THE PRODUCTION OF ALUMINIUM

Rio Tinto Alcan

1. Mining Bauxite

The first step in the production of aluminium is to mine the ore used to make aluminium, called bauxite. Bauxite is formed by the natural weathering of sedimentary rocks which contain a high proportion of aluminium-bearing minerals. It is named after the French district of Les Baux where it was first discovered in 1821. The most important use of bauxite is in the preparation of alumina for aluminium production.

Front end loaders use a shallow, open-cut technique to load the bauxite into 150-tonne, bottom-dump trucks. The bauxite is free-flowing, relatively easy to dig and does not require blasting. The ore is taken to a dump station for transportation to the processing plant by rail and belt conveyor.

The plant which processes the bauxite is called a beneficiation plant. The bauxite is screened and washed to remove fine particles. It is then placed on stockpiles before being loaded onto ships. Most of Weipa's beneficiated bauxite is shipped to Gladstone for use in the Queensland Alumina Limited (QAL) and Yarwun refineries to produce alumina. The remainder is exported to third party customers.

Typical Composition of Bauxite	Wt%
Al_2O_3	56
Fe_2O_3	10
TiO_2	2
SiO_2	7
Water/Organics	25
	100

Typical Composition of Alumina	Wt%
Al_2O_3	99.600
Fe_2O_3	0.011
TiO_2	0.004
SiO_2	0.012
Na_2O	0.300
CaO	0.020
	100.000

2. Refining Alumina

The second step in the production of aluminium is the refining of alumina (aluminium oxide) from the bauxite using a chemical refining process called the Bayer process. This process, which was invented in 1888 by German scientist Karl Bayer, has four stages:

Stage 1:
The bauxite ore is finely ground in mills then mixed with a hot, caustic soda solution which dissolves the alumina contained in the bauxite. Impurities such as silicon, iron and titanium compounds are not dissolved.

Stage 2:
The solution of alumina and caustic soda passes into rows of thickener tanks, in which the solid impurities sink to the bottom as a fine, red mud. This red mud is a waste product of the process, and is washed several times with water and then disposed of in ponds, called tailings dams. The remaining alumina trihydrate solution is filtered to make it even cleaner.

Stage 3:
The solution is cooled, concentrated and stored in open-top tanks until crystals form. Pure alumina is added to the mixture to assist the formation of alumina trihydrate crystals which can take several days.

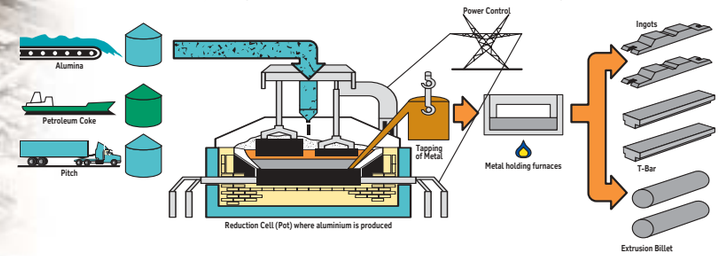
Stage 4:
The alumina trihydrate crystals are washed, filtered and then heated in gas-fired kilns at temperatures greater than 1,000ºC to remove water molecules. This forms alumina, a fine, dry, white powder which is cooled and stored.

Two tonnes of bauxite are needed to produce one tonne of alumina.

3. Smelting Aluminium

The third and final step in the production of aluminium is the smelting of alumina into aluminium metal. Two tonnes of alumina are needed to make one tonne of aluminium metal.

Alumina is made up of aluminium and oxygen. To produce aluminium metal, it is necessary to separate these two elements. The process that transforms alumina into aluminium is called smelting. It was invented in 1886 by Charles Hall in America and Paul Heroult in France. As Hall and Heroult made their discoveries independently at around the same time, the process is known as the Hall-Heroult process.



Smelting takes place in large, steel, carbon-lined furnaces known as reduction cells. The carbon lining is called a cathode. Alumina is fed into the cells where it is dissolved in molten cryolite, a liquid which can dissolve alumina and conduct electricity at around 970 °C. Electricity is introduced into each cell through carbon blocks manufactured by smelters, called anodes.

All of the reduction cells are connected in series by aluminium busbar which carries an electric current and these cells form a reduction line. A continuous electric current flows from the anode, through the alumina/cryolite mixture, to the carbon cathode cell lining, and then to the anodes of the next cell and so on. The electrical current enables alumina to react with the carbon anode to form aluminium and carbon dioxide. Between 13,000 and 15,000 kilowatt-hours of electricity are used to make one tonne of aluminium. The oxygen combines with the carbon to form carbon dioxide at the top of the cell.

The liquid aluminium sinks to the bottom of the cell. It is siphoned out in a process known as tapping and is transported to a holding furnace to be cast into products.

The metal may be cast as pure aluminium (better than 99.7%) or small amounts of other elements, such as magnesium, silicon or manganese, are added to form aluminium alloys. Different alloys give different properties to the metal such as extra strength or greater resistance to corrosion.

4 TONNES BAUXITE = 2 TONNES ALUMINA = 1 TONNE ALUMINIUM