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Low temperature investigations on magnesium-organic cell

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The need for high energy density and low cost reserve power source has led to the development of various magnesium reserve batteries like Mg-MnO_2, Mg-HgO, Mg-CuO and Mg-m-dinitrobenezene (m-DNB). Among these Mg-m-DNB cell system was found to be superior because of its high coulombic capacity per unit weight, constancy of the voltage, easy availibility and low cost. In the present paper, the effect of temperature and current density on the performance characteristics of 20 Ah cell have been studied and the internal resistance of the cell at different temperatures ranging from 303 to 253K was calculated.

Key words: Magnesium-organic cell, reserve batteries, internal resistance

INTRODUCTION

There is an increasing requirement for high energy, low cost power source for continuous operation. Magnesium organic cell meets this demand [1].

EXFERIMENTAL

Magnesium-organic cells of 20 Ah capacity were fabricated as described earlier [2] and the low temperature experiments were carried out using Colora thermostat.

RESULTS AND DISCUSSION

Capacity at different temperatures

To evaluate the capacity of the cells at different temperatures, the cells are discharged at 300 mA from 303 to 253K and the data are plotted in Fig. 1. It may be noted from the figure that the cells give their full capacity 20 Ah at 303K. As the temperature is lowered there is a corresponding decrease in capacity. The reduction in capacity is observed with the lowering of temperature from 303 to 253K. The capacity falls sharply as the temperature is decreased from 303 to 293K but below 293K the capacity decrease is not sharp.

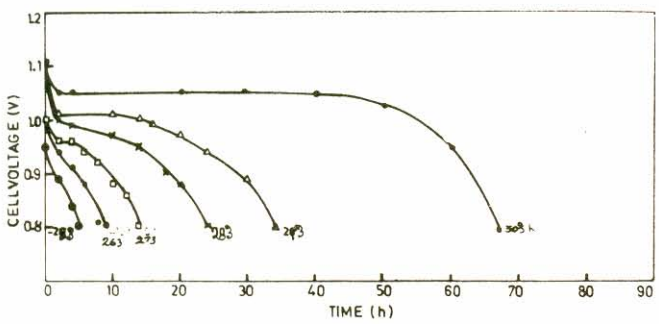

Fig. 1: Variation of cell voltage with duration at different temperatures

Voltage vs current characteristics at different temperatures

Voltage vs current data obtained with a time interval of 30 seconds at different temperatures from 303 to 253K is shown in Fig. 2. The linearity of the curve indicates that the polarisation is ohmic in nature. From the figure we learn that the slope value of the voltage-current curves is low in the temperature range of 303 to 283K, whereas it is high from 273 to 253K. This shows that when the cell is discharged at sub zero temperature, the cell polarisation is more pronounced resulting in higher internal resistance.

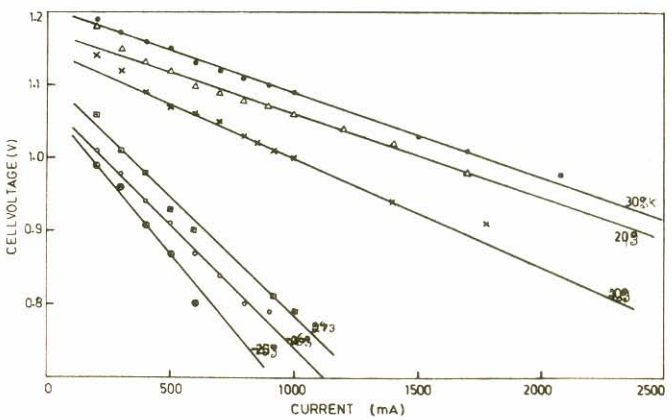

Fig. 2: Variation of cell voltage with current at different temperatures

Effect of current density on capacity at low temperatures

Cells of 20 Ah capacity were subjected to different current drains viz. 1.25, 0.833 and 0.416 $mA.cm^{-2}$ at 273, 263 and 253K. The capacity obtained at different temperatures and current densities is shown in Fig. 3. The cell capacity

depends both on the temperature of operation and the current density employed.

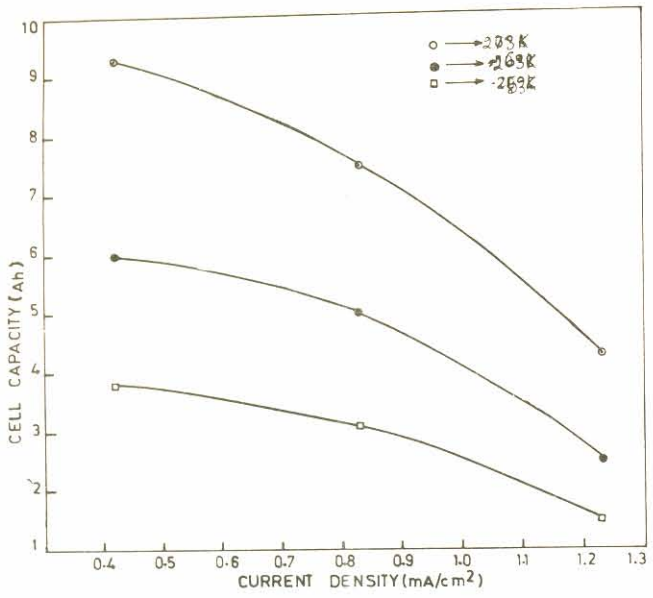

Fig. 3: Variation of cell capacity with current density at sub-zero temperatures

Temperature coefficient of resistance of cells

Figure 4 represents the variation of internal resistance with temperature. The slope of the curve gives the temperature coefficient of the internal resistance of the cells. The value of the slope of the linear portion of the curve in the temperature range 253 to 263K is found to be 0.019 ohms/K. The slope value decreases to 0.006 ohms/K when the temperature is increased from 263 to 283K. From the temperature coefficient value, it is possible to predict the fall in the cell voltage of this particular design cell when discharged at a given temperature and current drain.

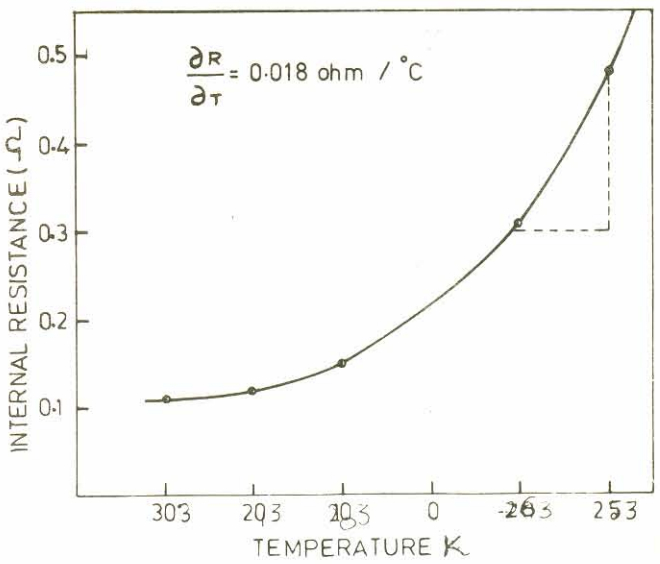

Fig. 4: Variation of internal resistance at different temperatures

CONCLUSION

It may be concluded from the data obtained that this cell system is well suited for low drain continuous operation for long duration.

REFERENCES

1. R Glicksman and C K Morehouse, *J Electrochem Soc*, **105** (1958) 299; **106** (1959) 288; **107** (1960) 717
2. D P Bhatt, N Muniyandi, R Balasubramanian and P B Mathur, *Bull Electrochem*, **2** (1986) 27