

## Steel from Iron Sands in New Zealand

Iron in New Zealand is used to make some of the above products. Steel is used in these products as it is strong and will last a long time.

Steel in New Zealand is obtained from the iron sand which is found on the west coast of the north Island. These were formed from volcanic activity and were first noticed in 1841. The hope then was that New Zealand may become the Britain of the south in terms of the production of iron and steel. Samples of these iron sands were sent overseas and attempts were also made to obtain iron from these samples. In 1853 Stensons from Messers Stenson and Co iron masters in Northampton noted difficulty in working with these iron sands.

The way iron was obtained at the time was to heat the iron ore with coal in a blast furnace. The oxygen in the iron oxides was transferred to carbon and carbon monoxide contained in the coal. In this way the iron oxide was reduced by a decrease oxidation number (or a removal of oxygen) and iron was formed. Any impurities in the iron ore would float above the molten iron and could be removed. This layer is referred to as slag.

The problem with the New Zealand iron sands was that the sands themselves were very fine and they blocked the flow of hot air into the furnace. In addition the New Zealand iron sands were rich in titanium compounds. When heated in a blast furnace titanium oxide was formed. This has a high melting point and a thick pasty layer formed beneath the slag. This layer blocked the tap holes which were used to remove the molten iron and waste slag. Other iron sands worldwide do not have this high titanium content. An early blast furnace was built near Nelson in the 1870's but again problems were found with the slag which was very viscous.

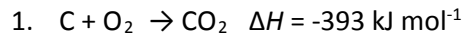


PROF. CULL.

In the 1900's professor John Cull carried out his own experiments to see if he could overcome these difficulties. He used magnetic techniques to concentrate the iron compounds in the iron sands. He then reduced the iron oxide directly at a temperature below the melting point of the iron. He then transferred this directly to an electric arc furnace where he carried out further reduction in the absence of air. He added lime as a flux and successfully separated the slag from the iron. The early experiments were carried out in the backyard of his parents' home in Christchurch. He discovered that iron could be obtained by using electric means but the earlier reduction at the lower temperatures required considerably less energy. He was able to do this because at lower temperatures titanium compounds were not formed. In addition limiting the amount of oxygen and controlling the amount of carbon this also prevented the formation of titanium compounds. This was to be the basis of how iron and steel would be made at Glenbrook years later.

In 1969 the steel mill at Glenbrook was opened. This mill now produces so much iron and steel that New Zealand now exports more steel than it imports. An important part of this process is what occurs in the rotary kiln.

Preheated coal, with limestone and the primary concentrate (ore after magnetic and gravity separation techniques along with pre-treatment in hearth furnaces) is fed into the rotary kiln. These kilns are 65 metres long and 4.6 metres in diameter. In the final part of the kiln (on the first part preheating occurs) the following chemical reactions occur:

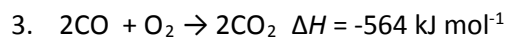


The coal is the source of carbon. This reaction is exothermic and produces heat which is used to make further reactions occur. The carbon dioxide produced reacts with more carbon to produce carbon monoxide.



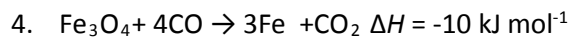
This reaction is endothermic and so the energy produced in reaction one helps this reaction occur.

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Again an exothermic reaction which produces more heat which can be used.

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During these reactions titanium dioxide is also formed. The mixture is now 70% iron.

At this point the mix is poured into melters and more limestone is added. The limestone reacts at these high temperatures producing calcium oxide. This calcium oxide acts as a flux which removes any acidic sulphur, phosphorous oxides, in addition to any other impurities such as silicon and titanium oxides. The energy is provided by carbon electrodes and the amount of air is monitored as earlier suggested by Professor Cull years ago.

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The mix is now poured into various further ladles. In the first vanadium is removed by blowing oxygen into the mix and forming oxides which is removed as slag. Then in a further ladle the remaining molten steel has further oxygen blown into it using the Klockner Oxygen Blown Maxhutte (KOBM) process. In this process oxygen is blown in at the top and the bottom of the ladle. The chemistry behind this process is that oxides are produced. These oxides are either liberated as a gas or react with the limestone to form a slag which floats on the surface of the liquid metal and is easily removed. The reaction of oxygen and limestone to remove impurities improved the quality of steel and influenced the development of steel as a technology. This process is unique to Glenbrook. In a normal blast furnace oxygen is normally blown in at just the top. 70 tonnes of steel has 1500 litres of oxygen blown in at the bottom and 2500 litres per second at the top of the ladle. This is more technically complex than other furnaces. Oxygen is required at the top and bottom because of the high content of titanium and vanadium in the iron which was part of the original ore. From here argon is blown into the steel to mix it evenly. Argon is an unreactive gas as it is in group 18 of the periodic Table. Elements in this group have a full outer shell of electrons and are unreactive. In the final step any alloying elements are added in the furnace and again mixing is achieved by blowing in argon. The metal is then cut into slabs and allowed to cool. Further treatments are then carried out depending on what the steel is going to be used for.

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