Predictive Battery Management System for Commercial Hybrid Vehicles

Cooperative Research and Development Final Report

CRADA Number: CRD-13-520

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In accordance with Requirements set forth in Article XI. Reports and Abstracts A.(3), of the CRADA agreement, this document is the final CRADA report, including a list of Subject Inventions, to be forwarded to the Office of Science and Technical Information as part of the commitment to the public to demonstrate results of federally funded research.

Parties to the Agreement: Eaton Corporation

CRADA Number: CRD-13-520

CRADA Title: Predictive Battery Management System for Commercial Hybrid Vehicles

Joint Work Statement Funding Table Showing DOE Commitment:

Estimated Costs	NREL Shared Resources
Year 1	$251,280 .00
Year 2 or Modification #	$230,453.00
Year 3 or Modification #	$218,246.00
TOTAL	$699,979.00

Abstract of CRADA Work:

NREL and Eaton Corporation will perform work together on DOE Advanced Research Projects Agency-Energy (ARPA-E) "Advanced Management and Protection of Energy Storage Devices" program (DE-FOA0000675). NREL will experimentally characterize aging behavior of Eaton cells and packs. Eaton and NREL will implement NREL's prognostic life model in Eaton HEV supervisory controllers and demonstrate the algorithms in accelerated life hardware-in-the loop testing conducted at NREL.

Summary of Research Results:

The Eaton/NREL AMPED project addressed the issue of battery overdesign and underutilization on medium-duty hybrid electric vehicles (HEV). The team developed a fast computing control oriented cell aging model and integrated it with a real-time HEV powertrain management algorithm. The semi-empirical aging model relied on cell cycling test data and electrochemical equations based on representing degradation mechanisms common to Li-ion cells. The resulting 'predictive battery management system' was not only capable of accurately tracking the battery state of health (cell capacity and resistance estimation with <10% error) but also quantified the impact of different HEV powertrain management strategies on the aging parameters. The powertrain management algorithm was able to optimize the power split between engine and battery/motor to maximize the HEV fuel economy while ensuring that the battery aging was within the HEV application requirements. The team was able to demonstrate significant battery downsizing using an innovative battery-in-loop testing approach. The test setup was developed to cycle full size HEV battery with any virtual battery downsizing factor. With the battery size cut in half, the predictive battery management technology achieved the battery aging requirement with only 3% fuel economy penalty compared to full-size battery and baseline powertrain controls. With battery downsized by 35%, all aging requirements were met with a 1.1% fuel economy gain compared to full-size battery and baseline powertrain controls. While the business conditions remain challenging for hybrid electric vehicles, the team is exploring opportunities for the predictive battery management technology in electric power grid applications.

Subject Inventions Listing:

None

Report Date:

7/26/2016

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