VIDYAVARDHAKA COLLEGE OF ENGINEERING
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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
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Project reference no.: 46S_BE_5042

Proposed Project Title:
"SUSTAINABLE AND ADAPTIVE BATTERY MANAGEMENT SYSTEM FOR ELECTRIC VEHICLES".

46S_BE_5042	Guides: Prof. BHUSHITH M K & Prof. GOUTHAM B	
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INTRODUCTION

Electric vehicles are the booming technology. Performance and reliability depend on sustainability and adaptivity of the battery. Electric vehicles need optimal temperatures (neither warm nor cold) to run efficiently. The optimum temperature is essential for the proper working of the battery pack, power electronic systems and motor in the electric vehicle. When maintained at an optimal temperature, the battery charge, health, and capacity are preserved. Power electronic systems and motors showcase their best working profile under optimal temperatures. If not thermally managed, temperature will increase and it'll lead to fast ageing of the battery and there are chances of some fire hazards taking place. Low temperature leads to degradation of battery capacity and energy density. Hence, we are developing a thermal management system for our battery through active immersion cooling. Active air cooling gets its air intake from an air conditioner, which includes an evaporator and a heater to control the air's temperature. Active cooling systems are usually better in terms of decreasing temperature than passive cooling systems. We will be employing active-immersion cooling, in which the hardware will be immersed in a dielectric which has high thermal conductivity. For any battery, there will be a battery management system. BMS is an electronic system that manages a rechargeable battery, by protecting the battery from operating it's safe operating area, monitoring it's state, calculating secondary data, reporting the data, controlling it's environment and balancing it. IoT enabled BMS is a budding technology which will monitor and control all the devices, including sensors and gateways with multiple protocols in one place. This platform also offers remote configuration capabilities and group management feature for large network of devices. One of the main advantages of using IoT enabled BMS is, it's accuracy in the estimation of battery parameters like SoC and SoH. IoT is a system of interrelated computing devices, mechanical and digital machines, objects, that are provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. Internet of Things, refers to the collective network of connected devices and the technology that facilitates communication between devices and the cloud, as well as between the devices themselves. Applications of IoT in smart homes: IoT allows you to connect all your home applications like air conditioners, lighting, locks, thermostat, theft alarm systems, and whatnot into a single system and have the control at your fingertips with a smartphone. Hence, IoT enabled BMS has a scope in future.

OBJECTIVES:

1. To develop a Li-ion battery pack, that can incorporate active cooling mechanisms.
2. To design and integrate IoT enabled battery management system.
3. To develop a user interface/ app for edge devices to access real-time information of the battery.

METHODOLOGY:

FLOWCHART

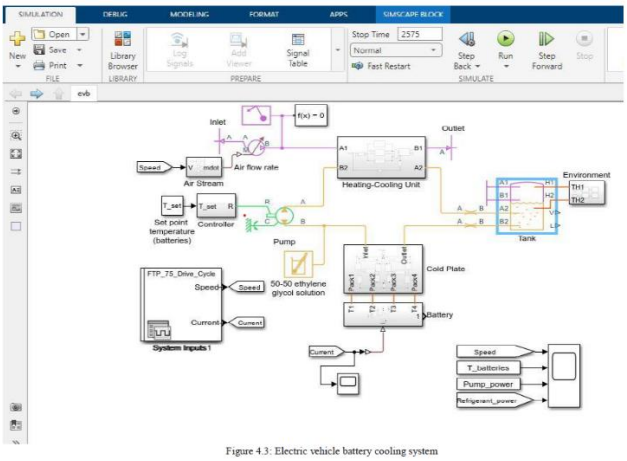
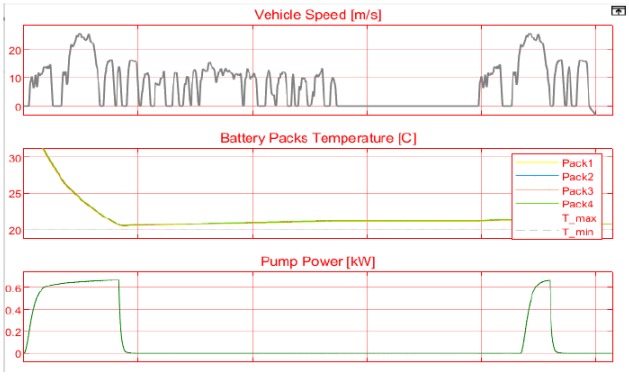
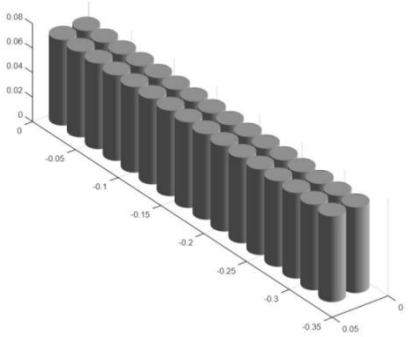
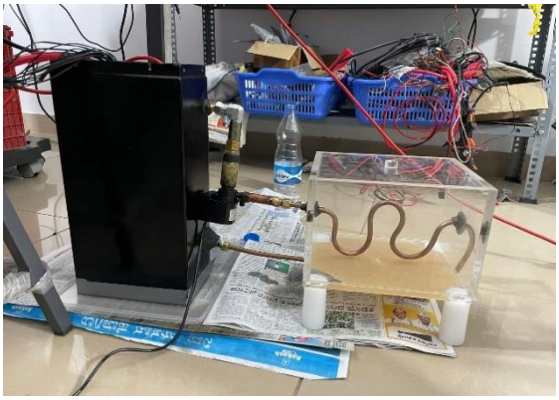


Figure 4.3: Electric vehicle battery cooling system

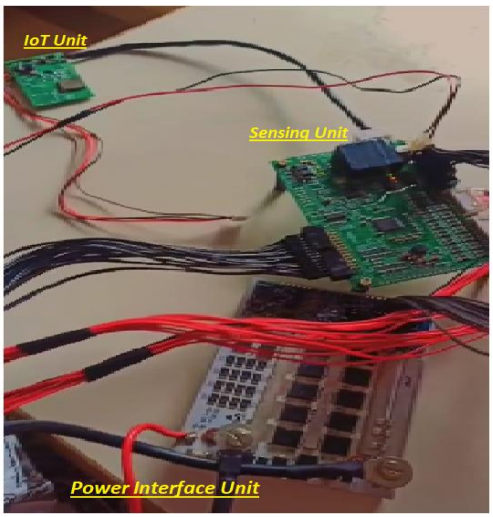


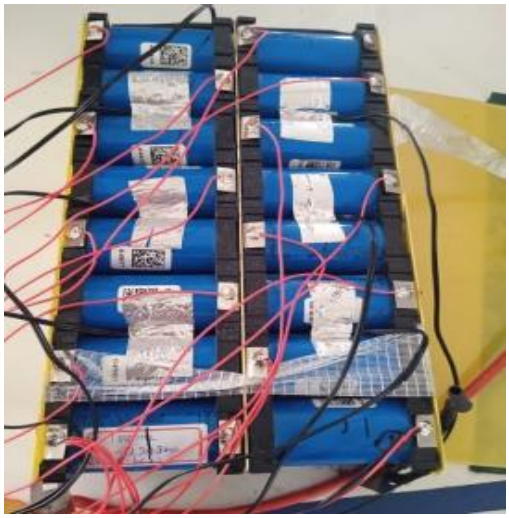


1. Designing and simulation of the battery pack

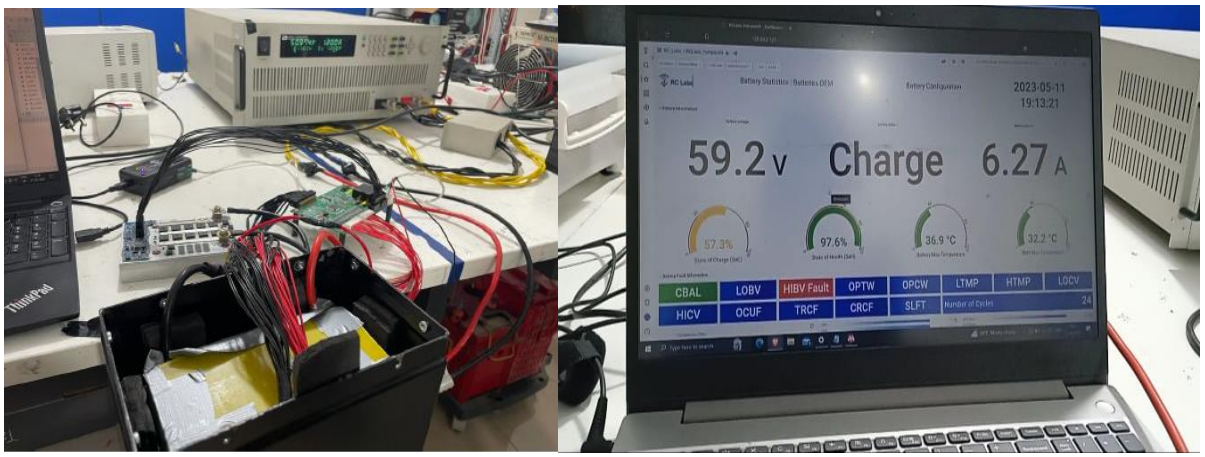


2. Develop battery pack with active immersion cooling mechanism





3. Develop a battery management system



4. Interfacing of Battery management system with the battery pack

5. Testing of the battery packs included

i. Charge discharge tests (With and without oil)

ii. Pulse discharge tests (with and without oil)

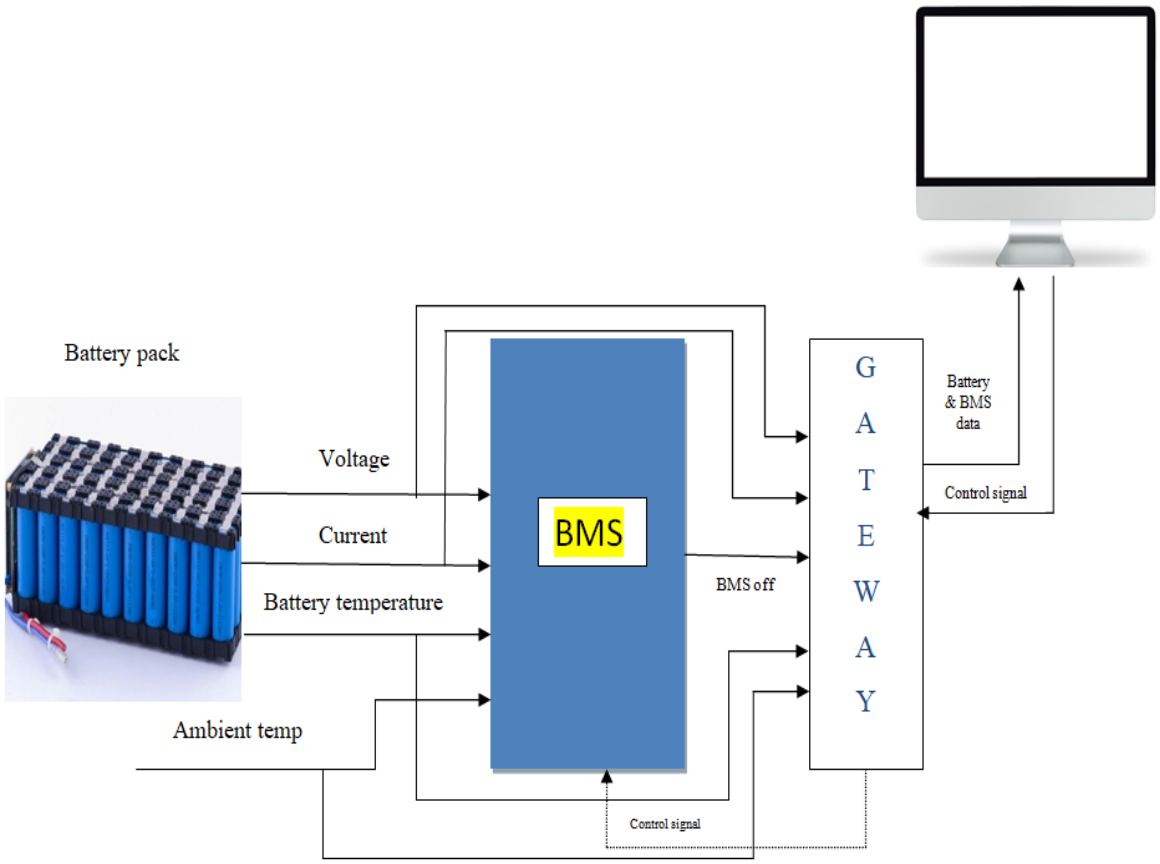


Fig: Block diagram of the proposed system

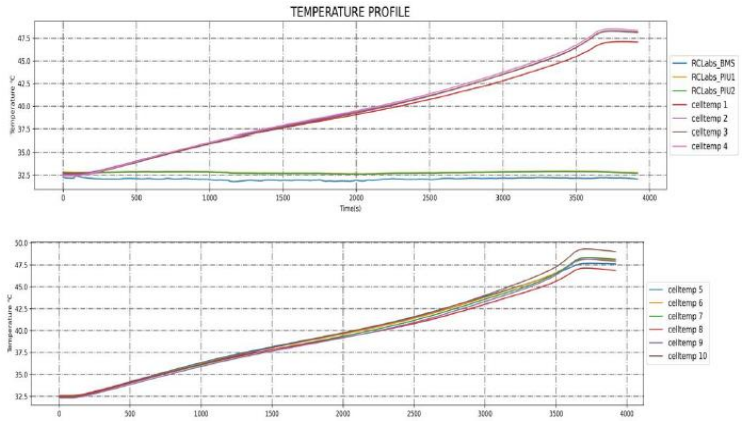
RESULTS AND CONCLUSIONS:

As our project mainly focused on thermal management of batteries in electric vehicles, active immersion cooling in mineral oil (the dielectric used) has given comparative results i.e. Significant reduction in temperature with the use of mineral oil was observed based on the different tests conducted.

1. **Charge-Discharge test:** The test objective is to determine the number of times a battery can be used by evaluating it until it deteriorates after repeated cycles of charging and discharging.

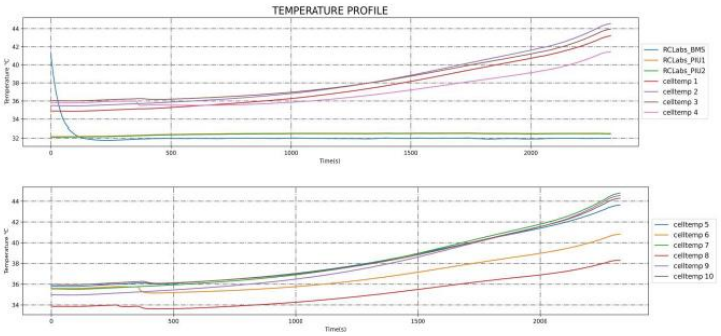
Fig: Charge -Discharge Test experimental setup

Tests results:



Results obtained regarding temperature behavior without oil.

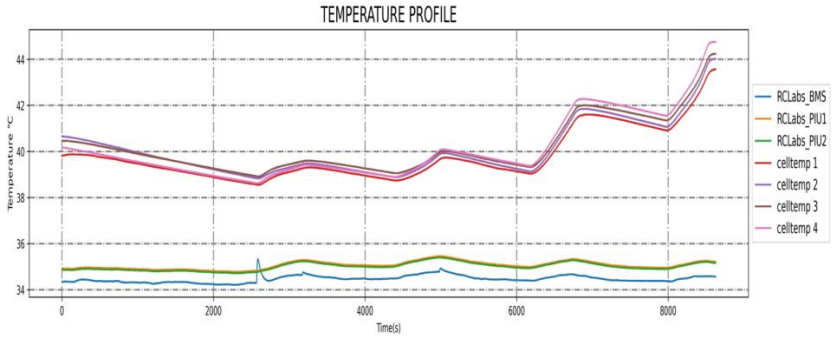
Fig: Results for Temperature Behavior without oil



Results obtained regarding temperature behavior with oil.

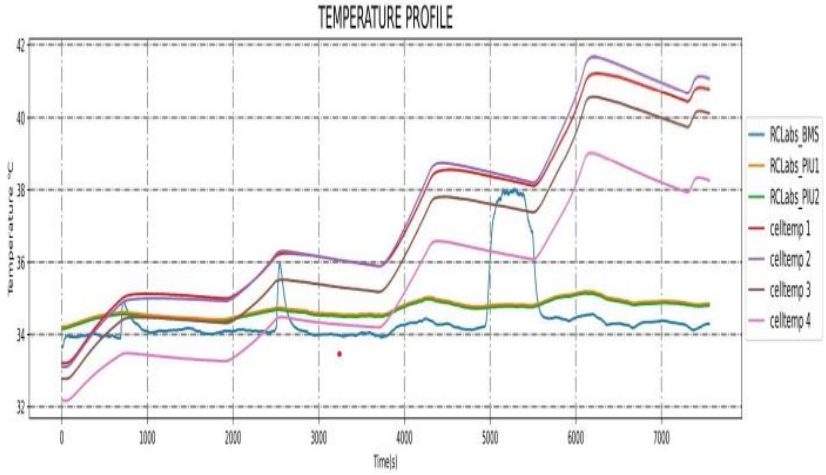
Fig: Results for Temperature Behavior with oil

2. **Pulse discharge test**: The test was conducted by mainly controlling the load through a python coded script wherein for the duration of 10 min there was discharging of the battery which was connected to the load and for the next 20 min the load was cutoff. This cycle was repeated for 3 to 4 times till the battery attains it's cut off voltage. Constant current was drawn from the load during discharge and when load was cutoff there will be zero current drawn. From the voltage drop obtained through the pulse discharge test the impedance can be plotted.



Results obtained regarding temperature behavior without oil.

Fig: Results for Temperature Behavior without oil



Results obtained regarding temperature behavior with oil.

Fig: Results for Temperature Behavior with oil

The objective was to make the battery to be ensured about the thermal management, which was instilled to monitor the temperature under extreme conditions through active immersion cooling mechanism. The major advantage was to improve the SoH, thus by increasing the battery span than the specified time. The temperature reduction was successfully analyzed through the IoT enabled Battery Management System, via the data logged on regular intervals on the edge devices. The user interface developed was useful in picturing the differences in temperature ranges with and without oil and plot results accordingly on various factors.

SCOPE FOR FUTURE WORK:

There is always a wider scope for an effective battery management system with active immersion cooling mechanism which would be of greater contribution for electric vehicles as the temperature governance becomes crucial factor to be taken heed of. The results as discussed in this project have shown great difference in temperature cut down up to minimal levels. Aftermath of implementing this technique we can expand the knowledge about battery management system and its need, along with ensuring safety from fire hazards. Bringing up more techniques in reducing the size and weight of the battery with this oil circulation system can be the next step in revolutionizing our work and improving technology for better life.

The mineral oil which is being used as an di-electric in this project, can be replaced with therminol oil or combinations of ester compounds as coolants. This project includes crude demonstrations on how the oil immersion cooling can be adapted to maintain the temperature and the process of circulation of heated oil through pumping mechanism, contributing the oil circulation in temperature reduction. This structure can be further simplified by designing the batteries with cooling system within them and designing the perfect battery management system with IoT enabled to take a leap in the usage of trending technology.

BHUSHITH M·K

Guide's Name with Signature: