CORRESPONDENCE

Readers may have noticed that we now have a correspondence column. Letters (less than 500 words) on matters concerned with science are invited for consideration for publication. We also intend to publish correspondence on scientific matters, not limited to those arising from an article published in Current Science.

—Editor

Premature failure in Ni–Cd batteries

Large numbers of rechargeable sealed nickel–cadmium batteries are in use all over the world. The rechargeable cells cost almost ten times as much as dry cells but are cheaper in the long run: even with a minimum of 20 recharges, the extra cost is recovered. Usually one can expect 50 or more recharges, although the capacity gradually decreases until it becomes uneconomical (usually after 100 recharges). In a well-sealed cell this loss of capacity is slow. I have some cells bought twenty years ago and used heavily, but still serviceable.

Unfortunately the ordinary user complains frequently of cells failing early. One common cause is leakage of electrolyte due to poor sealing. But frequently there is failure for no apparent reason. The cell shows zero volts and fails to charge. I tried heating to revive one such cell but to no effect. But when ten times the recommended charging current (equal to one hour charge rate) was passed, the cell regained charge. The dead cell usually shows full 1.25 volts after a minute or two of high-density charge. The full capacity is regained after putting it on normal charge.

After a study of several cells during the last fourteen years I found that such failures tend to occur towards the end of a deep discharge. Resistance measurement shows that the cell electrodes are shorted. One possible reason is the growth of dendrites or whiskers of cadmium metal crystals resulting in bridging of the electrodes. I think the large charging current melts the thin dendrite and removes the short. Cutting open such shorted cells and examining the electrode surface with a microscope may confirm this.

Some manufacturers are reported to be incorporating dendrite-inhibiting chemicals. But I have found premature failure in almost all makes and sizes of cells. Out of nearly 100 cells I have used, of various makes, about 60 failed and were revived, some two or three times during their life. Ultimately such cells fail to reactivate. I am writing this hoping that some research laboratory would take up the idea.

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A comment on the above:

The failure process of a sealed Ni–Cd battery is often a complex sequence of chemical and physical changes in the positive and negative electrodes, electrolyte or separator. Under normal conditions of design, fabrication and operation, sealed cells give 1000–2000 cycles (10–20 years of calendar life) in the wet condition, with deep discharge between the cycles. Unexpected failures can arise from inappropriate charging conditions (temperature, rate, amount of overcharge and mode of charging), cell reversal, or development of internal shorts. Irreversible failures can arise from either internal short or loss of electrolyte only.

For a sealed cell, the use of ten times the normal charging rate is always *dangerous* for the following reasons:

(i) Since the state of charge of the electrodes is not known, there is a possibility that all the current is used for gas evolution, causing pressure build-up, and, eventually, explosion due to gas generation in excess of the recombination rate (especially if the safety valve is not working or is absent).

(ii) Since the internal resistance of the cell is very high (as a result of failure in some cases) the Joule heating (I^2R) can increase the temperature of the cell, and this is catastrophic in combination with (i).

(iii) If the failure is due to electrolyte starvation, charging at higher rate can only worsen the condition.

(iv) Most of today's high-quality sealed Ni–Cd cells have ceramic-to-metal or combination glass/ceramic-to-metal seals. They work for more than ten years under normal charging conditions but can fail owing to stress-cracking under over-pressure.

In fact, for most of these cells, users are warned never to exceed the normally recommended charging rate for fear of explosion. There are separate designs for fast charging (3 *C* to 5 *C*) and superfast charging (5 *C* to 20 *C*) of sealed Ni–Cd cells, with devices to monitor pressure and temperature.

The failure of cadmium electrodes due to dendrite growth is only one reason for shorting and this problem has been successfully solved by employing several additives.

Articles that deal with failure modes of sealed Ni–Cd cells:

1. Gross, S., *Energy Convers.*, 1971, **11**, 39.
2. Durgaprasad, M., *Application of electrochemical kinetics to predict the failure modes of Ni–Cd cells*, Ph.D. thesis, Indian Institute of Science, Bangalore, 1984.
3. Salkind, A. J. and Duddy, J. C., *J. Electrochem. Soc.*, 1962, **109**, 360.

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The Battery Society of India has announced a 68-page publication from the Cadmium Association which contains the texts (and brief reports on discussions) of the thirteen papers presented at a seminar in Paris in April 1988. The seminar reviewed the features of performance of the main types of Ni–Cd batteries, currently available; applications in industry, railways, aircraft and automatic guided vehicles; photovoltaic applications; emergency lighting; small consumer batteries and battery-powered equipment; research and technological developments; and recycling. The publication is available (Rs. 300) from The Battery Society of India, No. 7 Shopping Centre, Block B-6, Safdarjung Enclave, New Delhi 110 029.

—Editor

Publishing codes

This has reference to the article 'A rapid technique for obtaining leaf prints for stomatal count with Fevicol' (*Curr. Sci.* **58**, 640–641, 1989) by K. A. Nayeem and D. G. Dalvi. I would like to bring it to your notice that imprinting by Fevicol was published from my research laboratory in 1969. I am citing the complete reference list of our papers on such techniques.

1. Inamdar, J. A. and Patel, R. C., *J. Microsc.*, 1969, **90**, 269.
2. Inamdar, J. A., Patel, R. C. and Bhatt, D. C., *Z. Wiss. Mikrosk. & Mikrosk. Tech.*, 1970, **70**, 140.
3. Bhat, R. B., Gangadhara, M., Bhatt, D. C. and Inamdar, J. A., *Curr. Sci.*, 1976, **45**, 344.
4. Inamdar, J. A., Gangadhara, M. and Bhat, R. B., *Microsc. Acta*, 1976, **78**, 39.

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We recognize the seriousness of the problem pointed out in this letter. We are tightening editorial procedures and also requesting reviewers to guard against publication of reports purporting to describe new work but actually only rehashing old ideas. Unfortunately in certain cases it seems it is rather difficult to detect such instances. One hopes authors themselves become more responsible.

—Editor

Dr S. Kanjlal, Department of Geology, Banaras Hindu University, Varanasi, has asked for details of S&T cooperation between India and Japan. The information may be obtained from the Indo–Japan Study Committee, Planning Commission, Yojana Bhavan, New Delhi 110 001.

—Editor