

Thermal Batteries for Electric Vehicles

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Current electric vehicles rely on the electrochemical battery, typically Li-ion, to supply the necessary power for the heating, ventilation and air conditioning (HVAC) system. It is estimated that the HVAC system can use up to 40% of the battery's available energy in extreme climates. We are developing a low cost, rechargeable, high-energy-density thermal battery technology to heat and cool of the cabin air, therefore, alleviating the load on the Li-ion battery.

The system consists of a cold battery and a hot battery, which contain phase change materials (PCMs) with a melting temperature close to 0 °C and 100 °C, respectively. These thermal batteries can be charged with off-peak electric power together with the electric batteries. During charging or discharging, an internal heat exchanger transfers heat between the PCM and the single-phase working fluid, which is also pumped through a liquid-air heat exchanger exchanging heat with the cabin air.

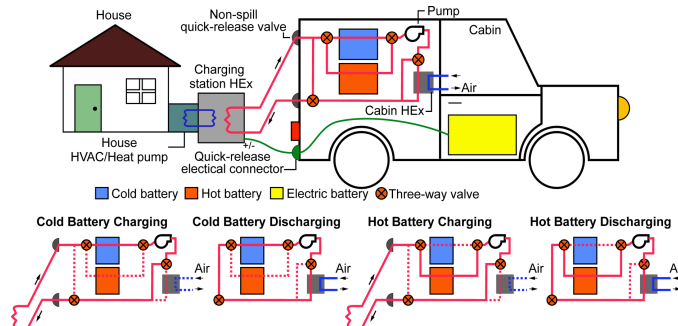


Figure 1: A system overview of the thermal battery technology under development is shown.

Personal focus has been on the full-scale experimental prototype, which has been designed to closely replicate the on-board operating conditions and equipment. Analytical modeling was used for optimization of the PCM heat exchanger, i.e. optimizing flow rates, geometry, etc. Testing is underway on the first-generation hot battery, and numerical modeling using COMSOL is being performed in parallel. Additionally, we are developing PCM composites utilizing ultrathin graphite foam to enhance the bulk thermal conductivity. We hope to increase the bulk thermal conductivity by a factor of 10 with a foam solid density of only ~1%. Composite thermal characterization is underway using a laser flash system. Team personnel also seek to increase the latent heat of a given PCM via molecular engineering.