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THERMAL MANAGEMENT OF BATTERY SYSTEMS

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The objectives of this project are to determine heat generation rates, measure temperature distributions, analyze heat transfer rates, and evaluate thermal management strategies for Li/MS batteries.

- A high-temperature calorimeter was built for measuring cell heat generation. The operating ranges of temperature and heat flow are room temperature to 500 °C and 0 to 50 W, and the detection limit is 1 mW.
- A constant-temperature furnace was built for precise cell electromotive force (emf) and overpotential measurements. The temperature distribution in the test chamber varies less than 1 °C at temperatures up to 500 °C.
- The temperature distribution in a 2.5-kW h LiAl/FeS battery was measured under a variety of operating conditions.
- A forced-air cooling system was designed and tested; it provided 1.0 to 1.5 kW of cooling to a 2.5-kW h battery at an air flow of 750 scfh.
- Cell reversal adversely affected battery performance, as expected, but also created hot spots during operation.
- The temperature coefficient of emf of LiAl/FeS cells was measured. It is a complicated function of temperature, state of charge, and electrolyte composition.
- The rate of thermal energy generation was calculated from a thermodynamic equation. The results were in good agreement with the heat flow measured with the high-temperature calorimeter.

- The cell reaction of FeS to J-phase and J- to X-phase during discharge has been noted in calorimetric measurements for cells containing LiCl–KCl–LiF electrolyte.
- The effect of varying electrolyte composition on cell heat generation was investigated. For cells containing no potassium ion, in which the formation of J-phase is impossible, the endothermic effect associated with the J-to-X transition is not observed.

The primary objective for 1983 is to determine the rate of thermal energy generation by cells at various rates of discharge and operating temperatures. Emphasis of this third phase of the project will be placed on cells containing LiAl and Li_4Si negative electrodes and iron disulfide positive electrodes. The results obtained for all cells to date will be processed to yield intensive properties useful for general design purposes.

Recent publications

1 D. M. Chen, H. F. Gibbard, R. M. Hart and L. D. Hansen, Calorimetric measurements of LiAl/FeS batteries up to 450 °C, *36th Calorimetry Conference, Washington, DC, October 7, 1981.*

2 C. C. Chen, T. W. Olszanski and H. F. Gibbard, Thermal behavior of an experimental 2.5-kW h lithium/iron sulfide battery, *Electrochemical Society Fall Meeting, Denver, CO, October 11 - 16, 1981, Extended Abstract No. 48.*

3 H. F. Gibbard and D. M. Chen, Generation of thermal energy in high-temperature lithium/iron sulfide cells, *Electrochemical Society Fall Meeting, Denver, CO, October 11 - 16, 1981, Extended Abstract No. 49.*

4 H. F. Gibbard, D. M. Chen, C. C. Chen and T. W. Olszanski, Thermal properties of LiAl/FeS batteries, *16th Intsoc. Energy Conversion and Eng. Conf., August 9 - 14, 1981*, Am. Soc. Mech. Eng., Vol. I, Paper Number 819362.

5 L. D. Hansen, R. H. Hart, D. M. Chen and H. F. Gibbard, High-temperature battery calorimeter, *Rev. Sci. Instrum., 53* (1982) 45 - 48.

PHYSICAL CHEMISTRY OF MOLTEN SALT BATTERIES

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The objectives are to provide experimental measurements of composition profiles in porous LiAl electrodes and molten LiCl–KCl electrolytes and to provide experimental data useful for the optimal design and operation of Li/FeS batteries.

Current-induced composition gradients were produced by electrolysis of LiCl–KCl melt in Y_2O_3 matrices between 1.0-cm-diameter solid and porous Li/Al electrodes with 0.2- to 0.3-cm separation, current 200 mA