EXTRACTION OF IRON IN A BLAST FURNACE

Iron is also below carbon in the reactivity series, so therefore carbon can be used to reduce it (note: reduction can also mean to remove the oxygen from a compound). This is done in a blast furnace. The most common ore of iron is called haematite (iron(iii) oxide). Its formula is Fe₂O₃.

Haematite is added to the top of the furnace along with coke (i.e. carbon) and limestone. Three reactions take place during this extraction.

Firstly, the carbon in the blast furnace burns with the hot air to form carbon dioxide. This reaction produces a lot of heat, and is the main source of heat in the furnace.

\[
\text{carbon} + \text{oxygen} \rightarrow \text{carbon dioxide}
\]

\[
C + O_2 \rightarrow CO_2
\]

The heat produced by the reaction brings about the next reaction. At the bottom of the furnace, the temperature is very high. Here, the carbon dioxide reacts with more carbon to form carbon monoxide.

\[
\text{carbon} + \text{carbon dioxide} \rightarrow \text{carbon monoxide}
\]

\[
C + CO_2 \rightarrow 2CO
\]

At this point, the reaction takes a slightly different turn. Some of the iron(iii) oxide reacts with carbon to form pure iron (along with carbon monoxide). However, most of it reacts with carbon monoxide, which is the main reducing agent of iron(iii) oxide. This produces pure iron and carbon dioxide.

\[
\text{haematite} + \text{carbon} \rightarrow \text{iron} + \text{carbon monoxide}
\]

\[
Fe_2O_3 + 3C \rightarrow 2Fe + 3CO_2
\]

\[
\text{haematite} + \text{carbon monoxide} \rightarrow \text{iron} + \text{carbon dioxide}
\]

\[
Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2
\]

The temperature in the furnace is high enough to melt the iron, so it can trickle down to the bottom of the furnace where it is tapped off (brought away).

Limestone (calcium carbonate) is added to the furnace at the beginning for a particular reason. Iron ores such as haematite are not in their pure form; they are mixed with other rocky bits which would not melt in the furnace, and would eventually clog it up. The limestone is broken down by the heat in the furnace to form calcium oxide and carbon dioxide:

\[
\text{calcium carbonate} \rightarrow \text{calcium oxide} + \text{carbon dioxide}
\]

\[
CaCO_3 \rightarrow CaO + CO_2
\]

The main impurity found in iron ore (i.e. the “rocky bit” that iron ore is often found mixed with) is sand, or silicon dioxide. The calcium oxide reacts with silicon dioxide to form calcium silicate:

\[
\text{calcium oxide} + \text{silicon dioxide} \rightarrow \text{calcium silicate}
\]

\[
CaO + SiO_2 \rightarrow CaSiO_3
\]

Calcium silicate is also called slag. This is also tapped off at the bottom of the furnace.