CONCEPT MAP

GENERAL PRINCIPLES AND PROCESSES OF ISOLATION OF ELEMENTS

ALUMINIUM EXTRACTION

The pure form of aluminium does not naturally occur in nature, so remained largely unknown until as recently as 200 years ago. Creating aluminium using electricity was first developed in 1886 and is still used.

Bauxite Mining

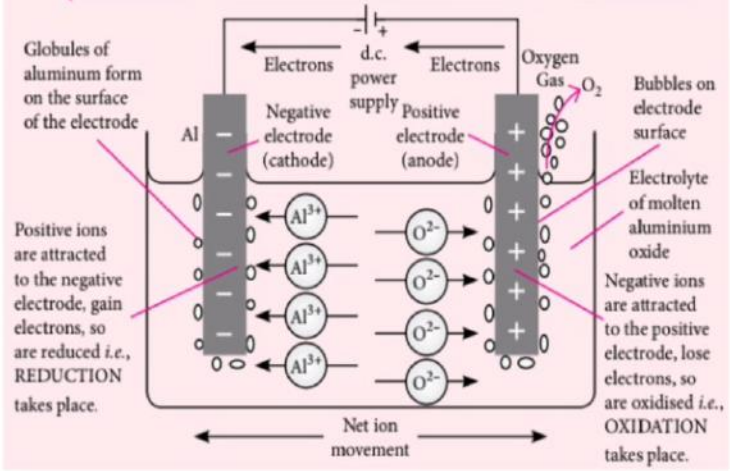
The aluminium production process starts with the mining of bauxite, an aluminium rich mineral in the form of aluminium hydroxide. Around 90% of the global bauxite supply is found in tropical areas.

Alumina Production

Bauxite is crushed, dried and ground in special mills where it is mixed with NaOH solution at high pressure. This process produces a thick paste which is collected in special containers and heated with steam to remove most of the silicon present in bauxite.

Electrolytic Reduction

At an aluminium smelter, alumina is poured into special reduction cells with molten cryolite at 950°C. Electric current is then induced in the mixture, this current breaks the bonds between aluminium and oxygen atoms resulting in liquid aluminium settling at the bottom of the reduction cell.

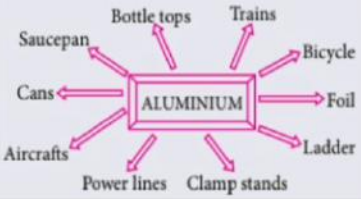


Casting

Primary aluminium is cast into ingots and shipped to customers or used in the production of different alloys.

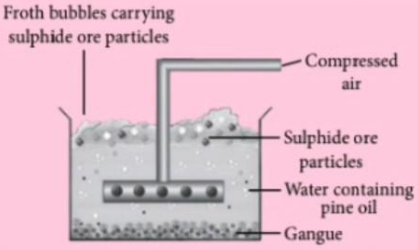
Alloys Making

Aluminium is shaped in required forms and used for making different products like telephone bodies, aeroplane bodies, etc.



Recycling

Aluminium is corrosion resistant so it can be remelted and reused an infinite number of times. Recycling aluminium requires only 5% of the energy required to make the same amount of primary aluminium.



Froth floatation process for the concentration of sulphide ores

Concentration of the Ore

The ore is mined, crushed, ball-milled and then concentrated by froth floatation. This removes unwanted components, including the lead compounds and waste rock.

Roasting of the Ore

The ore roasting usually takes place in a fluidised bed furnace at around 1300 K, with air being blown in, from the bottom. During roasting ZnS is converted to ZnO.

$$2ZnS_{(s)} + 3O_{2(g)} \longrightarrow 2ZnO_{(s)} + 2SO_{2(g)}\uparrow$$

The sulphur dioxide is often converted to sulphuric acid in a plant adjacent to the smelter.

Conversion of Zinc Oxide to Zinc Sulphate

The crude zinc oxide is leached with spent electrolyte, which is sufficiently rich in sulphuric acid to dissolve the oxide and restore the concentration of the zinc sulphate in the electrolyte solution.

$$ZnO_{(s)} + H_2SO_{4(aq)} \longrightarrow ZnSO_{4(aq)} + H_2O_{(l)}$$

Direct Leaching

Several methods have now been developed that dispense with the roasting stage, obtaining zinc sulphate direct from concentrated zinc sulphide ore. They generally use much more extreme conditions, and are suitable for lower-grade ores. One process developed in Canada, and capable of recovering 99% of the zinc from the ore, uses pressures in excess of 10 atmosphere and a temperature of 420 K. The presence of iron in the ore concentration is important in this method, as it is responsible for the conversion of zinc sulphide to zinc sulphate.

$$ZnS + H_2SO_4 + \frac{1}{2}O_2 \longrightarrow ZnSO_4 + H_2O + S$$

ZINC EXTRACTION

- Nearly all zinc is obtained from sulphide ores, which also usually contain lead, cadmium and other metals such as iron and silver. The most commonly occurring ores are zinc blende (ZnS), and marmatite which contains significant quantities of iron sulphides.
- The major deposits of sulphide ores are found mainly in North and South America (Canada, US, Mexico, Peru, Bolivia), Australia, Japan and China.

Electrolysis of Zinc Sulphate Solution

- The last stage entails the purification of zinc by electrolysis of a solution of zinc sulphate.
- Zinc is liberated preferentially at the cathode.
- Every 24 to 72 hours zinc is stripped off the electrodes, melted and cast into ingots. The metal is atleast 99.96% pure.