Compiled by
Dr. Arbind Prasad
Assistant Professor(Mech. Engg.)
Katihar Engineering College,Katihar
Bihar, India-854109

IRON-CARBON SYSTEM

(2MARKS)

Q.1. Write down the paratactic reaction in the equation of iron carbon equilibrium diagram?

Ans:- It is the reaction that occurs during the solidification of some alloys where the liquid phase reacts with solid phase to give a solid phase of different structure.

Equation: liquid+solid1→new solid2

Q.2. What is Ledeburite?

- Ans: Aneutectic mixture of austenite and cementite is known as ledeburite.
- It is formed at around 2230°c and carries above 0.8% carbon.

Q.3. What is tempering?

It is the process of reheating a quench hardened steel to reduce its internal stress and to increase its toughness. Reheating is done to a temperature varying from 250°c to 680 °C depending upon the reheating temperature the process is called low temperature tempering, medium temperature tempering or high temperature tempering.

5 MARKS

Q.1. Name the alloys used for high temperature service.

Ans: The various high temperature alloys are

Austenite, Stainless steels.

Ni 34% Cr 4%, and Fe 62% alloy

Ni 80%, and Cr 20% alloy

A number of non-iron ferrous material have been developed that possess high strength and corrosion resistance at temperature up to 1100°c. the non-ferrous alloys are udimet-500, Inconel 601, haste alloy-X and vanadium.

7 MARKS

Q.1.With neat diagram, explain the iron-carbon equilibrium diagram?

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Ans: The structure form of pure iron at room temperature is called ferrite or α-iron, ferrite is soft and ductile. Since ferrite has a body centered cubic structure, the inter-atomic space is small and pronouncedly oblate and cannot readily accommodate even a small carbon atom. Therefore, solubility of carbon in ferrite is very low, of the order of 0.006% at temperature. The maximum carbon content in ferrite is 0.05% at 723°c .in addition to carbon a certain amount of silicon, manganese and phosphorous may be found in ferrite.

- The face centered modification of iron is called austenite or γ-iron .it is the stable form of pure iron at temperature between 910°c and 14400°c. at its stable temperature austenite is soft and ductile and consequently, is well suited for manufacturing processes. The face centered cubic structure of iron has large inter atomic spacing than in ferrite. Even so, it FCC structure the interstices are barely large enough to accommodate carbon atoms, and lattice strains are produced .as a result, not all the intestinal sites can be filled at any one time. The maximum solubility is only 2% of carbon at 2230°c.
- Above 1400°c austenite is no longer the most stable form of iron, and the crystal structure changes back to a body- centered cubic phase called δ-iron. This is the same phase as the α-iron expect for its temperature range. The solubility of carbon in δ-ferrite is small, but it is appreciably large than in α-ferrite, because of higher temperature the maximum solubility of carbon in δ-iron is 0.1% at 1490°c.
- In iron –carbon alloys, carbon in excess of the solubility limit must form a second phase, which is called iron carbide or cementite. Iron carbide has the chemical composition of Fe_3C. This does not mean that iron carbide forms molecules of Fe_3C has an orthorhombic unit cell and thus has a carbon content of 6.67%.
- As compared to austenite and ferrite, cementite being an inter –metallic compound, is very hard and brittle. The presence of iron carbide with ferrite in steel greatly increases the strength of steel.
- The iron carbon equilibrium diagram is shown in fig. the solidification of the liquid iron and carbon melt beings along the liquid denoted in the figure by ABCD. Above the liquids the alloy is in a liquid state and is a homogeneous system. Along the liquids AB the crystals of the solid solution of carbon in γ-iron are separated from the liquid.

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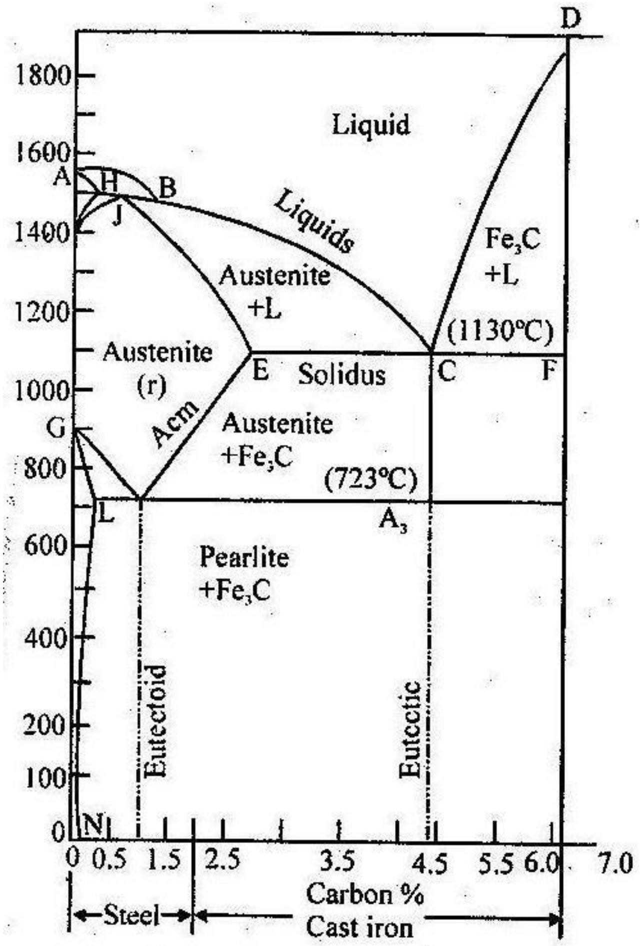

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Iron Carbon Equilibrium Diagram

- Crystals of austenite are separated from the liquid along the line BC with the composition ranging from 0.18 to 2.0%.the complete solidification of these alloys proceeds along the solidus line HJE. Those with 2.o to 4.3% carbon are completely solidified on line EC. The solidification of the last portion of the liquid phase, enriched in carbon to 4.3% takes along this line. All this liquid is completely solidified at 1130°c, at the same time crystals of austenite containing 2% carbon and cementite containing 6.67% carbon get separated from it. The solidification of alloys containing 4.3 to 6.67% carbon begins along line CD with the separation of primary cementite from the melt.
- At the lower temperature, the eutectoid reaction, i.e. formation of two solid from a single solid occurs at a temperature of 723°c. this is called the eutectoid temperature and the composition at which this reaction occurs (0.80% c)is called the eutectoid composition. The reaction may be shown as follows:
- Solid= solid2+solid3

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- In the reaction, the simultaneous formation of ferrite and cementite from austenite result at the temperature of 723°c and composition of 0.80% carbon. There are nearly 12%of iron carbide and slightly more than 88% of ferrite in the resulting mixture. Since the ferrite and cementite are formed simultaneously. They are intimately mixed. Characteristically the mixture is smaller,i.e. it is composed of alternate layer of ferrite and cementite. This microstructure is called pearlite which is very important in iron and steel technology, because it can be formed in almost all steel by means of suitable heat treatments.
- The alloy containing 0.80% of carbon is called the eutectoid steel. Upon cooling the eutectoid steel below 723°c all of the austenite is transformed in to pearlite. Alloys with less than 0.80% c are called Hypo-Eutectoid steels and those with higher composition are called hyper-eutectoid steels.
- When hyper-eutectoid steels are cooled below line SE, the austenite decomposes with the separation of cementite. Since this cementite contains 6.67% c the carbon concentration in the remaining austenite changes continuously along the line Se until the eutectoid composition of 80%c.
- The iron carbon equilibrium diagram has a peritectic (point j) an eutectic (point C) and an eutectoid (point S) .Peritectic reaction equation may be written as

Delta(δ)+Liquid= Austenite

- The horizontal line at 2720°F shows the Peritectic reaction.
- The eutectic reaction takes place at 2066°F and its equation may be written as

Liquid =Austenite+Cementite

- Eutectic point is at 4.3% carbon. Eutectic mixture is not usually seen in the microstructure. Because austenite is not stable at room temperature and must undergo another reaction during cooling.
- The eutectoid reaction is represented by the horizontal line 1333°F and (point)S marks the eutectoid point. The eutectoid equation may be written as

Solid = Ferrite+Cementite