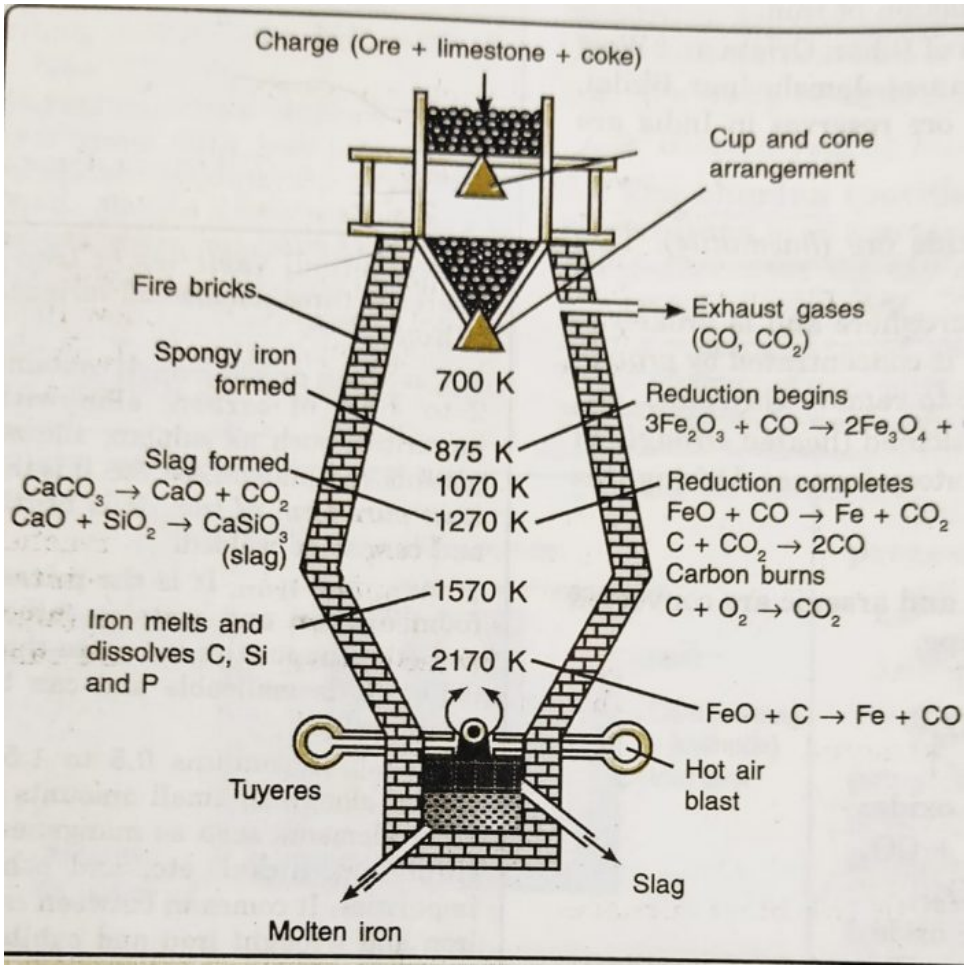
The following reactions take place in the furnace :



(1) Combustion zone: At the base, coke burns to produce CO_2 , which starts rising upward during the reaction. The reaction is exothermic and heat produced raises the temperature to about 2200 K. This region is called **combustion zone.**

$C + O_2$ ——> CO_2

ΔH = -393.4 KJ

(2) Fusion zone: As carbon dioxide rises upward, it comes in contact with layers of coke and gets reduced to carbon monoxide.

$CO_2 + C \text{ ——> } 2CO_2$

$\Delta H = +163.2 \text{ kJ}$

This is an endothermic reaction and therefore, the temperature is lowered to about 1570 K. The iron produced in the upper region melts here. Any Fe_2O_3 if present undergoes reduction by hot coke to iron. This region is called **fusion zone.**

$Fe_2O_3 + 3C \text{ ——> } 2 Fe + 3CO + Heat$

(3) Slag formation zone: In the middle portion of the furnace, the temperature is about 1270 K. In this region limestone decomposes to produce lime (CaO) and carbon dioxide (CO_2), The lime thus produced acts a a flux and combines with silica (present as an impurity) to produce slag.

$CaCO_3 \text{ ——> } CaO + CO_2$

$CaO + SiO_2 \text{ —> } CaSiO_3$

The molten slag forms a separate layer (being lighter) above the molten iron. This region is called **slag formation zone.**

(4) Reduction zone: The temperature near the top of the furnace is of the order of 875 K. The oxides of iron are reduced by carbon monoxide to iron.

$FeO + CO \text{ ——> } Fe + CO_2$

$3Fe_2O_3 + CO \longrightarrow 2\ Fe_3O_4$

$Fe_3O_4 + 4CO \longrightarrow 3Fe + 4\ CO_2$

$Fe_2O_3 + CO \longrightarrow 2FeO + CO_2$

This region of the furnace is called reduction zone. The spongy iron produced in the reduction zone moves down slowly and melts in the fusion zone.

At the lower hotter part, the main reaction is :

$FeO + C \longrightarrow Fe + CO$

It dissolves some carbon, silicon, phosphorus and manganese and forms the lower layer at the base of furnace. The iron thus obtained is called pig iron and cast into variety of shapes.

Preparation of Wrought Iron

Wrought iron is the pure form of iron and contains less than 0.5% impurities.The cast iron obtained above contains about 2.5-5% carbon and other impurities such as S, P, Si and Mn. In order to convert cast iron into wrought iron, the percentage of carbon and that of other impurities has to be decreased. This is done by heating the cast iron on the hearth of a reverberatory furnace (known as puddling furnace) with haematite. The haematite supplies the oxygen and oxidises carbon, silicon, manganese and phosphorus present in the cast iron to carbon monoxide (CO), silica (SiO2), manganese oxide (MnO) and phosphorus pentoxide(P_2O_5) respectively.

$Fe_2O_3 + C \longrightarrow 2Fe + 3CO$

$3Si + Fe_2O_3 \longrightarrow 3\ SiO_2 + 4Fe$

$3S + 2Fe_2O_3 \longrightarrow 3SO_2 + 4Fe$

Whereas CO and SO_2 escape, MnO and silica (SiO_2) combine to form manganous silicate ($MnSiO_3$) as slag.

$MnO + SiO_2 \longrightarrow MnSiO_3$

Similarly, phosphorus pentoxide combines with Fe_2O_3 to form ferric phosphate slag.

$2\ Fe_2O_3 + P_4O_{10} \longrightarrow 4\ FePO_4$

The metal is removed and freed from slag by passing through rollers.The melting point of wrought iron is about 1673 K and it can be welded at about 1273 K. It is tough, malleable and ductile and can be used for making chains, bolts , frameworks, etc.

Filed Under: Class 12, General Principles and Processes of Isolation of Elements

About Mrs Shilpi Nagpal

Author of this website, Mrs Shilpi Nagpal is MSc (Hons, Chemistry) and BSc (Hons, Chemistry) from Delhi University, B.Ed (I. P. University) and has many years of experience in teaching. She has started this educational website with the mindset of spreading Free Education to everyone.

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