Direct Methanol Fuel Cell System for Armored Vehicle Applications

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The U.S. Army requires a lightweight auxiliary power source that can power instrumentation on armored vehicles during field-testing. Such an auxiliary power source should be quiet, have a low thermal signature, be capable of producing up to 300 W of continuous power and deliver 30,000 Wh of energy.

The U.S.Army currently uses four deep cycle marine batteries to provide auxiliary power for this application. A direct methanol fuel cell (DMFC) power system can provide a twelve times increase in operating time before the need for refueling. Thus, substitution of the batteries with a DMFC system provides the U.S. Army with a tremendous logistics advantage by eliminating frequent battery recharging and in-field battery replacement.

The Jet Propulsion Laboratory, with support from the Director, U.S. Army Operational Test Command and the Army Research Laboratory, is developing an integrated DMFC power system to meet the needs of the U.S. Army described above. This system builds on the work carried out under previous DARPA and U.S. Army funded programs.

The DMFC system under development consists of a stack, an air subsystem, thermal and fluid management subsystem, and an electronics subsystem. The stack consists of 80 cells with an active electrode area of 80 cm^2. The stack is assembled with high-performance membrane electrode assemblies (MEAs) prepared at JPL. The MEAs are designed to operate at low airflow rates. The procedures for fabrication of such MEAs have been described previously[1].

Air required for stack operation is supplied using a centrifugal blower. The stack design ensures an ultra-low pressure-drop for airflow on the cathode side. This design is key to minimizing the parasitic power required to operate the system.

An aqueous feed of 0.5 –1.5 Molar methanol in water is circulated past the anode. The optimal concentration for operation is determined based on the operating temperature, load current and the MEA design. The concentration in the fuel loop is monitored and controlled using a methanol sensor developed earlier at JPL [2]. Pure methanol is drawn from a fuel tank and fed into the dilute circulation loop to maintain the concentration.

The temperature of the system is controlled by a heat exchanger that is part of the fuel circulation loop. The product water and water transported from the anode to the cathode by permeation and electro-osmotic drag is recovered and returned to the anode. The system design ensures conservation of water up to an environmental temperature of 45^{o}C and a relative humidity of 0%. The electronics subsystem controls the air, fuel and thermal subsystems, and also conditions the output power to the required voltage. A lithium-ion battery supports the start-up function.

The presentation will discuss the design and operation of the DMFC system. Stack and system data under various conditions of operation will be presented. The effect of the various operating parameters on power output and system efficiency will be discussed.

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References:

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