BATTERY THERMAL MANAGEMENT SYSTEM FOR ELECTRIC VEHICLES

Project Reference No.: 48S_BE_0060

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Keywords:

Thermal Management, Electric Vehicles, Battery Cooling, Phase Change Materials, Heat Pipes, Liquid Cooling, Battery Safety, Energy Efficiency, Thermal Runaway Prevention, EV Battery Performance

Introduction:

The global push toward sustainable transportation has accelerated the development and adoption of electric vehicles (EVs). As the heart of an EV, the battery system plays a crucial role in determining vehicle performance, driving range, and safety. However, battery cells are highly sensitive to temperature fluctuations, and improper thermal regulation can lead to reduced efficiency, accelerated degradation, and in severe cases, thermal runaway events.

To address these challenges, Battery Thermal Management Systems (BTMS) have emerged as a critical component in EV design. Various thermal management techniques—such as air cooling, liquid cooling, phase change materials (PCMs), and heat pipes—have been investigated and implemented in modern EVs.

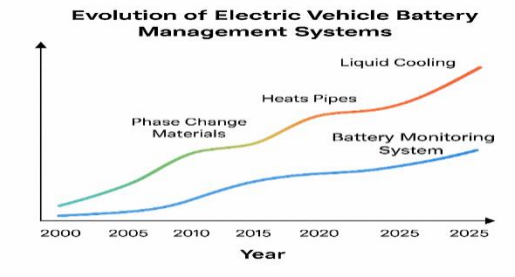

Figure 1: Evolution of electric vechicle (BMS)

Objectives:

1. To ensure optimal battery performance and longevity by maintaining the battery temperature within the ideal operating range under various driving and environmental conditions.
2. To design and implement an energy-efficient and compact thermal management system that minimizes power consumption and weight, contributing to the overall efficiency and range of the electric vehicle.

List the objectives 3 of project

1. To maintain the battery pack within the optimal temperature range for enhanced performance and safety.
2. To reduce the thermal stress on battery cells and extend battery life through efficient cooling/heating methods.
3. To develop a scalable and modular BTMS suitable for various EV models.

Methodology:

The methodology adopted for the analysis and evaluation of Battery Thermal Management Systems (BTMS) in electric vehicles (EVs) involves a combination of literature review**,** comparative analysis, and simulation-based validation**.** This structured approach ensures a comprehensive understanding of thermal management strategies and their impact on battery performance and safety.

Result and Conclusion:

The simulation and comparative analysis of various Battery Thermal Management Systems (BTMS) yielded several critical insights:

- **Liquid Cooling Systems** demonstrated superior performance in maintaining battery temperature within the optimal range (25°C–35°C) during high-load conditions. They offered high heat transfer efficiency but required complex integration and higher energy consumption.

Parameter Value/Performance

Maximum Battery Temperature ~30°C (maintained under high load)
Temperature Uniformity High (±2°C across battery pack)
Energy Consumption Moderate (due to pump and fans)
Suitability for Fast Charging Excellent
Integration Complexity Moderate to High
Safety and Reliability High, if coolant leakage is prevented

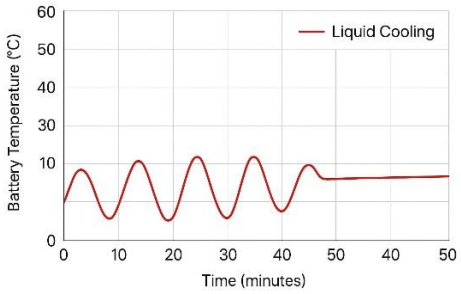

Figure 2: reading thermal in battery (charging and load)

Conclusion

An efficient Battery Thermal Management System is crucial for the safety, longevity, and efficiency of electric vehicle batteries. Based on the analysis, **liquid cooling and hybrid thermal systems** emerge as the most promising solutions for future high-performance EVs.

Future Scope:

The future scope of this project includes:

1. Integration with Smart Battery Management Systems

2. Use of Advanced Materials
3. Hybrid Cooling Solutions
4. Adaptation for Fast-Charging
5. Sustainable and Eco-Friendly BTMS