Renewable energy fuel cells

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Although the basic operations of all fuel cells are the same, special varieties have been developed to take advantage of different electrolytes and serve different application needs. The fuel and the charged species migrating through the electrolyte may be different, but the principle is the same. An oxidation occurs at the anode, while a reduction occurs at the cathode. The two reactions are connected by a charged species that migrates through the electrolyte and electrons that flow through the external circuit.

The direct-methanol fuel cell (DMFC) is similar to the PEM cell in that it uses a proton conducting polymer membrane as an electrolyte. However, DMFCs use methanol directly on the anode, which eliminates the need for a fuel reformer. DMFCs are of interest for powering portable electronic devices, such as laptop computers and battery rechargers. Methanol provides a higher energy density than hydrogen, which makes it an attractive fuel for portable devices.

Alkaline fuel cells use an alkaline electrolyte such as potassium hydroxide or an alkaline membrane that conducts hydroxide ions rather than protons. Originally used by the National Aeronautics and Space Administration (NASA) on space missions, alkaline fuel cells are now finding new applications, such as in portable power.

Phosphoric acid fuel cells use a phosphoric acid electrolyte that conducts protons held inside a porous matrix, and operate at about 200?C. They are typically used in modules of 400 kW or greater and are being used for stationary power production in hotels, hospitals, grocery stores, and office buildings, where waste heat can also be used. Phosphoric acid can also be immobilized in polymer membranes, and fuel cells using these membranes are of interest for a variety of stationary power applications.

Molten carbonate fuel cells use a molten carbonate salt immobilized in a porous matrix that conducts carbonate ions as their electrolyte. They are already being used in a variety of medium-to-large-scale stationary applications, where their high efficiency produces net energy savings. Their high-temperature operation (approximately 600?C) enables them to internally reform fuels such as natural gas and biogas.

Solid oxide fuel cells use a thin layer of ceramic as a solid electrolyte that conducts oxide ions. They are being developed for use in a variety of stationary power applications, as well as in auxiliary power devices for heavy-duty trucks. Operating at 700?C-1,000?C with zirconia-based electrolytes, and as low as 500?C with ceria-based electrolytes, these fuel cells can internally reform natural gas and biogas, and can be combined with a gas turbine to produce electrical efficiencies as high as 75%.

In addition to electricity, fuel cells produce heat. This heat can be used to fulfill heating needs, including hot water and space heating. Combined heat and power fuel cells are of interest for powering houses and buildings, where total efficiency as high as 90% is achievable. This high-efficiency operation saves money, saves energy, and reduces greenhouse gas emissions.

This special class of fuel cells produces electricity from hydrogen and oxygen, but can be reversed and powered with electricity to produce hydrogen and oxygen. This emerging technology could provide storage of excess energy produced by intermittent renewable energy sources, such as wind and solar power stations, releasing this energy during times of low power production.

Fuel cells are classified primarily by the kind of electrolyte they employ. This classification determines the kind of electro-chemical reactions that take place in the cell, the kind of catalysts required, the temperature range in which the cell operates, the fuel required, and other factors. These characteristics, in turn, affect the applications for which these cells are most suitable. There are several types of fuel cells currently under development, each with its own advantages, limitations, and potential applications. Learn more about the following types of fuel cells.

Polymer electrolyte membrane (PEM) fuel cells--also called proton exchange membrane fuel cells--deliver high power density and offer the advantages of low weight and volume comparedwith other fuel cells. PEM fuel cells use a solid polymer as an electrolyte and porous carbon electrodes containing a platinum or platinum alloy catalyst. They need only hydrogen, oxygen from the air, and water to operate. They are typically fueled with pure hydrogen supplied from storage tanks or reformers.

PEM fuel cells are used primarily for transportation applications and some stationary applications. PEM fuel cells are particularly suitable for use in vehicle applications, such as cars, buses, and heavy-duty trucks.

Most fuel cells are powered by hydrogen, which can be fed to the fuel cell system directly or can be generated within the fuel cell system by reforming hydrogen-rich fuels such as methanol, ethanol, and hydrocarbon fuels. Direct methanol fuel cells (DMFCs), however, are powered by pure methanol, which is usually mixed with water and fed directly to the fuel cell anode.