CONSTITUTION OF ALLOYS AND PHASE DIAGRAMS

1. What is an alloy?

A metal alloy, or simply an alloy, is a mixture of two or more metals or a metal and a nonmetal.

2. What is meant by Base Metal?

In an alloy, the element which is present in the largest proportion is called the base metal.

3. What are alloying elements?

In an alloy, all elements other than the base metal are called the alloying elements

4. Differentiate between substitutional and interstitial solid solutions

In a substitutional solid solution, the solute atoms substitute for parent solvent atoms in a crystal lattice.

In interstitial solid solution, the solute atoms fit into the space between the solvent or parent atoms.

5. What are intermetallic compounds?

The compounds formed by two or more metals in apparently stoichiometric proportion is called intermetallic compounds

6. What are the effects of crystal structure and atomic radii on formation of solid solution between two metallic elements? (MAY/JUNE 2006)

Hume Rothery's Rules

1. Crystal structure: The two metallic elements that form solid solution must have the same crystal structure. Otherwise, there is some point at which a transition occurs from one phase to a second phase with a different structure

2. Atomic radii: The solute and solvent elements atoms must be of similar size, with less than a 15% difference in atomic radius

7. Define Peritectic and Eutectoid reactions. (MAY/JUNE 2006)

In Peritectic reaction, upon cooling, a solid and a liquid phase transformation isothermally and reversibly to a solid phase having a different composition.

Liquid + Solid 1 cooling Solid 2

Heating

8. State the conditions under which two metallic will exhibit unlimited solid solubility. (NOV/DEC 2006)

To exhibit unlimited solid solubility, the solute and solvent elements should obey the following general rules of **Hume Rothery**

1. Size factor: The atoms must be of similar size, with less than the 15% difference in atomic radius

2. Crystal structure: The materials must have the same crystal structure.

3. Valance: The atoms must have the same valence

4. Electronegativity: The atoms must have the approximately the same electronegativity

9. Define the term "ferrite" and "austenite" in iron – carbon alloy system. (NOV/DEC 2006)

Ferrite is primary solid solution based on α iron having **BCC** structure. Austenite is a primary solid solution based on ϒ iron having **FCC** structure. Both are interstitial solid solutions of carbon in iron.

10. What do you understand by "allotropy of iron?"

Allotropy refers to the possibility of existence of two or more different crystal structure for a substance depending upon temperature.

11. Why carbon solubility is more in an austenite?

Austenite is a primary solid solution based on ϒ iron having FCC structure. Carbon solubility is more in austenite is an interstitial solid structure of carbon in iron.

12. What is steel?

steel.

The ferrous alloy having the carbon composition ranging from 0.008 to 2 % is known as

13. Distinguish between hypoeutectic and hypereutectic cast irons.

Cast irons that contain less than 4.3 % carbon are termed as hypoeutectic whereas cast iron that contains more than 4.3 % carbon are termed as hypereutectic cast irons.

14. What are cooling curves?

Cooling curves are obtained by plotting the measured temperatures at equal intervals during the cooling period of a melt to a solid.

15. State Gibb's phase rule.

Gibb's phase rule is given by

$F = C - P + 2$

Where,

F – Degrees of freedom of system or the no. of variables that may be changed independently without altering the equilibrium.

C – No. of components forming the system

P – Number of phases present in the system

16. What are intermediate phases?

If an alloying element is added in excess of the limit of solid solubility, a second phase appears along with the primary solution. If the second phase is differs in both crystal structure and properties from primary solid solution, than it is known as an intermediate phases.

17. What is an equilibrium phase diagram?

A phase diagram can be defined as a plot of the composition of phases as a function of temperature in any alloy system under equilibrium condiions.

18. Define phase.

A phase is defined as any physically distinct, homogeneous, and mechanically separable portions of a substance. Three different kinds of phases are solid, liquid and vapour.

19. How do cast irons differ from steels in terms of carbon content?

Composition from 0.008 to 2% carbon represent steel, and those above 2% carbon represent cast iron

20. What do you mean by invariant reaction?

The eutectic reaction is also called an invariant reaction since it occurs under equilibrium conditions at a specific temperature and alloy composition that cannot be varied.

HEAT TREATMENT

1. Define the term heat treatment.

Heat treatment may be defined as an operation or combination of operations involving heating and cooling of a metal in solid state to obtain desirable properties

2. What are the purposes of the processing heat treatments?

To relieve internal stresses To improve machinability To refin grain size

To soften the metal

3. List some of the important heat treatment operations widely used.

Annealing Normalizing Hardening Tempering Austempering

Martempering Case Hardening

4. what is meant by annealing

Annealing is defined as a softening process consisting of heating he steel to a temperature at or a near the critical point, holding there for a proper time and then allowing it to cool slowly in the furnace itself

5. What are the purpose of annealing?

To remove stresses

To induce softness

To refine grain structure

To remove gases

6. List the different types annealing

Full annealing

Process annealing

Stress relieve annealing

Recrystallization annealing

Spheroidise annealing

7. What is meant by Normalizing?

Normalizing means similar to full annealing, but cooling is established in still air rather than in the furnace

8. What is quenching.stages for quenching?

Quenching refers accelerated cooling

Vapour –jacket stage

Vapour-transport cooling stage

Liquid cooling stage

9. What is TTT diagram?

The TTT diagram is a plot of temperature versus he logarithm of time for a steel alloy of definite composition. It is a tool used by heat treaters to predict quenching reactions in steels

10. What is a CCT diagram?

The CCT diagram is a plot of temperature versus the logarithm of time for steel alloy of definite composition. It is used to indicate when transformations occur as the initially austenitised material is continuously cooled at a specified rate. In addition, it is also used to predict the final microstructure and mechanical charecteristics.

11. What is significance of the critical cooling rate?

The critical cooling rate is most important in hardening. In order to obtain a 100% martensitic structure on hardening, the cooling must be much higher than the critical cooling rate.

List some of the surface hardening techniques employed for altering surface chemistry

Diffusion methods

(a)Carburizing (b)Nitriding (c)Cyaniding (d) Carbonitriding

Thermal methods

(a)Flame hardening (b)Induction hardening

12. What do you mean by the term case hardening

In many applications, it is desirable that the surface of the components should have high hardness, while the inside or core should be soft. The treatments given to steels to achieve this are called surface heat treatments or surface hardening

13. In what ways flame hardening differs from induction hardening

The mechanism and purpose of induction hardening are the same as for flame hardening. The main difference is hat induction hardening the source of heat input is an induced electric current instead of using flame

14. In what ways cyaniding differs from carburizing

The salt both composition for cyaniding gives a case high in nitrogen, whereas carburizing gives a case rich in carbon

15. Case carburizing heat treatment is not generally carried out for medium carbon steels. Why (MAY/JUNE 2006)

The carburizing process is a diffusion treatment process. For diffusion take place the host metal must have a low concentration of the diffusing species and there must be a significant concentration of the diffusing species at the surface in the host metal. Since the medium carbon steels lack the above said criteria, they are not generally carburized

16. What is the critical cooling rate in hardening of steels (NOV/DEC 2006)

The slowest rate of cooling of austenite that will result in 100% martensite transformation is known as the critical cooling rate

17. Name and explain any one subcritical case hardening treatment (MAY/JUNE 2009)

Nitriding is a subcritical case hardening treatment

Nitriding is a process of introducing nitrogen atoms, to obtain hard surface of steel components

18. Mention few applications of induction hardening (April/May 2008)

The induction hardening is employed for hardening he surfaces of gears, tools, wrist pins, crank shaft bearings, machine tool ways and pump shafts

19. Advantages of austempering

Improved ductility

Increased impact strength and toughness Decreased distortion of the quenched metal Less danger of quenching cracks

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UNIT-III

MECHANICAL PROPERTIES AND TESTING

1. What is meant by mechanical properties of materials?

Mechanical properties are whose characteristics of material that describe its behavior

under the action of external forces.

2. Distinguish between elasticity and plasticity.

Elasticity is the property of the material by virtue of which it is able to retain its original

shape and size after the removal of load.

Plasticity is the property of the material by virtue of which a permanent deformation takes place whenever it is subjected to the action of external forces.

3. What are the factors affecting mechanical properties?

Grain size,

Heat treatment, Atmospheric exposure, Low and high temperature.

4. Define the terms Slip and Twinning.

Slip may be defined as the sliding of blocks of the crystal over one another along definite crytsollographic planes called Slip planes.

Twinning is the process in which the atoms in a part of a crystal subjected to

stress, rearrange themselves so that one part of the crystal becomes a mirror image of the other part.

5. Differentiate between ductility and malibility.

Ductility is the property of the material by virtue of which it can be drawn into wires before rupture takes place.

Malleability is the property of the material by virtue of which it can withstand deformation under compression without rupture.

6. Define the terms brittleness and hardness.

Brittleness is the property of the material by virtue of which it can withstand deformation under compression without rupture.

Hardness is the property of the material by virtue of which it is able to resist abrasive indentation, machining, scratching.

7. What do you mean by toughness and stiffness?

Toughness is the property of the material by virtue of which it can absorb maximum energy before fracture takes place.

Stiffness is the property of the material by virtue of which it resists deformation.

8. List any four technological properties of metals.

Machinability, Castability, Weldability,

Formability or Workability.

9. What is meant by fracture?

Fracture is the mechanical failure of the material which will produce the separation or fragmentation of a solid into two or more parts under the action of stresses.

10. List the different types of fracture in a material.

Brittle Fracture, Ductile Fracture, Fatigue Fracture, Creep Fracture.

11. What are the factors affecting the creep?

Grain,

Thermal stability of the micro structure, Chemical reactions,

Prior strain.

12. List some important destructive tests carried out on a material.

Tensile test, Impact test,

Fatigue test, Bend test, Torsion test, Creep test.

13. Define the term notch sensitivity.

The notch sensitivity refers to the tendency of some normal ductile material to behave like brittle material in the presence of notches.

14. Define endurance limit in fatigue test. (May / June 2006)

Endurance limit is defined as the value of stress below which the material will not fail even when it is loaded for infinite no. of cycles.

15. What are the properties are determined from tension testing of metallic products? (May / June 2006)

Limit of proportionality

Yield strength

Maximum tensile strength Breaking strength Percentage elongation Modulus of elasticity

16. How will you express the deformation charecteristics of a material through tension test? (May / June 2007)

The deformation charecteristics of a material through tension test expressed as

the stress-strain curve. With the help of stress strain curve, the various tensile properties such as elastic stress, strain yield strength, youngs modulus, etc are calculated.

17. Why are impact specimens notched? (NOV/DEC 2007)

The impact specimens are notched because the impact test also indicates the notch sensitivity of a material.

The notch sensitivity refers to the tendancy of some normal ductile materials to behave the like a brittle material in the presence of notches.

18. What are slip bands? (April/May 2008)

Slip bands are made up of several slip planes. They indicate that the atomic planes within the crystal have sheared with respect to each other.

19. What is creep? (May/June 2009)

The creep is defined as the property of material by virtue of which it deforms continuously under a steady load.

20. What are the different types of loadings available for fatigue testing? (April/May 2008) Shock or impact load

Static load

Random load

Repeated or reversed load.

UNIT-IV

FERROUS AND NON FERROUS METALS

1. what are metals. Classify engineering marterials

Metals are elemental substances. Metals are composed of elements which readily give up electrons to provide a metallic bond and electrical conductivity

Types of metals:1.Ferrous metals.2.Non-Ferrous meals

2. State three reasons why ferrous alloys are used extensively

Iron based components are relatively abundant and are widely distributed throughout the world

Ferrous materials can be produced very economically

Ferrous materials are versatile. Therefore wide range of mechanical and physical properties of ferrous matterials can be achieved

3. State three charecteristics of ferrous alloys that limit their utilization

Heavy in weight, lower electrical and thermal conductivity, lower resistance to corrosion

4. Why is alloying done?

To increase strength To improve hardness To improve toughness

To improve machinability

5. What are alloy steels.How are alloy steels classified Alloy steels mean may steels other than steels Alloy steels can be divided into two main groups

1.Low alloy steels:These contain upto 3 to 4% of alloying elements

2.High alloy steels:These contain more than 5% of alloying elements

6. List four important alloying elements added in alloy steels

The most commonly used alloying elements are chromium, nickel, molybdenum, vanadium, tungsten, cobolt, boron, copper and others

7. What are the required properties of a tool steel

Good toughness

Good wear resistance Very good machinability Resistance to softening on heating

8. What is meant by 18-4-1 high speed steel

A widely used high speed tool steel is 18-4-1 high speed steel. This steel contains

18% tungsten, 4% chromium, 1% vanadium. It is considered to be one of the best of all purpose tool steels

9. What are HSLA steels

HSLA steels are nothing but high strength low alloy steels. HSLA steels also known as micro alloyed steels, are low carbon steels containing small amounts of alloying elements.

10. What are maraging steels?

Maraging steels are low carbon, highly alloyed steels. These are very high strength materials that can be hardened o obtain tensile strengths of upto 1900Mpa

11. What are the effects of carbon on the properties of cast iron?

If a cast iron contains more of the brittle cementite, then it is mechanical properties will be a poor

12. What is the chemical composition of grey cast iron

Carbon-2.5 to 4% Silicon-1 to 3% Manganese – 0.4 to 1% Phosphorus-0.15 to 1% Sulphur -0.02 to 0.15% Remaining is iron

13. list some bronze alloys

Bell bronze, phosphor bronze, aluminum bronze, silicon bronze, coinage bronze, and leaded bronze

14. What are cupronickels? What is the use of monel metal

Cupronickels are alloys of copper and nickel

Uses of Monel metal: For making propellers, pump fittings, condenser tubes, steam turbine blades, sea water exposed parts, tanks, and chemical and food handling plants.

15. What is meant by precipitation hardening

precipitation hardening, also known as age hardening, is the most important method of improving the physical properties of some of the non-ferrous alloys by solid state reaction.

16. What is the main strengthening mechanism in high strength aluminum alloys. (MAY/JUNE 2006)

Precipitation strengthening treatment, also known as age hardening is the main strengthening mechanism in high strength aluminum alloys.

17. What are the effect of chromium and molybdenum in low alloy steels? (NOV/DEC 2006)

The effect of chromium in low alloy steels are to: Increase corrosion and oxidation resistance Increase hardenability

Increase high temperature strength

Resist abrasion and wear

The effect of molybdenum in low alloy steels are to: Improve high temperature creep resistance Increase hardenability

Stabilize carbides

18. Mention any two aluminium base alloys and their applications (NOV/DEC 2007)

1. Duralumin: Used for aircraft and automobile industries

For making electric cables, in surgical and orthopedic implements etc.

2. Y-alloy: Used for making pistons of engines, cylinder heads, gear boxes, propeller blades.,

19. What is carbonitriding? (April / May 2008)

Carbonitriding is a surface hardening process that involves the diffusion of both nitrogen and carbon into the steel surface.

20. What are super alloys?

Super alloys is a general term used to describe the nickel base and cobolt base alloys which have been developed for use at elevated temperatures

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UNIT – V

NON METALLIC MATERIALS

1. What are polymers?

Polymers are composed of a large number of repeating units of small molecules called monomers.

2. List any four attractive charecteristics of polymers

Low density

Good thermal and electrical insulaion properties

High resistance to chemical attack

Ease of fabrication

Relatively low cost

3.What is mean by isomerism

Isomerism is a phenomenon wherein different atomic configurations are possible for the same configuration

4.Why are additives added to polymers .

Filler materials Flame retardants Colorants

Reinforcements Plasticizers

Stabilizers Lubricants

5.Differentiate commodity plastics with engineering plastics.

The plastics which are not generally used for engineering applications are known as commodity plastics. The plastics which are used in engineering applications are known as engineering plastics.

6.Classify polymers

1.Plastics 2.Elastomers 3.Adhesives 4.Coatings 5.Fibers

7.Name any four commodity plastics and engineering plastics

Commodity plastics:Polyethylene, Polypropylene, Polystyrene, Polyvinyl chloride

Engineering plastics: Ethenic, Polyamides, Cellulosics, Acetals

8.What are the sources of raw materials for plastics? Animal and vegetable by products

Coal by products

Petroleum by products

9.Write short notes on nylons

Polyamides also known as nylons are the product of condensation reaction between an amine and an organic acid

10.What are engineering ceramics?

Engineering ceramics, are also known as technical/industrial ceramics, are those ceramics that are specially used for engineering applications or in industries

11.Name any four engineering ceramics

Alumina Silicon carbide Silicon nitride Sialons

12. What are composites?

Composites are produced when two are more materials are joined to give a combination of properties that cannot be attained in the original materials.

13. What is the role of matrix material in a composite?

The matrix usually provides the major control over electrical properties, the chemical behavior, and elevated temperature use of the composite.

14. Write the general mechanical properties of ceramics? (May / June 2009) Ceramics are strong, hard and brittle.

They are good thermal and electrical insulators.

They have high compressive strength but are weak in tension.

15. What do you meant by copolymers? (Apr. / May 2008)

Copolymers are polymers which are obtained by adding different types of monomers

16. How are refractories classified? (Apr. / May 2008) Fire clay refractories

Silica refractories Basic refractories Special refractories

17. Give two examples of particulate reinforced metal matrix composites. (May / June 2007) Sintered Aluminium Powder (Al/Al2O3)

Cermet

18. What are Cermets and applications?

Ceramic metal composite containing between 80 and 90% of ceramics are known as

Cermets.

Cutting tools, Slip gauge, wire drawing dies, rocket motor and jet engine parts.

19. What are the constituents of composites?

Composites are composed of two phases.

Matrix phase, Dispersed phase

20. Name any four engineering polymers.

Ethenic, Polyamids, Silicones, Polyimides