METAL PRODUCTION

Iron ores: An ore when contains more then

20 percent iron will be considered as iron ores.

The following iron ores are used for extraction of iron-

i. Magnetite (Fe_3o_4) containing about 73% of iron.
ii. Hematite ($Fe_2\ o_3$) containing about 70% of iron.
iii. Siderite ($Fe\ co_3$) containing about 40% of iron.
iv. Iron pyrites (Fe^s_2) containing about 47% of iron.

Iron pyrites are not used in India for iron extraction.
By melting iron ore in a furnace called “Blast Furnace”, pig iron is extracted.

Composition of pig iron:Theapproximate composition of pig iron is as follows –

Iron-	94%
Carbon-	3.1 %(3% to5%)
Silicon-1 %	
Sulphur-	00.3%
Phosphorus-	00.9%
Manganese-	00.5%
Total	100%

Properties and uses of pig iron: Pig iron is a very brittle and weak metal; For this it can never be used. But it is the original form of iron fromwhich other types of iron and steel are made for example; from pig iron we make cast iron, wroughtiron; steel etc.

Charges in Blast furnace: The charges in a Blast furnace are –
1. Ironores 2. Cokeand 3. Lime stone.

Functions of coke: The functions of coke in a Blast furnace are
(a) To supply heat necessary to start and continue chemical reactions between iron ores, lime stone and itself as result of which pig iron is ultimately produced.
(b)To provide carbonthis combines with iron oxides and produce pig iron.
(c) To provide ashes which together with Limestone forms slag.

The functions of Lime stone: In a Blast furnace are
(a) to help extraction of iron form iron ores,
(b) to unite with the ash of the coke and the impurities present in iron ores to form slag.

Slag &its function: Slag is a molten material formed by the combination of the ashes of coke, limestone and impurities present in iron ores.
The slag being of lesser density then molten iron, floats on the top of the molten iron like cream on milk. Slag prevents oxidation of molten iron under it as it does

not allow the iron to come in contact with oxygen present in air supplied to the Blast furnace.

Thyeres Air Blast: To supply air blast at the bottom of a Blast furnace thyeres are provided. The air blast helps for combustion of coke and carry upward the gases formed inside the furnace.

*At the bottom of the furnace the temperature is $1250^{o}_{c.}$To admit charge into the Blast furnace, at the top of the furnace, double gate hopper arrangement isproviding. The Blast furnace operates continuously up to five to seven years and is capable to produce 500 metric tons of pig iron per day.

Cupola: Cast iron is manufactured by refining pig iron in a furnace called cupola.

Charges in the cupola: The charge are –

i. Pig iron
ii. Scraps of cast iron andsteel,
iii. Coke, and
iv. Lime stone.

The proportion of different charges of a cupola will be
Iron: coke: limestone =10:1:0.2.
This means to melt 10 metric tons of pig irons, 1metric ton of coke, and 0.2 metric ton of Lime stone will be required.

Bed charge- it consists of a bed of coke charged initially into a cupola immediately afterkindling a few piece of wood on the sand bed of the cupola.

Melting rate: It is the rate at which iron is melted per hour per sq. cm. of floor area of the cupola. It depends on the internal volume of the cupola the height of the bed charge, and the pressure of air blast sent into the cupola.

Melting ratio: The ratio of the metal melted to the coke charge is known as melting ratio. This ratio for general case may be taken as 10:1. This means 1kg of coke is required to melt 10kg of iron.

Capacity of a cupola: The capacity of a cupola is given by the amount of iron that it can produce per hour.The capacity of a cupola depends on the inside diameter of the cupola,a 1m dia. Cupola will meant about 2 metric tons of iron.

Difference between Blast furnace and cupola:

I. A Blast Furnace is fitted with a double gate hopper arrangement at the top for admitting charge in to it without allowing the gases to escapethrough the top. But a cupola is not fitted with any such arrangement. In case of a cupola, the charge is taken through a door, calledcharging door, made at the vertical wall of the cupola.
II. The hot gases from within the Blast furnace are taken out through an outlet made at the vertical wall of the Blast furnace. But in case of cupola, the hot gases go out of the cupola, through the top.

III. In order to arrest the sparks of fire which may come out of the top of the cupola and cause accident to the workers, a cupola is fitted with a “spark arrester” at its top. But as there is no such possibility in case of a blast furnace it is not fitted with such arrangement.

IV. A Blast furnaceoperates continuously for several years but a cupola operates for a few hours a day.

V. Hot Air blast is sent through the Blast furnace to increase its thermal efficiency and accelerate the chemical reactions, but cold air blast is ordinarily sent through the cupola.

VI. Blast furnace consists of two truncated cones joined together, but the cupola is cylindrical thought out its height.

VII. Blast furnace is a stronger than that of a cupola. Cast iron contains 2 to 4.5 percent carbon and some amount of silicon, Sulphur, phosphorus and manganese as impurities.

SMITHING AND FORGING

Definition of forging: Forging is defined as the method of deforming metals into a predetermined shape and size after heated the metal into a predetermined hammered or pressed by the application of hammeror press.

Difference between smiting and forging

“Smiting “is related to production of small jobs which are heated in open hire and are deformed by manual labor to give it required shape and size. But “forging” is related to production of comparatively big jobs which are heated in closed furnace and are deformed generally by mechanized device to give it required shape and size.

For example, Rings chisels etc. are made by smiting and crank shaft, connectingrod of engine are made by forging.

Forgeability: Ability of a metal of being forged in called forgeability.Metals which possess mechanical

properties like malleability and plasticity can be forget atease. Low carbon steel or mild steel is much used in forging operation.

Forging temperature:

Forging temp of mild steel - 750-1300^{0}c

Forging temp of Al and Mg alloys- 350 -500^{0}c

Forging temp of Cu, Brass and Bronze- 600-950^{0}c

Forging temp of Medium carbon steel- 750-1250^{0}c

Forging temp of high carbon steel- 800-1150^{0}c

Forging temp of Stainless steel- 940-1180^{0}c

Forging tool: -Tools used in forging are Anvil, Hammers, Punches, chisels, Fullers,swages,flatter, Tong (hearth/Furnace).

Fuels used: Fuels used in furnaces for forging purposes are classified into-

i. Solid fuels, such as coal, coke and charcoal.
ii. Liquid fuels, such as furnace oil.
iii. Gaseous fuels, such as Natural gas.

Forging operations: -Various forging operations are up setting, drawing down, setting down, Bending, Punching, Drifting.

Forge wedding: Welding is the method of joining two pieces of metal. If the temperature of two pieces of a metal be raised untiltheresurfaces become pasty, and thenthey are pressed or hammered together, they will form a single pieces ofmetal, i.e. the two pieces will be welded. This welding is called forge welding.

Defects in forging: Usual defects in forged parts are-

i. Cold shuts –These are small cracks.
ii. Scales pits.
iii. Mismatched forging.
iv. Fins and rags.
v. Incomplete component –Due to less metal used.
vi. Defective Structure
vii. Burnt and overheated metal.
viii. Dimension not within given limits.

HOT WORKING OF METALS

Thermic condition for hot working:

Before hot working of metals, they are heated to plastic state. Under this state when pressure is applied to the metals, they are easily formed into desired shapes.

Principle methodsof hot working of metals:

i. Forging

ii. Rolling
iii. Electric resistance welding
iv. Drawing
v. Extruding etc.

Rolling: -Rolling is the method of reducing the thickness of a metalwhich has been heated to plastic state by pressing the metal in between two rolls.

Drawing:-Drawing or cupping is the method of making cup shaped parts from flat sheet metal blank.

Extrusion: -Extrusion process is similar to removal of tooth paste from its tube. It can be said that the toothpaste is the material to be extruded and the orifice (lie, out let) of the tube is the die.

The product of extrusion is rods, tubes, Structural shapes etc.

ADVANTAGES AND DISADVANTAGES OF HOT WORKING:

Advantages:

i. Porosity in the metal is eliminated.
ii. Impurities are broken up and distributed through the metal.
iii. Coarse (i.e.rough) grains are refined.
iv. Physical properties are improved because of grain refinement.
v. Ductility and resistance to impact, and strength are increased.

Disadvantage:

1. Close tolerance cannot be maintained.

2. Tooling and handling costs are high.

3. Due to high temperature of the metal, rapid oxidation of metal takes place and surface finish become poor.

*Electric resistance welding is an example of plastic welding.

In electric resistance welding no filter metal to require.

Heavy current is required in Electric welding. Itvariesfrom 13000 to 33000 ampere per cm^2. of electrode area.

FOUNDRY(orCasting)

Foundry or casting is a process of forming metallic products by melting the metal, pouring it into a cavity known as the mould,and allowing it to solidify. In this way the molten metal takes the shape of the mould. This product is cleaned and machined to desired dimensions. Moulds can be made of metal or nonmetals, but generally they are prepared in sands.

BASIC STEPS IN THE CASTING PROCESS:

The basic steps in the casting can be set forth as follows: 1. Pattern making, 2. Mould and core making, 3. Melting and pouring,4. Cleaning of the casting.

Pattern making: This is the first step in the casting of a job. The pattern is a model of the job and is made of a suitable material, commonly wood or metal, and is used to make the mould. The success of a casting process depends a lot on the quality and the design of the pattern.

Mould and core making: Mould is the cavity which is formed with the help of the pattern in a suitable mould material, commonly the molding sand. Sometimes a hole or a recess is required in the casting. This is achieved by placing a suitable core in the mould. The shape of the core corresponds to the shape of the hole or recess. The cores are usually made of sands having compositions much different from the molding sand.

Melting and pouring: Once the mould is made, it is ready to receive the molten metal. At this stage, the metal is melted in a suitable furnace depending upon the amount and the nature of the metal. When the metal is completely molten, it is tapped in a suitable ladle and then poured in the mould.

Cleaning: After the metal has been poured in the mould the whole thing is allowed to cool just solidifying the metal. When the process of solidificationis complete, the casting is taken out. The casting at this stage, however, is not in the same form in which it is desired and its cleaning is very essential. The processes of cleaning are done in two steps as given below:

1) All extra parts like sprues, gates, riser etc. are removed.
2) The surface of the casting is cleaned by removing the sand and other foreign particles clinging to its surface.

ADVANTAGES of the casting process: The main advantages of casting process over other fabrication processes can be summarized as follows:

1. Parts with very intricate shapes can be produced by casting at a cheaper rate.
2. Certain metals and alloys due their certain metallurgical properties, cannot be shaped by mechanical working, whereas, they can be cast without any difficulty, such as Cast iron.
3. In most of the cases, the process of casting, if done with accuracy, reduce the machining time to a great extant.
4. It gives a faster rate of production and thus the total time per unit production is minimized.

5. As compared to other manufacturing processes, the casting technique is simple, because number of operation in this technique are minimum.
6. Machinability and vibration damping capacity are better in cast metals, for example cast iron.
7. In certain light metals, strength, lightness and good bearing qualities can only be produced bycasting.
8. A wide range of alloys having various compositions and properties can be cast easily.
9. A better and controlled metal distribution is possible in casting, thereby increasing the fatigue strength of the product.

DISADVANTAGES of the casting process: 1) Casting is not economical when parts to be made are very small in number. 2) Casting are susceptible to various defects like internal porosity, shrinkage, blow holes, segregation and hot tears.