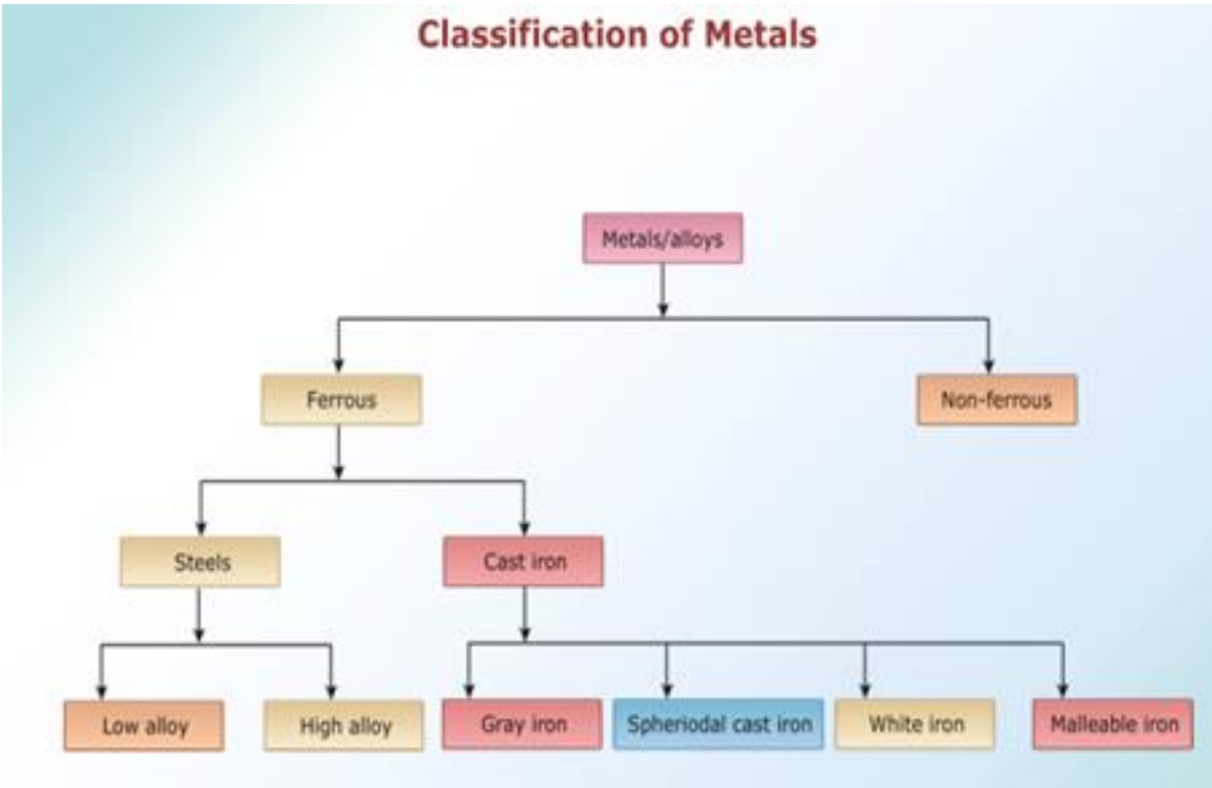
Classification of materials



1. ***<u>Cast and Ib importance:-</u>***

Cast iron are basically alloys of iron and carbon like steels in which the carbon percentage varies between 2.0 to 6.67% solubility limit of carbon will be more than that in austenite and less than the carbon content of cementite. High carbon percentage makes cast iron very brittle. There four most commercially manufactured cast iron has 2.5 to 4% carbon.

Cast iron cannot be rolled drawn or worked at room temperature as cast iron has very low ductility and poor malleability. But cast iron can be readily melted and casted into complicated shapes. It can be machine to the final dimension if needed. The only suitable process applied to these alloys is casting. Hence the name given as “cast iron”.

Raw materials used in the manufacture of cast iron are cheap, hence it is the cheapest alloy among the commercial alloys. The melting temperature of cast iron is in the range of 1150-1250

C which is less when compared to the melting temperature of steel hence it is easy to melt cast iron has good corrosion resistance.

2. ***Advantage of steel over cast iron:-***

1. Steels can be hardened and temperature.

2. Steels are tough and more elastic than cast iron.

3. Steels can be readily forged and welded compared to cast iron.

4. Steels can be permanently magnetized, where as cast iron cannot.

5. Steels are ductile.

6. Tensile strength of steel is better than cast iron.

7. Steels are not affected by salty water, where as cast iron becomes soft in salty water.

3. ***Heat treatment of cast iron:-***

The various heat treatments given to cast iron are

1. Stress relieving.
2. Annealing.
3. Normalizing.
4. Hardening and tempering.
5. Austempering

1. *Stress relieving:-*

It is the type of heat treatment usually applied to cast iron in order to relieve residual stresses which may reduce strength, cause distortion and in some extreme case even result in cracking. This type of heat treatment is most frequently applied for gray cast iron by heating it to a temperature range of 500 to 550°C Cunning remove residual stresses present.

2. *Annealing*:-

Annealing is a heat treatment given to cast iron in order to soften the casting and to improve their machinability and ductility. For roost gray of 850 to 900°c. to soften it and thus improve it machinability. For spheroidal graphite cast iron annealing girl done to increase in toughness and ductility.

The white cast iron has cementite structure which is very hard and brittle. So annealing heat treatment process is used to make the white cast iron poet i.e.malleable.

3.Normalizing: -

This is one of the Simplest heat treatment frequently applied to casting, forging etc... To refine grain structure to relive stresses and to increase strength and hardness. Normalizing girl a process of heat treatment given to gray cast iron by heating it to a temperature above the transformation range normalizing is done by cooling it in air from 900 to 920°c temperature

4. ***Hardening and tempering*:-**

Hardening and tempering heat treatment are applied to cast iron to increase it strength hardness and abrasion resistance. Hardening is a process of heat treatment applied for cast iron by heating it to a. temperature range of 860 to 900°c, where as tempering is the process of heat treatment applied for quenching cast iron. Tempering is of two types. Low temperature tempering having temperature range of 200 to 250°c came high temperature tempering having temperature range from 300 to 350°c. Tempering applied to cast iron improve it machinability strength and toughness.

5.Austempering:-

It is the heat treatment process, art iron are first heated duo a temperature of 850 to 900°c and them quenched in a bath at 500 to 550°c. Generally, this is applied on the casting to increase hardness, ductility, toughness.

4-VARIOUS TYPES of CAST IRON

The types of cast iron are as follows

1 White cast iron:-

All the carbon's are in combined form as cementite

2Malleable cast iron:-

All the carbons are to combined in the form of irregular sound particles called temper carbon heat treatment of white cast iron given malleable cast iron

3 Gray cast iron:-

All urn carbons are uncombined in the form of graphite flakes

4 Nodular cast iron:-

By addition of special alloys the carbon is largely uncombined in the form compact spheroids

white cast iron:-

The fact that is freshly broken surface shows a bright white fature given the name as white cast iron. White cast iron has almost all in carbon chemically bonded whither the iron as iron carbide. Iron carbide egress very hard and brittle. Thus white cast iron possesses excellent abrussive white resistance under normal conditions white cast iron is brittle and not machinacle

Malleable cast iron:-

Malleable cast iron can be hammered and rolled un get different shapes. Through a controlled neat conversation processes me white cast iron malleable cast iron is obtained. An alloy malleable cast iron contains chromium mane nickel and hence they have high strength and are corrosion resistant. Malleable cast iron possesses high yield strength low coefficient of thermal expansion lone year resistance and good vibration capacity

Grey cast iron:-

Gray cast iron is basically an alloy me carbon and silicon with iron. It is readily cast into a sand mouldun get required shapes. It is marked by the presence me graphite flake in a matrix of ferrite, pearlite or austenite 10% of metal volume is occupied by the granite flakes. Length of the flakes may very from 0.05mm to 0.1mm, gray cast iron posses low melting point among the ferrous alloy. Gray cast iron can be cast into complex shapes and thin section due un high fluidity. It also posses a good machinability, high resistance to wear and also a high vibration damping capacity. Gray cast iron has a excellent casting quality for the production me simple and complex shapes

Nodular cast iron:-

Nodular cast iron is also known as the ductile iron. Unlike The long flakes in the gray cost iron, granites appear as rounded particle or nodular. The spheroidizin element when added un melt estimate suphur and oxygen which change the solidification characteristics and possibly account for nodulizing. Ductile cast iron possess shone machinability. The properties of ductile cast iron depend on the metal composition name the cooling rate. It possess good cast ability and excellent wear resistance. Nodular cast iron is mostly used in internal combustion engines.

<u>5- Properties of white cast iron and gray cast iron:-</u>

<u>W.C.I:-</u>

1) Due to the presence of cementite in large amount white cast iron are hard and brittle.

2) It has wear resistance properties

3) Due un high hard mess,it is not machinable

<u>G.C.I:-</u>

1 It has high vibration damping capacity.

2 It mechinability is better compared to w.c.i.

3Rigidity of G.C.I Is high.

4 High compressive strength.

5 High wear resistance properties

<u>6- Malleabilizing treatment of white cast iron:-</u>

White cast iron consists me cementite which is very hard and brittle so in order to make the white cast iron soft and malleable, heat treatment is carried out. Cementite egress a malleable phase which decomposes in to iron and carbon. A Very long time heat treatment at higher temperature is called mallebilizing treatment.

This treatment contests the cementite in white cast iron into irregular nodules of temper carbon and ferrite. It consists me heating the white cast iron at a temperature around 900°c for long time. This process is carried out in two stages i.e... First stage annealing and second stage annealing.

It first stage annealing, white cast iron is heated in non-oxidizing environment to temperature at 900°c. This heating contests the pearlite into austenite at lower critical temperature. The austenite thus formed dissolves some more cementite during heating.

The graphitization starts by precipitation of a graphite nucleus. Which. Grows in all direction giving irregular nodules or spheroidal shape called temper carbon formed at a interface area b/w primary carbides and saturated austenite. The rate of decomposition of primary carbide increase with increase in annealing temperature and results in production me note graphite particles per unit area. The casting is them soaked at 900°c for two or more days. This results in spherical shape of graphite in austenite by breaking down the cementite.

In second stage annealing, the casting is them cooled very slowly, resulting gin changing of austenite into ferrite and more graphite. After completion of graphitization, there is no change in structure during cooling up to room temperature and the micro structure at this stage consists of tempered carbon nodules in a ferrite matrix,

7- Malleable iron and ductile iron in terms of:-

1) Manufacturing process
2) Structure
3) Properties
4) Applications

Manufacturing process:

Malleable cast iron is produced is by heat treating white cast iron. The heat treatment involves is annealing. Two stages are annealing are involved in first stage annealing, the white cast iron is slowly heated to a temperature b/w 900c to 950c. in second stage of annealing, the obtained casting is cooled slowly.

Ductile cast iron is produced by the addition of elements like calcium, sodium and magnesium to the molten metal. it is obtained directly by solidification and does not require heat treatment.

Structure:

Micro structure of malleable cast iron contains white ferritic layer with nodules of temper carbon in ferric (or) peralite matrix and that of black heat malleable cast iron consists of white ferric layer with nodules of tempered carbon ferritic matrix.

Micro structure of ductile cast iron consist of nodules of graphite in ferritic (or) perlitic matrix.

Properties:

Malleable cast iron has good wear resistance, vibration damping capacity high yield strength good cast ability and machinability. But malleable cast iron can’t be draw into wires i.e.. Ductility is very poor.

Applications:

Malleable cast iron is used in automotive industry brakes, crankshaft and cam shafts.

Ductile cast iron is used in metalworking rules, gears and sheat metal dies.

Gray cast iron:-

Properties and users why gray cost iron is brittle ,while malleable iron is not?

Properties

1 it has high compressive strength

2 It has high fluidity

3 high self damping capacity

4 High resistance to wear

5 good machinabilily

Users:-

1 gray cast iron is used in machine tool stretchers such as beds base for different types of machine tools frames etc.

2 Piston rings and engine frames

3 polling mills and general machinery parts

4 lower grade of gray cast iron is used for clutch plates brake drunk

5 water pipes

Gray cast iron is brittle due to the presence of

Graphite flaks where as in malleable cast iron

Graphite appears as spherical particles

Graphite flakes in gray cast iron is surrounded by ferrite areas

The cast irons containing graphite in the form of flakes are called gray cast iron. The graphite in these cast iron is formed during freezing. The graphite flakes interrupt the steel like matrix to a large extend most gray cast irons are hypoeutectic alloys containing between 2.5 and 4%carbon these alloys first solidity by forming primary anisnite the initial appearance of combined resulting from the eulacte reaction at 2065f the cementite resulting from will graphite rapidly the graphite appears irregular generally elongated and curved plates which gives gray cast iron its characteristic gray cast iron its characteristic grayish color when fractured

During continued cooling there is addition perception of carbon became as of decreased in solubility of carbon in assistance the carbon is participated as graphite which promptly graharities

The strength of gray cast iron depends on the matrix in which the graphite is embedded. This matrix is largely determined by the condition of eutectoid cementite also graphitizes, and then matrix will be entirely ferrite.

Since, gray cast iron is soft and ductile; the matrix will be purely ferritic.

Nodular cast iron:-

1) It is possible un make nodular iron by heat treatment

A) Nodular cast iron does not require heat treatment, they are usually obtained as a result me solidification.

Nodular cast iron are produced from gray cast iron by the addition me small quantity me certain element called as nodulizing elements usually magnesium is added un gray cast iron melt in the ladle just prior un pouring into hemoulds.

These cast iron do not suffer from the defects of gray acrylic iron such as growth and free cracks when used at elevated temperature. Hence, gray cast irons do not need heat treatment as they are obtained from solidification.

WHY SHOULD THE SULPHUR CONTENT IS BELOW IN THE MANUFACTURE ME NODULARIRON?

The nodulizing elements have strong affinity for sulphur and they separate with sulphur from the molten bath as an initial step in producing nodular graphite.

The addition are expensive and hence for effective utilization of there elements. The gray iron melt should contain less amount me sulphur i.e<0.03%.

MIN THE MANUFACTURE ME NODULAR IRON WHY ARE INOCULANTS ADDED ONLY JUST BEFORE CASTING..?

The best method me reducing the size and improving the distribution me granite flakes is by the addition me small amount me material called inoculant such as aluminium, magnesium, titanium mane silicon carbide etc. and there when added night increases the nucleation rate giving rise to a find interrupt the continuity me the matrix much less than the saphite flakes Due un this s.g cast iron has a high strength and toughness when compared un the same structure of the gray iron.

The general composition me s.g cast iron is

carbon

silicon

manganese

sulphur

phosphorus

magnesium

To increase the strength and hardess of s.g cast iron nickel may be added as an allying elements

THE PROPERTIES ME S.G CAST IRON

1 The strength of s.g cast iron is equal un Vietnam of steel

2 It also has good toughness and ductility

3 It has superior wear resistance

4 It has good strength and stock resistance

5 This type me cast iron is more ductile and stronger than gray cast iron.

Applications:

The S.G cost vrons are widely used for 1) crank shafp, 2) valves, 3) hydraulic cylinders, 4) cylinder heads, 5) connecting rods.

A major application of this, is in marine and steam plants due to the fact S.G cost vron has good compression and corrosion resistance.

Q: Effect of sulphur, manganese, silicon, and phosphorous on the properties of plain carbon steels.

Ans:

Sulphur: **a)** Vmproves machinability of steels.

b) Reduces ductility and toughness.

c) Increases hardness and brittleness.

d) Addition of sulphur is limited to 0.05%.

Manganese:

a) Reduces ductility and weldability when present in high amount with high Carlon content.

b) Counteracts brittleness from sulpher.

c) Increases yield strength, tensile strength, toughness and hardness.

Silicon:

a) Increases strength, hardness and toughness without loss of ductility.

b) It is strong deoxidizer.

c) Improves oxidation resistance.

d) Increases permeability of steel.

e) Strengthens low alloy steels.

Phosphorus:

a) it dissolves in ferrite and increases hardness and tensile.

b) increases resistance to corrosion.

c) improves machinability.

d) strengthens low carlon steel

Q: AISI-SAE classification of steels.

Ans: American iron and steel institltion (AISI) adopted and expanded the standardization for steel used in the automotive indvstry which was provided by society of auhmotive engineers. They identified both plain carlons and alloy steel by a four digit number. In this case first digit indicates the mazor alloying element the second indicate the trimary alloying element and the last two digit indicate the carlon content in percentage value.

AISI Number	**Type**
1xxx	Carbon steel
10xx	Plain carbon
2xxx	Nickel steel
3xxx	Nickel chromium

Q: Red shortness and cold shortness.

Ans:

Red shortness: Red shortness is the fragmentation of the steel by fractures and fissures developed along the grain boundaries due to working of steel at rolling or forging temperature.

Cold shortness: Cold shortness is due to the distortion of crystal latice by the prerence of phosphorus as solid solution in ferrite which increases yeild point and tensile strength.

Q:

Stainless steel: Adding a small percentage of chromium to plain carbon steels for the formation for the formation of hard carbider when dispersed as fine precipitates, they increase and hardness and reduces the critical cooling rate. To improve hardenability with a less rapid cooling martenstic structure can be obtained. The amount of chromium added is less than 2%. By adding a large amount of chromium the corrosion resistance of the steels can be improved. But the rate of corrosion resistance decreases if the amount of chromium added is more than 12%. In general there are many types of stainless steels some of them are feritile, martersitic and arestenitic.

Austenitic stainless steal: The steels that contan 16% to 26% chromium more than 6% of nickel and a less percentage of carbon(0.1%) are austenitic steels. A steel of this group has the following composition 0.5% carbon, 18% chromium and 8.5% nickel. The steels which has percentage of chromium and nickel in the ratio 18:8 as they are terminated as 18/8 stainless steels. A steel without nickels called ferritic steel. The presence of nickel in stainless steal is to give them an aurstenite phase, this will be increased when the amount of nickel is increased. The increase in this aurstinite phase will be upto a point where the alloy becomes completely austeritic at all temperatures there steels cannot be hardend by the process of oueneching.

Q: Different kinds of carbon steels give their carbon context?

Ans: Carbon steels are the alloys of iron and carbon. There are different from cast iron in percentage of carbon. These are also known as plain carbon steels and are classified depending on the carbon context.

1) Low carbon steels (0.008 - 0.30%)
2) Medium carbon steels (0.30 – 0.60%)
3) High carbon steels (0.60 – 2.0%)

1) Low carbon steels: (0.008 - 0.30%)

It is also called as mild steels. They can be easily rolled into steels, hence good for cold working purpose. Good for fabrication work by welding, pressing or mechining. They are machinable, weldable, soft, malleable, auctile, tough and cannot be hardened by heat treatment process.

They are again classified according to carbon percentage.

a) Dead mild steel with 0.05 – 0.15% carbon:

This is used in making steel wires, reverse pipes, screws, nails and chains. Hardness of the steel will be about 115BHN and tensile strength about 390 N/mm^2.

b) Mild steel with 0.15 - 0.20% carbon:

Used for making com shafh sheel and strips hardness of the steel is 125 BHN with a tensile strength of 420 N/mm^2.

c) Mild steel with 0.20 - 0.30% carbon:

It is used valves, gears, crank shafp, connecting rods, railway axles etc.. Hardness of the steel is 140 BHN and tensile strength is a bout 555 N/mm^2.

2) Medium carbon steel (0.30 - 0.60%) carbon:

They have intermediate properties. High cooling rates are needed for hardening and less hardness is obtained they are malleable not so ductile medium tough.

They are again classified according to the carbon %.

a) carbon steel with (0.20 - 0.45% carbon) :

Used for making clihs gear shafh connecting rods tensile strength is 750 N/mm^2 and hardness of the steel is 200 BHN

b) Steel with (0.45 - 0.55% carbon) :

used for making harb with are subzeeted to shock and heavy reversal loading .like axels crankshafb. tensile is 100 N/mm^2 and hardness of the steel is 300 BHN .

c) steel with (0.55 to 0.6% carbon) :

Used for making valve springs, die, blocles, clutch dises, cushion rings etc..

Tensile strength is 1230 N/mm^2 and hardness of the steel is 400 - 450 BHN.

3) High carbon steels (0.6 to 2.0/carbon) :

These are hardened by the heat treatment process for high hardness. Depth of hardening and hardenability depth. It cannot be cold worked.

They are classified based on the carbon percentage.

a) Steel with 0.7 – 08% carbon:

used for making cold chisels, wrenches, etc.. The tensile strength is 1400 N/mm^2 and hardness is 450 – 500 BHN.

b) Steel with 0.8 - 0.9% carbon:

used for making rock drilb railway lines etc.. The tensile strength is 660N/mm^2 and hardness is 500 - 600 BHN.

c) Steel with 0.9 - 1.0% carbon:

Used for making punches and dies speed discoek the tensile strength is 580 N/mm^2 and hardness 550-600 BHN.

Q: Advantages of maraging steel as compared to regular stainless steel.

These special types of steel are air hardened by martenitic transformation and subsequently precipitation hardened by a ging hence the name maraging steels.

1)These steel are capable of attaining tensile strength of upto 210kg/mm.

2) Has excellent fracture toughness.

3) Used for special application like rocket engines and engine components, injection moulds, dies, pressure vessels.

4) Has high strength as they are hardened and properly aged.

Q: What is high speed steel. Give the typical compositing of high speed steel. Explain the part played by each of the alloying element in tool steel . explain treatment process of high speed steel.

Ans: High speed steel:

It is a highly alloyed tool steel which is used for removing metal at much higher speed. These are generolly used for making metal cutting tools. High speed steels are mainly of two types i.e.. tungsten base and molybdenum base high speed steels. These steels have excellent red harness and shock resistance. From tool performance and manufacturing point of view there is little difference between the two types of high speed steel and also the properties like red hardness wear resistance toughness etc are same. The basic composition of the tungsten high. Speed steel is given as

Tungsten	-	18%
Chromium	-	4 - 8%
vanadium	-	1%

Generally used tungsten based high speed steel is designaled as 18:4:1 ratio, indicating 18% tungsten 4% chromium and 1% vanadium is used to increase the abrasion resistance.

Effect of alloying element on tool steels:

1) TUNGSTEN:

a) Increase red hardness.

b) Promotes strength at higher temperature.

c) Resist heat.

d) promotes fine grains.

2) chromium:

a) increase hardnability.

b) increases abrarion and wear temperatures.

c) increases strength at high temperature.

d) increase corrosion and oxydation resistance.

3) Vanadium:

a) increase hardnability.

b) increases abrarion resistance to great extent.

c) promote fine grains.

d) impact strength and toughness.

In a typical heat treatment process of high speed steel, it is austenized at 1270^0C, salt ouenched to 600^0C air cooled and double tempered at 525^0C. As the constituents like w, me, cr, v are carbide formers, the micro structure consists of carbide in the matrix of tempered martensite. This given the contribution of wear resistant carbides in heat resisting matrix. They are widely used for lathe, /planer and sharper tools etc..

Q: Alloying elements that dissolve in ferrite increases its strength?

Ans: Barically alloying elements are added to seek to increase hardenability, strength, toughness and other mechanical properties. Most of the alloying elements are soluble in ferrite to some extent and forms solid solution when added to steel. Solid solutions are harder and stronger than pure metals and hence these elements increases strength and hardness of fertile. Thus copper, cobalt, nickel, aluminium and silicon are all found largely dissolved in fertile. The order of increase in strength is based on the equal addition of the elements by weight. The hardining effect of these alloying elements is actually small and hence contributes less to the overall strength of the steel.

Q: What effect would the addition of 1% chromium have on properties of steel?

Ans:

Chromium is considered to be a less expensive element than nickel and forms two carbides. These carbides have high hardness and good wear resistant.

If 1% chromium is added to low carbon steel it tends to go into the solution thus increasing the strength and toughness of the ferrite.

If 1% chromium is added to high carbon steel, the hardness and wear resistant of the steel increases.

Q: Compare the properties of plain carbon steels with those of alloy steel?

Ans:

A plain carbon steel is an alloy of iron and carbon these are different from the cast irons in regard of the carbon percentage. Plain carbon steel contain carbon in the range of 0% to 1.5%. They are used at atmospheric and ordinary temperatures that are not corrosive. The strength that can be obtained expect in thin sections is relatively less hardened. The carbons have a wide range of applications it ranges from a massive. I beam to good quality tool bit used in workshops.

Compared with alloy steel carbon steels have some disadvantages like lower hardenability, in heat treatment conditions plain carbon steel exhibit a poor combination of properties. Also the plain carbon steel have limited which a

1) Good ductility and toughness. High strength cannot be obtained.

2) Uniform hardening cannot be obtained in large section.

3) At high temperatures the plain carbons have poor resistance to corrosion and oxidation.

4) The strength and hardness of the plain carbon steel are poor at high temperatures.

So, to improve the above disadvantages of plain carbons steel, some elements other than carbon are added. Though in plain carbon steel these elements are present (manganese upto 0.90% silicon up to 0.30%) but in less amount and they are used as oxidizer. Other elements that may be added to steel are nickel, chromium tungsten, molybdenum, vanadium, coppers and cobalt. Due to presence of these element alloy steels posses the following properties.

1) High toughness, strength and hardness.

2) High corrosion and oxidation resistance.

3) They posses high hardness and strength at high temperature.

4) Improved magnetic and electric properties.

The amount of manganese in this alloy steel is 1.65% and that of silicon is 0.60% when these element are mixed in steel they are called alloy steels.

Q: Short notes on die steel and tools?

Ans:

Tool and die steel are special type of steel which are used for changing the shape of the material into a finished or semi-finished product, by forming or cutting. During hardening, they change in form posses good wear resistance, toughness, machinability, and softening.

Die steel, Should be heated slowly and uniformly, protective furnace atmosphere

CLASSIFICATION OF MATERAILS

Metallic materials are divided into two types

1. Ferrous materials

2. Non-ferrous materials

The ferrous materials are iron based and the non ferrous materials are having some elements other than iron as the principal constituent

The bulk of the non ferrous materials are made up of the alloys of copper, aluminum, magnesium, nickel, tin, led& zinc. Other non-ferrous materials and alloys are used to a lesser extent include cadmium, molybdenum, cobalt, zirconium, beryllium, titanium and the precious metals gold, silver and the platinum.

IMPORTANT PROPERTIES OF COPPER:-

1. High electrical and thermal conductivity.

2. Good corrosion resistant, mechinability, strength and ease of fabrication.

3. It is having pleasing color and can be welded, brazed, soldered and easily finished by plating or lacquering.

APPLICATIONS:-

1. Most of the copper is used for electrical conductors contains over99.9% copper is identified as electrolyte tough pitch copper [ETP] or oxygen free high conductivity copper [OFHC]

2.ETP copper also used for roofing, gutters, down-spouts, automobile radiators and gaskets, vats, pressure vessels, distillery and process equipment.

3. Oxygen free copper is used in electronics tubes or similar applications because it makes a perfect seal to glass.

4. Arsenic copper contains about 0.3% arsenic has improved resistance to special corrosive conditions and is used for certain condenser and heat exchanger applications.

5. Free cutting copper with about 0.6% tellurium has excellent machining properties and is used for bolts, studs, welding tips and electrical parts such as contact pins, switch gears, relays and precession electrical equipment.

6. Silver bearing copper has a silver content of 70 to 30%.Silver raises the recrystallization temperature of copper thus preventing softening during soldering of commu

It is preferred in the manufacture of electric motors for rail road and air craft use.

Copper Alloys:-

The most important commercial copper alloys may be classified as follows

1. Brasses
2. Bronzes
3. Cupronickels
4. Nickel silvers

Brasses:-

Brasses are alloys of copper and zinc and containing more than 5% zinc. Brasses are classified into two types

a. α-Brasses

b. (α+β) Brasses

a. α-Brasses:-

α-brasses are containing up to 36% zinc possess relatively good corrosion resistance and good working properties. The colours of α brasses varies according to copper content from red for high copper alloys to yellow at about 62% copper so, that those α brasses may be divided into two groups yellow α brasses and red brasses.

α-brasses having 5-22% zinc are in reddish colour and are called as red brasses.

α-brasses having zinc content between 20 to 36% are yellow in colour and are called as yellow brasses.

Commercial brasses:

Commercial brasses contain 90% copper and 10% zinc. It is stronger, harder than pure copper and is used for rivits ,screws, jewellary.

Cartridge brass:-

cartridge brass contains 70% cu and 30%zn.It has excellent deep drawing property and is used for making cartridge cases, house hold articles, radiator fins, lamp fixtures etc.

Admirality brass:-

Admirality brass contains 70%cu and 29% zn and1% tin. It has superior corrosion resistance than that of ordinary brass and is extensivity used for propellers and marine works.

Aluminium brasses:

-Aluminium brasses contains 76% cu,22%zn and 2%Al.It has better corrosion resistance than admirality brass and hence extensively used for marine works.

b.(α+β) Brasses:-These contain from 54 to 62% copper. These alloys will consists of two phases α and β'. these β' phase is harder and more brittle at room temperature than α. Therefore, these alloys are more difficult to cold work than the α-brasses. At elevated temperatures the β phase becomes very plastic and since most of these alloys may be heated into single phase β region, they have excellent hot working process.

Muntz metal:-The most widely used (α+β) brasses is muntz metal which contains 60% cu and 40%zn.It has high strength and excellent hot working properties and is extensively used for marine fittings, condenser heads, radiator cores, springs, chains ete….

Naval brasses:-These contains 60%cu, 39%zn and 11%tin.It has high corrosion and abrasion resistance and is widely used for condenser plates, propeller shafts and marine works.

2.Bronzes:-

Alloys of copper with other elements except zinc are called bronzes. The most important bronzes are alloys of copper and tin, aluminium, silicon or beryllium .These may also contain phosphorous, lead, zinc or nickel.

1. Tin bronzes or phosphor bronzes:-

Tin bronzes are alloys of copper and tin and contain tin between 1 to 11%.These are also called as phosphor bronze .phosphorous invariably present as a de oxidizer in casting.The phosphorous content varies from 0.01 to 0.05%.

These bronzes posses high strength, toughness, high corrosion resistance, low coefficient of friction and do not susceptible to season cracking. These are used for bushes, cottor pins, clutch disks, springs, taps, marine pumps etc….Tin bronzes have good castability and widely used in the foundry.

Gun metal:-

Gun metal contains 88%cu,10%tin and 2%zn.It has considerable strength and toughness and resistance to sea water corrosion. It is used for bushes, nuts, hydraulic fittings, heavy load bearings, marine pumps etc…

Aluminium bronzes:-

Commercial aluminum bronzes contain aluminum between 4 to 11%.Aluminium bronzes containing up to 7.5% Al are generally single phase alloys. while those containing between 7.5 and 11% Al are two phase alloys.

The single phase aluminum bronze have good cold working properties, good strength and good corrosion resistance. These are used for corrosion resistance vessels, nuts, condenser tubes etc…

The properties of two phase aluminum bronzes can be improved by heat treatment. By controlling the composition and by heat treatment the tensile strength of these alloys van be varied from 47 to 95kg/sq mm with elongation gradually decreasing from 70 to 5%.The heat treated aluminum bronzes are used for gears, propellers, pump parts, bearing, bushings ,drawing and forming dies ets….

Silicon bronzes:-

These contains 90-97%cu,1-4%si and small amounts of zinc, iron and manganese. The thermal and electrical conductivity of those alloys is about 10% of that pure copper. Silicon bronzes have mechanical properties comparable to that of mild steel and corrosion resistance comparable to that of pure copper. These are used for storage vessels for chemical and gasses, marine construction, nuts, bolts, rivets etc…

Beryllium bronzes:-

Beryllium bronzes contain 1.5-2.25% of beryllium. These alloys can be easily cast, can be easily hot or cold worked and can be easily welded. Like Al alloys, beryllium bronzes can be age hardened and the hardness obtained will vary between 200 to 400 brinell, depending upon the aging time and also tensile strengths upto142kgl sq.mm can be obtained by suitable heat treatment and cold working. The thermal and electrical conductivities of these alloys is comparable to that of pure copper.

These bronzes are used for diaphragms, springs, surgical and dental instruments, gears, watch parts, screws, bearings etc….

Cupro nickels:-

These are the alloys of copper and nickel and contain upto 30% nickel. The copper-nickel binary phase diagram shows complete solubility. So that all cupronickels are single phase alloys. They are not susceptible to heat treatment and may have their properties altered only by cold working.

These alloys have resistance to corrosion fatigue and also high resistance to the corrosive and erosive action of rapidly moving sea water. They are widely used for condenser distiller, evaporator and heat exchanger tubes for naval vessels and costal power plants.

Nickel silvers (German silver):-

Nickel silvers are alloys of copper, nickel and zinc and contain 20-30% Ni,10-30% zn and the balance copper. The appearance of those alloys is similar silver and posses good corrosion resistant characteristics. These are mainly used for utensils, costume jewellary, name plates etc…

Aluminium & Aluminium alloys:-

Properties of aluinium:-

1. It is ductile and malleable due to FCC structure. It can be worked either hot or cold but after recrystallization does not show twins as are seen in cu &cu alloys.

2. It is light in weight (specific gravity 2.7kg/cm3)

3. It has very good thermal & electrical conductivity on weight to weight basis, it carries more electricity than copper.

4. It has excellent ability of getting alloyed with other elements like cu, si, Mg, zn etc….some of the alloys respond to precipitation hardening and some have excellent castability due to this and their light weight & good corrosion resistance and oxidation. They are widely used in automotive and aeronautic fields.

5. Al has good malleability and formability, high corrosion resistance and high electrical & thermal conductivity.

6. Al ultra pure form of aluminium is used for photo graphic reflectors to take advantage of it's light reflectivity and non tarnishing characteristics.

7. Al is non toxic, non magnetic and non sparking. The non magnetic characterstic makes aluminium useful for electrical shielding purposes such as bus bar housings or enclosures for other electrical equipment.

8. One of the most important characteristics of aluminium is it's machinability & work ability. It can be cast by any know method rolled to any desired thickness, stamped, drawn, span, hammered forged and extruded to almost any conceivable shape.

9. These are extensively used for cooking utensils, various architectural components, food and chemical handling and storage equipment and assemblies.

Aluminium-Magnesium Alloys (Magnalium):-

1. Composition:-5.0% magnesium, 0.5%manganise

Properties:-

1. It is highly resistant to corrosion, machines well.
2. It takes high polish and anodizes well.
3. It has high strength.

Applications:- This type of alloys are used in the marine environments.

2.composition:- 10% magnesium with aluminium.

Properties:-

1. It oxidizes very easily
2. Light weight
3. Machinability good
4. Can be welded

Applications:- These alloys are used for the air craft and automobile components, dairy equipments and architectural work.

Aluminium copper alloys:-

1. These alloys having 4.5%cu and remaining material should be aluminium
2. This is a precipitation hardenable alloy and produces good strength after precipitation hardening.
3. This alloy has a moderate corrosion resistance and very much susceptible to hot tearing.
4. These alloys are mainly used for air craft castings and for other highly stressed parts due to its good mechinability properties and shock resistance.

Y-Alloys:-

Composition:- 4% cu, 2% Ni, 1.5% magnesium

1. It has an excellent ability to retain the strength at elevated temperatures with faitly good corrosion resistance.
2. It can be easily cast and hot worked.

Applications:- These alloys are mainly used for pistons and cylinder heads of diesel and high duty petrol engines.

induminium:-

1. It contain about 5%cu & 1.5% Ni with small amounts Mn, Ti, Sb, Co and Zr.
2. It is superior to y-alloys at elevated temperature service particularly in respect of creep resistance.
3. It is used in aero engines and other continuous elevated temperature service applications up to 300°c.

Duralumin:-

It contain 3.5-4.5% cu, 0.4-0.7% Mn, 0.4-0.7% Mg, Fe or si <0.7%, Al balance.

Properties:-

1. it posses high machinability.
2. It is having high tensile strength.
3. Excellent casting & forging properties.

Applications:-

1. Air craft and automobile parts.
2. Al-bars, sheets, tubes and rivets etc…

Titanium & its alloys:-

Major characteristic & properties of Titanium:-

1. Titanium is one of the few allotropic metals i.e it can be exist in two different crystallographic forms. At room temperature it has a close packed hexagonal structure, designated as the Alpha-phase.

   At around 885°c, the alpha phase transforms to body centered cubic structure, known as the beta phase which is stable upto titanium's melting point of about 1680°c.
2. Titanium mechanical properties are closely related to these allotropic phases. For example the beta phase is much stronger but more brittle than the alpha phase.
3. Ti-alloys can be usefully classified into three groups on the basis of allotrophic phases i.e alpha, beta & alpha-beta alloys.
4. Ti & Ti-alloys are having attractive engineering properties. They are about 40% lighter than steel & 60% heavier than aluminium. The combination of moderate weight and high strengths up to 1400kg/cm2, gives titanium alloys the highest strength to weight ratio of any structure metal roughly 30% greater than aluminium &

   This exceptional strength to weight ratio is maintained from -220°c up to 540°c
5. A second outstanding property of titanium material is corrosion resistance. The presence of a thin, tough oxide surface film provides excellent resistance to atmospheric and sea environments as well as a wide range of chemicals, including chlorine and organics containing chlorides. Being near the chloride end of the galvanic series, titanium performs the function of a noble metal.
6. Other notable properties are a higher melting point than iron, low thermal conductivity, low co-efficient of expansion and high electrical resistivity.

Applications:-

These titanium and its alloys are used for surgical implants, marine hard ware, compressors & valve bodies.

Titanium alloys:-

Alpha alloys:-

1. These alloys contain the alloying elements as aluminium, tin, columbium, zirconium, vanadium and molybdenum in amounts varying about 1-10%.
2. They are non heat treatable, having good stability up to 540°c and down as low as -220°c. They have good combination of weldability, strength and toughness.
3. The 5% Al and 25% tin alloy is the most widely used alpha alloy has been employed in numerous space and air craft applications.
4. It has strength at room temperature of 8400kg/cm2, acceptable ductility and is useful at room temperature up to 430 and 540°c. In addition, it has good oxidation resistance and good weldability and formability.

Alpha-Beta alloys:-

This is the largest and most widely used group of titanium alloys. Because these alloys are a two phase combination of alpha & beta alloys, their behaviour falls in a range between the two, single phase alloys.

1. They are heat treatable, useful up to 430°c, more formable than alpha alloys, but less tough and more difficult to weld.
2. The most popular alloy in this group is the 6% Al & 4% vanadium. It can be heat treated up to 11,972kg/cm2 has good impact and fatigue strength and unlike other alpha-beta alloys is weldable.
3. The 6% Al, 6% vanadium & 2% tin alloy is heat treatable to higher strength than any other alpha beta alloy(13380kg/cm2)

Beta alloys:-

These beta alloys have exceptional high strength over 14085kg/cm^2. Their lack of toughness and low fatigue strength limits their use. They retain an unusually high percentage of strength up to 320°c but cannot be used at much higher temperature and they become brittle at temperature below -40°c.