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At-a-glance 16:02:09

What are fuel cells?

Fuel cells are electrochemical devices that convert a fuel, most commonly hydrogen, into electricity and heat. It is similar to a battery in that it contains a cathode, anode and electrolyte that releases hydrogen ions and electrons when an external electrical circuit to be attached between the anode and cathode.

The fundamental difference is that a battery has to be either recharged (reversing the reaction) or replaced. A fuel cell has a continuous supply of fuel that replenishes the source of hydrogen ions. It chemically combines hydrogen and oxygen to produce water, electricity and heat without combustion or pollution.

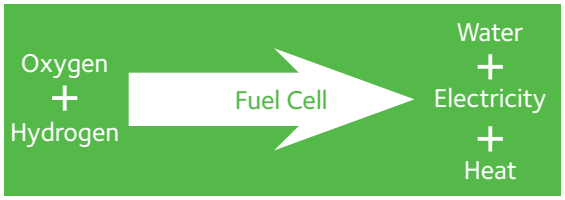
A fuel cell system may include a fuel reformer to generate hydrogen from any hydrocarbon fuel. However, high temperature fuel cells do not even need a fuel reformer and can use fuels such as natural gas, coal gas and methanol that have been generated from fossil fuels, waste streams or biological sources. Since the fuel cell uses electrochemistry rather than combustion, emissions are much lower than from the cleanest combustion processes.

What are the current developments in the fuel cell technology? The cost of fuel cells is currently too high to put them general use, but some commercial applications are beginning to appear.

It is an emerging technology with a potential in a range of industry, transport and household applications. A non-pollutant power generator could be the engine of a future passenger car or as an energy storage and electricity production station.

Hydrogen is the most favoured energy carrier for fuel cell systems. It is a very plentiful element, but to achieve the ambitious goal of the hydrogen economy often mentioned by politicians, technologies for safe and cost-effective production, distribution and storage of hydrogen still need to be developed. However, once the hydrogen is available the only by-product of the operating cell is water.

The US and Japan currently lead the world in developing the technology, but the EU has recently mobilised substantial resources to catch up. The diagram below shows a simple schematic diagram of a proton exchange membrane (PEM) fuel cell. This type of cell is most favoured for automotive applications.



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How fuel cells work

A fuel cell is a device for harnessing the energy that is liberated when hydrogen, or a hydrogen-rich fuel, reacts with oxygen to produce water. Normally, when hydrogen and oxygen react a flame and heat energy is produced. In a fuel cell a flame is not produced, and the reaction produces both heat and electricity.

In some ways a fuel cell is similar to a battery. Both are electrochemical devices in which an electric current is produced from chemical reactions that take place at the electrodes. A battery, however, stores electricity and needs regular recharging or replacement; a fuel cell will continue producing electricity as long as it is supplied with fuel.

A single fuel cell consists of an electrolyte sandwiched between two thin porous electrodes, the anode and the cathode. The anode of the cell is usually coated with a special catalyst which splits each hydrogen molecule into two protons (H+ ions) and two negatively charged electrons.

The electrons leave the anode and provide the electrical current in the external circuit to which the fuel cell is connected. Oxygen, usually from air, is fed to the cathode of the cell where it reacts with protons and the electrons returning from the external circuit to produce water.

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