IRON–AIR BATTERIES FOR ELECTRIC VEHICLES

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The purpose of this research and development program is to develop a low cost, long life secondary iron–air battery for use in the ground transportation of both goods and people. The ultimate performance goals for the iron–air system are a stored energy density of 140 W h/kg at the four hour discharge rate with a power capability in excess of 120 W/kg. The manufacturing cost objective for the system is $30 per kilowatt hour with an ultimate cycle life capability of 1000 cycles at an energy efficiency in excess of 50%.

The present program is directed at demonstrating the necessary electrochemical performance characteristics for both electrodes to accomplish these desirable system performance goals in a fully developed battery package. During the past 18-month work period, particular emphasis has been placed on the advancement of the individual electrodes. Significant progress has been made toward achieving the iron electrode utilization goal of 0.5 A h/g at the four hour discharge rate. Preliminary scale-up experiments, to 400 cm^2 prototype size electrodes have demonstrated acceptable performance utilization characteristics. Progress on the development of a stable, high performance, bifunctional air electrode has encountered manufacturing process and production problems. Procedures are now being evaluated to optimize the processes necessary to form a stable, composite carbon based structure which will duplicate the excellent performance characteristics which were achieved in the past for 500 cycles on electrodes which were hand processed. The near term performance goals for the bifunctional air electrode, produced by methods which lend themself to high volume, low cost manufacturing methods, is a cathodic potential of −100 mV–*vs.*–Hg/HgO at 25 mA/cm^2 and −150 mV at 125 mA/cm^2 with cyclic stability for 300 cycles with an anodic potential of less than +500 mV at 12.5 mA/cm^2.

The cell life testing program in 100 cm^2 size cells continues to evaluate both state-of-the-art air and iron electrodes. Cycle life, with stable capacity, is exceeding 100 cycles with the air electrode being the performance limiting component of the cell. Cell design options continue to be evaluated along with the auxiliary systems necessary for air supply and electrolyte maintenance.

Continued development work is planned which emphasizes the bifunctional air electrode with respect to the manufacturing processes and procedures. The air electrode presents a technical problem in its transition from research electrodes to production-type structures which are of high quality. The production procedure must be further defined and optimized before prototype size battery modules and low voltage battery packs can be built to demonstrate the expected performance characteristics necessary to achieve the established system goals. Further basic studies as related to the composite,

carbon based air electrode structure are planned further to clarify and identify the means and methods for upgrading the performance and life of future electrodes.

Recent publications

1 E. S. Buzzelli, Iron–air battery development program — Interim report, June 1976 - June 1977, *Report No. COO/7949-1, November 1978.*
2 W. A. Bryant, C. T. Liu and E. S. Buzzelli, Iron–air battery characteristics, *28th Power Sources Symp., June 12 - 15, 1978, Atlantic City, NJ.*
3 E. S. Buzzelli, C. T. Liu and W. A. Bryant, Iron–air batteries for electric vehicles, *13th Intersoc. Energy Conversion Engineering Conf., August 20 - 25, 1978, San Diego, CA.*
4 C. T. Liu, Wet-proofing of air electrodes for use in alkaline electrolytes, *154th National Meeting Electrochem. Soc., Oct. 15 - 20, 1978, Pittsburgh, PA.*
5 E. S. Buzzelli, Iron–air batteries for electric vehicles, *154th National Meeting Electrochem. Soc., Oct, 15 - 20, 1978, Pittsburgh, PA.*
6 W. A. Bryant and G. D. Leap, Electrochemical half cell performance of sponge iron electrodes, *154th National Meeting Electrochem. Soc., Oct. 15 - 20, 1978, Pittsburgh, PA.*
7 E. S. Buzzelli and W. A. Bryant, Fe–Air, *Metal–Air Batteries Project Workshop, DOE, April 10 - 11, 1979, Washington, DC.*
8 E. S. Buzzelli, W. A. Bryant and C. T. Liu, Iron–air battery development, Interim Report, June 1977 - June 1978, draft in review.

REACTIVE METAL–AIR BATTERIES FOR AUTOMOTIVE PROPULSION

Continental Group Inc./Lockheed Palo Alto Research Lab., Lockheed Missiles & Space Co., Inc. (U.S.A.)

The objective of this 15-month contract is to develop potential battery systems for use in automotive propulsion application. The systems to be evaluated include the alkaline lithium–water–air and alkaline aluminum–water–air batteries. The lithium–water–air development program will result in the design, construction, and demonstration of a 500 cm^2 cell, followed by the construction of a six-cell power module. The aluminum–water–air assessment program will reveal critical system parameters through laboratory and subscale cell testing with subsequent design, construction, and evaluation of a 1000 cm^2 cell.

During fiscal year 1978 - 79 a program is being conducted to examine the operational characteristics and determine the technical feasibility of the lithium–water–air and aluminum–water–air battery systems as applied to automotive propulsion power sources. The effort is concentrated in three areas: (1) design, construction, and evaluation of a 500 cm^2 lithium–water–air cell with subsequent expansion to a six-cell module; (2) design, construction, and evaluation of the operational characteristics of a subscale (50 cm^2)