FUEL REFORMING

Fuel Cell Today – Education Kit 5

Since most fuel cells are powered by hydrogen, one major issue is in which way hydrogen will be generated. Ideally this would be done by non-polluting and renewable methods, such as solar, wind or hydro power (See Education Kit 6). However, in the short-term the most likely solution to generate hydrogen is by extracting it from hydrocarbon fuels such as natural gas (NG), methanol, gasoline or ethanol, known as reforming.

Reformer Systems

Generally, there are two different kinds of reforming: external reforming, which is carried out before the fuel reaches the fuel cell, and internal reforming, which takes place within the fuel cell stack.

External reforming could be carried out at a refinery or chemical plant and the hydrogen delivered by pipeline to filling stations. For automotive uses, on-board reformers may be used so that vehicles can use liquid fuels which are converted to hydrogen in a processor attached to the fuel cell structure. This option will of course add to the cost and complexity of the vehicle's power system. The use of hydrogen on-board reformers would allow for a less complex fuel cell system but would necessitate the introduction of hydrogen storage facilities.

For high temperature systems, such as molten carbonate and solid oxide cells, it is theoretically possible to supply natural gas or methanol direct to the fuel cell without

prior reforming. The high temperature allows this stage to take place within the fuel cell structure. In practice, some preliminary reforming will probably be carried out. The exception to this is for direct methanol fuel cells that are being developed to run on methanol without reforming.

Reforming Technologies

Steam Reforming

In steam reforming, fuel is mixed with steam in the presence of a base metal catalyst to produce hydrogen and carbon monoxide. This method is the most highly developed and cost effective method for generating hydrogen and is also the most efficient, giving conversion rates of 70 to 80 per cent on a large scale.

Partial Oxidation Reforming

Partial oxidation can be used for converting methane and higher hydrocarbons but is rarely used for alcohols. This method involves the reaction of the hydrocarbon with oxygen to liberate hydrogen, and produces less hydrogen for the same amount of fuel than steam reforming. The reaction is, however, exothermic and therefore generates heat. This means that the reaction can be initiated by a simple combustion process leading to quick start up. Once the system is running it then requires little external heating. The technology is preferred where there is little access to natural gas or an abundance of oil.

Autothermal Reforming

Autothermal reforming combines the endothermic steam reforming process with the exothermic partial oxidation reaction, therefore balancing heat flow into and out of the reactor. These systems can be very productive, fast starting and compact and have been demonstrated with methanol, gasoline and natural gas. A number of auto and oil companies are also working on proprietary versions of this technology.