

Steel making in New Zealand

In 1841 it was noted by The Plymouth Company in Taranaki that “from certain indications, iron will be found in large quantities in this neighbourhood”. Settlers saw this as a potential source of iron. However the extraction of iron from these “iron sands” proved frustrating and a lot of time was put into efforts to access this source of iron. In fact it took over a hundred years to develop the technology and expertise to make iron and hence steel from this abundant source of iron located mainly along the West Coast of the North Island.

In the 19th century iron was extracted around the world from iron ore by using a blast furnace. The iron in iron ore is normally in the form of iron oxides. In a blast furnace these iron ores are heated with coke (different forms of carbon, sometimes charcoal). The oxygen in the iron oxides is transferred from the iron oxides to the carbon. In this process the iron oxides are reduced (removal of oxygen) to iron and the carbon is oxidised (gain of oxygen). The coke serves two purposes. One is to provide the reductant and the other is to provide the source of energy required. The iron formed is molten due to the heat and forms at the bottom of the furnace. Any other impurities (slag or waste) form on the top and these can be removed. The problem with the iron sands found in New Zealand is that as well as containing iron they also contain titanium, vanadium and other impurities. The titanium dioxide present has a high melting point and this blocks the holes in the blast furnace. In addition iron produced which contains large amounts of impurities can be brittle.

In 1969 a steel mill was opened at Glenbrook (60 Km south of Auckland). This site was chosen as it was close to Waikato North Head where the iron sands are mined and also close to Huntly (a source of coal). The iron sands are concentrated by magnetic and gravity methods, and are then mixed with water and pumped 18km to the Glenbrook site.

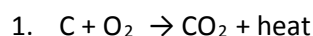
The hearth Furnace

This primary concentrate (PC) is mixed with limestone and coal in a hearth furnace. In this furnace the PC is preheated and volatile matter in the coal is removed. If these gases were not removed they would interfere with some of the processes further down the line. These waste gases are burnt to make steam to generate electricity for energy later on. At this stage the mix is heated to 650 degrees.

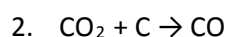
The rotary Kilns

It is in these kilns the iron oxides in the PC are reduced to iron. Preheated coal, with limestone and the PC 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 heat produced by this strongly exothermic reaction is used to fuel the process.



This reaction requires heat.

3. $2\text{CO} + \text{O}_2 \rightarrow 2\text{CO}_2$
4. $\text{Fe}_3\text{O}_4 + 4\text{CO} \rightarrow 3\text{Fe} + \text{CO}_2$

Carbon monoxide is the main reducing agent. During these reactions titanium dioxide is also formed. The mixture is now 70% iron.

Melters

This reduced primary concentrate (RPP) is then poured into melters, along with limestone. The purpose of the limestone is to provide calcium oxide. Calcium oxide is produced by decomposition of calcium carbonate ($\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$). The calcium oxide reacts with any acidic sulphur, phosphorous oxides or any acidic oxide like silicon dioxide, which can harm steel at high temperatures. The reaction with silicon dioxide is: $\text{CaO} + \text{SiO}_2 \rightarrow \text{CaSiO}_3$. This chemical process has been introduced into the steel making process to further develop it.

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The temperature is raised to 1500 degrees. The energy is provided by large carbon electrodes. Two layers form. The lower layer is molten iron with some dissolved elements notably carbon. The upper layer known as slag (waste) contains TiO_2 , Al_2O_3 , MgO , CaO , SiO_2 and some vanadium oxides. The molten iron and slag is tapped off through holes.

Steel making

Before steel making any vanadium is recovered. This is done as the vanadium rich slag formed can be sold and steel with too much vanadium content can be too hard. In this process oxygen is blown into the mix. This oxidises any silica, titanium, manganese, and vanadium which then forms a slag that floats and can be removed.

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. 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. In vanadium recovery, oxygen is blown over the surface of the molten metal where it oxidises silicon, titanium, manganese and vanadium to form a slag that floats on the surface. Argon gas is used to stir the molten metal. Argon is used because it is non-reactive. Other iron sands around the world do not have this high content of these two metals.

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The slag is removed. The metal is then cut into slabs and allowed to cool.

The technologies involved in these entire processes have all been refined and developed further since 1969. Since 1991 New Zealand has exported more iron and steel than it imports. In 2004 60% of Glenbrook steel was exported.