Summary

Iron oxide, the ore from which iron to be extracted, is concentrated by roasting or calcination impurities can be eliminated.

Removal of Volatile Impurities by Roasting and Calc

$$H_2O \rightarrow H_2O(g)\uparrow$$
(Water Vapour)

$$CaCO_3 \rightarrow CaO(s) + CO_2(g)\uparrow$$
(Carbon dioxide)

$$2FeS + 3O_2 \rightarrow 2FeO + 2SO_2(g)\uparrow$$
(Sulphur dioxide)

This concentrated ore is mixed with limestone and coke, and sent into a blastfurnace to reduce the metal oxide to the metal.

$FeO(s) + C(s) \rightarrow Fe(s) + CO(g)$

Reduction of Metal Oxide to Metal

This is a combination of two simple reactions

Step:1

$FeO(s) \rightarrow Fe(s) + ½O_2(g)$ [ΔG(FeO,Fe)]

Step:2

$C(s) + ½O_2(g) \rightarrow CO(g)$ [ΔG(C,CO)]

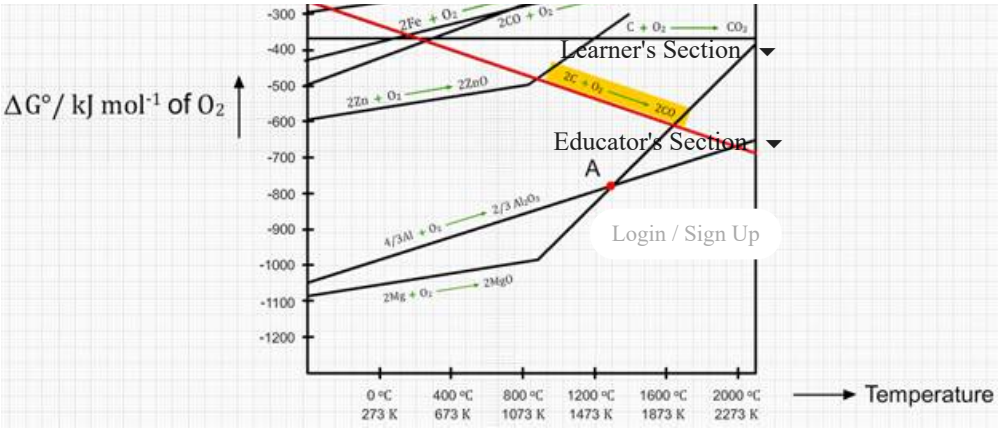
When the two reactions occur, the net Gibbs energy change.

[ΔG(C,CO)] + [ΔG(FeO,Fe)] = ΔrG

This becomes spontaneous when delta G (reaction) = -ve

Ellingham diagrams are useful in predicting the conditions under which a metal ore can be reduced to the metal. It gives information to predict the equilibrium temperature between the metal oxide and the metal.

If a graph is plotted for standard Gibbs energy change ΔG^0 against temperature in kelvin scale T for both these reactions, then it will go upwards for the reduction of ferrous oxide to iron(FeO, Fe), and downwards for the oxidation of carbon to carbon monoxide(C,CO).



In the temperature range of 900 to 1500 kelvin, carbon monoxide reduces ferrous oxide to iron.

At 900 - 1500 K (Higher temperature range in the blast furnance)

$$C + CO_2 \rightarrow 2CO$$

$$Fe + CO \rightarrow Fe + CO_2$$

$$CaCo_3 \rightarrow CaO + CO_2$$

(Limestone)

$$CaO + SiO_2 \rightarrow CaSiO_3$$

(Slag)

Silica is an impurity. Limestone removes it in the form of molten slag, which is taken out from the bottom of the furnace.

The molten iron obtained in this process contains 4% carbon, along with some other impurities like sulphur and phosphorus. It is called **pig iron**.

Pig iron is melted with scrap iron and coke in the presence of hot air to form **cast iron**, which contains only 3% carbon.

Cast iron is heated in a reverberatory furnace lined with haematite, which oxidises carbon to carbon monoxide to get wrought iron or malleable iron, the purest form of iron.

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

Videos

References

Learnnext - Extraction of Iron From its Oxides

Ucdavis - The Extraction of Iron

Chemguide - Iron and Steel