Development of a 300 W Direct Methanol Fuel Cell Based Power Source

T. I. Valdez and S.R. Narayanan

Jet Propulsion Laboratory,
California Institute of Technology,
4800 Oak Grove Drive, Pasadena, CA 91109

The Jet Propulsion Laboratory is currently developing a 300 W direct methanol fuel cell (DMFC) power source for integration into embedded test electronics which operate on armored vehicles. Some system attributes for this novel power source include: low thermal signature, operation in a high dust environment, attitude insensitivity of +/- 45° to vertical, "in-field" refueling, operation at 45 °C (in system water balance), and 100 hour continuous operation at the rated power of 300 W.

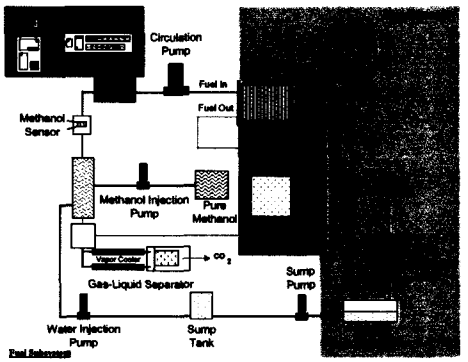

Figure 1. Direct Methanol Fuel Cell System Schematic

A DMFC based power source can be divided into four subsystems as shown in figure 1. The air subsystem, fuel subsystem, thermal subsystem and electronics and control subsystem work in unison to efficiently convert methanol to electrical power. The function of the air subsystem is to condition the air from the environment for fuel cell use. The air subsystem also serves the function of capturing fuel cell product water that will be recycled to maintain a system water balance. The fuel subsystems main function in to maintain the methanol concentration in the fuel circulation loop constant. The thermal subsystem function is to maintain a steady operating temperature. The electronics and control subsystem incorporates logic algorithms to operate the fuel cell system.

The effect of stack operating air stoichiometry on system efficiency and mass has been discussed [1-3]. The 300 W DMFC power source is built around a low-pressure-drop 80-cm^2 active area DMFC stack. The performance of this stack has been previously reported [3]. Recent advances in membrane electrode assembly (MEA) fabrication techniques have allowed for higher cell efficiencies and greater power densities to be realized. The voltage-current performance for both state-of-art and advanced MEAs operating in a five-cell stack is shown as figure 3. The peak stack power is 16.4 and 25.8 W for the state-of-art and advanced MEAs respectfully. At the system operating airflow of 1.7 times stoichiometry the stack power density and efficiency are expected to be 55 mW/cm^2 and 33% respectfully.

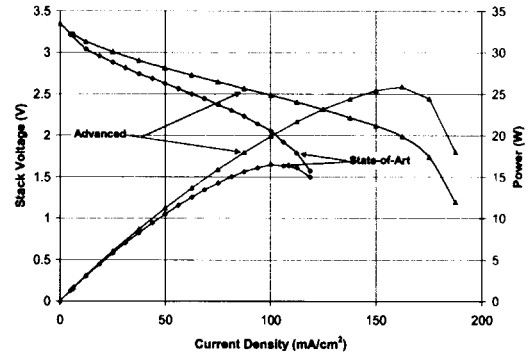

Figure 2. Five-cell DMFC stack voltage-current performance operating at 60 °C, 0.5M methanol and 1.72 LPM ambient pressure airflow.

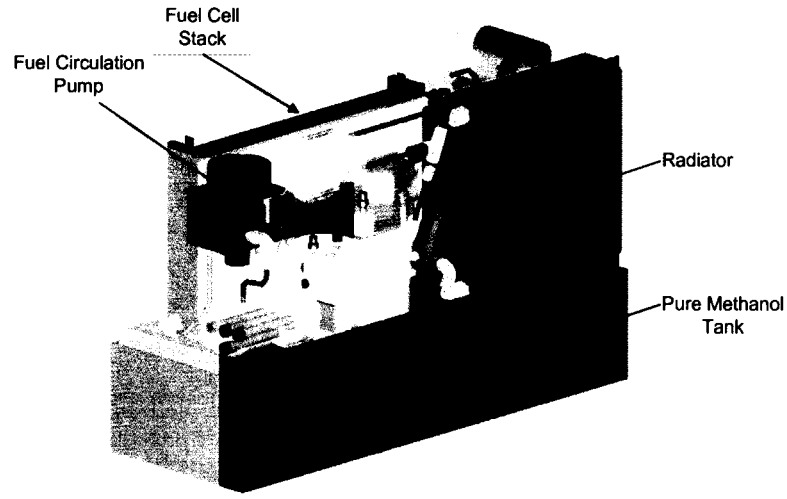

Figure 3. CAD model of the 300 W DMFC power source being developed

The development of high performance low airflow DMFC MEAs has enabled the development of compact light weight DMFC power sources. A CAD model of the 300 W DMFC system is shown as figure 3. The total system volume is 123 L, the current best estimate (CBE) mass is 55.6 kg. The CBE figures of merit for this power source are 540 Whr/ kg and 243 Whr/ L for the specific power density and volumetric power density respectfully.

Acknowledgement
The work presented here was carried out at the Jet Propulsion Laboratory, California Institute of Technology for the National Aeronautics and Space Administration. The research was sponsored by Test and Evaluation/ Science and Technology.

References

1. S.R. Narayanan, T. Valdez, N. Rohatgi, J. Christiansen, W. Chun, G. Voecks, and G. Halpert, in Proton Conducting Membrane Fuel Cells II/ 1998, S. Gottesfeld and T Fuller, Editors, PV 98-27, p. 316 The Electrochemical Society Proceeding Series, Pennington, NJ. (1998)

2. T.I. Valdez, S.R. Narayanan, H. Frank, and W. Chun, Proceedings of the 11th annual Battery Conference on Applications and Advances, Long Beach, CA., Jan 9-12, 1997. IEEE pg. 239 – 244 (1996)

3. T.I. Valdez, S.R. Narayanan, and N Rohatgi, Proceedings of the 15th annual Battery Conference on Applications and Advances, Long Beach, CA., Jan 11-14, 2000. IEEE pg. 37 – 40 (2000)