The production of iron from its ore involves an oxidation-reduction reaction carried out in a blast furnace. Iron ore is usually a mixture of iron and vast quantities of impurities such as sand and clay referred to as gangue. The iron found in iron ores are found in the form of iron oxides. As a result of these impurities, iron must be first separated from the gangue and then converted to pure iron. This is accomplished by the method of pyrometallurgy, a high temperature process. The high temperatures are needed for the reduction of iron and the oxidation of the limestone which will be seen below.

Introduction

The production of iron from its ore involves a redox reaction carried out in a blast furnace. The furnace is filled at the top with the iron ore oxide most commonly hematite (\(Fe_2O_3\)) but can also magnetite (\(Fe_3O_4\)), carbon called coke and limestone (\(CaCO_3\)). For the purpose of this discussion the iron ore oxide hematite (\(Fe_2O_3\)) will be shown. On a side note, Hematite gets its name from the Greek word meaning blood like because of the color of one form of its powder. The Ancient Greeks believed that large deposits of hematite were formed from battles that were fought and the blood from these battles flowed into the ground.

To begin the process a blast of hot air is forced in at the bottom of the furnace that helps create a large temperature variation with the bottom being 2273 K and the top 473 K. The amount of oxygen is strictly controlled so that carbon monoxide is the main product as shown:

\[
2C (s) + O_2 \; (g) \longrightarrow 2CO (g) + \text{heat}
\]

Similarly carbon and carbon monoxide both contribute in the reduction of the iron (III) oxide to give the impure metal as shown:

\[
Fe_2O_3 \; (s) + 3C \, (s) \longrightarrow 2Fe (l) + 3CO_2 (g)
\]
\[
Fe_2O_3 \; (s) + 3CO_2 (g) \longrightarrow 2Fe (l) + 3CO_2 \; (g)
\]

One of the most interesting part of this redox reaction is that the majority of the carbon dioxide formed is itself reduced when it comes to contact with the unburned coke and produce more reducing agent. As the process continue the molten iron flow down through the furnace and collects at the bottom, where it is removed through an opening in the side. When it cools the impure iron is brittle and some cases soft due to the presence of the small impurities, such as sulfur and phosphorus.

Thus the impure iron coming from the bottom of the furnace is further purified. The most common method is the basic oxygen furnace. In the furnace, oxygen is blown into the impure iron. This is vital because the oxygen oxidizes the phosphorus and sulfur shown in the following redox reactions:

\[
P_4 (s) + 5O_2 \; (g) \rightarrow P_4O_{10} \; (g)
\]
\[
S_8 (s) + 8O_2 \; (g) \rightarrow 8SO_2 \; (g)
\]

The oxides either escapes as gases or react with basic oxides that are added or used to line the furnace. This final purification step removes much of the impurities and the result is ordinary carbon steel. Thus iron is obtained through the
process of oxidation-reduction.

Outside links

- A video showing the production of steel: http://www.youtube.com/watch?v=Yov7Z0rMyHI&feature=related
- A Video showing the chemistry of iron: http://video.google.com/videoplay?docid=iron+production

References