2001 R&D 100 Award Recipient

Charging Algorithm Extends the Life of Lead-acid Batteries

The National Renewable Energy Laboratory (NREL) has been working with Recombination Technologies and Optima Batteries to develop a current interrupt charging algorithm to extend the deep life cycle of valve-regulated lead-acid (VRLA) batteries. The work in this area is based on the hypothesis that VRLA batteries reach end-of-life prematurely with "normal" constant current/voltage charge. Using a current interrupt technique, NREL and Optima Batteries improved the cycle life of VRLA modules from 150–200 deep discharge cycles to 700 deep discharge cycles. This simple technique is considered a "breakthrough" for use of VRLA batteries in electric vehicles.

"By increasing potential battery life by a factor of three or more, the cost of energy storage on a yearly basis is drastically reduced; thus the current-interrupt method developed by this work promises to be a significant breakthrough in providing an economically rational energy sorage device, and thus an enabler of electric vehicle technologies."

Ron Brost – Ford (TH!NK Technologies)

Project Payoffs/Benefits

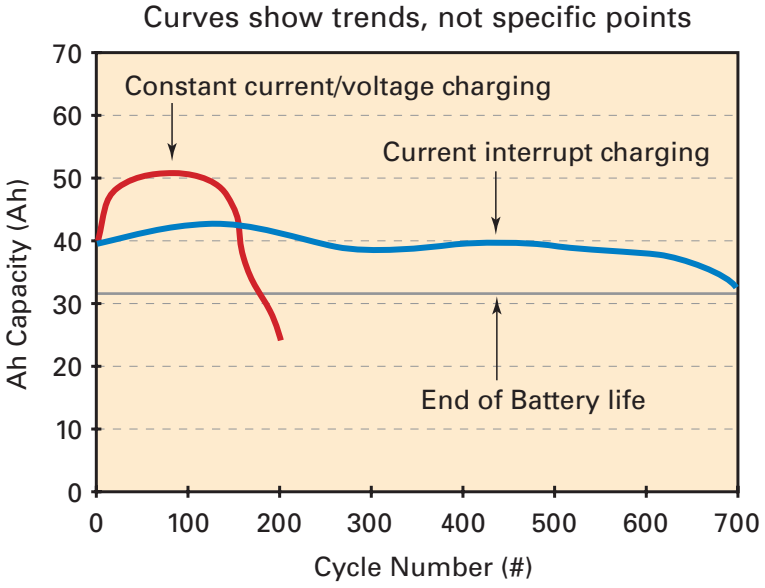
California legislation is requiring thousands of zero emission vehicles to be sold in the next 10 years. It is estimated that more than 200,000 hybrid electric vehicles will be in the market in the next 10 years. Extending the deep cycle life of lead-acid batteries using the current interrupt charging algorithm provides an economically rational energy storage device and thus an enabler of electric vehicle technologies.

Significant Accomplishments

- High inrush currents prevent the loss of capacity in the negative plates of VRLA batteries.
- High finishing currents provide enough charge for the recombination cycle and still have some available to finish charging the active materials.
- The current interrupt technique involves overcharging the battery, 5–20% depending on battery life, by applying a current to the battery for approximately 5 seconds and then allowing the battery to rest for 5 seconds.
- The rest period allows the battery to cool and helps prevent the battery from going into the oxygen recombination cycle or gassing cycle.
- The current interrupt technique was applied to a battery pack consisting of an Optima lead acid battery module and extended its life to 700 deep discharge cycles (4 times better than using standard constant current/voltage charging).

Background

Although lead-acid batteries are less expensive, more recyclable and better prepared for high-volume production for electric vehicles (EVs), their relatively short deep life cycle has been a major hurdle for wider use—until now. The Advanced Lead Acid Battery Consortium funded this project to investigate extending the deep cycle life of valve-regulated lead-acid (VRLA) batteries by improved charging techniques. Current interrupt charging technique was found to extend the cycle life 3-4 times making lead acid batteries more competitive with the NiMH batteries that are currently used.



Research Partners

Research and development funding was provided by the Advanced Lead Acid Battery Consortium, consisting of more than 60 industry members. The NREL team developed the current interrupt charging algorithm with Optima Batteries (a Johnson Controls company) and Recombination Technologies. Testing at NREL was performed with the Department of Energy's Office of Transportation Technologies equipment.

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