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PERFORMANCE CHARACTERISTICS OF ALKALINE ZINC-ORGANIC BATTERY

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ABSTRACT

The present work relates to the investigations on zinc-organic cell wherein alkaline solutions are used as the electrolyte. The effect of concentration of the electrolyte, temperature and the discharge rates on the voltage-current and voltage-time characteristics of the cell, have been studied and the data are presented in the paper. The important features of the cell system are fairly flat voltage-time characteristics at different current drains and high energy density in comparison to the cells using certain inorganic depolarisers.

INTRODUCTION

Since late fifties, extensive investigations were carried out by Glicksman, Morehouse [1-2] and Losier [3] on a series of organic materials as cathodic depolarisers for use in batteries. Among them, nitro, nitroso and chloro compounds are of greater importance. On the basis of these studies magnesium-m-dinitrobenzene cell and magnesium-hexa chloro melamine cell drew greater attention. The authors have also reported earlier the results of their study on magnesium-m-dinitrobenzene cells of different capacities [4].

The importance of the use of organic depolariser materials in batteries lies in their high energy density capacity in comparison to those of inorganic depolariser materials. While inorganic materials normally deliver 1 to 2 electron transfer per gram mole of materials, organic depolariser materials are capable of delivering 4 to 12 electron transfer per gram mole of the material upto nearly 100% theoretical efficiency. Another important aspect of organic batteries is the constancy of their discharge voltages. Many of the organic batteries operate within a very narrow cell voltage range for 60% of their energy drain. In view of these attractive features of organic batteries, the authors felt it desirable to explore organic battery system in conjunction with zinc anode in place of conventional magnesium anode. Since zinc operates very well in alkaline electrolytes, it is felt useful to study an alkaline zinc-organic battery. Hence investigations were carried out on zinc-m-dinitrobenzene alkaline cell system and the results of these studies are reported in this paper.

EXPERIMENTAL

Zinc anodes were made by cutting out zinc plates of commercial grade into 4 × 2.5 cm size. These electrodes were soldered to copper wires which acted as current lead. The soldered point as well as the portion of the wire which remained submerged in the electrolyte was coated with quick-fix or other non-conducting plastic material. m-Dinitrobenzene cathode was made by pressing a mixture of organic material, a binder and acetylene black over nickel plated mesh. The electrodes were wrapped in cellophane paper. Cells were made by placing one organic cathode plate between two zinc anodes of same size.

The electrode packs were loosely wound by nylon thread and placed in suitable size plastic container and the cells were activated with definite volume of sodium hydroxide solution of different concentrations as per the nature of the experiments.

RESULTS AND DISCUSSION

The cells were discharged at 50 mA current at room temperature (30° ± 1° C) using 5%, 10%, 15%, 20% concentrations of NaOH solutions and the discharge characteristics of the same are presented in figure 1. It may be noted from this figure that the

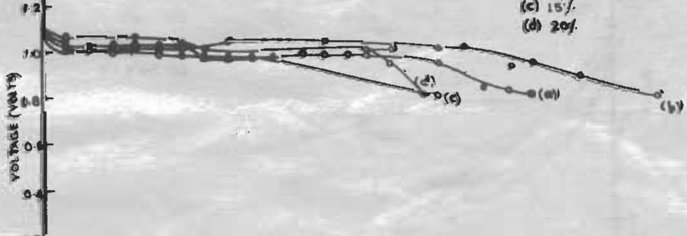

Fig. 1 : Voltage vs. Time Curve

best discharge performance of the cells is obtained in 10% NaOH solution. High concentrations reduce the cell capacity. Figure 2 also depicts the voltage vs time curves, at different current drains. In these studies 10% NaOH solution has been used in all the cells. The cells are discharged at room temperature at 50 mA, 100 mA, 150 mA and 200 mA current drain. Figure 2 indicates that

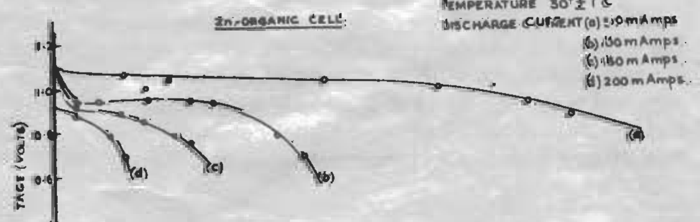

Fig. 2 : Voltage vs. Time Curve

capacity of cells regularly falls with the increase in the rates of discharge at same cut off voltage. For instance, cells discharged at 50 and 100 mA show 25 hour and 10 hour discharge capacity. This may be due to large polarisation with the increase of discharge current. In figure 3, the effect of variation of NaOH

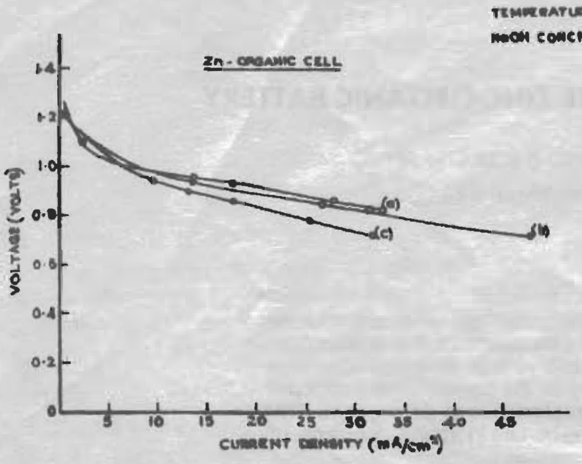

Fig. 3 : Voltage vs. Current Density Curve

concentration on voltage vs discharge current is shown. From the figure 3, it is evident that the cell discharged in 10% NaOH concentration shows least polarisation. The deterioration in discharge characteristics becomes more significant at 20% NaOH concentration. The effect of temperature on voltage vs current characteristics of the cell system containing 10% NaOH solution is presented in figure 4. It may be noted that at low current

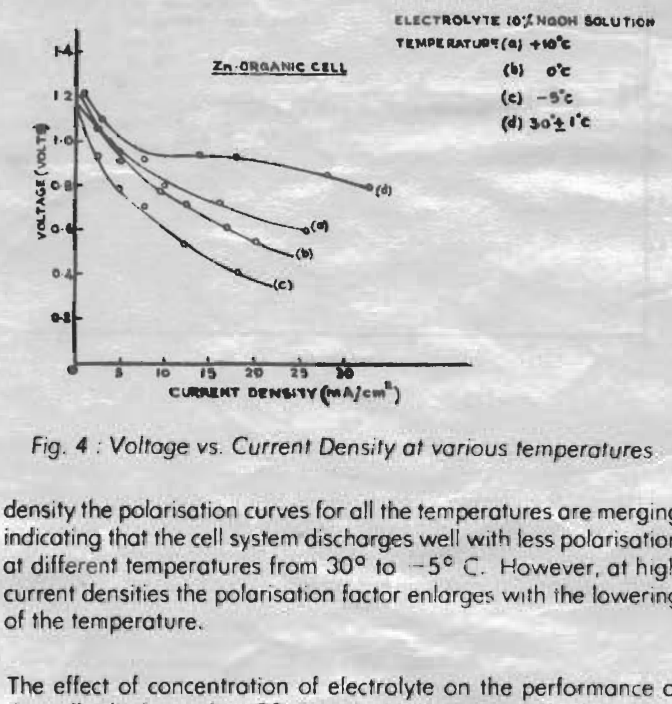

Fig. 4 : Voltage vs. Current Density at various temperatures

density the polarisation curves for all the temperatures are merging indicating that the cell system discharges well with less polarisation at different temperatures from 30° to −5° C. However, at high current densities the polarisation factor enlarges with the lowering of the temperature.

The effect of concentration of electrolyte on the performance of the cells discharged at 0° C is depicted in figure 5. It may be observed from this figure that at low temperature (0°C) 15% concentration of NaOH shows a higher potential current plateau than 10% or 20% NaOH concentration curve.

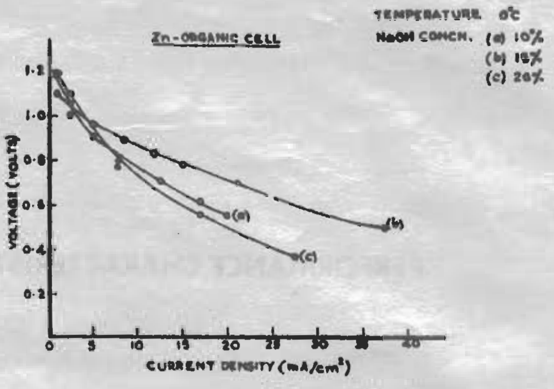

Fig. 5 : Voltage vs. Current Density

In figure 6, voltage versus current polarisation curves obtained at

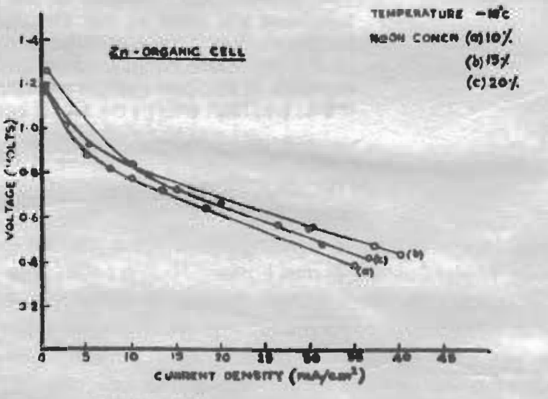

Fig. 6 : Voltage vs. Current Density

−10° C for the cells containing different concentrations of NaOH solution (10%, 15%, 20%) are presented.

All the curves are almost identical in nature although the curve corresponding to 15% NaOH is showing comparatively lesser polarisation.

CONCLUSION

The present investigation establishes the fact that zinc organic cell making use of alkaline electrolyte is a good battery capable of operating in the voltage range of 1.1 V to 0.9 V. Because of the low cost and high energy density, this cell system may find applications in some of the electronic equipment.

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