University of Anbar/ Faculty of Engineering

Department of Mechanical Engineering

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Lecture # 15

NONFERROUS ALLOYS

Steel and other ferrous alloys have some distinct limitations chiefly:

1) a relatively high density.
2) a relatively low electrical conductivity.
3) a susceptibility to corrosion in some common environments.

H.W. Cite three characteristics of ferrous alloys that limit their utilization?

Cast and Wrought alloys:

What is the principal difference between wrought and cast alloys?

Answer: ***wrought alloys*** are ductile enough so as to be hot or cold worked during fabrication, whereas ***cast alloys*** are brittle to the degree that shaping by deformation is not possible and they must be fabricated by casting.

Heat-treatable and non-heat-treatable alloys:

What is the chief difference between heat-treatable and non-heat-treatable alloys?

Answer: ***heat-treatable alloys*** may be strengthened by a heat treatment (precipitation hardening) or a martensitic transformation. ***Non heat-treatable alloys*** are not able to strengthening by heat treatments.

Non-ferrous metals are used due to following properties different from ferrous metals:

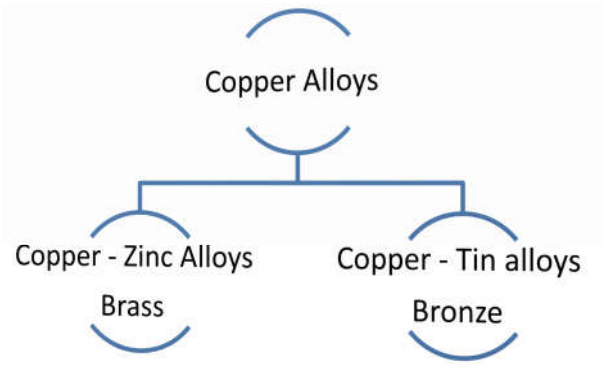
1. Melting point of non-ferrous metals is lower than that of ferrous metals.
2. Non-ferrous metals generally have lower strength as compare to ferrous metals.
3. Shrinkage is generally more than ferrous metals.
4. Corrosion resistance is more than ferrous metals.
5. Castability and formability is good.
6. Low density as compare to ferrous metals.
7. Cold working is easy.
8. Special electrical and magnetic properties are possessed by non-ferrous metals.
9. Softness is more than ferrous metals.

Copper and Its Alloys

Physical and mechanical properties of Copper and Its Alloys:

1. Copper is distinguished from all other metals by its red colour.
2. Copper is so soft and ductile.
3. It is very effective conductor of heat and electricity
4. It has good Castability, weldability, and machinability.
5. it is highly resistant to corrosion in different environments including the ambient atmosphere, seawater, and some industrial chemicals.
6. Density of copper is 8.9 gram/ cm^3
7. The crystal structure is **FCC** at room temperature.
8. Melting point is 1084°C.
9. The copper castings may have tensile strength varying from 150 to 170 N/mm^2
10. The mechanical and corrosion-resistance properties of copper may be improved by alloying.

Note: 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.



Following are some common alloys of Copper:

Copper alloys Name	Composition	Applications
Electrolytic tough pitch	0.04 O + Remaining Cu	Electrical wire, rivets, gaskets
Beryllium copper	1.9 Be, 0.20 Co + Remaining Cu	Springs, pins, bushings, valves, diaphragms
Cartridge brass	30 Zn + Remaining Cu	Automotive radiator, lamp fixtures, cores
Phosphor bronze, 5% Sn	5 Sn, 0.2 P + Remaining Cu	clutch disks, springs, welding rods
Copper–30% Nickel	30 Ni + Remaining Cu	Condenser and heat exchanger components, saltwater piping
Leaded yellow brass	29 Zn, 3 Pb, 1 Sn+ Remaining Cu	radiator fittings, light fixtures, battery clamps
Tin bronze	10 Sn, 2 Zn+ Remaining Cu	Bearings, bushings, piston rings, steam fittings, gears

Aluminum and Its Alloys

Physical and mechanical properties of Aluminum and Its Alloys:

1. Aluminum and its alloys are characterized by a relatively low density (2.7 g/cm^3 as compared to 7.9 g/cm^3 for steel).
2. It has high electrical and thermal conductivities.
3. It has a resistance to corrosion in some common environments, including the ambient atmosphere.
4. Easily formed by feature of high ductility because aluminum has an FCC crystal structure
5. It has low melting temperature 660°C.
6. The mechanical strength of aluminum may be enhanced by cold work and by alloying.

Following are some common alloys of aluminum :

Aluminum alloys Name	Composition	Applications
Duralumin	**Aluminum–Copper alloys** (designated as the 2000 series by the International Alloy Designation System) Ex: 2024 [4.4 Cu, 1.5 Mg, 0.6 Mn+ remaining aluminum]	Aircraft structures, rivets, truck wheels, screw machine products
y-alloy	**nickel-containing aluminum alloy** [4%Cu, 2%Ni, 1.5%Mg+ remaining aluminum]	Important for **pistons**, and for **engine components** in general.
Hindalium	Alloy of (Al, Mg, Mn and Si).	used for cooking utensils.
Magnelium	Alloy of (Cu, Mg, Ni, Sn, Fe, Mn, Si and 95% Aluminum).	Gear box housing, door handles, luggage racks, fixtures, coffee grinder parts

H.W. Select one metal or alloy that is best suited for each of the following applications?

1) Automotive radiator
2) Aircraft structures
3) welding rods
4) radiator fittings
5) Gear box housing