UNIT – III

FERROUS AND NON- FERROUS METALS.

3.1 PURPOSE OF ALLOYING:

To increase hardenability.

To increase strength at temperature.

To improve high temperature properties.

To increase resistance to corrosion.

To increase wear resistance.

To improve toughness at any minimum hardness.

To improve electrical and magnetic properties.

3.2 EFFECTS OF ALLOYING ELEMENTS :

Solid solution formation.

Carbide formation.

Shifting of critical temperature.

Lowering of critical cooling rate.

Effect on grain growth.

Corrosion resistance.

3.3 EFFECT OF ALLOYING ADDITION ON STEELS :

Carbon (C)

Sulphur (S)

Phosphorous (P)

Silicon (Si)

Manganese (Mn)

Nickel (Ni)

Chromium (Cr)

Titanium (Ti)

Tungsten (w)

Molybdenum (Mo)

Vanadium (V)

Cobalt (Co)

Aluminium (Al)

Boron (Br)

Carbon (c):

It increases hardness and strength.

It increases machinability.

Sulphur (S):

It is hard and brittle.

It increases machinability.

Phosphorous (P):

It dissolves in ferrite solid solution.

It Increases tensile strength and hardness.

It is hard and brittle.

It increases machinability.

Silicon (S_i) :

It is a ferrite solid solution.

It reduces losses.

It increases toughness.

It increases strength and hardness.

Manganese (Mn):

It improves Machinability.

It improves strength and toughness.

It dissolves in Ferrite.

Nickel (Ni) :

It is a ferrite solid solution.

It increase tensile strength and hardness.

It increase corrosion resistance.

It reduces co- efficient of thermal expansion.

Chromium (Cr) :

It increases hardenability.

It increases wear resistance.

It increases corrosion resistance.

Titanium (Ti)

It is strong carbide former.

It increases hardenability.

Molybdenum (Mo) :

It increases hardenability.

It makes grain finer.

It forms carbides.

It increases wear resistance.

Grain growth.

Tungsten (w) :

It increases hardenability.

It forms carbides.

It increases wear resistance.

Improves hot hardness.

Vanadium (V) :

It have fine grain structure.

It increases hardenablity.

Forms stable carbides.

Cobalt (Co) :

It reduces hardenability.

It improves strength.

It have fine grained structure.

It improves heat resistance.

Improves hot hardness.

Aluminium (Al) :

It have fine grained structure.

Boron (Br)

It increases hardenability.

It improves wear and fear resistance.

3.4 α AND βSTABILIZERS :

They are :

- alpha stabilizers

β- Beta stabilizers

α- alpha stabilizers increases the temperature at which alpha phase is stable. e.g. : Aluminium, Oxygen, tin .

Beta stabilizers at lower temperature.

e.g. : Copper, Chromium, Vandium, Molybdenum.

Steel consists of two or more phases knower as ferrite, austenite, carbide, graphite.

3.5 STAINLESS STEELS (SS):

Stainless steels are most notable for their corrosion resistance, which increases with increasing chromium content. Additions of molybdenum increase corrosion resistance in reducing acids and against pitting attack in chloride solutions. Thus, there are numerous grades of stainless steel with varying chromium and molybdenum contents to suit the environment the alloy must endure. Stainless steel resistance to corrosion and staining, low maintenance, and familiar luster make it an ideal material for many applications where both the strength of steel and corrosion resistance are required. It is the composition of iron , carbon, and chromium and it contain minimum 12% Chromium. Mo, Ni (Molybdenum, Nickel) is a added as alloying elements.

Types of stainless steel :

Austenitic stainless steel.

Ferritic stainless steel.

Martensitic stainless steel.

i) Austenitic Stainless steel :

Austenitic stainless steel is a specific type of stainless steel alloy.These stainless steels possess austenite as their primary crystalline structure (face centered cubic). This austenite crystalline structure is achieved by sufficient additions of the austenite stabilizing elements nickel, manganese and nitrogen. Due to their crystalline structure austenitic steels are not hardenable by heat treatment and are essentially non-magnetic.

Composition :

C $\rightarrow$ 0.03 to 0.15 %,Mn $\rightarrow$to 10%,Si $\rightarrow$ 1 to 2 %,Cr$\rightarrow$ 16to 26%,Ni $\rightarrow$ 3.5 to 22%

Properties :

High corrosion resistance.

Non Magnetic.

Good ductility.

High strength.

Application :

Air craft industry.

Chemical processing.

Food processing unit.

Dairy industry.

Transportation industry.

ii) Ferritic Stainless steel :

Ferritic steels are high chromium, magnetic stainless steels that have a low carbon content. Known for their good ductility, resistance to corrosion and stress corrosion cracking, ferritic steels are commonly used in automotive applications, kitchenware, and industrial equipment.

Composition:

C→0.08 to 0.1%,Si→ 1%,Mn→ 1 to 1.5%,Cr→ 12 to 25%

Properties :

They are magnetic.

Good ductility.

High strength.

Soft.

Corrosion resistant.

High toughness.

Application :

Petroleum industry.

Heating element for furnace.

Chemical industry.

Combustion chamber.

This steels can be welded, forged , rolled and machined.

iii) Martensitic stainless steel :

Martensitic stainless steel is a specific type of stainless steel alloy. Martensitic stainless steels can be high- or low-carbon steels built around the Type 410 composition of iron, 12%

chromium, and up to 1.2% carbon. They are hardenable by heat treatment (specifically by quenching, or by quenching and tempering).

Composition:

C→ 0.1 to 1.5%,Si →1%,Mn →1%,Cr→12 to 25%

Properties :

High hardness.

High strength.

Good ductility and thermal conductivity.

Good toughness.

Corrosion resistance.

High magnetic.

Application:

High hardness.

High strength.

Good ductility and thermal conductivity.

Good toughness.

Corrosion resistance.

High magnetic.

Application :

Valves, pumps, surgical instruments, turbine blades.

3.6 STEEL :

Steels are alloy of iron carbon however steel contain other element like Si, Mn, S,P, Ni, (Silicon, Manganese, sulphur, phosphorous, Nickel).

Plain carbon Steel :

Composition :

C→ up to 1.5%,Cu→ up to 0.6%,Mn →upto 1.65%,Si →upto 0.6%

3.6.1 CLASSIFICATION OF PLAIN CARBON STEEL :

Low Carbon steel:

The steel which contain less than 0.2% c is called as low carbon steel.

Medium carbon Steel :

The steel which contain 0.25% to 0.6% carbon content is called as medium carbon steel.

Alloy Steel :

Any steel other than carbon steel is called as alloy steel. Alloy elements are Cr, Ni, Mo, V,W,Co, Cu (Chromium, Nickel, Molybdenum, Vanadium. Tungsten, Cobalt, Copper).

3.6.2 CLASSIFICATION OF ALLOY STEEL :

3.6.2.1 LOW ALLOY STEEL:

This contain up to 3 to 4% of alloying element.

Types of low alloy steel :

AISI Steel (American iron and steel institute).

HSLA Steel (High strength low alloy).

3.6.2.2 HIGH ALLOY STEEL :

This contain more than 5% of alloying element.

Types of high alloy steel :

Tool of high alloy steel.

Stainless steel.