

- Freeze-thaw problem
- Safety under EV mechanical environment.

2.3 Conclusions re Molten Salt Systems

1. Life cycling data is sketchy
 - British Railroad 6 cell 250 Whr unit gave 1000 cycles.
 - (a) R. J. Banes & D. A. Teagle - Experimental Study of Six Interconnected Na-S cells, *J. Power Sources* 3, 45 (1978).
2. Cell and component evaluations are still being actively pursued but few batteries have ever been assembled and/or tested.
3. First Molten Salt application will be '83 BEST facility test of 2.5 M Whr. Na-S battery. Chloride will be testing a Na/S battery in a van in '79.
4. Reliability in β alumina tubes is a continuing problem.
5. System does not appear suitable for consumer EV usage since safety is still of major concern.
 - Cell balancing by overcharge is not feasible due to the inability to overcharge without permanent damage to cell.
7. Thermal shock problems remain unresolved as to how to survive start up after freezing in large Na-S cells.
8. Seal reliability continues to require study and further improvement.
9. Basic material costs do not look too excessive with Na @ 41¢/lb but substantial capital investment will be required to minimize costs.
10. β alumina cost reduction will only be achieved as a consequence of the development of a load leveling or other large market demand.
11. Power density of molten salt cells is not attractive. Present prediction is that power/Wt and cycle life cannot be mutually achieved; NaS has better capability than Li(Al)/E 5.

11.
 - Na/S requires substantial paralleling of cells.
 - Li/FeS can multiple plate cells thus reducing need for paralleling.
12. Molten Salt
 - Systems will not be developed to permit "battery" evaluation to be completed by 1981 on a single design concept.

2.4 Nickel Iron Battery System

Appendix C contains the technical analysis and data on this system. As indicated, non proprietary data is limited but additional comments are warranted.

NiFe

- Best nickel iron cells in Europe are Daug (German) cells but little data are available although tests have been underway for some time.
- Swedish Su iron electrode costs are said to be 1/3 of Ni electrode cost but since process is proprietary these cannot be justified.
- Swedish Su electrode is reported to have highest efficiency due to .8mm thickness. Westinghouse iron electrode is reported only 60/70% as efficient as SU.
- Problems of iron contamination on nickel electrode are beginning to be reported.
- Thermal control is required since NiFe system is inherently inefficient at high and low temperatures.
- Water addition and frequent servicing is needed.
- Electrolyte circulation has been proposed as a means of overcoming thermal problems but this introduces even more difficult problems.
- O.C. capacity loss is 2.2%/day for the SU electrode.
- Low cell voltage necessitates additional cells in series.
1.12v for NiFe vs 1.50v for NiZn vs 1.95v for Pb.

2.5 Nickel Zinc Battery Systems

Appendix D contains the technical analysis and data on this system. Major emphasis has been given to conventional nickel zinc systems since data on the ESB Vibrocell[®] system is still limited. Additional comments on the nickel zinc system follow.

- Cycle life is still the major problem. It is aggravated by very high temperature rise during cycling of present cells.
- System tests with large size cells in excess of 100v show wide performance variations.
- Zinc poisoning of the nickel electrode is emerging as a problem.
- Separators for EV-Hi power applications are still sought. Inorganic separators that reportedly have long life are too resistant to permit high rate discharge.
- Cost of Ni and cost of cell assemblies remain as major obstacles.

The ESB Vibrocell[®] capacity degradation with cycling appears to be less than with conventional cells.

- Vibrocell[®] is probably more sensitive to power demands due to need for spacing between electrodes.
- Polarization appears to be minimal in the Vibrocell[®] negative.

2.6 Lead Acid Batteries

The lead acid battery has been the most widely used power source for propelling electric vehicles in use today. The golf cart, the forklift trucks, and mine locomotive are typical examples of motive power use. In general, these applications stress long life, reasonable power and energy density and cost. Weight has never been of major concern.

The other major usage of lead acid batteries is the SLI market where major emphasis has been directed toward maximizing cold cranking (amps) performance.

The Department of Energy's contracts with ESB, Globe and C&D (Eltra) managed by Argonne National Labs are directed at two levels of improvement.

1. Improved State-of-the-Art.
2. Advanced Batteries.

These goals are given in Table 1. Each of the three subcontractors has expressed confidence in being able to simultaneously achieve all of the ISOA goals.

Figure 1 shows a typical Ragone plot (Watts/Kg vs Watt hr/Kg) for the present Golf Car (EV106) battery to which have been added a line for "Improved Golf Car" and the ISOA and Advanced Battery goals. Data from ESB experimental cells and batteries tested in July 1978 have been added to indicate performance that has been achieved. Similar results have been indicated by other DOE contractors. Life test data is still being accumulated but the risk in this area does not appear to be too great. Cost goals (based on '76 estimates) should be achievable; actual prices will rise since '76 estimates were based on 25¢/lb lead with Feb '79 lead at the 44¢/lb and rising!

Since this development effort is based on "Improving the State-of-the-Art", manufacturing facilities are available to supply initial requirements for the EV market and scale up can be accomplished on a schedule consistent with the scale up required by the vehicle manufacturers.

Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts



Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research



With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips



Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS

Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS

Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS

Sync your system to PACER to automate legal marketing.