We acknowledge the support of the Natural Sciences and Engineering Council of Canada (NSERC), which invests annually over $1 billion in people, discovery and innovation.

EECOMOBILITY (ORF) & HEVPD&D CREATE

Battery Manufacturer: LG Chem
Type: Lithium-Ion (LMO)
Cell Voltage Max/Min: 4.2/3.0 V
Pack Configuration: 86S 5P
Number of Cells: 430
Nominal Cell Voltage: 3.7 V
Nominal System Voltage: 318.2 V
Rated Pack Capacity: 75 Ah
Rated Pack Energy: 23 kWh
Weight of Pack: 303 Kg
Cooling: Active – Liquid Cooling
Pack Location: Two Sections: (1) Behind Rear Seats (2) Under Rear Seats

Battery Pack Design and Thermal Management
Centre for Mechatronics and Hybrid Technology (CMHT)
Mechanical Engineering McMaster University
Raven Chen

Constrains and Objectives

- Design and dimension of battery pack based on suitable models
  - evaluate suitable battery technologies to specify electric and thermal termination
  - battery management systems to predict state of charge, health, function
  - battery thermal management system to operate cooling and heating effectively

Electro-Thermal Model

Electrical Model

\[ V_T = V_{OCC} - V_1 - I_R \]
\[ V_1 = -\frac{1}{R_1} C_1 V_T + \frac{1}{R_1} I_T \]

Thermal Model

\[ \frac{d T}{d t} = \frac{Q}{C_1} - \frac{T_T - T_o}{R_1 C_1} \]
\[ \frac{d T_a}{d t} = \frac{T_a - T_T}{C_1 R_{conv1}} + \frac{T_T - T_o}{C_1 R_{conv2}} \]

Conduction between cells

Where,
- the second equation describes the dynamic voltage across the RC circuit
- parameters R & C are function of SOC and T

Main Battery Pack

- Air cooling of a battery creates a high potential for energy savings and heat recovery.
- Locate the pack in the front of a vehicle for improving heat transfer.
- The heat can be a source to warm up the cabin in cold weather conditions.
- The operation of most Li-ion cells should be limited to a temperature of 20°C to 40°C.
- Temperature differences between cells should maintain below 5°C.

Secondary Battery Pack

- Battery designed with ribs can increase the heat transfer rate.

Explosive View of a VW Pack

Constrains and Objectives

- General work procedure to select battery technology and battery design constrains

Electrical Model

- Power

Thermal Model

- Voltage range
- Battery weight
- Battery volume
- SOC range
- Durability

Aging Model

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