cut file



(c) Rasp cut file

Fig. Types of Files on the basic of Number of Cuts

On the basis of number of cuts

- Single cut files.
- Double cut files.
- Rasp files.

In single cut files the teeth are cut in parallel rows at an angle of 60 degree to the face. An other row of teeth is added in opposite direction in case of double cut files. Material removal is more in case of double cut files.

Precautions for files

- FIles should be stored in wooden racks.
- Files should not be used without handle or with loose fitting handle.
- The file should not be allowed to rust. To prevent it, it should be coated with machine oil. The oil should be removed before using the file.
- File cleaner should be used for cleaning the files. Use file card or hard wire brush for cleaning.

• The new file should be used first on copper, brass and then on wrought iron or mild steel.

• Never use files as a hammer.

Filing: Filing is required after chipping, cutting or to finish the shape of the workpiece. The filing operation consists of the following steps:

1. The work should be held tightly in the vice. The amount of projection of the workpiece from the vice should be minimum to reduce the noise.
2. The file handle is hold by the right hand. Left-hand palm is pressed against the end of the file.
3. The file must remain horizontal throughout the stroke. The stroke should be long, slow and steady. Pressure should be applied only in the forward direction.
4. The pressure is relieved during the return stroke but file should remain in contact with the workpiece.
5. When quantity of material removal is more, use rough files and for finishing cut use smooth files. Surface smoothness is generated progressively.

Q. 5. (a) Explaain with sketches, the following operations in forging. (6.5)
(i) Upsetting (ii) Drawing down (iii) Setting down (iv) Punching (v) Bending.

Ans. (i) Upsetting

In this operation the thickness of the bar or section is increased at the expense of the length. If the end of the bar is required to be upset, its end is heated and hammering is done while holding the bar vertically on an anvil. The process is repeated till the required shape is obtained.

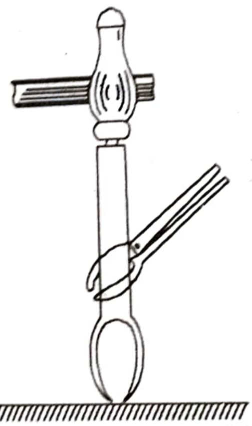


Fig. Jumping or upsetting

(ii) Drawing down: Drawing down is the process of increasing the length of any workpiece, while cross-sectional area is reduced. It is also known as drawing out. For this operation the workpiece is heated up to the plastic stage and placed on the anvil and the metal is beaten down by a sledge hammer.

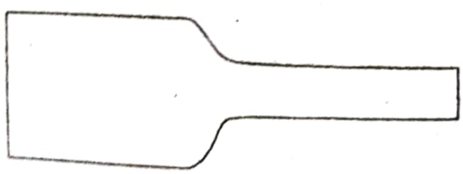


Fig. Drawing Down

(iii) Setting down – Setting down is the operation by which the rounding of a corner is removed to make it square hammer. Setting down used to finish to a good smooth surface.

(iv) Punching: In thick workpiece the holes are punched. The workpiece is heated to 1000°C placed on the anvil.

If the holes is deep, punch should be withdrawn after every 30 °C hammers blows and cooled inwater.

(v) Bending: To carry out bending operation the bar stock is heated to dark red heat and then bending operation is carried out over the anvil edge or on the beak or on the swage block.

Q. 5. (b) Write a short note on the following operations (i) Chipping (ii) Grinding (iii) Sawing, (iv) Scrapping and (v) Tapping. (6)

Ans. (i) Chipping

The removal of thick layers of metal by chisel is known as chipping. This is carried out as follows

1. The work is properly held in a vice.
2. The chisel is properly gripped in the left hand. The fingers are kept below the head of the chisel.
3. The hammer is grasped in the right hand near the end of the hammer handle. Then apply the blow on the chisel.
4. Lubricate the surface if needed.

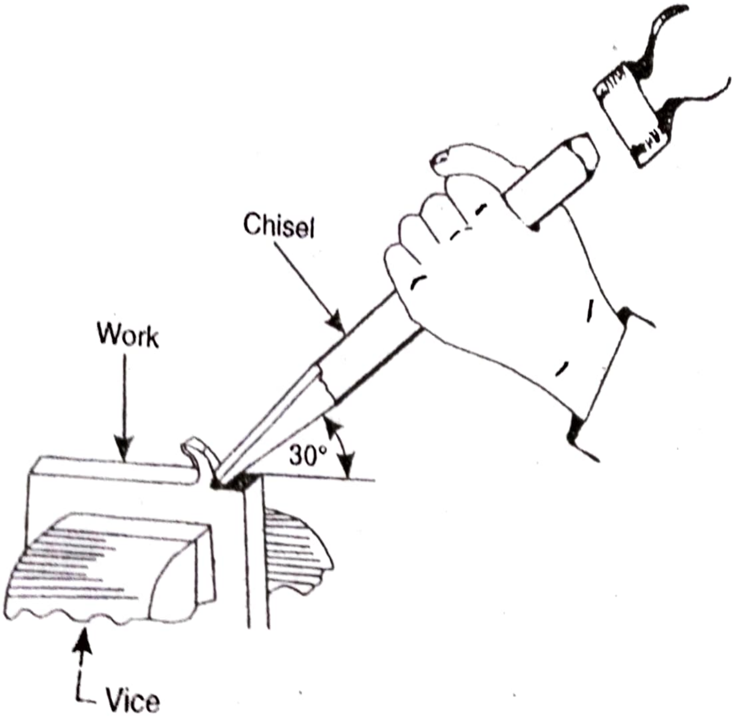


Fig. Chipping

(ii) Grinding: Grinding is a abrasive machining process that uses a grinding wheel as the cutting tool. A wide variety of machines are used for grinding.

1. Hand-cranked knife-sharpening stones (grindstones)
2. Bench grinder
3. Various kind of expensive industrial machine tool called grinding machine.

(iii) Sawing: Sawing is a cutting operation in which a tool consiting a tough blades, wire or chain with hard toothed edge. It is used to cut through material, very often wood though sometimes metal or stone.

The cut is made by placing the toothed edge against the material.

(iv) Scrapping: Scraping work is that of scraping off very fine depressions on the polished surface using a tool called a "Scraper". Such scraping operation is done on the sliding surface of the bed of a machine or on the surfaces of moving machine parts.

Purposes

1. To make lubricating oil stay evenly on the surface.
2. To reduce friction resistance by making the contact area small.
3. To suppress thermal expansion by reducing the generation of friction heat.

(v) Tapping: The process of cutting internal threads into a drilled hole by using a tap is known as tapping:

The procedure is described below:

- First of all, a hole is drilled to a diameter smaller than the outside diameter of the thread on the tap. The diameter of the hole to be drilled is called tapping size.
- Tapping size = outside diameter 2 × depth of thread.
- Where depth of thread = 0.64 × pitch of thread.
- After drilling, the taper tap is fixed in the tap wrench and screwed in the hole. The tap is held with its axis vertical.
- For all materials except cast iron, a little lubricate oil is applied to improve the action.
- The tap is not turned continuously, but after every half turn, it should be reversed slightly to clear the threads.
- When a blind hole is being tapped, the tap should be withdrawn from time to time and the metal is cleared from the bottom of the hole.
- When the hole is through, the reduction of resistance on the tap indicates the cutting of a full thread by taper tap.
- Then use intermediate tap and follow the same procedure and after intermediate tap use bottom or plug tap to finish the threads.
- When large no. of holes are to be tapped, in that case taping is done by drilling machine with slow speed.
- If the tap is broken during the operation, it creates the problem. If the piece is projecting out of the hole, use pliers to unscrew it. For removing the piece, which does not project out of the hole, two pins or four pins tools is used. The tool used is called tap extractor.

UNIT-III

Q. 6. (a) Discuss with the neat sketch, the principle of atomic hydrogen welding. **(6)**

Ans. Atomic Hydrogen Welding: In this welding process, welding heat is obtained from an electric arc maintained between two tungsten electrodes in an atmosphere of hydrogen, which also acts as a shielding gas. Filler rod and pressure may or may not be applied depending upon the requirement.

Principle: This process combines gas welding with electric arc welding. The electrode holder consists of two electrodes arranged in inclined position and the hydrogen nozzle is in between the tips of these electrodes to eject the hydrogen. The electric arc between the electrodes breaks down the molecular hydrogen into atomic hydrogen. This atomic hydrogen, when touches the relatively cold metal, recombines into molecular hydrogen, thus liberating considerable heat, which melts the metal to be welded.

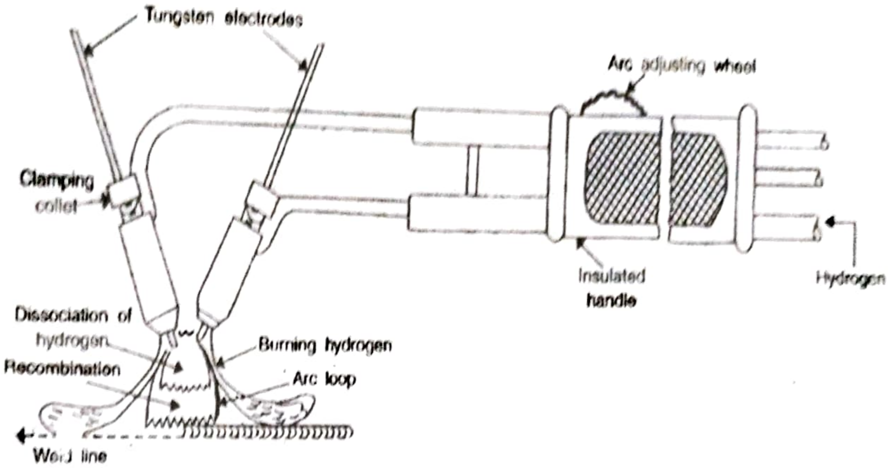


Fig. Atomic Hydrogen Welding

Procedure

- Supply of hydrogen gas and current are switched on.
- The arc is struck by touching the electrodes momentarily and then separating then by a proper distance (arc length, app 1.5 mm).
- The current value can be adjusted depending upon the job thickness.
- The atomic hydrogen welding arc is held over the job to be welded till a molten pool forms.
- Depending upon the job thickness, the filler metal may or may not be added.

Equipment

- Welding torch with tungsten electrode.
- Hydrogen gas supply (cylinder, pressure regulator, hoses etc.)
- A.C. power source.

Q. 6. (b) Discuss, with the help of neat sketch, the principle of electric arc welding. What is straight polarity and reversed polarity. **(6.5)**

Ans. Arc Welding Principle

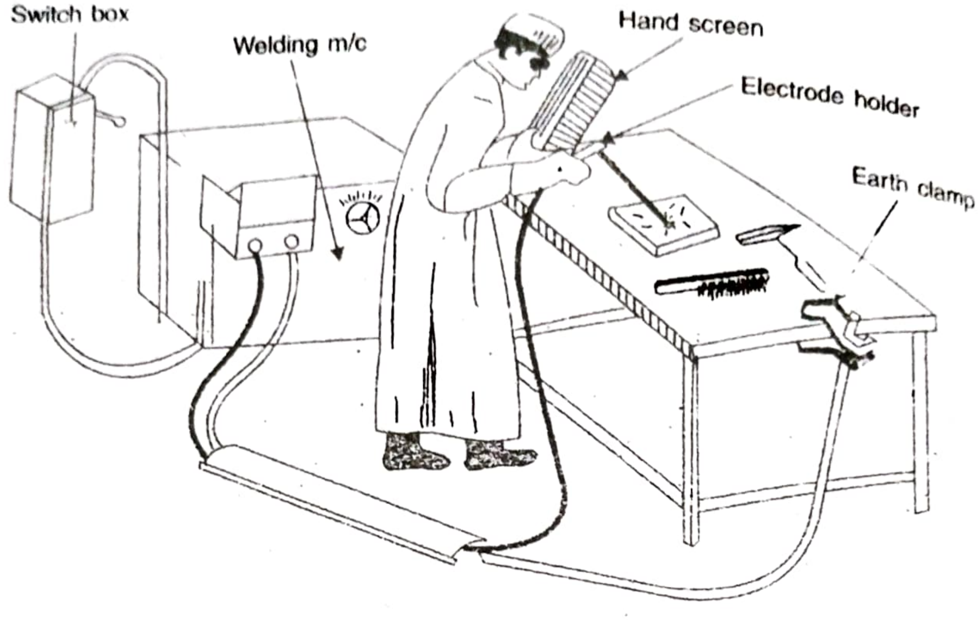
In arc welding, arc is generated between the positive pole of D.C. (direct current) called anode and negative pole of D.C. called cathode. When these two poles are brought together, and separated for a small distance (1.5 to 3 mm) such that the current continues to flow through a path of ionized particles, called plasma, an electric arc is formed. Since the resistance of this ionized gas column is high, so more ions will flow from anode to the cathode. Heat is generated as the ions strike the cathode.

ARC welding Equipment

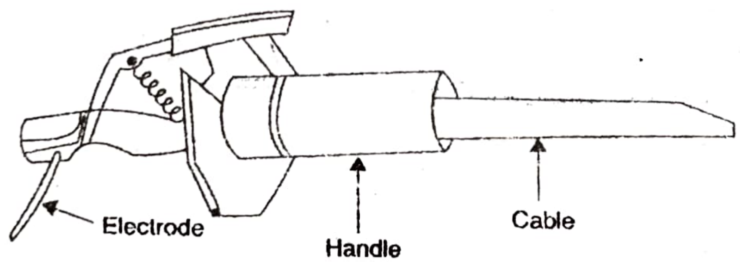
The most commonly used equipments for arc welding are:

- A.C. or D.C. power supply source
- Electrode holder
- Electrode
- Cable, cable connectors
- Cable lug
- Chipping hammer
- Earthing clamps
- Wire brush
- Helmet
- Safety goggles

- Hand gloves
- Aprons, sleeves etc.



(*a*) Set up of Metal Arc Welding (FMAW).



(*b*) Electrode holder for metal arc welding.

Fig. Arc Welding Equipment

Polarity: Polarity is defined as the type of potential given to the workpiece or electrode. In case of direct current (D.C.) power source, positive and negative terminals are fixed whereas in case of alternating current (A.C.) power source, positive and negative terminals are not fixed i.e. the terminal which is positive during one half of cycle becomes negative in another half. So polarity principle is applicable only in case of direct current power source.

Polarity are of following two types

1. Straight Polarity: In straight polarity, electrode is having terminal while workpiece is connected to the positive terminal of the direct current power source.

2. Reverse Polarity: In reverse polarity, electrode is connected to positive terminal whereas workpiece is connected to the negative terminal of the direct current power source.

Application. About 2/3 (67%) of total heat produced during welding is generated at positive terminal while rest of total heat is generated at negative terminal. So, if our job is thick, means we want more heat on workpiece so we connect workpiece to the positive terminal hence we adopt straight polarity. Similarly, if job is thin, means we want less heat on job so we connect workpiece to the negative terminal hence we adopt reverse polarity.

If our electrode is non-consumable, means we want less heat on electrode (generally) so connect electrode to the negative terminal i.e. use straight polarity for doing welding.

Q. 7. (a) Explain the term 'Weldability'. What are the advantages and disadvantages of welded joints over other joints. **(6)**

Ans. Welability: Weldability of a metal in the ease with which two similar or dissimilar metals are joined by fusion with or without the application of pr and with or without the use of filler metals

Advantages of welding

- A good weld is as strong as the base metal.
- A large no. of metals/alloys can be joined by welding.
- Repair by welding is very easy.
- Welding can be easily mechanized.
- Portable welding equipment is available.
- General welding equipment is not very costly.
- Total joining cost is less in case of welding joint.

Disadvantages of welding

1. Welding heat produces metallurgical changes.
2. Cost of equipment (initial cost) is high.
3. Edge preparation is required before welding.
4. More sefety devices are required.
5. Jigs and fixtures are required to hold the parts to be welded.

Advantages and disadvantages of welded joint over other joints

- Welding is more economical and is a much faster process as compared to both casting and riveting.
- As compared to rivetinting and casting, fewer persons are involved in a fabrication process.
- Welding involves less cost of handing.
- Welding produces less noise as compared to riveting.
- Welding designs involve less cost and are flexible also (we can change easily).
- Cost of pattern making, storing, maintenance, repairs is eliminated.
- Welding structures are comparatively lighter.
- Welding can be carried out at any point on a structure, but riveting requires enough clearance.
- Welding can produce a 100% efficient joint, which is difficult to make by riveting.

Q.7. (b) Differentiate between (a) TIG welding and (b) MIG welding processes. **(6.5)**

Ans. Refer Q.1.(e) of End Term Examination 2016.

UNIT-IV

Q. 8. (a) Discuss the various methods available for manufacturing metal powders in powder metallurgy. **(6)**

Ans. Refer Q.5. (b) of End Term Examination 2017.

Q. 8. (b) What are the various sheet metal operations? Discuss any four of them in brief with neat sketch.

Ans. Sheet Metal Operations

The following are the various sheet metal operations

- Measuring and marking
- Cleaning
- Cutting and shearing
- Stretch forming
- Riveting
- Hollowing or Blocking
- Laying out
- Bending
- Deep drawing
- Soldering
- Sinking

• Raising • Planishing

1. Measuring and Marking: In order to cut the required sheet from the standard sheet (available in market). First measuring and marking is done i.e. how much sheet is required, it is marked. Measuring is done with the help of steel rule, steel tape, folding rule, steel circumference rule etc. After measuring the various dimensions, marking is done with the help of scribers, punches etc. While doing the marking, little allowance for cutting is always added to the overall size. Sometimes, the sheets are coated with a coloring media, so that the scribed lines are clearly visible. The procedure for marking straight lines, curved lines, indentation marks and transferring a pattern is as follows:

(a) Marketing straight lines. The straight edge or steel square is used to draw straight lines as discussed below. When straight edge or steel square is used, a sharp pointed scriber is helf in one hand at an angle against the edge of the striaght edge or steel square, then the lines are drawn by applying a little pressure to the scriber.

(b) Marking circles and arcs. The circles and arcs are marked on the surface of a sheet metal with the help of a divider or a trammel point. One leg of the divider is placed at the centre of a circle or arc, the other end is mvoed with a little pressure on the divider to mark the circle or arc. In order to prevent slipping, the divider is inclined in the direction in which the circle or arc is drawn.

2. Cleaning: Sometimes, the blank surfaces need proper cleaning before being processed. For cleaning, pickling process is used. In this process, sheets are immersed in a hot bath of 1 part dilute sulphuric acid and 20 parts water. After allowing sufficient time for pickling, the blank are thoroughly washed in a stream of water and then allowed to dry.

3. Laying out: While doing the marking of development of the surface of the component on the sheet, certain material for various allowances (such as overlapping, cutting, bending etc) are added. Such a layout when made on the sheet is called laying out process.

4. Cutting and Shearing: The word cutting is normally used when the sheet metal is cut by means of a chisel and a hammer manually. The term shearing means cutting of sheet metal by two parallel cutting edges moving in opposite directions manually. Shearing is done by hand shears or snips or by means of machines. Shearing action has three basic stages. Plastic deformation, fracture and shear. When the metal is placed between the upper and lower blades of the shear and pressure is applied first plastic deformation takes place. Then there is fracture and ultimately shearing takes place when further pressure is applied. General shearing (or cutting) process by hand shear is described below.

- Hold the snip in one hand and sheet in the other hand.
- Place the upper blade on the line of cut to be followed.
- Start the cut by exerting pressure on handles of snips. After cutting about 15 mm, open the blades again and push the snip forward. Repeat this until cut is completed.
- In order to maintain proper space for snip, curl the sheet.
- The inside curves such as circular holes (manually) are cut with curved snips. The holes are first cut roughly with a cold chisel and hammer. Then it is trimmed to the required size by the curved snip.

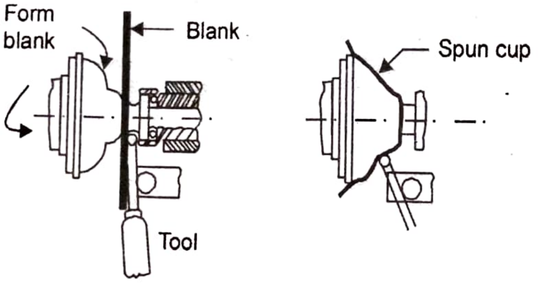
If punch and die set up is used for shearing operation, then the punch is of the same shape as that of die opening except that it is smaller on each side by an amount known as clearance.

Q. 9. (a) Explain spining and stretch forming operations and enumerate their characteristics and applications. **(6)**

Ans. Spinning: Spinning is the used for making cup-shaped articles which are axi-symmertical. The process of spinning consists of rotating the blank, fixed against the form block and then applying a graduually moving force on the blank so that the blank takes the shape of the form block. A typical set-up is shown is Fig.

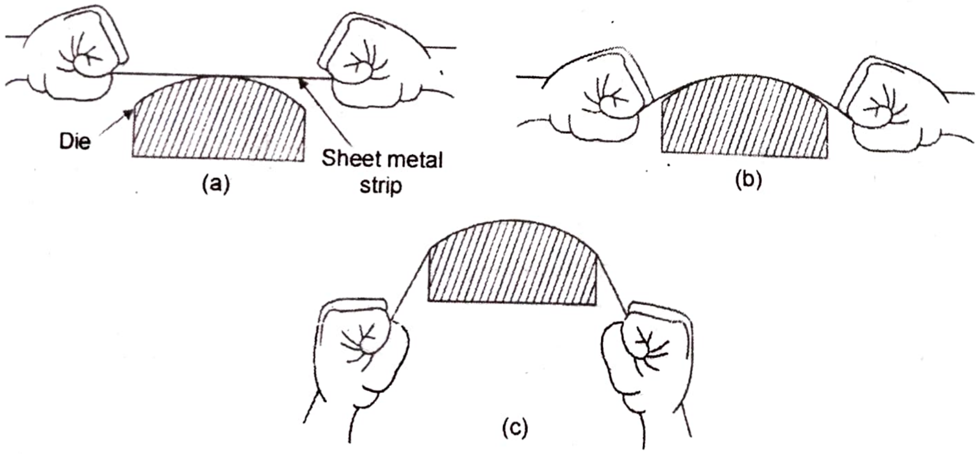
The set-up essentially consists of a machine similar to a centre lathe. In the head stock of the spinning machine, a hard wood form block that has the shape of the desired part is fixed. The blank is held against the form block by means of the freely rotating wooden block from the tail stock. After proper clamping, the blank is rotated to its operating speed. Then the hard wood or roller-type metallic tool is pressed and moved gradully on the blank so that it conforms to the shape of the form block. The manipulation of spinning tools is a highly skilled art. The tool is to be moved back and forth on the blank so that no thinning takes place anywhere on the blank.

Spinning is comparable to drawing for making cylindrical-shaped parts. Because of the simple tools used in spinning, it is economical for smaller lots. But the time required for making a cup is more in spinning and also more skill is required in the process. Thus, it is not suitable for large-scale production. Complicated shapes and re-entrant shapes are not feasible by drawing, but can be made by spinning using the sectional and collapsible form blocks. Large parts are much more easily made in spinning than by drawing. When sheet thickness is more, for example, in making the dished ends of pressure vessels, cold spinning is not sufficient. Then the blank is heated to the forging temperature and so the process is called *hot spinning*. Also in hot spinning, the tools are mechanically manipulated because of the higher magnitudes of forces required.

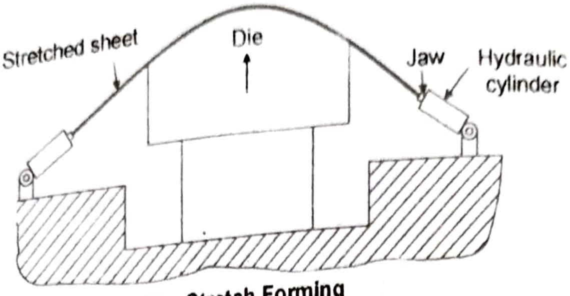


Stretch Forming: Stretch forming is an attractive way of producing the large sheet metal parts in limited or low quantities. In this process the sheet of metal is gripped by two or more sets of jaws that stretch it and wrap it around a single form die block. This process of simultaneously stretching and bending is called stretch forming.

• In stretch forming most of the deformation is induced by the tensile stretching, therefore, forces on the die are far less than those normally present in bending or forming because forces are so low that the dies can often be made of wood, low melting point metal or even plastic.



Various steps to illustrate the process of stretch forming. It is also shown the how metal is subjected to stretching and bending in stretch forming.



· Fig. Stretch Forming

• As in this process deformation is carried out in plastic region there is very little spring back and work piece closely conforms to the shape of tool.

• In stretch forming we can have component either single or double *curved surfaces*. The sheet should have uniform thickness otherwise the thinner portions be over stretched. Also if the sheet is having any holes *before the* stretch forming they are likely to be enlarged.

Q. 9. (b) Describe briefly the various secondary operations performed on powdered metal parts. (6.5)

Ans. Secondary operation

(1) Most powder metallury products are ready to use after the sintering process.

(2) Some product may use secondary operation to provide enhanced precision, improved properties or special characteristics

Secondary Treatment

– Sizing and coining.

– Machining

– Impregnation

– Imfiltration

– Infiltration

– Surface engineering

(1) Sizing: Sizing is done to refine dimensional accuracy pr used are no more than initial compacting pr.

(2) Coining: Pressure used are more than the initial compacting pr. It increases mechanical properties.

(3) Machining: Machining is any of various processes in which a piece of raw material is cut into a desired final shape and sized by a controlled material removal process.

(4) Impregnation: Controlled porosity permits PM parts to be impregated with oils resins. This can be done simply by submerging the PM components in an oil both for several hours vaccum inpregation process gives better result

(5) Infiltration: Operation in which the process the PM part are filled with a molten metal.

(6) Surface engineering: Surface engineering refers to a wide range of technologies design to modify the furface properties of metal or non meltalic components for functional and/or decorative propose.