

---

## Contents

<b>Iron <i>Fe</i></b>	<b>3</b>
Characters . . . . .	3
Ores of Iron . . . . .	3
<b>Types of Iron</b>	<b>4</b>
Pig Iron . . . . .	4
Uses of Pig Iron . . . . .	4
<b>Wrought Iron</b>	<b>5</b>
Formation of Wrought Iron . . . . .	5
Properties of Wrought Iron . . . . .	6
Uses of wrought iron . . . . .	6
<b>Steel</b>	<b>6</b>
Types of steel . . . . .	7
Steel . . . . .	7
Nickel Steel . . . . .	7
Stainless Steel . . . . .	7
Invar . . . . .	8
Tungsten Steel . . . . .	8
Manganese Steel . . . . .	8
Steel . . . . .	8
Nickel Steel . . . . .	8
Stainless Steel . . . . .	9
Invar . . . . .	9
Tungsten steel . . . . .	9
Manganese steel . . . . .	9
Steel . . . . .	9
Nickel Steel . . . . .	9
Stainless steel . . . . .	10
Invar . . . . .	10
Tungsten Steel . . . . .	10
Manganese Steel . . . . .	10
Steel . . . . .	10
Nickel Steel . . . . .	11
Stainless steel . . . . .	11
Invar . . . . .	11

---

Tungsten Steel . . . . .	11
Manganese Steel . . . . .	12
<b>Heat Treatment of Steel</b>	<b>12</b>
Types of Heat Treatment of Steel . . . . .	12
Quenching . . . . .	13
Method of quenching . . . . .	13
Change in properties after heat treatment of steel . . . . .	13

---

## Iron $Fe$

### Characters

- **Symbol** :  $Fe$
- **Atomic no**: 26
- **Group** :  $VIII$
- **Period** : 4
- **Valency** : 2, 3
- **Density** :  $7.86g/cc$
- **Melting Point** :  $1500^{\circ}C$
- **Boiling Point** :  $3000^{\circ}C$
- **Electronic configuration** :  $[Ar]4s^23d^6$

### Ores of Iron

- **Haemetite** :
  - also called **red oxide of iron**
- **Magnetite** :
- **Limonite** :
- **Siderite** :
  - also called **iron carbonate** .
- **Iron Pyrite**:
- **Copper Pyrite**:
- The **locations** of the **ores** in Nepal are:
  - Phulchoki
  - Ilam
  - Puythan
  - Ramechaap

- 
- Baitadi
  - Parbat

## Types of Iron

- The **types** of iron are:
  - **Pig Iron**/*Cast Iron*
  - **Wrought** Iron
  - Steel

## Pig Iron

- **Constitution:**
  - **Carbon** in 2 – 5%
  -
- **Properties:**
  - It is very **hard** .
    - \* **Pig Iron** has presence of **cementite** .
    - \* **Cementite** is **iron carbide**
    - \* **Pig Iron** cannot be rewelded.
  - **Pig iron** is **resistant** to **corroison**.
  - **Pig iron** can't be **magnetized** *permanently* .
  - **Pig iron** is hard and brittle.
  - **MP:**  $1200^{\circ}C$

## Uses of Pig Iron

- **Pig iron** is used in:
  - gas stoves.

- 
- **agricultural** tools.
  - **railings**, *gates* , *grills* .
  - **sewage drainage**

## Wrought Iron

- Wrought Iron is the purest form of iron.
- Wrought Iron contains some amount of impurities.
  - Carbon C = 0.12 to 0.25%
- The other impurities that contain in trace amount are:
  - S
  - Mn
  - Si
  - P

## Formation of Wrought Iron

- Pig iron is made into wrought iron.
- This is done by removing impurities from pig iron.
- The impurities are removed by using oxidizing agents.
- An example that removes impurities from carbon is:
  -

The chemical equation expressing the oxidation of carbon from pig iron is:

- 
- The only carbon product in the product is CO.
- Ultimately CO evolves as a gas.

---

## Properties of Wrought Iron

The major properties of wrought iron are contributed by the fact that the amount of carbon present in wrought iron is very less.

- Wrought iron is less hard compared to other forms of iron such as pig iron.
  - This compensation in hardness is brought about by the missing of iron carbide.
  - This also imposes an implication of property of less brittleness in wrought iron.
- Wrought iron is also called **soft iron**.
- Melting point M.P. of wrought iron is: 1500°[C]
- Wrought iron gets rusted easily.

## Uses of wrought iron

Wrought iron is used for the following purposes.

- Wrought iron is used to make magnet and dynamos.
- Wrought iron is used to make knots and bolts of vehicles , bicycles.
- Wrought iron is used in making chains of vehicles.
- Wrought iron has use in making electric wires.

## Steel

- Steel is the intermediate between :
  - wrought iron
  - pig iron

This implies that steel has it's carbon content between that of: - pig iron 2%-5% - wrought iron 0.12%-0.25%

The carbon content in steel is between : - 0.25 % - 2 %

---

## **Types of steel**

The types of steel are:

- steel
- nickel steel
- stainless steel
- invar
- tungsten steel
- manganese steel

## **Steel**

Steel is composed of the following materials:

- Iron
- Carbon

## **Nickel Steel**

Nickel steel is composed of the following materials:

- Iron
- Nickel

## **Stainless Steel**

Stainless steel is composed of the following materials:

- Iron
- Chromium
- Nickel

---

## **Invar**

Invar is composed of the following materials:

- Iron
- Chromium
- Nickel

## **Tungsten Steel**

Tungsten steel is composed of the following materials:

- Iron
- Tungsten

## **Manganese Steel**

Manganese steel is composed of the following materials:

- Iron
- Manganese

The amount of compositing materials in the types of steels are:

## **Steel**

- Iron 99-99.8
- Carbon 0.2-2

## **Nickel Steel**

- Iron 96-98
- Nickel 2-4



---

### **Stainless Steel**

- Iron 74-80
- Chromium 12-18
- Nickel 1-8

### **Invar**

- Iron 64
- Nickel 36

### **Tungsten steel**

- Iron 80-86
- Tungsten 14-20

### **Manganese steel**

- Iron 82-90
- Manganese 10-18

The properties of the types of steel are:

### **Steel**

- Steel is elastic
- Steel is less brittle
- Steel is less hard than pig iron.

### **Nickel Steel**

- Nickel steel is hard
- Nickel steel is resistant to corrosion.
  - This property is due to the presence of nickel in nickel steel.

---

### **Stainless steel**

- Stainless steel is resistant to corrosion.
- Stainless steel is hard.
- Stainless steel is less brittle.

### **Invar**

- Invar has no coefficient of expansion.
- The dimensions of invar remain constant at all temperatures.

### **Tungsten Steel**

- Tungsten steel is hard.
- Tungsten steel is brittle.
- Tungsten steel is strong.

### **Manganese Steel**

- Manganese steel is hard.
- Manganese steel is resistant to :
  - wear
  - tear

The uses of the types of steel are:

### **Steel**

- Steel is used for making knives.
- Steel is used for making kitchen tools.
- Steel is used for making parts of machineries.

---

### **Nickel Steel**

- Nickel steel is used to make gear box of vehicles.
- Nickel steel is used to make cutting tools.
- Nickel steel is used to make electric wires.

### **Stainless steel**

- Stainless steel is used in cosmetics to make
  - razors
  - shaving blades
- Stainless steel is used in hospitals to make
  - scissors
  - forceps
- Stainless steel is used in decoration in
  - railings
  - bars
  - frames

### **Invar**

- Invar is used to make clocks
- Invar is used to make pendulums.
- Invar is used to make measuring tapes.

### **Tungsten Steel**

- Tungsten steel is used to make drilling machines.

---

## **Manganese Steel**

- Manganese steel is used in drilling rocks.
- Manganese steel is used in helmet of vehicles.
- Manganese steel is used in the blades of grinding machines.

## **Heat Treatment of Steel**

Heat treatment of steel is the phenomenon of heating or cooling steel under certain conditions to customize the physical properties of the steel without altering any change in chemical composition.

Heat steel generally is:

- phenomenon
- where heating or cooling is done
- there is the presence of condition

The purpose of heat treatment of steel is:

- to customize the physical property of the steel to one's need without altering chemical composition.

The properties that heat treatment of steel acts on are:

- hardness
- malleability
- ductility

The application of heat treatment of steel are:

- Heat treatment removes internal trapped gas present at the steel.
- Heat treatment of steel increase the hardness of the steel.

## **Types of Heat Treatment of Steel**

The types of heat treatment of steel are: - quenching - annealing - tempering

---

## Quenching

- **Objective of quenching:**

- The hardness of the steel increases form quenching.

- **Reason for increased harness for steel.**

- The reason for increased hardness of steel is due to the presence of cementite.
- Cementite is iron carbide.
- The molecular formula for cementite is

## Method of quenching

The process of quenching is done in the following way:

- The steel is heated to redness initially.
- The steel is suddenly plunged into solvent.
- The solvent may be water or oil.

## Change in properties after heat treatment of steel

- Steel becomes more harder.
- Steel becomes more brittle.
- The elasticity of steel decreases.