THERMAL DESIGN & ANALYSIS OF BTM

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INTRODUCTION:

Verification for thermal performance of battery stack system is of critical importance during the design stage of any energy management system. The temperature of batteries during charging and discharging cycles should not exceed a permissible value. In current analysis work, Multiphysics analysis model of a battery rack system based in flow dynamics & heat transfer is established for design optimization and validation ensuring fewer prototypes. The flow distribution of cold air from cabinet AC is mapped inside the battery rack system enclosure to study the thermal profile of individual battery. The model (Fig-1)is further enhanced to study a flow network of ducts to ensure uniform and efficient cooling. The flow network is designed for equal mass flow rates by a series of iterative analysis. Enhancement in the system performance is noted in the form of drop in the temperature rise value on comparison with the previous model.

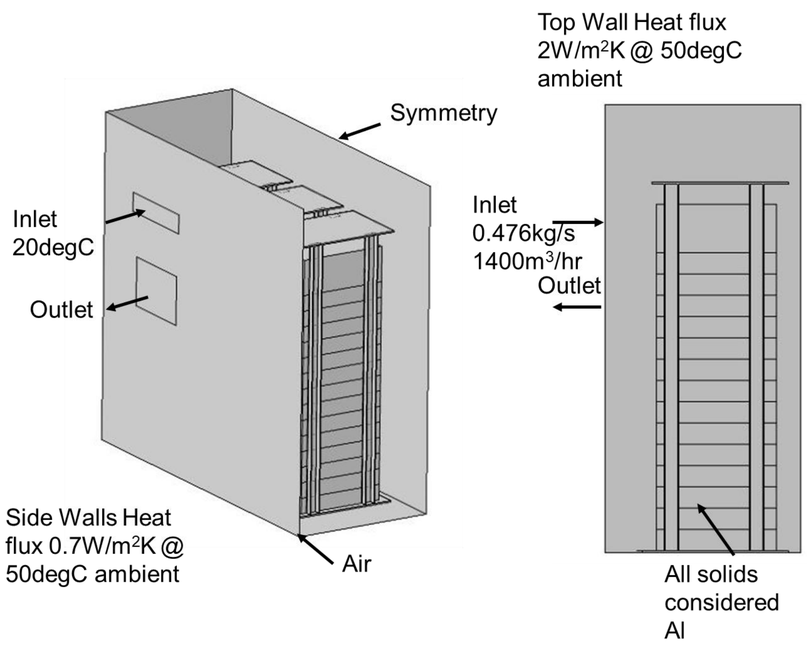

Figure 1. Baseline Model of BTM

NUMERICAL MODEL (3D, Stationery):

- Model simulates the airflow patterns in the battery cabinet from AC cabinet.
- Turbulent flow (spf) and heat transfer (ht) interfaces are coupled to obtain the finite element solution for flow pattern & temperature profiles.

PRELIMINARY RESULTS:

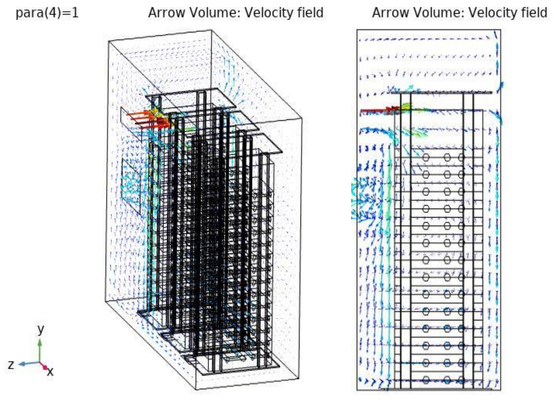

Figure 2. Velocity vectors

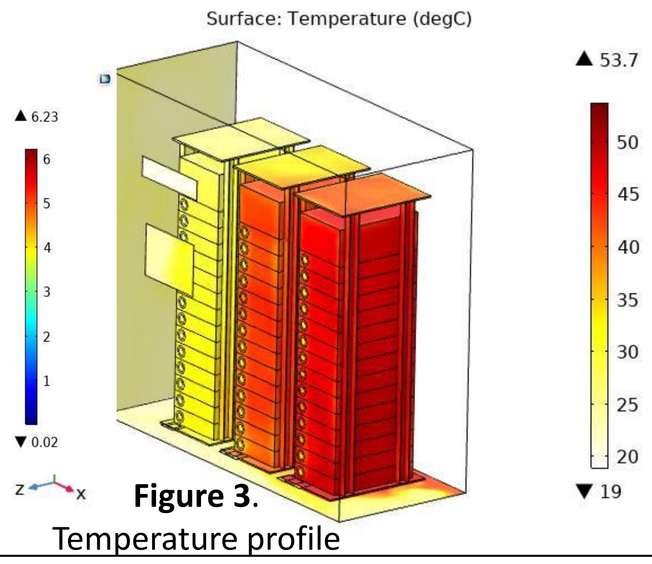

Figure 3. Temperature profile

DUCT DESIGN:

- The airflow pattern indicate recirculation & intermixing of hot and cold air.
- The temperature is higher and non-uniform.
- Hence a duct was designed to overcome the above concerns.
- A series of simulations were carried out to finalize duct dimensions for equal mass flow rates in each limb.

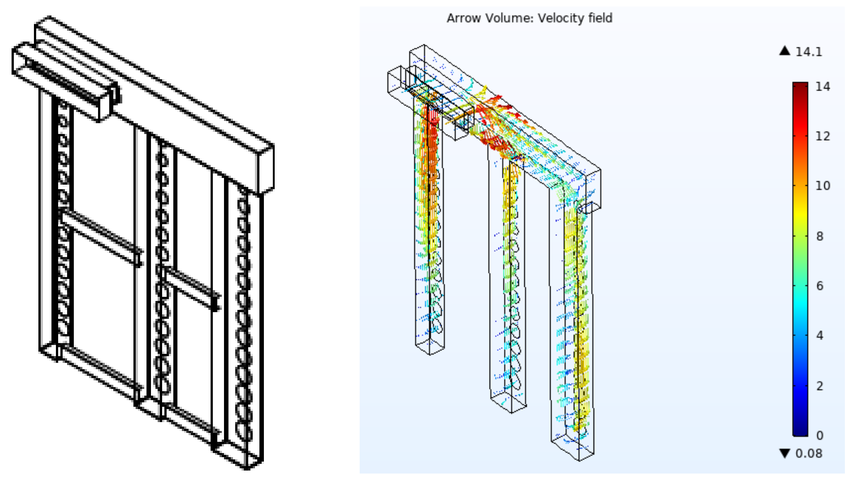

Figure 4. Duct Design & Analysis

IMPROVED MODEL:

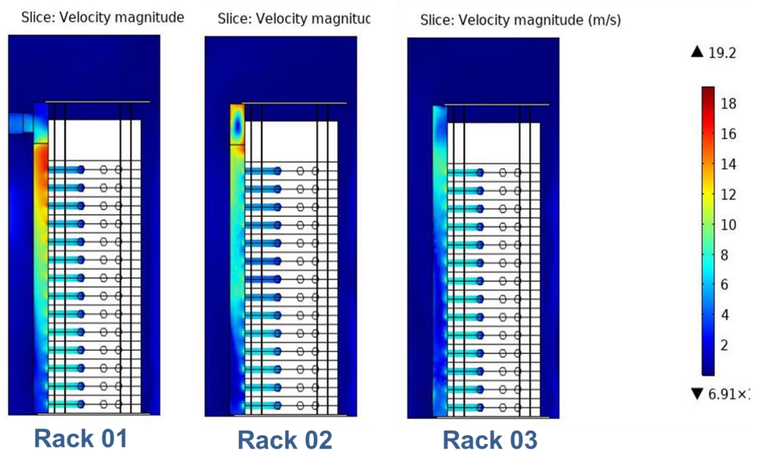

Figure 5. Velocity profile in duct limbs

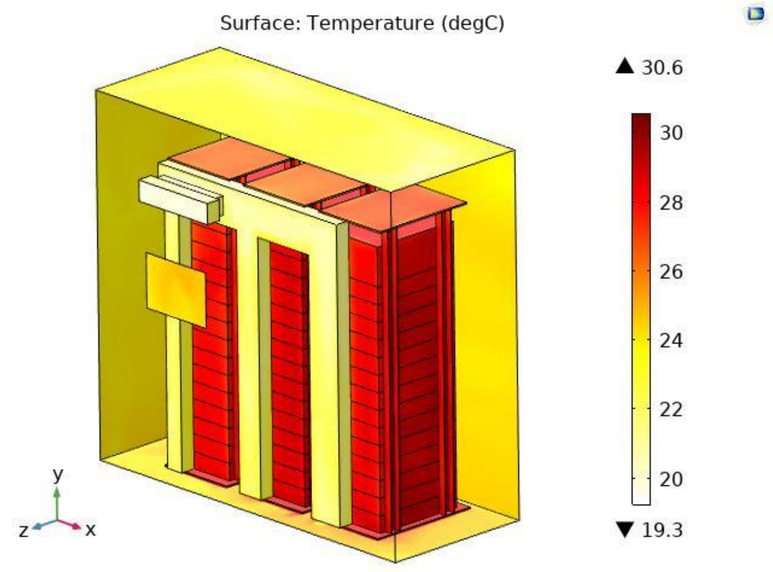

Figure 6. Temperature Profile

CONCLUSIONS:

Reduction & Uniformity in temperature profile obtained with a simplified solution.
Desired cooling of batteries & ambient air achieved.
Analysis helped to identify reliable and efficient solution.