UNIT - III

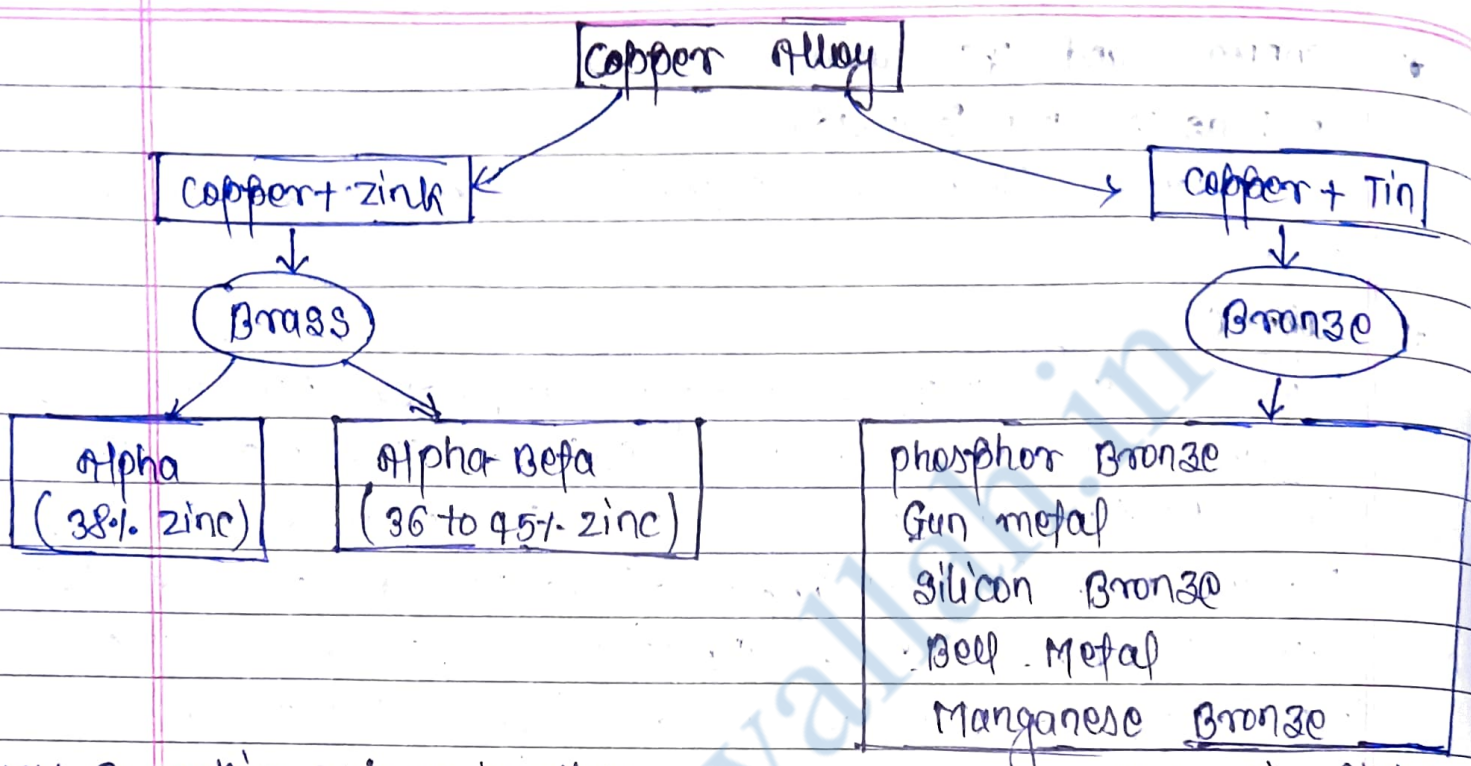
copper and its alloys :-
- Brasses and Bronzes

chemical Composition, properties, applications.

copper :-
The crude form of copper extracted from its ores through series of processes contains 68% purity known as Blister copper by electrolytic refining process, highly pure (99.9%) copper which is re-melted and casted into suitable shapes. copper is a corrosion resistant metal of an attractive reddish brown colour.

properties and uses :-
- High thermal conductivity
- High electrical conductivity
- Good corrosion Resistance
- High Ductility and Malleability
- Antimicrobial properties
- Non-magnetic.

uses :-
- copper is widely used in electrical wiring, cables and electronic components
- used for providing coating on steel prior to nickel and chromium plating.
- Can be easily cold worked, folded and spun. Requires annealing after cold working it loses its ductility.
- used in heat exchangers, heating vessels and appliances etc.
- it is used in machinery for its conductivity, malleability and resistance to corrosion.



uses:- In making costume jewellery, cartridge casings, automotive radiators, musical instruments, electronic packaging and coins.

uses:- Hydraulic fittings, bearing bushes, utensils, sheets, rods and many other stamped and drawn products.

Alloys of copper:-

Most copper alloys cannot be hardened or strengthened by heat-treating procedures, consequently, cold working and/or solid solution alloying must be utilized to improve these mechanical properties. Copper alloys are among the best conductors of heat and electricity and they have good corrosion resistance. The common types of copper alloys are brasses and bronzes.

Brasses :-

All brasses are basically alloys of copper and zinc. Commercially there are two main varieties of brasses :-

1) Alpha-brass :- Contains upto 36% Zn and rest copper for cold working.

2) Alpha-Beta brass :- Contains 36 to 45% Zn and remainder is copper for hot working.

- There are various types of brasses depending upon proportion of copper and zinc.
- fundamentally brass is a binary alloy of copper with as much as 50% zinc.
- various classes of brasses such as Cartridge brass Munts, Metal leaded brass, Admiralty brass, naval brass and nickel brass depending upon the proportion of copper and zinc plus third alloying metal are available for various uses.

Brasses chemical composition :-

Alloy of copper and zinc, commonly contains lead may include iron, manganese, aluminium, silicon or other elements.

properties :-

- It is more malleable than copper or zinc. Not as hard as steel
- corrosion resistance, • exposure to ammonia may produce stress cracking • good strength • decent electrical & thermal conductivity
- low melting point • easily machinability

Applications :-

- Brasses possess very good corrosion resistance and can be easily soldered.
- In making costume jewelry, cartridge casings, automotive radiators; musical instruments, electronic packaging and coins.

Bronze :-

The alloy of copper and tin are usually termed Bronze.

- The useful range of composition is 75 to 95% copper and remainder tin.
- In general, it possesses superior mechanical properties and corrosion resistance to brass.

Brasses chemical composition :-

Alloy of copper, usually with tin, but sometimes other elements may be added including manganese, phosphorus, silicon and aluminium.

properties :-

- Better conductor of heat and electricity than many steels.
- corrosion resistant • Brittle • hard • Strength
- and resists fatigue also and wear resistance
- it has slightly higher melting point than brass.
- The alloy can be easily cold rolled into wire, rods and fins. Sheets.
- Moderate electrical conductivity

- With increase in tin content, the strength of this alloy and its corrosion resistance increases. It is then known as hot working bronze.
- The properties of bronzes are modified with different alloying elements.

Applications:-

- Bronze is generally utilized in hydraulic fittings, bearing, bushes, utensils, sheets, rods and many other stamped drawn products.

Aluminium and its Alloys:-

Aluminium may be alloyed with one or more alloying elements such as copper, manganese, magnesium, silicon and nickel.
The addition of small quantities of alloying elements converts the soft and weak aluminium into hard and strong metal, while it retains its light weight.

The main alloys of aluminium are:- Duralumin, Y-alloy, Magnalium and Hindalium which are discussed as follows:-

Aluminium Alloys

Duralumin	Y-alloy	Magnalium	Hindalium
Composition	Composition	Composition	Composition
Aluminium with 4% copper, 0.5% manganese, 0.5% magnesium	Al with 93% Al, 2% Cu, 1% Ni and magnesium	Aluminium with 2 to 10 % magnesium.	Al with magnesium with small quantity of Chromium.

Duralumin :-

composition :-

- This is a famous alloy of aluminium containing 4% copper, 0.5% manganese, 0.5% magnesium and a trace of iron with remainder as aluminium is known as duralumin.

properties :-

- It possesses high strength comparable with mild steel and low specific gravity.
- However, its corrosion resistance is much lower as compared with pure aluminium.
- The strength of this alloy increases significantly when heat treated and allowed to age for 3 to 4 weeks, it will be hardened.
- To improve upon the corrosion resistance of it, a thin film of aluminium is rolled on the duralumin sheets. • excellent machinability, • light weigh

Applications :-

- These aluminium rolled sheets are known as Alclad by trade name and are widely used in aircraft industry.
- Due to lightweight and high strength this alloy may be used in automobile industry.

Y-alloy :-

It is also known as copper-aluminium alloy.

composition :-

- The addition of copper to pure aluminium improves its strength and machinability.
- Y-alloy contains 93% aluminium, 2% copper, 1% nickel and magnesium.

properties :-

- This alloy is heat treated as well as age hardened just like duralumin.
- A heat treatment of Y-alloy casting, consisting of quenching in boiling water from 510°C and then aging for 5 days develops very good mechanical characteristics in them.

applications :-

- Since Y-alloy has better strength at elevated temperature than duralumin therefore it is much used in aircraft cylinder and piston.
- It is also used in strip and sheet form.

- Excellent machinability
- good corrosion resistance
- good strength
- light weight

Magnalium :-

composition :-

- It is produced by melting the aluminium and 2 to 10% magnesium in a vaccum and then cooling it in vaccum or under a pressure of 100 to 200 atmosphere.
- About 1-75% copper is also added to it.

properties :-

- Magnalium lighter and more workable than aluminium is used in making metal mirrors and scientific instruments.
- Magnalium is an alloy of aluminium with significant amounts of magnesium, thereby lowering its density, improving corrosion resistance and fatigue while simplifying processing.

Applications :-

- Due to its light weight and good meachanical characteristics, it is mainly used for aircraft and automobile components.

Hindalium :-

Composition :-

- It is an alloy of aluminium and magnesium with small quantity of chromium.
- It is manufactured as rolled product in 16 gauge mainly used in manufacture of anodized utensils.

Properties :-

Hindalium is a common trade name of aluminium alloy. It is an alloy of aluminium, magnesium, manganese, chromium and silicon etc. In india, it is produced by Hindustan Aluminium corporation ltd., Renukoot (U.P.). Hindalium is commonly produced as a rolled product in 16 gauges. utensils manufactured by this alloys are strong and hard, easily cleaned, low cost than stainless steels, having fine finish, having good scratch resistance, do not absorb much heat etc.

Applications :-

- Hindalium is mainly used for manufacturing anodized utensil utensils manufactured by this alloys are strong and hard, easily cleaned, low cost than stainless steels, having fine finish, having good scratch resistance, do not absorb much heat etc.
- Due to its light weight and good mechanical properties. it is mainly used for making aircraft and automobile components marine equipment and construction.

Nickel is a versatile metal that alloys with many other metal incl. chromium, Molybdenum, Aluminium, iron, copper, Cobalt & Titanium

Nickel :-

About 85% of all nickel production is obtained from sulphide ores.

properties and uses :-

- pure nickel is tough, silver colored metal, harder than copper having some but less ductility but of about same strength.
- It is plated on steel to provide a corrosion resistance surface or layer.
- widely used as an alloying element with steel. Higher proportions are advantageously added in the production of steel such as monel or inconel.
- It possesses good resistance to both acids and alkalies regarding corrosion so widely used in food processing equipment.
- Excellent high-temperature strength • good corrosion resistance and
- Good weldability fatigue resistance

Alloys of Nickel :-

(a) German silver :-

composition :-

- The composition of this alloy is 60% Cu, 30% Ni and 10% Zn

properties :-

- It displays silvery appearance and is very ductile and malleable.

Applications :-

- It is utilized for electrical contacts, casting of high quality valves, taps and costume jewellery.
- It is also used in producing electrical wires.

(b) Monel metal :-

Composition :-

- It contains 68% Ni, 30% Cu, 1% iron and remainder small additions of Mn and other elements.

properties :-

- It is corrosion resistant and possesses good mechanical properties and maintains them at elevated temperatures.

(c) Nichrome :-

- It is an alloy of nickel and ~~aluminium~~ chromium.
- which is utilized as heat resistant electrical wire in electrical appliances such as furnaces, geysers and electric iron etc.

Compositions :-

- usually, 80% Ni and 20% Cr is present.

Applications :-

- It is used in some dental restorations (fillings).
- It is used in ~~some~~ the explosive and fireworks industry as a bridgewire in electric ignition system.

(d) Inconel and incolony :-

- These alloy principally contains Ni (52-57%), Cr (17%), fe (13%), Mo (0.5%), Ti (1%), Al (0.5%) and very small proportions of carbon.
- These are used as high temperature alloys.
- Inconel does not respond to treat treatment.
- It provides mechanical strength at elevated temperatures and high oxidation resistance and corrosion.
- High strength, high corrosion resistance & fatigue resistance, Good weldability

uses → used in aircrafts engines, gas turbines, rocket motors and spacecraft components
↳ oil & gas industry

Bearing materials :-

A bearing materials should possess the following characters

- It should possess enough compressive strength to provide adequate load carrying capacity.
- It should possess good plasticity to negate small variations in alignment and fitting.
- It wear resistance should be adequate to maintain a specified fit.
- The coefficient of friction of the bearing material should be low to avoid excessive heating.

Some significant bearing metals are as follows :-

- Babbit's metal :- • It is used for production of heavy duty bearing. • It is white in color containing 88% tin, 8% antimony and 4% copper.
- It is a soft material with a low coefficient of thermal expansion.

White Metal : [Sn (Tin metal)]

- Babbitt metal is an antifriction metal alloy first produced by Isaac Babbitt in 1839. In present-day usage the term is applied to a whole class of silver-white bearing metals or "white metals".
- These alloys usually consist of relatively hard crystals embedded in a softer matrix, a structure important for machine bearing.
- They are composed primarily of Tin, copper and Antimony, with traces of other metals added in some cases and lead substituted for tin in others.
- Tin-based white metal is an alloy with minimum 88% Tin (Sn), the rest of the alloy composition is antimony (Sb), copper (Cu), cadmium (Cd) and small amounts of other elements that are added to improve the ~~finess~~ fineness of the grain structure and homogeneity during the solidification process.
- Tin based white metal is used in the main bearings, crankpin bearing, crosshead bearing, guide shoes, camshaft bearing and thrust bearing because of its excellent load carrying and sliding properties.

Aluminium Bronze:-

- Aluminium Bronzes are a family of copper-based alloys that use iron and nickel in their composition - but rely on aluminum as the principle alloying elements.
- Aluminum significantly adds to the strength to the point that it is similar to that of medium carbon steel.
- The additional advantages is that aluminum bronze also possesses excellent corrosion resistance.

- There are two major groups in the Aluminum Bronze family. Aluminum Bronze contains approximately 9-14% aluminum and 4% iron while Nickel Aluminum Bronze contains approximately 9-11% aluminum, 4% iron and 5% nickel. That addition of nickel in the latter further improves the corrosion resistance of a material that is already strong in this area.

- These major properties has led to the use of Aluminum Bronzes for a variety of parts requiring strength, hardness, resistance to wear and galling, low magnetic permeability, resistance to cavitation, erosion, softening, weldability and oxidation at elevated temperatures.

Self-Lubricating Bearings:-

- Self-lubricating works by having lubricant impregnated within the sliding layer of the bearing. This lubricant can either be liquid (oil) or solid (graphite, MoS_2, lead) based on requirements of the application (such as operating temperature).
- As the bearing operates, the lubricant is released through pores in the sliding layer, lubricating the bearing surface.
- The lubricant is uniformly dispersed throughout the sliding layer and thus there is no reduction in low friction bearing materials performance, even if the sliding layer becomes worn.
- Self-lubricating bearings materials are bronze, nickel, iron, iron/nickel and lead can be produced with the lubricants graphite or graphite and molybdenum.

Advantages of Self-Lubricant materials:-

- Self-lubricant materials contains the maintenance free benefits of self lubricating sintered bronze/graphite. The concentrated micro dispersion of the graphite throughout the metallic matrix ensures consistent lubricating properties over the entire wear area of the part.
- Low coefficient of friction, whether used in wet or dry conditions, the materials exude a very low coefficient of friction. Higher loads increase the lubricating features and further reduce friction wear.
- Self-lubricant materials are suitable for oscillating, rotational, linear and micro-movements as well as applications involving high edge pressure.

- Extreme conditions intended to withstand hot, harsh and dirty environments, the material can also be used in seawater, radioactives areas and corrosive situations
- High load capacity and can handle high static or dynamics loads.
- Temperature Resistance by these materials can endure heat upwards of 650°C and temperature as low as 50°C