THE TECHNOLOGY

Fuel Cell Today – Education Kit 2

Fuel cells generate electricity from a simple electrochemical reaction in which oxygen and hydrogen combine to form water. There are several different types of fuel cell but they are all based around a central design which consists of two electrodes, a negative anode and a positive cathode. These are separated by a solid or liquid electrolyte that carries electrically charged particles between the two electrodes. A catalyst, such as platinum, is often used to speed up the reactions at the electrodes.

Fuel cells are classified according to the nature of the electrolyte. Each type requires particular materials and fuels and is suitable for different applications.

Alkaline Fuel Cells (AFC)

The alkaline fuel cell uses an alkaline electrolyte such as potassium hydroxide. It was originally used by NASA on space missions. NASA space shuttles use Alkaline Fuel Cells.

Direct Methanol Fuel Cells (DMFC)

As a relatively new type of fuel cell, the direct-methanol fuel cell (DMFC) is similar to the PEM cell in that it uses a polymer membrane as an electrolyte. However, a catalyst on the DMFC anode draws hydrogen from liquid methanol, eliminating the need for a fuel reformer. Therefore pure methanol can be used as fuel.

Molten Carbonate Fuel Cells (MCFC)

The molten carbonate fuel cell uses a molten carbonate salt as the electrolyte. It has the potential to be fuelled with coal-derived fuel gases, methane or natural gas. These fuel cells can work at up to 60% efficiency and this could potentially rise to 80 per cent if the waste heat is utilised.

Phosphoric Acid Fuel Cells (PAFC)

A phosphoric acid fuel cell (PAFC) consists of an anode and a cathode made of a finely dispersed platinum catalyst on carbon and a silicon carbide structure that holds the phosphoric acid electrolyte. This is the most commercially developed type of fuel cell and is being used to power many commercial premises. The phosphoric acid fuel cell can also be used in large vehicles, such as buses. Most fuel cell units sold before 2001 used PAFC technology.

Proton Exchange Membrane Fuel Cells (PEMFC)

The proton exchange membrane (PEM) fuel cell uses a polymeric membrane as the electrolyte, with platinum electrodes. These cells operate at relatively low temperatures and can vary their output to meet shifting power demands. These cells are the best candidates for cars, for buildings and smaller applications. The PEM fuel cell is also sometimes called a polymer electrolyte fuel cell (PEFC).

Solid Oxide Fuel Cells (SOFC)

Solid oxide fuel cells work at even higher temperatures than molten carbonate cells. They use a solid ceramic electrolyte, such as zirconium oxide stabilised with yttrium oxide, instead of a liquid and operate at 800 to 1,000°C. These cells can reach efficiencies of around 60 per cent and are expected to be used for generating electricity and heat in industry and potentially for providing auxiliary power in vehicles.

Regenerative Fuel Cells (RFC)

This class of fuel cells produces electricity from hydrogen and oxygen, but can be reversed and powered with electricity to produce hydrogen and oxygen; effectively storing energy or electricity.

Metal Air Fuel Cells (MAFC)

Metal air fuel cells are not fuel cells in a conventional way. They work similarly to batteries, generating electricity using metal and oxygen, although they are rechargeable.

	AFC	DMFC	MCFC	PAFC	PEMFC	SOFC
Electrolyte	Potassium hydroxide	Polymer membrane	Immobilised Liquid Molten Carbonate	Immobilised Liquid Phosphoric Acid	Ion Exchange Membrane	Ceramic
Operating Temperature	60-90°C	60-130°C	650°C	200°C	80°C	1,000°C
Efficiency	45-60%	40%	45-60%	35-40%	40-60%	50-65%
Typical Electrical Power	Up to 20 kW	< 10 kW	> 1 MW	> 50 kW	Up to 250 kW	> 200 kW
Possible Applications	Submarines, spacecraft	Portable applications	Power stations	Power stations	Vehicles, small stationary	Power stations