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Prospects for lead–acid batteries in the new millenium☆

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Abstract

The European lead–acid battery industry has been adversely affected by the collapse of the telecommunications and information technology expansion of the last several years and by general economic conditions in other sectors. This has had a substantial effect on the industrial battery market, particularly standby batteries, but the automotive business has been less affected. The industry has reacted to these continuing changes by consolidation and specialisation within the different sectors but this alone is insufficient to ensure future success. The industry faces significant challenges to improve efficiencies through better manufacturing systems, but the development of new products for both existing and future applications is the greater priority. Advanced automotive batteries for Powernet applications and for hybrid electric vehicles, new types of standby and traction batteries and improvements to automotive batteries can all be achieved with lead–acid technology. This is a system with enormous potential for further improvement building on current strengths. This is a challenge to which the industry must respond in order to underpin the lead–acid battery as the most important electrical energy storage system.

Keywords: Lead–acid batteries; Automotive batteries; Industrial batteries

1. The European battery industry in 2002

The last few years have seen continuing changes in the battery industry but the collapse of the telecommunications and information technology expansion of the last decade has had, and will continue to have, a major impact on our industry. The automotive battery market has been less affected but the strong returns that were being obtained in the industrial battery market, particularly for standby batteries, have been substantially reduced for many companies.

Industry consolidation has continued and this has also evidenced a further trend towards specialisation within the lead–acid battery industry to automotive and industrial battery companies. Invensys sold its Hawker business to EnerSys earlier in 2002 and whilst both groups were focussed on industrial lead–acid batteries, Hawker had divested its speciality lithium battery business to SAFT at an earlier stage and did not include its automotive battery business in the transaction. Johnson Controls acquired Hoppecke's automotive battery business leaving Hoppecke as a smaller player solely manufacturing industrial batteries and has recently announced the intention to acquire Varta's automotive battery division. Exide's overall position is dominated by the financial condition of its American parent although the European companies are not under any form of bankruptcy procedure. FIAMM has consolidated its business with the acquisition of Akuma and United Energy. Rationalisation of manufacturing operations has taken place within various companies. The effect of all of these changes both in the structure of the overall industry and within the individual businesses has not been to provide adequate levels of investment in new technology. The key question for the industry is how to ensure health and prosperity for the future.

2. Technology as a route to improved business performance

The lead–acid battery is perceived as being an old technology with limited potential for technological development. This needs to change if we are to move forward from within the industry. It is clear that there have been enormous improvements in product technology and manufacturing technology. Batteries are more reliable, do not need maintenance and are cheaper to produce than before. Furthermore, the environmental pressures resulting from the toxicity of lead need to be countered with the efficiency of lead recycling.

The route forward is clearly twofold. Consolidation and rationalisation provide opportunities for efficient manufacture that will continue to be realised and at some point a

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greater level of stability will be achieved within the major groupings. The other key is technological development. Lead–acid batteries are capable of substantial improvements for a variety of applications and, in particular, valve-regulated lead–acid (VRLA) batteries both for 12 and 36 V automotive applications. New markets will open up in the next few years because of increased power requirements for vehicles as well as for hybrid electric vehicles of all types. Higher energy density batteries for these applications favour nickel/metal hydride and lithium-based technologies but an aggressive programme of product development will ensure that lead–acid becomes an important offering. Furthermore, improvements for advanced automotive batteries will be applicable to standby and traction batteries.

The lead–acid industry needs to have a much higher profile as an innovator. Investment in research and development will deliver improved products and processes but each company needs to promote itself as able to move forward from today's perception to a much stronger position.

The environmental position also needs to be clearly stated. Lead–acid batteries are fully and effectively recycled without economic support and are never dispersed to the environment. Plant emissions are fully controlled and the health of plant workers is protected by precisely defined measures.

3. Advanced automotive batteries

Advanced automotive batteries need to comply with a variety of requirements and duty cycles (Table 1) depending on application. These vary from simple requirements for higher levels of on-board power to hybrid electric vehicles with an electric range. At a first level a move from 12/14 to 36/42 V is beneficial in reducing the current levels, but with stop and go duty cycles where the engine stops each time the vehicle comes to rest and is then restarted, the duty cycle becomes more onerous. At the next level, the alternator becomes an integrated starter generator and provides energy recovery for regenerative braking and launch assist for acceleration. In this case the battery needs to operate in a partially-charged condition and have a high cycle life for small levels of discharge. Higher power levels for hybrid vehicles lead to higher voltages (144 V or greater) This is generally seen as the watershed between lead–acid and mixed metal/hydride or lithium batteries but there is potential for lead–acid to secure a position in part of this segment.

Table 1
Requirements for advanced automotive batteries

36/42 V Powernet batteries
Different levels of requirement
36 V SLI battery for higher power ancillaries
36 V Stop&go battery
36 V Soft hybrid with launch assist and regeneration
36 V Mild hybrid (higher voltage full hybrid)

Automotive batteries will also tend to move from today's flooded maintenance-free construction to VRLA as 12 V units with advantages in engine-starting performance, cyclic behaviour and safety. Development of 36 V batteries and the identification of cost effective solutions in this area will facilitate improvements to 12 V batteries.

Longer term, fuel cells will open up new opportunities for batteries. Economic sizing of fuel cells dictates that the fuel cell delivers energy at a base level sufficient for cruising but not for the peak power demands of acceleration. A battery is essential to deliver power and also to permit regenerative braking. The duty will be similar to hybrid vehicles and all development in this area will ultimately help optimise batteries for application alongside fuel cells.

New material technologies need to be re-appraised. The active materials will remain lead-based but utilisation can be improved. The use of lead for the current collectors and support structures in a battery may not, however, be the best solution. Coatings and composites may be more efficient and even allow new constructions such as bipolar concepts to be reduced to practice.

4. Standby and traction batteries

Standby batteries have evolved in two directions; shorter life and higher power for uninterruptible power systems (UPS) and longer life or lower power levels for telecommunications applications. Improved designs will permit a level of convergence and as life is improved, the benefit can be taken in durability or energy density.

Similarly the abuse resistance of traction batteries will be increased through an understanding of the factors needed to deliver reliable performance for advanced automotive batteries. Further enhancements of the behaviour of VRLA batteries for traction applications can be expected and energy density will be increased.

5. The way forward

The lead–acid industry is at an important stage in its development in so far as the efficiencies that have come from increasing the scale of manufacturing operations are tending to become more limited in scope. Innovation in products and processes is the key to the future. Lead–acid has the ability to become an enabling technology for the future particularly in the automotive sector which represents the largest actual and potential market. Higher voltage Powernet batteries and hybrid vehicle batteries must be affordable. Nickel- and lithium-based batteries are all intrinsically more expensive than lead batteries and do not have a well-developed infrastructure for recycling. The battery industry and its suppliers needs to rise to the challenge to keep lead–acid in its pre-eminent position. Support from Government and European Union agencies is also needed. Given the necessary level of commitment, the future can be secured.