

Advantages of HTPEM fuel cells over LTPEM fuel cells

The HTPEM (High Temperature Polymer Electrolyte Membrane) fuel cell system developed by Serenergy is the first commercially available, low pressure, air-cooled HTPEM fuel cell system in the world. There are a number of major advantages of Serenergy's HTPEM fuel cells versus commonly available LTPEM (Low Temperature Polymer Electrolyte Membrane) fuel cells:

High system efficiency of HTPEM fuel cells. As a result of not needing the humidifier, compressor and radiator as in the LTPEM system, the HTPEM system is very simple. The Serenergy fuel cell system uses less than 4% for this base purpose, making this the fuel cell system with the lowest parasitic power consumption searchable. We term it The Power of Simplicity. Partly due to the low parasitic losses we have achieved fuel cell system efficiencies of up to 57%. Most fuel cell systems have an energy usage of approximately 10-20% of the output, just to achieve operational status. The best LTPEM fuel cell systems have parasitic losses of 6–8%, but parasitic loss exceeding 10% are common.

Lower system cost of HTPEM fuel cells. As a result of not needing the humidifier, compressor and radiator as in the LTPEM system, the HTPEM system is built using a very simple internal architecture reducing the Balance Of Plants (BOP) cost to approximately 25% of the fuel cell stack cost. This is achieved by eliminating a number of traditionally used components such as humidifiers, pumps, compressors and radiators. The fuel cell itself only requires a single air-fan, similar to those used to cool CPUs in computers. For LTPEM fuel cell BOP components may cost up to 200% of fuel cell stack costs.

HTPEM fuel cells are highly tolerant to CO. CO is a known fuel cell poison and is a result of using reform liquid fuels. The CO content necessitates fuel clean up which in turn means that use of reform liquid fuels requires much cumbersome systems because of larger and therefore more costly systems. Due to the elevated temperatures in HTPEM, hydrogen with a higher CO concentration can be used without the same negative impacts on the performance. This makes it possible to directly use hydrogen reformat originating from cheap, and easy to handle energy-carriers such as methanol, ethanol, diesel etc.

The HTPEM fuel cell can tolerate up to 3% (30,000ppm) CO and up to 20ppm of sulphur without permanent degradation. In comparison, LTPEM fuel cell normally can tolerate less than 30ppm CO and less than 1 ppm of Sulphur. This is a factor of 1,000 difference in CO tolerance. Because of the high operating temperature, a PrOx reactor is normally not necessary. PrOx reactors are expensive, bulky and significantly lower the system efficiency. The result is that very simple, lightweight and inexpensive reformers can be used to produce hydrogen from a broad range of energy-carriers including the choices listed above.

HTPEM fuel cells is easier to control. Since HTPEM fuel cells can be operated over a broader operating window temperature-wise (compared to LTPEM fuel cells) it is far easier to control than a LTPEM fuel cell system.

High quality waste heat from HTPEM fuel cells. The waste heat needs to be hot to be of high quality. The waste-heat from a HTPEM fuel cell (~155°C) is therefore by definition of higher quality than waste-heat from a LTPEM fuel cell (~70°C).

The waste-heat needs to be concentrated in a usable directional stream. In Serenergy's case more than 90% of the waste-heat leaves the fuel cell system through the exhaust-pipe and is therefore easy to utilize.

Since the waste-heat in Serenergy's fuel cell systems is of high quality and is contained in a usable directional stream it is easy, cheap and simple to recover some, or most, of the waste-heat using air-to-air or air-to-liquid heat exchangers.

Fewer components in HTPEM fuel cell systems:

No humidifier. There is no need for a humidifier due to the composition of the Membrane Electrode Assembly (MEA) which results in a simpler, cheaper and more reliable fuel cell system.

No compressor. There is no liquid water in a HTPEM MEA and therefore there is no need for a compressor. This further reduces system complexity, cost and noise level while greatly increasing fuel cell system efficiency. Due to the high operating temperature, heat can easily be removed from the fuel cell system.

No radiator. There is no need for a liquid cooling loop. Assuming an ambient temperature of 40°C, a LTPEMFC operating temperature of 70°C and a HTPEMFC operating temperature of 160°C, then one has a Δt of 30°C for the LTPEM system compared to a Δt of 120°C for the HTPEMFC. The Δt of a HTPEMFC is therefore 400% more than for the LTPEMFC. The result is that there is no need for a complicated, bulky and expensive liquid cooling system. A simple, small and inexpensive fan can be used for cooling instead. The parasitic loss from the fan reaches a maximum of 3.5%.