

CONCEPTS OF
MECHANICAL
ENGINEERING – I
(25ME111)

PRAVEEN K

WEEK 03

- Non-Ferrous Materials Properties, composition and applications of
- Aluminium and Aluminium Alloys – Duralumin, Y-Alloy, Magnesium, Hindalium.
- Copper and Copper Alloys - Brass, Bronze, Gun Metal, lead, Tin. Bearing Metals.
- Zinc Based Alloys – Solder, German silver.
- Nickel Based Alloys – Inconel, Monel metals.

NON-FERROUS METALS

Non-ferrous metals are those which contain metal other than iron as their chief constituent.

Non-ferrous metals are generally employed in industry due to its excellent characteristics.

Characteristics or Properties of Non-ferrous Metals:

- 1) Good resistance to corrosion.
- 2) Light in weight.
- 3) Good electrical and thermal conductivity.
- 4) Good machinability.
- 5) Easily rolled, forged and casted.
- 6) Soft and easily cold worked.
- 7) Easily joined by brazing, fusing and resistance welding.

The various non-ferrous materials used in engineering practice are:

- 1) **Aluminium and its alloys**
- 2) **Copper and its alloys**
- 3) **Lead and its alloys**
- 4) **Zinc and its alloys**
- 5) **Tin and its alloys**
- 6) **Nickel and its alloys.**



ALUMINIUM

Aluminium:

Aluminium is a **white metal produced by electrical process** from the oxide (Alumina), which is prepared from a Bauxite. It is light in weight with specific gravity of 2.7 and melting point is 660° C.

It is available in pure state and it is a weak and soft material, when it is mixed with small amounts of other alloys, it becomes hard and rigid. So, it can be blanked, formed, drawn, turned, cast, forged and die casted.

Properties:

Following are the properties of aluminium

- a) It is a good conductor of electricity.
- b) Greater resistance to corrosion.
- c) Non-toxic.
- d) Non-magnetic and ductile.
- e) Light in weight.
- f) Specific gravity is 2.7
- g) Good conductor of heat.
- h) It is a good reflector
- i) It can be forged, formed, blanked, casted, drawn, turned and die casted.

Applications

It is used for overhead.

Used for cooking utensils.

Used for aircraft and automobile components.

Used in furniture's, rail road and trolley cars.

Aluminium foils are used for food protection elements.

Aluminium Alloys

Aluminium may be alloyed by using one or more elements. Such as copper, magnesium, manganese, silicon and nickel.

The main Aluminium alloys are:

Duralumin

γ-alloy

Magnesium

Hindalium

Duralumin

It is an important wrought alloy.

This alloy possess maximum strength after heat treatment and age hardening.

It can be hot worked at 500° C, but after forging and annealing, it can be cold worked.

Composition:

Copper	3% to 4.5%
Manganese	0.4% to 0.7%
Magnesium	0.4% to 0.7%

Rest in aluminium.

Properties:

Excellent strength.

Light in weight.

It can be hot worked at 500° C.

It is relatively soft and ductile.

It can be forged, rolled and extruded into various forms.

Applications:

It is widely used in wrought conditions for forging, stamping, bars, sheets, tubes and rivets.

It may be used in automobile and aircraft components.



Y Alloy

It is a copper aluminium alloy.

The addition of copper to a pure aluminium increases its strength and machinability.

This alloy can be heat treated and age hardened.

Composition:

Copper	3.5% to 4.5%
Manganese	1.2% to 1.7%
Nickel	1.8% to 2.3%
Silicon, Magnesium, Iron	0.6% each
Rest is aluminium.	



Properties

It has a better strength at high temperatures.

Good strength.

Good machinability.

It can be heat treated and age hardened.

Applications:

It is used for castings.

It is used for forged components.

It is used in aircraft engines.

Used for cylinder heads and pistons

Magnesium

It is made by melting the aluminium with 2% to 10% magnesium in a vacuum and then cooling it in a vacuum or under pressure of 100 to 200 atmospheres.

It also contains about 1.75% copper. It is light in weight

And good mechanical properties.

It is mainly used for aircraft and automobile components.



Hindalium

It is an alloy of aluminium and magnesium with small quantity of chromium.

It is mainly used for atomised utensils manufacture.



COPPER AND COPPER ALLOYS

Copper and Copper Alloys:

Copper is one of the most widely used non-ferrous metals in the industry.

It is soft, ductile and malleable material with a reddish-brown, appearance. Its specific gravity is 8.9 and its melting point is 1083°C .

Copper is a good conductor of electricity and it is largely used in making the electrical cables and wires for electrical machineries and appliances in electrotyping, electroplating in making coins and household utensils.

It is a non-corrosive under ordinary conditions and resists weather very effectively.

It may be casted rolled, forged and drown into wires.

Copper in the form of tubes is widely used heat exchanges. It is also used in making the ammunitions.

It is used in making useful alloys with tin, zinc, nickel and aluminium.



Copper alloys are the following:

1. Brass
2. Bronze
3. Gun metal
4. Lead
5. Tin
6. Bearing metals.

Properties

Good conductor of electricity.

High ductile material.

Low hardness with moderate strength.

Specific gravity is 8.9.

Melting point is 1083° C and boiling point is 2595° C.

Easily casted, forged, rolled and drawn into wires

Good resistance to corrosion.

Good non-magnetic properties.

Easily alloyed with other metals.

Copper can be used for following purposes

Uses

1. For making coins and electroplating.

2. For making thin sheets, water pipes tanks, taps, etc.

3. Used for hardware fittings, washers etc.,

4. Telephone cables, electrical cables, electrical equipment's like bushes, solders, switch gears, coils.

5. Heat exchangers, etc.

Copper Alloys:

1. Brass:

Brass is an **alloy of copper and zinc**, in which zinc is the principle alloying metal. There are various types of brasses depending on the proportion of copper and zinc.

This is fundamentally a **binary alloy of copper with zinc each 50%**, by adding small quantities of other elements, the brass material properties can be changed.

For example, addition of lead from 1% to 2% improves the machining qualities of brass.

It has a greater strength than the copper, but lower thermal and electrical conductivity.

It has a good corrosion resistance and can be easily fabricated.

Applications of Brass:

It is used for hydraulic fitting and pump linings.

Used for making utensils.

Used for making bearings and bushes etc.

Used for valves, automobile fittings and type writer parts.

Used for musical instruments.

Used for cold rolled sheets, wire drawing pressing.

For tube and plate manufacturing

Properties of Brass:

Brass has the following properties:

It has a greater strength than the copper.

It has a low thermal and electrical conductivity.

It has a good corrosion resistance.

It can be easily fabricated.

Its melting point ranges from 800° C to 1000° C.

It is soft and ductile.

It is non-magnetic.

Bronze

Bronze is an alloy of copper and tin. The composition of Bronze is as follows:

Copper 75 to 95%

Tin 5 to 25%.

By adding other elements its properties can be changed.

Following are the Properties of Bronze:

It is comparatively hard and resists the surface wear. .

It can be easily shaped or rolled into rods, wires and sheets.

It has a good corrosion resistance than the Brass.

Applications:

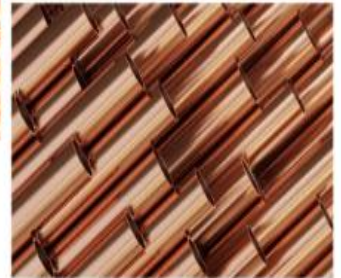
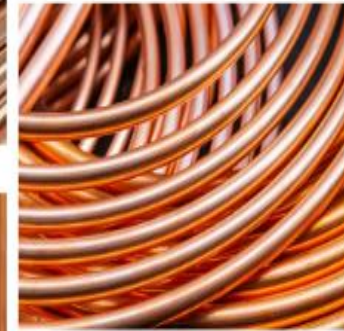
Used for bearings, worm wheels, gears, nuts, pump parts and springs.

Used for boilers, tanks, stoves etc.

Used for bushes, plungers, feed pumps, rods etc.

Used for imitation jewellery and decorative purposes.

Used for air pumps, slide valves, bushes, cam rollers etc.



Gun Metal

Gun metal is a type of bronze and an alloy of copper, tin and zinc that is used to make variety of objects. It is also known as red brass.

Composition:

The typical composition of gun metal is:

Copper -88%

Tin -8-10%

Zinc 2-4%



APPLICATIONS

It is used to make gears, bushings and bearings.

Used for pump parts and steam fittings.

It is used to make statues, buttons etc.

Used for ship components.

Used for bushings and valves.

Used for making steam fittings.

PROPERTIES.

Good corrosive resistant

It has a high tensile strength of 221 to 310 Mpa.

Good thermal conductivity.

Its melting point is around 1000°C.

Good casting quality

Good hardenability.

Relatively high density.

Good wear resistant.

Good corrosion resistant,

Good electrical conductivity.

It is easy to weld.

Lead

Lead (Pb) occurs occasionally in free state in nature. In combined form it occurs as sulphide.

The ore of a lead is Galena (PbS).

Lead is bluish-grey colour and heavy metal.

It can be easily cut, cold worked and extruded.



Composition:

It consists of stable isotopes and traces of radio isotopes, stable

Lead-204 -1.48% of natural lead

Lead-206 -23.6% of natural lead

Lead-207 -22.6% of natural lead

Lead-208 -52.3% of natural lead

Properties:

It is bluish-Gray in colour and heavy metal.

It can be cut by a knife.

It makes impression on paper.

It is soft and little strength.

It melts at 328 °C and boils at 1620 °C.

Specific gravity is 11.36.

It is highly malleable.

It is a poor conductor of electricity.

High coefficient of expansion.

Applications:

It is used for making shots, bullets, alloys.

Used for sanitary fittings, cisterns, water-proof and acid-proof Chambers.

Used in gas pipes, roof gutters etc.

Tin

Tin is usually obtained from its oxide known as tinstone through refining process. It is also available in nodules known as stream tin.

It has a brilliant shining white metal.

Composition:

Pure tin is 99.99% pure with small amounts of other elements.

Applications:

It is used for plating, lining lead pipes.

For preparation of alloys and solders.

Used in food industries for coating cans, dies etc.

Used for wrapping up cheese and chocolates.

Used for packing of tobacco, soaps etc.



PROPERTIES

It is ductile and soft malleable material.

Having low strength.

If tin bar is bent, produces noise called as cry of tin.

It becomes brittle when heated above 200 °C.

It has excellent corrosion resistance.

Good conductor of heat and electricity.

It melts at 232 °C and boils at 2260 °C.

Specific gravity is 7.31.

Not affected by dry air and pure water.

BEARING METALS

Followings are the widely used bearing metals:

Hard bearing bronze

Phosphors bronze

Admiralty gun metal

Lead bronze

White metals

Babbitt metal

Cadmium silver bearing alloy

Graphite bearing metals.

Beryllium copper bearing



Properties of Bearing Metals:

- ❖ **Good wearing quality.**
- ❖ **Low co-efficient of friction.**
- ❖ **High thermal conductivity.**
- ❖ **High melting point.**
- ❖ **Good casting qualities.**
- ❖ **Ability to withstand continuous bearing pressure and impact.**
- ❖ **Low shrinkage after casting.**
- ❖ **Economical in cost.**
- ❖ **Non-corrosive property.**
- ❖ **Desired plasticity under the load it is called upon to bear.**
- ❖ **Non-corrosive property.**

1. Hard Bearing Bronze

Composition:

Cu-85%

Sn-15%

Properties:

1. Its tensile strength is 220 MN/m^2
2. Elongation in 5 cm length is 2%
3. It has brinell hardness 100

Applications:

1. It is used in heavy compressive loads.
2. It is used in locomotive slide valves.
3. It is used in bearings for turn tables.



2. Phosphor Bronze:

Composition:

Cu-89%

Sn -11%

Properties:

1. Its tensile strength is 280 MN/m^2
2. Its elongation in 5 cm length is 4%
3. It has Brinell hardness 100

Application:

1. It is used for heavy loadings.



3. Admiralty Gun Metal

Composition:

Cu-88%

Sn-10%

Pb-2%

Properties:

1. Tensile strength is 270 MN/m².
2. Elongation in 5 cm length is 20%
3. Brinell hardness is 65.

Applications:

1. Used for general casting process.
2. Used for resist to marine corrosion.



4. Lead Bronze:

Composition:

Cu-80%

Sn 10%

Pb -10%

Properties:

- 1. Tensile strength is 230 MN/m^2**
- 2. Elongation in 5 cm length is 15%.**

5. White Metal:

These metals are copper-lead alloys and are generally used for heavy duty bearings.



6. Babbitt Metal

It is a white metal bearing alloy.

Composition:

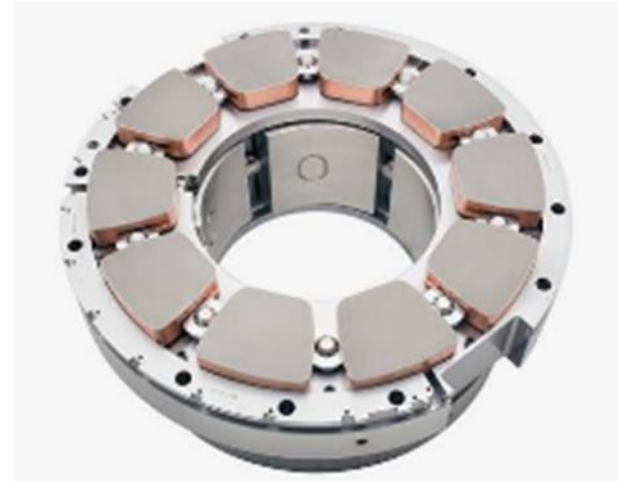
Tin-89.2%

Cu-3.8%

Antimony-7%

Properties:

1. It is soft metal.
2. Possesses sufficient mechanical strength for normal use.
3. It is easy to cast.
4. Used for bearing linings.



1. Zinc

- ❖ The zinc does not occur in Free State in nature.
- ❖ Its main ores are zincite or red zinc ZnO , franklinite ZnO , FeO , Zinc copper ZnCO_3 , and Zinc blende ZnS .
- ❖ A good quality zinc may contain 50% zinc.
- ❖ A pure ZnS contains about 65% zinc.

Properties:

1. Low ductility and malleability.
2. High resistance to corrosion.
3. It is weak and soft metal.
4. It has a low melting point i.e., 409°C .
5. It is bluish white metal.
6. It is not affected by dry air and pure water.
7. Specific gravity is 7.14.
8. It can be easily cast and bent into any shape.

APPLICATIONS

1. It is used for electric coils.
2. For galvanizing
3. In preparation of alloys and paints.
4. Used as a coating over iron sheets, corrugated sheets etc.



Zinc Based Alloys: German silver

German silver is an alloy of copper, nickel and zinc, which is used to make jewellery, diyas and other items. It is also known as nickel silver and argentan.

Composition:

Copper-60%

Nickel-20%

Properties:

1. It has a silvery appearance.
2. It is hard and tough.
3. Resistance to corrosion.
4. Light weight.
5. High electric resistance.



Applications:

1. It is used for making table ware such as spoons, forks etc.
2. Jewellery such as earrings, bracelets etc.
3. Musical instruments like tubes, keys, braces etc.
4. Fittings for ships and plumbing systems.
5. Heating coils etc.

Nickel Base Alloys

Following are the important nickel base alloys

1. Monel metal
2. Inconel
3. Nichrome
4. Nimonic



1. Monel Metal

It is an alloy of nickel and copper.

COMPOSITION:

It contains

Nickel -68%

Copper -29%

Other constituents - 3%

Like iron, manganese

Silicon and carbon.

PROPERTIES:

1. Its specific gravity is 8.87.
2. Its melting point 1160°C
3. It is strong, ductile and tough
- 4 It is superior to brass and bronze in corrosion resistance.

APPLICATIONS:

It is used for propellers, pump shafts, condenser des

Used for steam turbine blades, sea water exposed parts and tanks

Used for chemical and food handling plants.



Inconel

Compositions:

Nickel - 80%

Chromium - 14%

Rest is iron

Properties:

1. Its specific gravity is 8.55.
2. Melting point is 1395°C.
3. Excellent mechanical properties at ordinary and elevated temperatures.
4. It can be casted, rolled and cold drawn.

Applications:

1. It is used for making springs.
2. It is used for exhaust manifolds of aircraft engines.
3. Used in oil and gas extraction plants.
4. Used in pollution and waste processing plants.



Thank You

Any question? **!!?**