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Alloys

Definition : An alloy is a homogeneous mixure of two or more metals [or one metal and one or more metal or non metal, elements]

Metal + Metal + ... = Alloy
Metal + Non-metal + ... = Alloy

Properties :-
1) Stronger, harder & tough
2) Lower M.P.
3) More resistant to corrosion
4) Lower electrical conductivity

Purposes of making Alloys

1. To increase the hardness
2. " " " tensile strength.
3. " " resistance to corrosion.
4. " lower the melting point.
5. " modify the colour.
6. " " chemical reactivity
7. " produce good casting
8. " reduce malleabity & ductility

Note : An alloy containing mercury (Hg) as one of the metals is known as amalgam.

Types of Alloys

1. Ferrous Alloys : The alloys containing iron as one of the main components are known as ferrous alloys.

   e.g. ⇒ stainless steel, plain carbon steel, magnetic steel, nickel steel.

2. Non-ferrous Alloys : The alloys which do not contain iron as one of the main components are known as non-ferrous alloys.

   e.g. ⇒ brass, bronze (alloy of Cu), duralumin (alloy of Al).

Steel

Steel is very ductile alloy consisting of iron and carbon.

Based on the percentage of carbon content, steel is classified as follows:

1. Low-carbon or mild steel : up to 0.25%
2. Medium-carbon or medium hard steel :- 0.25% to 0.70%
3. Hard High carbon or hard carbon steel : 0.70% to 1.50%

Properties :

1. Ductile, malleable, tougher, more elastic than wrought iron.
2. Can be forged & welded.
3. High tensile strength.

Applications :

1. ~~mild steel~~ Used to manufacture tools, machine / engine parts, sheet metal etc.
2. Medium hard steel is used to manufacture machine / engine components, hammers, springs, cylinders etc.
3. Hard steel is used to manufacture of plates, springs, drills, heavy tools, lathes etc.

Methods of Steel Making

Steel contains 0.2 to 1.5 % carbon. Thus, for obtaining steel, following are some of the methods generally employed / used for this purpose :-

Note :- An alloy of Fe & C only is called plain carbon steel.

1. Electric process
2. L.D. process
3. Duplex process
4. Cementation process
5. Crucible process
6. Bessemer (acid or basic) process
7. Open hearth (acid or basic) process
8. Kaldo process.

Plain Carbon Steel [Alloy of Fe & C]

~~Low Carbon Steel or~~ Dead Mild Steel :-

Composition :- Carbon : 0.05 to 0.15 %
Iron : 99.85 to 99.95 %

Applications :- Chains, nails, automobile body steel

1. Low Carbon Steel or Mild Steel :-

Composition : a) Carbon : 0.15 to 0.30 %
b) Iron : 99.70 to 99.85%

Properties :
a) Tough & more elastic than wrought iron.
b) Malleable & ductile.
c) Can be easily forged & welded
d) Better tensile strength than cast iron and wrought iron.

Applications :

1. Used in machine and structure work.
2. Used in gears.
3. Used in forging.
4. Used in screws.

2. Medium Carbon Steel :

Composition : a) Carbon : 0.3 to 0.8%
b) Iron : 99.2 to 99.7%

Properties :

1. It has good strength & ductility.
2. It is hardenable by heat treatment.

Applications :

1. Forging
2. Machinery steel
3. Hammers
4. Cold chiesels
5. Hacksaws
6. Jaws for vices etc.

3. High Carbon Steel or Very Hard Steel :

Composition : Carbon : 0.8 to 1.5 %
Iron : 98.5 to 99.2 %

Properties :

1. H.C.S. lose their hardness at temperature from 200°C to 250°C.
2. It is use easy to forge and simple to harden.
3. Because of high hardness, these are suitable for wear resistant parts.
4. Spring steel is also high carbon steel.

Applications :

1. Springs
2. Balls.
3. Tools [Heavy tools]
4. Taps
5. Railway springs
6. Pins
7. Thread metal dies
8. Lathes etc.

Effects of Alloying Elements on Steel

1. Chromium (Cr) :

a) It increases hardness, tensile strength and heat resistance.
b) It decreases malleability of steel.
c) It provides stainless property in steel.
d) It improves corrosion resistance (about 12 % addition).

2. Nickel (Ni) :

a) It increases toughness, tensile strength and yield strength.
b) It improves corrosion resistance.
c) It improves response to heat treatment.
d) It improves forming properties of stainless steel.

3. Tungsten (W) :

a) It increases hardness.
b) It increases wear resistance & shocks resistance.
c) It increases ~~to~~ ability to retain hardness and toughness at high temperature.

4. Molybdenum (Mo) :

a) It increases hardness, wear resistance, thermal resistance.
b) It improves corrosion resistance, when added with nickel.
c) It makes steel tough at various hardness levels.

5. Silicon (Si) :

a) It improves elastic limit.
b) It improves magnetic permeability.
c) It decreases weldability and forgeability.

6. Vanadium (V) :

a) It improves tensile strength, elastic limit, ductility.
b) It improves shock resistance.
c) It improves reponse to heat treatment.

Copper Alloys

1. Brass [Cu : 60-90% & Zn : 10-40%]

- Composition : a) Cu ÷ 60-90 %
  b) Zn ÷ 10-40 %

- Properties :

1. They have high strength & hardness.
2. Low thermal & electrical conductivity as compared to Cu.
3. High corrosion resistance.
4. Low melting point than Cu & Zn.

- Applications :

1. Utensils
2. ornaments
3. Press working
4. Condenser tubes.

2. Bronze [Cu ÷ 75-95 % & Sn = 5-25 %]

Properties :

1. Hard, ~~malleable & ductile~~. strong & tough.
2. Better corrosion resistance & wear resistance.
3. Can be rolled into sheets, wire & rods.

Applications :

1. For making home utensils.
2. Statues, coins & bells etc.
3. Springs & other instruments parts.

3. Nickel Silver or German Silver [It is a type of special brass]

Composition: (a) Cu = 60 %
(b) Zn = 20 %
(c) Ni = 20 %

Properties :

1. It looks like silver
2. Extremely malleable & ductile
3. It has good strength and corrosion resistance to salt (sea) water.

Applications :

1. In decorative articles.
2. Coins, utensils, ornaments.
3. screws, bolts etc.

Aluminium Alloys

1. Duralumin [Al = 95 %, Cu = 4 %, Mg = 0.5 %, Mn = 0.5 %]

Properties :

a) It is light, tough, highly ductile.
b) It is good conductor of heat & electricity.
c) It is easily castable & corrosion resistance.
d) High tensile strength and as strong as mild steel.

Applications :

a) Used in making cables.
b) Forging, nuts, bolts, tubes & sheets.
c) For making aeroplanes & automobiles.

2. Magnalium [Al = 90 % & Mg = 10 %] :

Properties :

a) Light weight, tough & strong even than Al.
b) It is brittle & having good mechanability.

Applications :

a) Used in aircraft & automobile industries.
b) For making light instruments.

Other Alloys

1. Timan's Solder [Sn = 50 % & Pb = 50 %]
   or, [Sn = 40 % & Pb = 60 %]

Properties : It melts below red heat
Working Temperature : 200°C or 392°F.
Applications :

a) Used for cast iron, wrought iron, mild steel, cast steel, brass, bronze, copper etc. for soldering at low temperature

b) It is commanly used for sealing the tin cans.

2. Plumber's Solder [Sn = 35 % & Pb = 65 %]

Properties :

- Hard & pasty
- Working Temperature : 237°C or 459°F

Applications :

- Used for heavy duty soldering
- For general plumbing

3. Soft Solders :-

Composition : 1) Sn = 67 % , Pb = 33 %
2) Sn = 50 % , Pb = 50 %
3) Sn = 33 % , Pb = 67 %

Properties :

1.

Applications :-

1. Used for joining sheet metal parts which are not subjected to heavy load.

4. Branzing Alloys [Cu = 50-70 %. & Zn = 30-50 %.]

Application :

5. Rose Metal [Bi = 50 %, Pb = 28 %, & Sn = 22 %]

Property : Its melting point is 88°C

Applications :

1. Casting for dental work.
2. Fuse wires
3. As automobile sprinklers.