

Book review

Batteries for electric vehicles

by D.A.J. Rand, R. Woods and R.M. Dell, Research Studies Press Ltd., Taunton, UK, ISBN 0 86380 2052.

This is an excellent book, well structured and clearly written. The authors set out to provide an up-to-date review of batteries for electric vehicles, and they accomplish this aim admirably. There is no material that is surplus to the requirements of the central theme and it is a relief to find a technical text from which errors have been carefully purged.

The reader is presented with a balanced view of the issues bearing on the choice of batteries for electric vehicles and is drawn through the carefully structured review to the conclusion that “the day of the electric vehicle (EV) is dawning, but much remains to be done before a pure battery vehicle, or perhaps a battery hybrid vehicle, becomes the major mode of personal transportation”.

The book opens with a comprehensive review of battery powered vehicles.

The great variety of vehicles that have been built over the past 100 years is described; from the early horseless carriages to the present-day automatic-guided vehicle, the EV1 and the Lunar Rover. There is a wealth of information about the motivation for the development of EVs at different stages and over a hundred photographs of different products. The initial review concludes that the key to the future development of electric cars is a better battery—one that weighs less, lasts longer, can be recharged more rapidly and costs less than present batteries. In chapter two, there is a valuable grounding in electrochemical energy storage theory, carefully and clearly presented, spelling out terminology that is often confusing elsewhere—for example, relating to positive and negative electrodes. A discussion of thermal issues here is also very useful.

The third and fourth chapters provide thorough treatments of the performance criteria for EV batteries in terms of the needs of the vehicle in order to achieve prescribed driving performance. The derivation of such parameters and the description of the laboratory testing of EV batteries are also covered. Here, we see a clear history of the

development of the several simulated driving cycles with their several merits and shortcomings and the manner in which they are used to provide useful comparative information about batteries and other components.

The principal types of battery that are candidates for use in the EV are dealt with in the next five chapters—with that devoted to lead-acid (chapter 5) occupying more space than any other. This is doubtless because the valve regulated lead acid (VRLA) system is the bench mark battery against which all other EV candidate energy storage systems are judged. As the authors point out, the advantages of the VRLA battery are: (i) the highest cell voltage of all battery systems using aqueous electrolyte; (ii) the ability to supply both high and low currents over a comparatively wide range of temperature; (iii) a high degree of reversibility with a satisfactory energy efficiency (> 80%); an acceptable charge retention during inoperative periods in a charged condition; (v) a low cost compared with other secondary batteries; (vi) established manufacturing and recycling facilities. The major disadvantage is a modest specific energy, although this has been, to some degree, offset by the recently recognized possibility of recharging the battery in a short time. The authors provide here a good general description of the principles of operation of the battery followed by a discussion of issues that influence capacity, self-discharge and charging procedures together with a valuable account of the characteristics that distinguish the VRLA battery from its flooded predecessor and the subtle balance of hydrogen evolution at the negative plate with grid corrosion at the positive. There is a well-illustrated description of the manufacturing processes where the reader is introduced to the pernicious nature of α PbO in the flash drying process. A valuable section on advanced designs of lead acid battery is most instructive, particularly as applicable to the neoteric valve regulated technology.

The important features of the prime alkaline electrolyte candidate batteries are provided in chapter 6. Nickel/iron, nickel/cadmium, nickel/zinc, zinc/air and nickel/metal hydride all have strong claims, but each is frustrated from a perfect match with the required specification by a different element of their performance parameter set. However,

in most cases, there seems to be some prospect of overcoming the difficulties. Nickel/zinc and nickel/metal hydride, together with mechanically rechargeable zinc/air batteries, are seen to be promising. In the case of metal/air systems, the importance of overall resource-to-wheels energy conversion efficiency is rightly emphasized.

Chapter 7 is devoted to bipolar batteries that store active materials external to the cell stack. These include acid electrolyte zinc systems and the so-called redox batteries. These seem to be assessed rather less critically than are the batteries described in earlier chapters.

Despite the need to operate at high temperatures and the apparent safety hazard, sodium batteries, as described in chapter 8, have been developed into realistic candidates for electric vehicle energy storage systems. Generic aspects, such as the sodium electrode and the beta alumina electrolyte, are dealt with first and then the two separate types of sodium battery: the sodium/sulphur and the 'zebra' battery are described in some detail. There is much useful information about the development of the two systems, their current status and their respective prospects for ultimate acceptance. It is intriguing that a mixture of American and English spellings (sulfur and aluminium) has been adopted here.

Chapter 9 deals with all lithium batteries. The different types include: those that have liquid organic electrolytes and operate close to room temperature; those that have polymeric electrolytes and operate at a up to 100°C; and those that have molten salts and operate at even higher temperatures. A short section on primary batteries provides a useful introduction. The technical problems and issues of the several different types are all reviewed and sound conclusions drawn.

The final chapter consists of a considered forecast of the future for electric vehicles. This most difficult of tasks is undertaken by considering the technical state of the art and then the extraneous factors, such as infrastructure and the influence of the various stake holders on the development of the market. A cautiously optimistic scenario is foreseen.

In conclusion, the book is founded on a detailed historical perspective, is well referenced and has clear and carefully prepared illustrations. It should be no surprise that these three distinguished authors should produce such a valuable work.

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