Department of Defense Molten Carbonate Fuel Cell Demonstrations

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ABSTRACT

Demonstration of molten carbonate fuel cells (MCFC) is underway at three Department of Defense (DOD) sites. LOGANEnergy (LOGAN) has received contracts to install four MCFC systems at the three DOD sites. The four 250-kW MCFC systems will be model DFC300MA units manufactured by FuelCell Energy (FCE). The projects are still in-progress but are already producing valuable experience. Experience to date is shared in this article.

DEPARTMENT OF DEFENSE MCFC DEMONSTRATIONS

The U.S. Navy, China Lake, contracted LOGANEnergy to install and operate two 250-kW molten carbonate fuel cells (MCFC) systems at one site and an additional MCFC system at another site. Both sites selected are near dining facilities on Camp Pendleton, CA.

The first Camp Pendleton site is located at the building 14036 dining facility. The fuel cell hardware was delivered to the site in July 2006 with commissioning in August 2006. The 500-kW electrical output of the two MCFC systems is connected to the 12-kV electrical distribution system through separate transformers. All fuel cell power is consumed in the area. No power is exported across the meter to the utility company system. Pipeline natural gas is provided to the MCFC systems at 15 psig. The 600,000 Btus per hour of thermal energy will be utilized in a heating loop that will supplement domestic hot water and space heating in both the dining facility and neighboring barracks buildings. The systems will be operated for a period of 5 years.

The second Camp Pendleton site, where one 250-kW MCFC system will be installed, is located near the area 24 dining facility. Current plans call for commissioning this unit in the first quarter 2007. Thermal output will again be used for domestic hot water and space heating at the dining facility and nearby barracks.

The U.S. Army, Engineer Research and Development Center, Construction Engineering Research Laboratory (ERDC/CERL) contracted with LOGANEnergy to install another 250-kW MCFC system at the 29 Palms Marine Corps Base, CA. Delivery of the fuel cell hardware to the site is scheduled for September 2006. This unit will be used to displace the purchase of grid electricity.

LOGANEnergy Corporation

LOGANEnergy Corp. (LOGAN), founded in 1994, is dedicated to providing fuel cell services to energy consumers in the U.S. and overseas. LOGAN specializes in designing, installing, and maintaining clean, quiet and reliable fuel cell projects with a primary focus on customer design requirements.

LOGAN works closely with fuel cell manufacturers to assist their commercialization strategies. LOGAN's product catalog includes polymer electrolyte membrane (PEM) fuel cell, phosphoric acid fuel cell (PAFC) and molten carbonate fuel cell (MCFC) power plants ranging from 5-kW to 2-MW capacities designed for residential/light commercial, commercial and industrial applications.

LOGAN's staff has installed over 100 fuel cell power plants exceeding 9-MW capacity at over 65 locations. Customers include the Department of Defense, fuel cell manufacturers, utilities, banks, universities, real estate developers and other business centers.

Fuel Cell Energy, Inc.

FuelCell Energy, Inc. (FCE) based in Danbury, Connecticut, is a world leader in the development and manufacture of high temperature hydrogen fuel cells for clean electric power generation. The company's patented Direct FuelCell® (DFC®) technology combines high efficiency, low emissions, simplicity and economical cost for stationary power generation. FCE products, ranging in size from 250 kW to 2 MW, are designed for a wide range of customers, including: hospitals, universities, hotels, utilities, and wastewater treatment facilities. FCE is also developing next generation high temperature fuel cell products.

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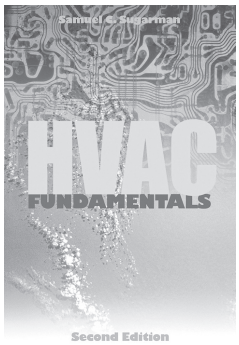

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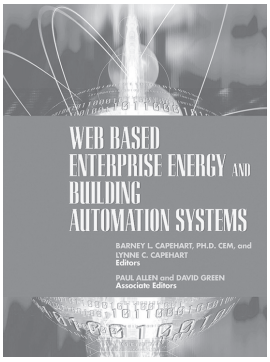

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FUEL CELL SITING ISSUES

A number of issues should be considered in the selection of a site for MCFC systems.

Physical Space

Installation of a 250-kW MCFC system requires adequate space. A single DFC300MA has three major components, see Figures 1 and 2, that will require a space of approximately 20-ft by 30-ft plus additional maintenance access area.

Proximity to Utility Connections

Connections are required to utility systems, such as electric, fuel (natural gas), water, drain pipe, thermal systems, and telephone. During the site installation, utilities must be verified to exist within acceptable distances.

Thermal Loads

If thermal loads exist nearby, fuel cell exhaust can be used to provide heat. The DFC300 available heat is approximately 300,000 Btu per hour at 650˚F. Typical thermal loads include domestic hot water systems, building space-heating systems, preheating water to boilers, swimming pool heating, and (with additional hardware and design) heat for adsorption cooling.

Spark Spread

The difference between electric prices and natural gas prices (known as spark spread) will obviously impact economics of a potential site. When electric prices are low and/or gas prices high, maximum usage of the fuel cell thermal energy may be important just to obtain an annual energy output of greater value than the annual fuel input cost.

Incentive Funds

Project incentive funds may be available from federal or state governments or utility companies. Incentive programs may have stipulations such as minimum thermal usage, length of project, or other requirements.

CONSTRUCTION AND INSTALLATION ISSUES

Planning and experience have led to the identification of significant issues that require attention during the construction and installation phase of a fuel cell project. The following discusses some specific experiences from the in-progress DOD MCFC projects.

Site Preparation

The DFC300MA requires a fixed placement of the stack module relative to the placement of the mechanical balance of plant (MBOP) enclosure. Therefore, it is important to carefully place under slab pipes and conduits prior to constructing the concrete pad.

Water

The fuel cell manufacturer has specifications for water that can be used by the fuel cell. Site water should be tested for constituents. If water is not within specified limits, an auxiliary water treatment system will be required.

Water usage and discharge rates can be significant (2 gpm and 1

Figure 1. Camp Pendleton Prepared Site

gpm, respectively) for MCFC systems. Discharge water does not add constituents but does concentrate constituents found in the supply water.

Electrical Interconnect

Utility companies will typically require an interconnection agreement to be signed when operating generating equipment in parallel with their system. Requirements for proof of properly operating disconnect hardware may vary from state to state or between various utility companies. Fees and utility response times may also vary. Utility companies may also impose specific metering hardware requirements.

Natural Gas Supply and Tariffs

The significant quantities of natural gas used by fuel cells may require changes in tariffs. Some gas tariffs do not apply for generation or are limited in the annual usage quantity. Also, utility companies may require separate metering or even a separate houseline (installed at the customer's expense) from the nearest utility main line.

Communication Lines

Both telephone and high-speed internet connection may be needed at the site. The DFC300 uses both internet connection and phone lines for data collection, interrogation, and remote control. Utility company gas and electric meters may also require separate phone lines.

Figure 2. Camp Pendleton Components on Pads

Heat Recovery

Collecting heat from the fuel cell exhaust (with temperatures in the 650˚F range) requires an external heat exchanger. The heat exchanger will need to be incorporated into the existing mechanical system. One design approach that reduces the impact of fuel cell outages is to integrate the fuel cell such that the existing system operates normally in absence of the fuel cell heat.

OPERATIONAL EXPERIENCE

Because the current projects are being installed at the time of this writing, operating performance data does not yet exist for the DOD MCFC projects mentioned.

CONCLUSIONS

The Department of Defense currently has several on-going molten carbonate fuel cell demonstrations at Camp Pendleton and 29 Palms, CA. Site selection and construction activities have already provided informative experiences in utilizing MCFC systems. Some issues are identified in this article. Operating performance data will be forthcoming as the units continue to log operating hours.

ABOUT THE AUTHOR

William R. Taylor is a project engineer with LOGANenergy Corporation. Bill Taylor recently joined the LOGANEnergy team after more than 20 years with a U.S. Army research laboratory where in the past 10 years he was involved with dozens of distributed generation field projects including fuel cell and microturbine demonstrations. His experience includes project management and development, initial site screening and evaluations, and performance monitoring and analysis. Mr. Taylor has a B.S. in electrical engineering from the University of Missouri–Rolla. Mr. Taylor may be contacted at *btaylor@loganenergy.com.*