LEAD INDUSTRIES ASSOCIATION

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Security Information

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SUBJECT: EIGHTH ANNUAL BATTERY RESEARCH AND DEVELOPMENT CONFERENCE

To Members of the Lead Industries Association:

The Power Sources Branch of the Signal Corps Engineering Laboratories at Fort Monmouth, New Jersey, annually sponsors a Battery Research and Development Conference to acquaint the battery industry with the progress of Signal Corps Battery Research and Development programs and to encourage cooperative interchange of information on batteries with the aim of producing a more rapid advancement of knowledge in the battery art.

The Association, as it has in the past, was invited to send a delegate to this Conference which was held on May 25 and 26, 1954, at Asbury Park, New Jersey. Reports on those papers of specific interest to the lead industry are attached.

We have been requested to caution you that this report is security information. It contains information effecting the national defense of the United States within the meaning of the espionage laws and the transmission or the revelation of its contents in any manner to unauthorized persons is prohibited by law.

Very truly yours,

Secretary

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EIGHTH ANNUAL BATTERY RESEARCH
AND DEVELOPMENT CONFERENCE
MAY 25-26, 1954

INTERNAL HEATERS FOR STORAGE BATTERIES

by
Carrol A. Peterson
Connecticut Hard Rubber Company

It is recognized that the output level of lead-acid storage batteries is considerably decreased under low-temperature conditions. External heating methods are inherently poor in thermal efficiency because of the low conductivity of the battery case, while this same property of the case materials favors the use of internal heating methods.

Investigations were carried out which led to the development of internal electric heating units for the BB-221/U free-electrolyte type battery. The heaters are immersed in the battery electrolyte and, in conjunction with an external control system, are arranged in a circuit which permits operation of either 115 volts AC or 28 volts DC. Heating of the battery contents from -65° F to +40° F is accomplished in approximately thirty minutes and is thermostatically controlled to prevent damage to the battery or heating units from overheating.

AC HEATING OF STORAGE BATTERIES

by
Marcel J. Racine
Power Sources Branch

Cold storage batteries can be heated using alternating current to temperatures at which they can satisfactorily accept a charge. An equipment was designed to superimpose a regulated AC source of power on a regulated DC charging current. This is accomplished by two parallel rectifiers connected in opposition, both being connected in series with the battery and the AC input transformer. The AC power source and DC charging current are automatically regulated according to the temperature of the battery. Starting with a cold battery, the AC current is applied until the temperature of the battery is high enough to accept a charge. Then this point is reached, the DC charging current is applied and increased as the temperature rises until the normal rate of charging current is reached. The AC current used for heating is decreased as the temperature of the battery rises.

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IMPROVED LEAD-ACID BATTERIES

by

J. F. Dittmann
Eagle-Picher Company

In studying methods of improving the lead-acid storage battery, consideration was given to the following general phases:

a. Grid material and design
b. Separator material and design
c. Case material and design
d. Oxide formulations
e. Element design

These phases were investigated systematically, first by accelerated laboratory tests and secondly by correlating results obtained by similar tests on actual battery assemblies.

An accelerated laboratory corrosion test on binary and tertiary lead alloys has revealed that antimony, arsenic and calcium increase corrosion while copper and tellurium decrease corrosion slightly and silver and tin reduce corrosion markedly. The corrosion resistance of alloys compounded by additions of tin, silver and tellurium to a base alloy of 6 percent antimony, .2 percent arsenic and .06 percent copper were investigated, and good correlation resulted from tests on batteries.

The abrasion resistance of various separator materials were determined and changes in electrical resistance of separators as a function of immersion time at 80°, 0° and -20° F., has been established, as well as electrical resistance values at 130°, 80°, 0°, -20° and -40° F.

Battery separators were found to have an effect on the formation of battery plates, positive and negative efficiencies, on-charge voltages, five-second voltages and battery life. It was found difficult to correlate these effects with data obtained from laboratory tests.

Various types of plastic, rubber and rubber-resin battery containers were evaluated as to their strength and ability to withstand thermal shock.

A study of element design has included investigations of various active material ratios, grid and separator thicknesses, number of plates per cell, and positive plate densities. Increasing the negative active material weight, reducing the positive plate density, and use of thin plates were found to be important in obtaining greater capacity at high rates and low temperatures of discharge.

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IMPROVED NICKEL CADMIUM BATTERIES

by
Paul Rappaport
Power Sources Branch

During the past year extensive studies of the electrical and physical characteristics of nickel-cadmium high rate thin sintered plate batteries have been continued by these Laboratories and by several contractors due to the ever-increasing consideration of this system by the military for guided missile power supplies and low temperature cranking batteries. Some of the more important results obtained in evaluating the following characteristics will be discussed:

a. Performance characteristics at discharge current densities from .075 to 1.40 amperes per square inch and from 80 to -40° F.

b. Effect of charging at -40° F.

c. Maintenance of negative plate capacity during cycling by use of electrolyte additives, separator materials and charging rates.

These investigations will be continued in the future in order to obtain as complete a picture as possible of the nickel cadmium high rate thin sintered plate battery. Contracts have also been issued to study means of effecting improvements and simplifications in the design and preparation of the nickel cadmium battery in order to reduce its cost of manufacture without a sacrifice in performance.

THE BATTERY INDUSTRIAL PREPAREDNESS PROGRAM

by
Charles H. Clark
Power Sources Branch

The Battery Industrial Preparedness Program has been initiated in order to establish pilot and/or semi-production scale assembly lines in battery plants for cells and batteries. These lines are to incorporate improved cell manufacturing techniques that have been developed as a result of internal and external research and development programs initiated by the Signal Corps.

Since the 1953 Battery Conference, Industrial Preparedness Study contracts have been placed with six dry battery companies for the establishment of pilot lines for the manufacture of paper-lined cells, utilizing cell compositions specified by SCEL. Cells made in this manner will subsequently be incorporated into the manufacture of Battery BA-270/U-IPL. Four IPS contracts have been initiated pertaining to low temperature dry cells and batteries. SCEL cell formulations have been recommended for the low temperature battery types. It is expected that batteries from these pilot lines will become available by Fall 1954.

Contracts have also been initiated for the setting up of pilot lines for the manufacture of certain alkaline primary cell types; a miniature size for possible transistor or "B" supply use and a larger "D" size cell for possible high rate use. Investigative work has not yet been started on these contracts.

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ZINC-SILVER OXIDE SYSTEM

by
J. S. Bone
Eagle-Picher Company

The objective of this project is to improve the general performance characteristics of the silver oxide-zinc system. This has encompassed studies of the zinc plating bath, evaluation of separator materials, development of secondary cells and the design of special batteries.

It has been found that by increasing the concentration of KOH in the zinc plating bath, a deposit of zinc is obtained that will withstand high temperatures better than those previously produced. Also, placing a non-cellulosic material between the positive plate and the cellulose sausage casing has been found to increase shelf life.

Rechargeable "A" cells have been developed through a study of separator materials and charging procedures. Secondary 30 volt "B" batteries have proven practical when the activating manifold is excluded. At the same time, exclusion of the manifold has made possible the development of various activating mechanisms.

A special 12 volt battery has been developed for a 24 hour drain. The battery is designed to be activated automatically by shock forces. A 6.5 volt battery has been designed to operate while spinning about its perpendicular axis at speeds up to 7,000 r.p.m.

Future work will continue in these same fields of investigation with emphasis being placed upon improving the characteristics of rechargeable (secondary) batteries; extending the shelf life of activated (reserve and non-reserve) batteries; and evaluation and perfection of automatic activating devices.

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NICKEL-CADMIUM SYSTEM

by

Dr. L. Grant Hector
Sonotone Corporation

The purpose of this contract is the improvement of the high rate discharge characteristics of the nickel-cadmium system so that the capacity at the one minute rate approaches as closely as possible the capacity at the one hour rate; the improvement of charge retention of the system under conditions of storage at various temperatures; and the development and design of a readily activated reserve type battery using the nickel-cadmium system.

The data reported last year on cells of approximately 3 ampere hour capacity, which included discharges at -40° F and 10 amperes, have been extended to cover both -40° F and -65° F at 10 and 20 amperes. In addition to this, an extensive test program is described for investigating the effect of several factors on high rate performance in which variations due to unavoidable or unknown differences in processing are minimized. These factors, whose effects are being studied, are plate thickness, separator thickness, plate compression, introduction of greater than normal amounts of active material, and grid (metallic plate reinforcement) conductivity. Some preliminary test data are presented and discussed.

The determination of the charge retention characteristics of the nickel-cadmium system has extended over periods of a year in casual storage and over lesser periods at elevated temperatures up to 165° F. In addition, the effects of separators and additives on these characteristics are being systematically investigated.

The data at hand show that the system is fundamentally capable of retaining a high fraction of its charge over long periods of time up to and including a year. Permanent capacity reductions have not been noted following storage with charge.

Reserve type cells have been constructed by drying completed cells, washing and drying completed cells, and by assembling cells with plates which have been precharged, processed and dried.

No loss of charge due to washing and drying was observed for positive plates when handled separately from the negative plate as compared with no loss due to washing and 20 percent loss due to drying when performed on cells. The 25 percent loss of charge for the negative plate due to washing as a cell was eliminated, when the negative plate was washed separately. The 15 percent loss of charge of the negative plate due to drying was not eliminated when the plates were dried separately.

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NUCLEAR BATTERIES

by
Alexander Thomas
Tracerlab, Inc.

Low cost radioactive isotopes are becoming available in ever-increasing quantities from the growing atomic energy installations in this country. Because of the electrical nature of radioactive disintegration, one of the uses for certain of these isotopes is in primary cells to generate small amounts of electrical power. In a battery of these cells, the rate of generation of electrical energy is governed by this radioactive process and not be anything man does in utilizing the power by placing an external load across the battery. This particular feature of the radiodisintegration process suggests the prime merit for the nuclear battery is that of being a long lived power source. At the present time, because of the supply and cost of the suitable isotopes, power generation is limited to applications requiring about a microwatt or less. It is not likely that the order of watts of power by this method will be economically feasible for many years to come. However, as a power supply for an ion chamber, for charging quartz fibre devices, or for maintaining a charge on a low leakage condenser for a one-shot trigger of some military control device or perhaps a civilian warning device, these nuclear batteries show immediate promise for application. With continued decrease in cost and increased availability of the isotopes, hearing-aid-like devices come into the realm of possibility.

Practical models utilizing all the known principles for converting the energy of radioactive disintegration into electrical energy have efficiencies of a few percent or less. One of the most promising of these is the utilization of the contact potential difference (CPD) between the surfaces of plates of dissimilar metals to collect ionization produced in the radioactive medium between the plates. Experimental demonstrations of this type of battery were described by Mr. J. B. Kramer in the Electrician for October 31, 1924, using naturally occurring radioactive substances.

Our first year's work involved explaining the mechanism of the CPD type of battery, deriving theoretical expressions for the current-voltage characteristics and a preliminary experimental verification of this theory.

The experimental program has had a twofold direction; first, finding a stable couple having a high CPD; and second, the construction of practical models according to the general Signal Corps requirements. Measurements taken on these models have served to establish confidence in the correctness of the theoretical relations so that the effect on the current voltage characteristics of gas pressure, plate separation, plate area, and amount of activity are predictable and can be used in optimizing the design for any specific application. Variations in materials and structure of these models have pointed up the importance of isolating adjacent cells and of using low leakage insulators with low susceptibility to ingassing.

Although practical models have been made, there is room for further improvements in electrode surfaces and in construction materials. An accelerated testing to simulate the conditions to which the electrodes and insulators are subjected in fifteen years will be used to establish the best battery components.

CPD type batteries using solid instead of gaseous ionization media will be investigated. Investigation of secondary processes such as a radioactive electret or electrolyte production by radiodecomposition are also contemplated.

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NUCLEAR BATTERIES

by
Dr. John H. Coleman
Radiation Research Corporation

Purpose: To investigate the utilization of radioactive energy as a direct source of electrical energy for use as a portable battery having at least a 15 year operating life and an operating temperature of 160° F to -65° F.

History: It was found that good insulators under continuous beta radiation first decrease in resistance, reach a minimum, and then increase in value. A battery was constructed and demonstrated after a satisfactory accelerated life test on one insulator.

Experimental Work: Studies were continued on the induced resistance effect and radiation degradation in accelerated life tests. Resistance-temperature tests on activation energies of insulators under radiation indicated a correlation between trap distribution and the induced resistance effect.

Experiments indicated the radioactive battery had application as an electric field source in an electrostatic induction generator since only a high potential and no current is required. Such a battery requires only microcuries of isotope, however, to attain a high output potential, it is necessary to first irradiate the battery insulator with a separate high radiation field to increase the resistance sufficiently.

A tritium-zirconium source, which has a significantly lower toxicity than strontium 90, was fabricated. Tests on these sources in a demountable vacuum battery indicated carbon to be the most satisfactory material as a collector. Several demountable batteries were constructed with an efficiency exceeding 1/4 micromicroamp output current per millicure of tritium at 300 to 1000 volts with a total current of 10 micromicroamps.

Future Plans: a. Continue induced resistance studies to (1) establish accelerated life tests and (2) fabricate solid insulators for tritium batteries.

b. Construct 10 micromicroamp vacuum tritium battery using information from demountable battery.

c. Fabricate source for 1000 micromicroamp tritium battery.