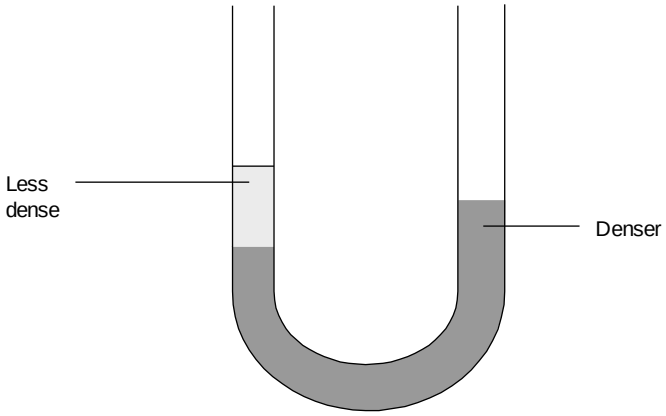
# Sodium: Teacher Notes

## Filling the two hour tank

The density of sodium is 0.97 g/cm$^3$ and that of molten sodium chloride is 2.17 g/cm$^3$. This means that not only does molten sodium float on top of the molten sodium chloride but that the sodium is forced up into the two hour tank which is situated above the level of the molten sodium chloride in the cell. The situation is similar to a U-tube containing two liquids of different densities.




The level of the less dense liquid is above that of the denser liquid.

Molten sodium in the two hour and 24 hour tanks is protected from moisture and oxygen in the air by blankets of nitrogen gas.

## The diaphragm

Unlike the diaphragm in the membrane cell, the steel gauze diaphragm does not prevent the movement of ions. Its function is to keep the sodium and chlorine apart and prevent them reacting back to sodium chloride.

## Salt flow

Dry salt flows into each cell down a diagonal pipe at a rate of about 1.3 kg/min. A plant operator can be seen adjusting this flow in one of the video shots.

## Moisture in the salt

The moisture content of the salt is about 0.05%. If all were to react with sodium, it would produce about 450 cm$^3$ of hydrogen gas per minute in each cell. The ignition of this is the cause of the occasional small ‘explosions’ which can be heard from time to time. Calculating the quantity of hydrogen produced could be a useful exercise for more able students.

## The electrolyte

The electrolyte mixture (called ‘cell bath’) consists of 26% calcium chloride, 46% barium chloride and 28% sodium chloride. Virtually no barium is discharged and so the barium chloride only needs occasional topping up. A little calcium is discharged at the cathode but most of this is returned to the cell during ‘tickling’. The rest solidifies and is removed by filtering, after which it is reacted with water to give an effluent containing calcium hydroxide. Losses of calcium chloride are occasionally made up manually. Sodium is discharged at the cathode in preference to calcium or barium because of its less negative discharge potential.

The cell bath's melting point of 600 °C, rather than 800 °C for sodium chloride alone, is advantageous for two reasons:

- it reduces the rate of attack of sodium and chlorine on the materials of the cell; and
- it is cheaper to maintain the cell at the lower temperature.

Gas heaters below the 24 hour storage tanks keep the sodium in them molten and a flame is also seen keeping the sodium in the nozzle molten during the pouring of blocks of sodium.

### Pouring sodium

The fact that sodium above its melting point (98 °C) does not ignite in air is a good illustration of the effect of surface area to volume ratio on rate of reaction. It is also worth noting that in this case the blocks of sodium are packed in drums wrapped in polythene sheet – no oil needs to be used.

### Protective clothing

Workers operating the plant wear protective clothing (similar to that used by motor racing drivers) made from a double layer of flameproof material called Kanox. The clothing was designed by plant operators and protects against accidental spills of the hot, molten electrolyte which would burn through conventional fabrics.