Backup Power Fuel Cell Systems for Telecom Applications

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Backup Power Fuel Cell Systems for Telecom Applications

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1 Summary

With the rapid expansion of wireless communication systems worldwide, and the increasing socioeconomic benefits of mobile phone technology, the need for dependable and economical backup power is critical. Electric grid loss throughout the year, whether from severe weather, natural disasters, or limited grid capacity, is an on-going challenge for network operators. An alternative to the traditional backup power for telecom sites is the fuel cell. Telecom companies are increasingly choosing fuel cell systems as backup power because they are a clean, reliable, and low maintenance solution compared to batteries and diesel generators.

The type of fuel cell commercially available today and most appropriate for use with telecommunications sites is the PEM (Proton Exchange Membrane) fuel cell. A PEM fuel cell is fueled by hydrogen and produces electricity through an electrochemical reaction. These fuel cells are compact, durable, reliable, quiet, and operate at peak efficiency in a wide range of climates (-40°C to +50°C) and adverse weather conditions.

In addition, they have few moving parts (thus needing minimal maintenance), come in sizes ranging from 250 W to 250 kW, can readily adjust their electronic output to meet shifting power demands and offer a high energy density. Also, fuel cells are fast starting and can begin delivering electricity within seconds of activation.

2 What Is PEM?

Proton exchange membrane (PEM) fuel cell systems are proving to be an attractive alternative to traditional and existing solutions such as valve-regulated lead acid (VRLA) batteries and diesel generators.

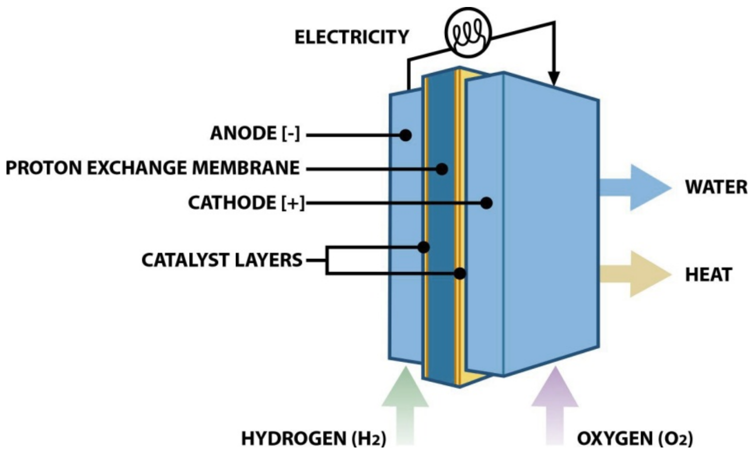

Figure 1: Proton exchange membrane.

Membrane electrode assembly consists of anode and cathode, which are each coated on one side with a thin catalyst layer and separated by a proton exchange membrane (PEM). Flow-field plates direct hydrogen to the anode and oxygen (from air) to the cathode. When hydrogen reaches the catalyst layer, it separates into protons (hydrogen ions) and electrons. Free electrons, produced at the anode are conducted in the form of a usable electric current through the external circuit. At the cathode, oxygen from air, electrons from external circuit and protons combine to form water and heat. Individual fuel cells are combined to form a fuel cell stack. Increasing the number of cells in a stack increases the voltage while increasing the surface area of the cells increases the current.

3 The Hydrogen Challenge

Typical backup power fuel cell systems use pressurized bottled hydrogen which powers the fuel cell stack and produces regulated DC power and clean exhaust and waste heat. Bottled hydrogen is suitable and cost effective for a range of telecom backup requirements, including eight hours or less of backup power time, lower power needs, and where convenient access to hydrogen refuelling is available. Six bottles of hydrogen provide ten hours of backup power for a 5 kW load. However, in situations requiring extended backup power times, higher power needs or in situations where hydrogen delivery is difficult or impossible, compressed hydrogen is a challenge.

Figure 3: Compressed hydrogen cylinders.

The typical run time for one of today's fuel cells operating on 6 cylinders* of hydrogen (*1 T-cylinder = 7,392 liters of hydrogen) is 10 hours at 5 kW of output power. For longer run times, additional cylinders of hydrogen can be hot-swapped into the hydrogen storage cabinet. However, there can be limitations as to how much backup power run time can be achieved by hot swapping cylinders of hydrogen. The run time can be limited by the amount of space for hydrogen storage at a telecom site and/or the remoteness of a telecom site, which makes hot swapping hydrogen cylinders less desirable.

4 Liquid Fuel vs. Hydrogen Cylinders

In the comparison between liquid fuel and hydrogen bottles, 55 gallons of HydroPlus, a methanol/water fuel mixture, and a fuel reformer will provide the same amount of power for the same length of time as 30 hydrogen cylinders. In situations where hydrogen storage is difficult due to space and weight restrictions, then HydroPlus liquid fuel combined with a fuel reformer makes sense.

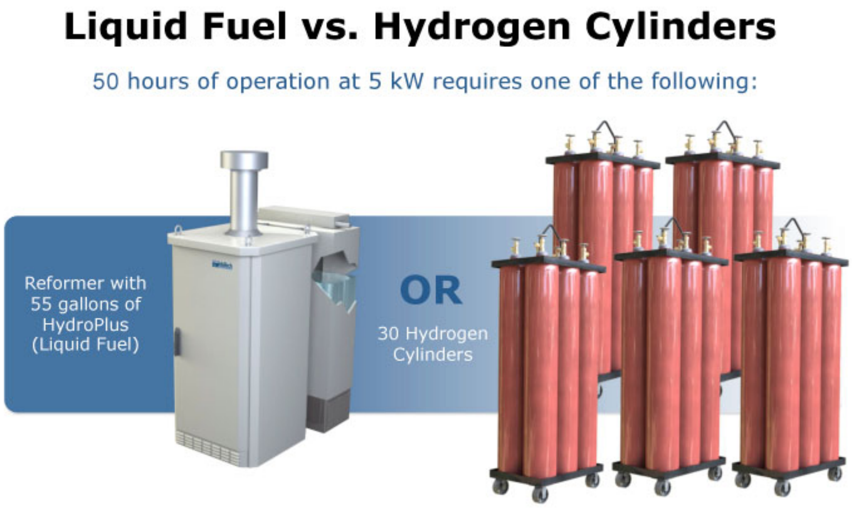

Figure 4: Liquid fuel reformer vs. hydrogen cylinders.

The fuel distribution channel for HydroPlus is developing quickly, and the fuel can be ordered and shipped directly from manufacturers as needed in five- and 55-gallon drums. Qualified HydroPlus liquid fuel distribution partners are available worldwide including in North America, Latin American, Europe, Middle East, Asia Pacific, and Africa.

5 How Fuel Processors Work

IdaTech has developed fuel processors for a variety of common fuels including HydroPlus, a methanol and water liquid fuel found in windshield washer fluid and many other common products. A fuel processor uses a liquid fuel to make hydrogen on site and on demand. Fuel processing is the act of converting hydrogen rich fuels into pure hydrogen gas as needed, then feeding the pure hydrogen directly into a fuel cell stack.

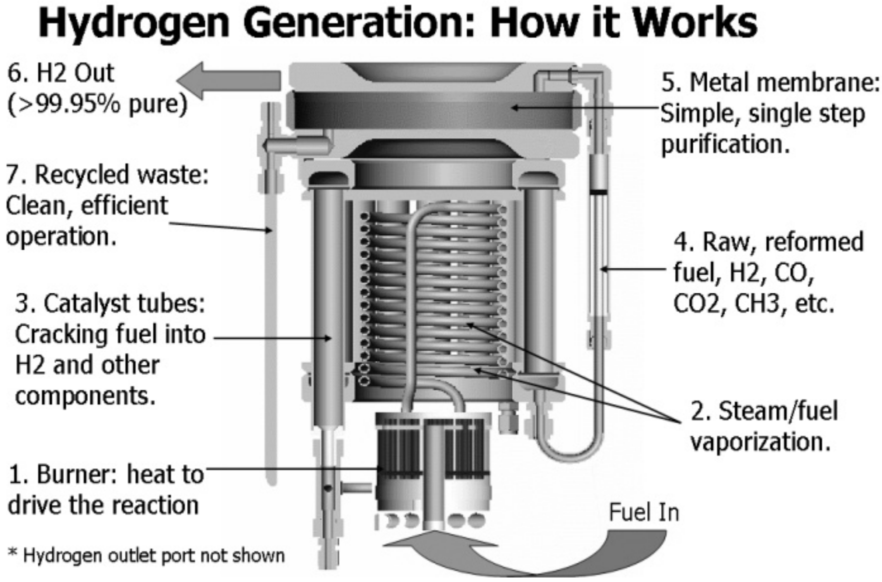

Figure 5: Fuel processor.

Fuel cell systems with liquid fuel processors can provide backup power for days instead of a few hours by using energy dense liquid fuel.

To create power, the fuel cell system first activates a burner to drive the reaction, followed by fuel vaporization. Within the catalyst tubes, the fuel is broken into hydrogen molecules and other components. From there, the raw reformed fuel (H2, CO, CO2, etc.,) is purified by the metal membrane, and the waste elements are recycled in a clean, efficient operation, producing 99.9+% pure hydrogen. The key differentiator in the fuel processing stages is the hydrogen purification method.

6 Fuel Cell Installations

Backup power fuel cell systems have been installed at telecom base station sites worldwide. These installations have shown the benefits and ease of fuel logistics for fuel cell systems that run on liquid fuel. Fuel cell systems with built in fuel processors and integrated 220 liter fuel tanks can operate without interruption for 50 hours at full output (5 kW). Fuel can be easily stored, transported onsite and units can be re-filled even while in operation. Fuel is stored locally for rapid dispatch to sites when needed.

7 Replacement of VRLA Batteries and Diesel Generators

As can be seen traditional solutions aren't always appropriate for sites requiring extended run times (days vs. hours), and don't always work. VRLA batteries, for instance, are suitable for typical eight hour run times.

Generators have significant limitations in that they add to overall backup power system cost and space requirements, they are increasingly difficult to install on-site due to significant noise and emissions, and have high maintenance requirements. Other benefits fuel cell systems have over traditional solutions like VRLA battery strings or diesel generators include operation in a larger temperature variance, lighter weight, longer life expectancy and greatly reduced maintenance intervals, reduced emissions and hazardous waste, are easily scalable, and have the option for remote monitoring and control.

8 Summary

In summary, fuel cell backup power systems operating on a compact liquid fuel can remove the challenges that hydrogen-only systems face. Whether the challenge is hydrogen delivery and storage due to a remote or roof-top location or the high price of hydrogen, reformer-based fuel cell systems have numerous advantages versus hydrogen-only systems as well as traditional battery strings or diesel generators.

In addition to those benefits, the compact liquid fuel allows virtually unlimited fuel cell backup power. Existing solutions are commercially available today for mission critical and remote sites, such as telecommunication carrier's tower sites and other critical communications networks. Backup power for critical telecommunication applications is an example of the range of solutions that can be addressed today using fuel cell and reforming technology.