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BATTERY LITERATURE SEARCH

BIBLIOGRAPHY AND ABSTRACTS

July 1976

Volume I

Prepared by

The Boeing Company
P.O. Box 3999
Seattle, Washington 98124

For

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California 91103

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PREFACE

This comprehensive bibliography with abstracts, consisting of five volumes, was compiled to assist battery technologists to obtain information quickly on secondary aerospace battery cells and related technology. The subject index was extracted from The Battery Information Index prepared by the Battelle Memorial Institute, Columbus, Ohio, under Air Force Aero Propulsion Laboratory Contract No. AF33 (615)-3701. Index Citations B-1 through B-2189 (Vols. II through IV) were from the AFAPL sponsored work and includes references up to mid-1972. References TBC-3001 and on (Vol. V) were prepared by Boeing after reviewing computer searches from JPL's S.D.C. International Search Service, DDC, NTIS, Lockheed Information Retrieval Service, and Boeing Literature Search. References TBC-3301 and on cover the literature from 1972 to the end of 1975 and a few references prior to 1972 missed by the AFAPL work. Volume I consists of an extensive cross-referencing subject listing and an author index. An article covering several different subjects is referenced under each of the subject headings in the index. The index or author number refers to the referenced publications which are listed in a numerical sequence in Volumes II through V. Most citations contain an accession number which refers to the computer searches of the Defense Documentation Center, National Technical Information Service, etc. This number can be used to obtain a copy of the publication from the appropriate file source.

R. S. Bogner
Project Manager

ACKNOWLEDGEMENTS

This work was performed by D.D. Abbott and I.S. Mehdi, supervised by H. Ohman and approved by S.W. Silverman. JPL also wishes to acknowledge the cooperation of R. Marsh of AFAPL for supplying a large portion of the information used to compile this document.

CONTENTS

Contents of the Bibliography

A comprehensive bibliography of references has been compiled dealing with nickel-cadmium cells and related technology for aerospace applications. The bibliography consists of a list of approximately 2400 articles, papers, test reports, and books with abstracts. An extensive subject listing is provided with cross-referencing with an author index in D180-18849-2, (Volume I). Both the subject index and author index list numbers after the subject or name of author and these numbers refer to the accession lists of D180-18849-2, Volumes II through V. The citations are accompanied by abstracts in most cases and also numbers which refer to computer searches of Defense Documentation Center, NTIS, etc.

The subject index was extracted from the Battery Information Index prepared by The Battelle Memorial Institute, Columbus, Ohio, under Air Force Aero Propulsion Laboratory Contract No. AF33(615)-3701. The index is not limited to nickel-cadmium battery technology only, but encompasses all batteries. This index can be used in the future to develop a bibliography for other types of batteries also. To support this index the citations referred to also have been included in Volumes II, III, and IV. (B-1 through B-2189). This list includes most of the citations up to the middle of 1972. Volume V lists (TBC-3001 and on) all the citations from mid 1972 up till the first quarter of 1975 and also picks up a few of the items prior to 1972 not in the AFAPL Battery Information Index.

Most of the present effort was expended in getting the most recent citations. The effort began with review of computer searches from JPL's S.D.C. Internation Search Service, DDC, NTIS, Lockheed Information Retrieval Service, and Boeing Literature Search. Technical Journals were also scanned and articles selected from them.

User's Guide

The method for using the bibliography is as follows:

If literature regarding a particular subject is required, the subject index is entered and the subject heading found. There will be some numbers listed in the bibliography in Volumes II-V. Locate these numbers in the list of citations and obtain information regarding titles, authors and abstracts. For further related literature, other articles or reports by these authors can be looked up through the author index. An example of how to go about locating the literature for a particular subject follows.

EXAMPLE: Suppose we would like to get information on flight data for batteries used on the Mariner Spacecraft. We would look up "Flight Data Mariner Spacecraft". A copy of page 32 of the subject index is shown in Exhibit 1 and the subject of interest is circled. There are three citations - Nos. 670, 1803, and 3146 listed. Now, by going to the list of citations in Vol. II - V we can get the titles, author, and abstract information related to these numbers. Exhibits 2, 3, and 4 are copies of these pages.

EXHIBIT-1A

EXHIBIT 1

B-670. Charles W. Brooke, Jr., California Institute of Technology, Jet Propulsion Laboratory, "Development of an Electrochemical Energy Source for the Mariner II Spacecraft", NASA-CR-71772, JPL-TR-32-854 (March 15, 1966), Contract NAS 7-100. N66-22207. Abstract only.

The development of an electrochemical energy source for the Mariner II spacecraft is described. The data presented trace the development of this battery, beginning with the definition of the electrical and mechanical requirements for the battery and concluding with the telemetered data obtained from the battery during 109 days of spaceflight to Venus. The design changes resulting from the type approval test program on the development model battery and the additional changes dictated by the Mariner II spacecraft system requirements were combined in the final Ag-Zn battery design.

B-671. R. Lutwack and G. M. Arcand, California Institute of Technology, Jet Propulsion Laboratory, "Energy Storage", NASA-CR-64605, Space Programs Sum. No. 37-33, Vol. IV, pp 47-48 (June 30, 1965). N65-32420. Abstract only.

Progress is reported on the development of a separator for the Ag-Zn battery that will be capable of withstanding heat sterilization. Analysis of test results showed that the material prepared from the low-density polyethylene by precross-linking with electron beam irradiation to the 70-megarad level followed by grafting with acrylic acid should be considered for more extensive testing. Also, experimental results are given for the measurement of the effects of γ-radiation on the behavior of nickel and cadmium electrodes in alkali media. Irradiated Cd electrodes lose more capacity than comparison electrodes. Also, there seems little doubt that maximum loss occurs when the electrodes are cycled about the 75%-of-charge point. Further, the data show that more material is lost from the Cd than from the Ni.

B-672. Martin Sulkes, Yardney Electric Corporation, "Development of the Sealed Zinc-Silver Oxide Secondary Battery System", Report (1966). AD 635 776. Abstract only.

The reaction between Zn and O was investigated during overcharge and on stand. The electrolyte level and the type of separator used in cells were the most important factors in the reaction rate. Investigation of the AgO-Ag_2O hydrogen reaction showed that the rate increased with temperature potential, the addition of Pd to the Ag, and the mobility of the electrolyte. Sealed Ag-Zn cells may be overdischarged at the C/4 rate without developing excessive pressure. Electrochemically inactive or nondischargeable Zn reacts with the O generated during reversal. Physical, chemical, and electrical properties are presented for many separator and interseparator materials. Several inorganic separator materials were evaluated. Evaluation cycling and cycle life data were obtained for 244 sealed Ag-Zn cells.

B-673. R. S. Bogner, General Motors Corporation, "Heat-Sterilizable Silver-Zinc Battery Investigation", Final Report, NASA-CR-63597 (March 15, 1965), Jet Propulsion Laboratory Contract JPL 950364 under Prime Contract NAS 7-100. N65-27367. Abstract only.

B-1802

A. Caiola, H. Guy, and J.C. Sohm, Ecole Nationale Superieure d'Electrochimie et d'Electrometallurgie de Grenoble, "Prospects of Research in the Field of Storage Batteries", Entropie, (26), 57-65 (March-April 1969).

In an aprotic organic solvent, it is possible to use very reducing metals (e.g., lithium) in a secondary battery. The use of a metal oxide at the positive electrode is no more possible as it was the case in aqueous systems. A thermodynamic study shows the metal oxide can be replaced by a copper salt and it confirms the choice of lithium as negative electrode. A systematic study is done to select the solvents which are suitable; this study can be lead by some experimental rules about the length of the hydrocarbon chain, the function, the presence of cycles and so on. The experimental results exhibit that it is possible to make a rechargeable second kind lithium electrode. A screening study of different anions which form the lithium salts is carried out.

B-1803

Card 1/2

NASA Jet Propulsion Laboratory, "Space Programs Summary 37-61. Vol. 1, Flight Projects", November 1 to December 31, 1969 (January 31, 1970), NASA Contract NAS 7-100. N70-26079.

I. Mariner Mars 1969 Project
    A. Project Description and Status
    B. Guidance and Control
        1. Post-Encounter Performance of Mariner VI Spacecraft Battery
        2. Mariner Mars 1969 Power Subsystem
            a. Mariner VII Pre-Encounter Anomals
            b. Extended Mission Support

Table 1. Battery Testing Sequence
Figure 1. Mariner VI Battery Current and Voltage Versus Time Test Sequence
Figure 2. Mariner VI Battery Current, Voltage, and Temperature Versus Time for First Post-Encounter Maneuver
Figure 3. Mariner VI Battery Charge Current Versus Time After First Post-Encounter Maneuver
Figure 4. Mariner VI Battery Current, Voltage, and Temperature Verus Time for Second Post-Encounter Maneuver

The test was performed on 180 sealed cells. The test program demonstrated that temperature is the most important factor affecting cell behavior. Cell operation is good at minus 10 C and + 10 C at any d.o.d. considered, while at + 30 C operation is generally bad. With a few exceptions, cells undergoing the cycling still work after about 440 cycles.

TBC-3145

David A. Aikens and Howard Littman, Rensselaer Polytechnic Institute, "Electrochemical Power Sources," Final Technical Report ECOM-69-0063-F, September 18, 1968 to January 31, 1974, Contract DAAB07-69-C-0063 (September 1974).

The report summarizes research in the areas of electrodes and electrolytes and heat and mass transfer in porous media. Heats of solution were determined for alkali metal salts in nitrile solvents and the structure of electrolytes - nitrile solutions has been studied by Raman spectroscopy and conductance. Data on non-aqueous electrolytes has been compiled. Properties of reference electrodes and liquid junctions in propylene carbonate have been studied potentiometrically and the problem of uncompensated resistance has been studied by electrostatic methods. The effect of cycling on sealed Ni-Cd batteries has been studied. Liquid-gas distribution in porous media has been studied by modeling techniques and by gamma scattering. The coupling of thermal and mass transport with electrochemical processes at the three phase interface has been studied using a microelectrode, and theoretical studies of evaporation from thin films have been performed.

TBC-3146

R. S. Bogner, Jet Propulsion Laboratory, "Mariner Mars 1971 Battery Design, Test, and Flight Performance," Report No. NASA-CR-132986, (JPL-TM-33-591), Contract NAS 7-100 (April 15, 1973) p. 194.

The design, integration, fabrication, test results, and flight performance of the battery system for the Mariner Mars spacecraft launched in May 1971 are presented. The battery consists of 26 20-Ah hermetically sealed nickel-cadmium cells housed in a machined magnesium chassis. The battery package weighs 29.5enl kg and is unique in that the chassis also serves as part of the spacecraft structure. Active thermal control is accomplished by louvers mounted to the battery baseplate. Battery charge is accomplished by C/10 and C/30 constant current chargers. The switch from the high-rate to low-rate charge is automatic, based on terminal voltage. Additional control is possible by ground command or onboard computer. The performance data from the flight battery is compared to the data from various battery tests in the laboratory. Flight battery data was predictable based on ground test data.

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