Fuel Cell Systems

Hydrogen and Fuel Cell Technologies Office

The design of fuel cell systems is complex and can vary significantly depending upon fuel cell type and application. However, several basic components are found in many fuel cell systems:

- Fuel cell stack
- Fuel processor
- Power conditioners
- Air compressors
- Humidifiers.

Fuel Cell Stack

The fuel cell stack is the heart of a fuel cell power system. It generates electricity in the form of direct current (DC) from electrochemical reactions that take place in the fuel cell. A single fuel cell produces less than 1 V, which is insufficient for most applications. Therefore, individual fuel cells are typically combined in series into a fuel cell stack. A typical fuel cell stack may consist of hundreds of fuel cells. The

amount of power produced by a fuel cell depends upon several factors, such as fuel cell type, cell size, the temperature at which it operates, and the pressure of the gases supplied to the cell. Learn more about the parts of a fuel cell.

Fuel Processor

The fuel processor converts fuel into a form usable by the fuel cell. Depending on the fuel and type of fuel cell, the fuel processor can be a simple sorbent bed to remove impurities, or a combination of multiple reactors and sorbents.

If the system is powered by a hydrogen-rich, conventional fuel, such as methanol, gasoline, diesel, or gasified coal, a reformer is typically used to convert hydrocarbons into a gas mixture of hydrogen and carbon compounds called "reformate." In many cases, the reformate is then sent to a set of reactors to convert carbon monoxide to carbon dioxide and remove any trace amounts of carbon monoxide remaining and a sorbent bed to remove other impurities, such as sulfur compounds, before it is sent to the fuel cell stack. This process prevents impurities in the gas from binding with the fuel cell catalysts. This binding process is also called "poisoning" because it reduces the efficiency and life expectancy of the fuel cell.

Some fuel cells, such as molten carbonate and solid oxide fuel cells, operate at temperatures high enough that the fuel can be reformed in the fuel cell itself. This process is called internal reforming. Fuel cells that use internal reforming still need traps to remove impurities from the unreformed fuel before it reaches the fuel cell. Both internal and external reforming release carbon dioxide, but due to the fuel cells' high efficiency, less carbon dioxide is emitted than by internal-combustion engines, such as those used in gasoline-powered vehicles.

Power Conditioners

Power conditioning includes controlling current (amperes), voltage, frequency, and other characteristics of the electrical current to meet the needs of the application. Fuel cells produce electricity in the form of direct current (DC). In a DC circuit, electrons flow in only one direction. The electricity in your home and workplace is in the form of alternating current (AC), which flows in both directions on alternating