STRUCTURE OF ALLOYS

SOLID SOLUTION :

- An alloy is a material (metallic substance) formed by combination of a metal and one or more than one metal or non-metal, but has metallic properties.

- The metal which is present in largest proportion is referred to as the parent metal or solvent or base metal, while the metal in smaller proportion is called solute.

- Minor amount of solute are more accurately added in the form of weighted amount of master alloy.

- If the dissimilar atoms attract each other and if they are electro-chemically similar, then they often form an ordered solid solution or even superlattice.

- If the two species differ a lot electrochemically the bond between them becomes partly ionic, in the formation of inter metallic compound.

- The introduction of solute atoms into solid solution in the solvent-atom lattice invariably produces an alloy.

→ There are two types of solid solutions.
1) Substitutional solid solution
2) Interstitial solid solution
- If the solute and solvent atoms are roughly similar in size, the solute atoms will occupy lattice points in the crystal lattice of the solvent atoms.
- Carbon, nitrogen, oxygen, hydrogen and boron are the elements which commonly interstitial solid solutions.

Criteria for substitutional solid solutions :-
(Hume-Rothery Rules)

1) If the sizes of the two-atoms differ by less than 15%. The size factor is favourable for solid-solution formation. When the size factor is greater than 15%, the extent of solid solubility is usually restricted to less than 1%.

2) Metals do not have a strong chemical affinity for each other to form solid solutions, while metals which are apart on electromotive series tend to form intermetallic compounds.

3) The relative valence of the solute and solvent must be same. The solubility of a metal with higher valence in a solvent of lower valence is more extensive than for the reverse situation.

4) The solute and solvent atoms must have the same crystal structure.

Interstitial solid solution :-

- If the solute atoms are much smaller than the solvent atoms, they occupy interstitial positions in the solvent lattice. C, N, O, H, B are generally used for interstitial solid solution

- Interstitial solid solution :-

Solute atoms are much smaller than the solvent atoms, occupy randomly interstitial space in between the solvent atoms in the crystal lattice of the solvent.

- Small carbon atoms fits here better but lattice distortion is still sufficient to make it impossible to locate carbon atoms at all the interstitial sites in FCC-iron structure.

Types of Interstitial Void

When same sized spheres are packed in three dimen void spaces are present between the sphere.

- Two main types of interstitial voids (between the bigger atoms) occupied by interstitial solute atoms.

1) Tetrahedral void 2) octahedral void.

⇒ In FCC tetrahedral voids are eight in number.
In BCC 12 tetrahedral voids per unit cell.
In HCP 6 atoms per unit cell.

Octahedral void :-

Six corner of of a regular octahedron (called octahedral because of eight equal faces of equilateral triangle).

In FCC - 4 atoms per unit cell in FCC crystal.

Cast-Irons

- Cast iron are basically iron-carbon alloys having carbon more than 2% (actually (2-11%)) more than the maximum solid solubility of carbon in austenite.
- Carbon content of cast iron can lie between 2.11% 6.67%, but because higher carbon content tends to make them more brittle.
- Cast iron are brittle, and cannot be forged, rolled can only be cast into desired shape and size.
- As casting is the only and exclusively suitable process to shape these alloys, these alloys are called cast iron.

Types of cast Iron :-

1) white cast iron - This cast iron derive its name to the appearance of its fracture, white due to white cementite and has more than 2-11% carbon.
- White cast iron is hard, wear resistant, brittle and unmachinable.

2) Grey cast Iron - Grey colour of the fracture by the carbon present in free form as graphite flakes embedded in steel matrix.

Tl. flakes form from melt.

3) Spheroidal Graphite Iron (S.G. Iron) or Nodular Iron
- These are iron-carbon alloys having a structure of nodules of graphite embedded in steel matrix.
- These nodules of graphite are formed directly from liquid during solidification.

4) Malleable Iron -
These are iron-carbon alloys consisting of structure of irregularly formed graphite particles called temper carbon embedded in steel matrix.

Chilled cast Iron - The surface layers are of white cast iron with interior made of gray iron.
- by faster cooling of surface layers, the liquid here solidified as white cast iron.
The composition is so chosen that normal slow cooling would have resulted in getting gray iron structure throughout the section.

Alloy cast Iron -
These are cast iron in which properties or microstructure or bulk of main cast iron is modified by the addition of the alloying elements.