CERAMIC FUEL CELLS LIMITED

Fuel Cell Facts

Different Types of Fuel Cells

No. 3 Rev.1 05/06

Just like there are different types of internal combustion engines, there are also different types of fuel cells - choosing the most suitable fuel cell depends on the application. Designers and engineers need to consider many factors including; the operating temperature, the fuel type, the electrical efficiency, the amount of vibration, physical shock loading and of course, any size constraints.

Fuel cells can be grouped into high temperature and low temperature types. Low temperature fuel cells require a relatively pure supply of hydrogen as a fuel. This often means that a fuel processor is required to convert or 'reform' the primary fuel (such as natural gas) into pure hydrogen. This process consumes additional energy and requires specialised equipment. High temperature fuel cells do not need this additional process because they can 'internally reform' the fuel at elevated temperatures, meaning it is not necessary to invest money in hydrogen infrastructure.

Different types of fuel cells are categorised by the type of electrolyte. Within each fuel cell type different companies are using different designs to tailor a fuel cell's performance for a given application. The main groups of fuel cells are listed below:

Polymer Electrolyte Fuel Cell (PEFC) or **Proton Exchange Membrane Fuel Cell** (PEMFC)
Here, the electrolyte is a polymer ion exchange membrane that is very good at conducting protons often combined with an expensive platinum catalyst. These fuel cells are a good option for automotive and portable applications as they are best suited for fast start up and shut down situations.

Phosphoric Acid Fuel Cells (PAFC)
In this fuel cell, concentrated phosphoric acid is used as the electrolyte. The design and power outputs make them suitable for buses and large stationary applications.

Alkaline Fuel Cells (AFC)
The electrolyte is essentially a potassium hydroxide solution. These fuel cells are often used for expensive mission critical applications such as the USA space programme.

Molten Carbonate Fuel Cells (MCFC)
These highly specialised fuel cells use a combination of high temperature alkali carbonates (sodium or potassium) as an electrolyte and can use a wide range of fuel types. MCFC are best suited to large stationary power applications.

Solid Oxide Fuel Cells (SOFC)
With SOFCs, the electrolyte is a solid non-porous ceramic based metal oxide often Yttria doped Zirconia material. Because SOFCs operate at high temperature, a wide range of fuels can be used with out having to specially pre-treat the fuel.

Fuel Cell Type	Operating Temperature	Electrical Efficiency	Fuel Type	Applications
MCFC	~ 550 – 700°C	~ 50 to <70 %	Most hydrocarbon based fuels	Large (100's of kW to mW) stationary power generation
SOFC	~ 450 – 1,000°C	~ 45 to <70 %	Most hydrocarbon based fuels	Small (<1kW) to large (mW) stationary power generation
AFC	~ 150 – 200°C	~ 40 %	Pure Hydrogen	Space exploration
PAFC	~ 100 – 220°C	~ 35 to 40 %	Pure Hydrogen	Buses, trucks & large stationary applications
PEFC/PEMFC	~ 80°C	~ 30 to 35 %	Pure Hydrogen	Passenger cars & mobile applications

SOFC's are ideally suited to producing constant power for small stationary applications. Ceramic Fuel Cells Limited is developing SOFC systems for domestic applications generating highly efficient electricity from today's existing fuel sources and infrastructure.

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