Current Interrupt Charging Technique for Lead Acid Batteries

Background

The performance and lifecycle costs of battery electric vehicles and hybrid electric vehicles (HEVs) are closely tied to their energy storage systems. The nickel-metal hydride (NiMH) battery has been the recent battery of choice for these vehicles because of its high specific energy and long cycle life. However, NiMH batteries are expensive, and researchers have looked for methods of extending the cycle life of less costly valve-regulated lead acid (VRLA) batteries in order to make them competitive with NiMH systems. VRLA units are also suitable for high-volume production methods, and their recyclability makes them environmentally sustainable. An improvement in their deep cycle life by a factor of three or four would make them practical for use in transportation systems.

Use of VRLA batteries in neighborhood vehicles is widespread.

The National Renewable Energy Laboratory (NREL), with support from the Department of Energy's FreedomCAR and Vehicle Technologies Program, has developed an award-winning "current-interrupt technique" that extends the life of a lead acid battery by a factor of four. NREL worked in partnership with Recombination Technologies and Optima Batteries, Inc., to achieve this success. In 2001, the three organizations were awarded an R&D 100 Award from *Research and Development Magazine* for their accomplishments.

The Technology

There are two reasons why a VRLA battery reaches its end-of-life prematurely when subjected to a conventional constant current/voltage charge: (1) insufficient recharge at the negative plate and (2) interference with recharge of the negative plate by the "oxygen cycle" or recombination reactions, which cause the oxidation of sulfuric acid to sulfate.

The new technique involves applying a current to the battery for 5 seconds, overcharging it slightly,

then interrupting the current for 5 seconds to cool the battery and prevent it from going into the oxygen recombination phase. Tests on a pack of 24 Optima yellow-top batteries verified that the VRLA battery can sustain 700 deep discharge cycles with this method, four times more than when it is charged with a standard constant current/voltage system. The research team hopes to eliminate the battery management system, further lowering the cost of producing and using this battery.

Commercialization

Lead acid battery producers, auto manufacturers, and battery integrators have recognized the importance of the new technology for electric and HEVs. As these vehicles become more reliable and fuel-efficient, they will attract a greater consumer following, especially with the recent increases in gasoline prices. This technology was developed with funding from the Advanced Lead Acid Battery Consortium and is available for free use by its consortium members and non-members as well. The current-interrupt charging technology was initially used by Th!nk Mobility, a unit of Ford Motor Company, on its neighborhood electric vehicles. Th!nk Mobility engineers observed significant improvements in the performance and life of the lead acid batteries when using variants of this charge regime. Since Ford has divested from the battery electric vehicle market, others have picked up the technology: different variations of the current-interrupt charging and control similar to those developed by NREL and Recombination Technologies have been developed and are being utilized by other companies involved in the neighborhood electric vehicle market. These charging methods give inexpensive lead acid batteries significantly longer lives and will enable large-scale deployment of neighborhood electric vehicles. Global Electric Motorcars, ZAPworld, Dynasty Motorcar Corporation, and Nevco are currently producing and selling low-speed electric vehicles. The leading manufacturer has sold over 30,000 units, and most of these are equipped with VRLA batteries.

Benefits

- Extends the life of VRLA batteries by 4 times over standard charging
- Easily incorporated into the charging control of electric vehicles
- Eliminates the need for frequent replacement of lead acid battery packs

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