Aluminium Extraction: Teacher Notes

Siting the plant

The plant is situated on the island of Anglesey, near Holyhead. It was built in the late 1960s, at which time a regional development grant of 40% of the capital expenditure was available from the government. This was to encourage developments in the area that would reduce the level of unemployment on Anglesey which, at that time, was particularly high. Other factors in the decision to site the plant near Holyhead were the availability of a large (100 hectares) site close to a deep water port and the relatively good road and rail links with the rest of the country.

Electrical power

The process depends on electricity and the site uses the same amount of electrical power as a small city (population about 60,000). A loss of power for more than a couple of hours would be disastrous as the electrolyte and aluminium in the cells would solidify, and restarting the cells would be impracticable. The process can, however, cope with short power interruptions of a few minutes.

Power is supplied through a company called Magnox which owns and manages the nearby Wylfa nuclear power station. At certain times when power is not available from Wylfa, a supply from the National Grid is available. The plant has an arrangement with the National Grid that in times of short term high demand for electricity (such as half time during the televising of a major soccer match) power to the site can be switched off to save having to bring another power station on line.

The electrolysis uses a high current (157,000 A) at low voltage (4.5 V, about the same voltage as a typical torch) so that it is quite safe to touch the connecting cables. High magnetic fields are generated close to the lines of electrolysis cells by the high currents and these can wipe magnetic strips on credit cards, stop analogue watches and affect heart pacemakers (and video equipment!). During filming of the video clips it was necessary to use a mini camera, based on a charge-coupled device (CCD), linked *via* coaxial cable to a video recorder kept several metres away in an iron box.

The electrolyte

The electrolyte is a 2-5% solution of aluminium oxide (Al_2O_3) dissolved in cryolite (sodium hexafluoroaluminate(III), Na_3AlF_6). The electrolyte mixture is kept liquid at 955 °C. This compares with the melting point of pure aluminium oxide of 2072 °C. The use of cryolite thus reduces the costs of keeping the electrolyte liquid. The melting point of aluminium is 660 °C, so it is liquid at the temperature of the electrolyte.

Anode manufacture

The temperature in the pits where the anodes are baked is checked using a pyrometer which measures the temperature of the furnace from the radiation it emits. Each anode has a mass of about 1000 kg. This information could be used to construct a question about the amount of carbon dioxide produced by the plant as the anodes burn away.

Alloying

Following addition of alloying metals such as magnesium the contents of the furnace are stirred by attaching a steel paddle to the prongs of the fork lift truck and driving the truck rapidly backwards

and forwards with the paddle dipping in the liquid alloy inside the furnace.

Some students who have burnt magnesium ribbon might ask why the magnesium does not ignite. There are several factors involved. The temperature in the furnace is less than that of a Bunsen flame, the magnesium blocks have a lower surface area to volume ratio than ribbon and it is not clear how much oxygen there is above the molten metal in the furnace.