The cell will be tested in conjunction with an aluminum trihydroxide crystallizer with design specifications derived in 1979. A full scale cell with provisions for rapid anode addition will also be designed. Fundamental studies are planned concerning the effects of minor alloying agents on anode behavior. Subcontracts have been signed or are being planned for (1) development of full-scale single-cell hardware, (2) development of cost effective anode alloys, (3) development of air cathodes for use in aluminum–air cell development, (4) development of processes and components for on-board vehicle production of industrial grade aluminum trihydroxide, (5) economic and energy use studies, and (6) safety and environmental impact analysis.

Four major technical issues are: (1) development of a cost-effective air cathode capable of operating in an automotive environment; (2) development of a cost-effective anode capable of being produced in a single-step reduction process, using calcined battery reaction product as the feedstock; (3) development of a cell capable of rapid anode addition; (4) demonstration of on-board processes and components for production of industrial-grade aluminum trihydroxide.

Recent publications

1 J. F. Cooper and E. L. Littauer, Mechanically-rechargeable, metal–air batteries for automotive propulsion, *Proc. 13th Intersoc. Energy Conversion Engineering Conf., SAE, San Diego, CA, August 22, 1978. (Lawrence Livermore Lab. Rep. UCRL-81178.)*
2 J. F. Cooper and E. Behrin, General purpose aluminum–air/flywheel electric vehicles, *Univ. California, Lawrence Livermore Lab. Rep. UCRL-82003, November 1978.*
3 Aluminum–air battery for electric vehicles, *Energy and Technology Review*, Lawrence Livermore Laboratory, November 1978.
4 R. V. Homsy, Aluminum–air power-cell system design, *Univ. California, Lawrence Livermore Lab. Rep. UCRL-82497, August, 1979.*
5 J. F. Cooper, Control of battery electrolyte composition through precipitation of aluminum trihydroxide: feasibility study, *Univ. California, Lawrence Livermore Lab. Rep. August 1979.*

ASSESSMENT OF AIR CATHODES FOR METAL/AIR BATTERIES

Institute of Gas Technology, 3424 S. State Street, Chicago, IL 60616 (U.S.A.)

Emphasis to date has focused on zinc/air batteries using alkaline electrolytes; the major obstacles to this system's successful development have been: low cycle life at high depths of discharge, carbonate buildup in the electrolyte, zinc electrode cost, and greater tendency of Teflon-bonded electrodes to flood in alkaline than in acid electrolytes. Most of these problems can be eliminated if the battery is modified to an acid electrolyte system. Zinc electrodes are well-developed for acid electrolyte cells because of the development of metal/halogen batteries. As a result, the air electrode is the major problem limiting the development of acid electrolyte zinc/air batteries. The purpose of this literature study, therefore, was to evaluate the technical viability of air cathodes in acid electrolytes for application in secondary zinc/air batteries. This assessment was carried out in the following manner:

(1) Polarization data for oxygen reduction and evolution obtained on smooth electrodes were identified for candidate electrode materials in acid electrolyte. From this information, the exchange current density and Tafel slope were evaluated as a function of electrolyte pH and temperature.

(2) Data on oxygen electroreduction on porous electrodes were evaluated with emphasis being placed upon those studies which have eliminated electrode structural effects from the electrode kinetic measurements. These data, together with those obtained with smooth electrodes, were used to determine the relative effects of activation and concentration polarization on the total electrode polarization.

(3) Techniques for preparing high surface area supported metal catalysts were evaluated, together with improvements in electrode performance using various supported catalysts.

(4) The status of research on non-noble metal catalysts was reviewed for application to the proposed battery system.

(5) Data on the polarization curves of zinc electrodes were obtained from research on zinc/halogen batteries. These, together with air electrode data, were used to project polarization curves for zinc/air cells in acid electrolyte.

Because of the good agreement between data for smooth and diffusion electrodes, it was possible to calculate air electrode polarization curves. Using these data, the performance characteristics of the zinc/air acid electrolyte battery could be predicted. An electrochemical energy efficiency of 51% was projected at an operating current density of 35 mA/cm^2. There was no information on the stability of the air electrode in the weakly acidic electrolyte used in these cells. However, our evaluation indicated that long-term stability, particularly during charge, is the major technical issue to be addressed. The anode and separators are well-developed, and this will shorten the development time of the battery system. Experimental data are required to confirm our estimated cell performances and to determine the air electrode stability. However, we believe that this system should be competitive with other advanced battery systems and, in particular, compete with the metal/halogen system because oxidant storage is not required.

Recent publications

1 M. J. Powers, A. F. Sammells and K. F. Blurton, Assessment of air cathodes for metal/air batteries, *Final Report, Contract No. W-7405-ENG-48, Lawrence Livermore Laboratory, January, 1979.*

2 M. J. Powers, K. F. Blurton and A. F. Sammells, Evaluation of the zinc–air cell in acid electrolyte, *Paper presented at the Fall Meeting of the Electrochemical Society, Los Angeles, 1979.*