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ELECTRIC VEHICLE BATTERY THERMAL MANAGEMENT SYSTEM BASED ON CALCULATING STATE OF CHARGE ANDSTATE OF HEALTH

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ABSTRACT

The transportation industry is increasingly turning towards electric vehicles as asustainable and environmentally friendly option, as they produce zero emissions. In order to power these vehicles, it is important tohave efficient battery storage technology inplace.Batteries when kept in isolation or a closed compact space, as in electrical vehicles tend to heat up drastically resulting in depreciation of efficiency as well as lifetime ofthe battery. The heat generation in the battery during charging and ischarging of the battery.Battery thermal management system that keepsthe battery temperature within the range of 25 C and 30 ° C will significantly improve the power consumption and enhance both the charge storing capacity and battery life. The SOC and SOH is calculated using coulomb counting method. This Paper battery thermal management system is a combination of forcedair cooling, and liquid cooling. A motor is connected to the battery system and used to pump fluid around the external layer of the battery. This liquid coolant indirectly contacts the battery and serves as the medium for removing the heat generated during operation.Forced air assisted heat removal isperformed from the reservoir.

Keywords—BTMS-BatteryThermal Management systems, Battery Thermal Model, SoC-State of Charge, SoH State of Health**,**Charging and Discharging, Cooling System, Efficiency**.**

INTRODUCTION

The power generated in our surroundings comesfrom various sources, which are mainlyclassified into renewable and non-renewable resources. The battery system is essential in all electrical and electronics fields and plays a significant role in renewable sources of energy. Proper monitoring of the battery system is necessary to safeguard its lifetime, especially inthe battery thermal management system where temperature is critical.Batteries are widely used in various fields, including electrical vehicles, electronic appliances, powerhouses, and industries. Lithium-ion, storage batteries, and fuel cells are common types of batteries used in these fields. However, the use of these batteries may generateheat during charging and discharging, which canreduce the battery's lifespan. The battery dissipates heat from its external surface. The battery dissipates heat from its external surface.The increase in temperature within the battery system can lead to overheating, which can havenegative effects on

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modern electrical appliancesand electric vehicles [2,3]. To maintain an appropriate temperature level, it is important to regulate the temperature of the battery system effectively. Typically, the lead-acid battery [4] isused as an uninterrupted power supply (UPS) inhousehold appliances. However, any irregular activity within the battery can significantly reduce its lifespan.To maintain the battery thermal system, it is crucial to monitor various parameters of the battery at all times. These parameters include temperature, current, voltage, SOC (State OfCharge), health, battery percentage level, and more. Monitoring and recording these common parameters are necessary to ensure the proper functioning of the battery.These batteries are utilized in most of the abilityplants which are connected to the larger loads and also the voltage is going to be produced in KV. The uniform temperature should be maintained to urge the accurate current and voltage range. That the amount of the temperature also nearly be high compared with the voltage produced by the battery. This high- rated battery is capable of handling a wide temperature range. This battery is also utilized in the EV (electric vehicles) [5-7] and within thepowerhouse which must be monitored whenever.In this field, a battery monitoring system can bevery useful to prevent serious damage to the system. Typically, the battery temperature ismaintained within a range of 30°C to 40°C. However, if the temperature exceeds this level, a cooling system is employed to reduce thetemperature of the battery and enable it to function within the normal range.Various strategies are utilized in the thermal management of battery systems to reduce the temperature level and maintain optimal operating conditions. Our approach is an easy, efficient, and cost-effective cooling system thatutilizes fan and motor pumping technology. Fans are attached to the battery to observe heat and mix it with the atmosphere, while a motor pump transfers the cooling liquid around the battery through pipes..

METHODOLOGY

Battery thermal management systems typically use two methods to regulate the temperature of batteries during operation. The first method involves using air cooling, where the battery is cooled by circulating air around it. The second method involves using a liquid cooled tube thatis wound around the battery. This tube isHowever, during charging and discharging, the temperature of the battery can increase rapidly, which can negatively affect its lifespan. To address this issue, a DHT11 temperature sensor is used to monitor the temperature of the battery. The sensor is connected to an Arduino microcontroller, which alerts the user when the temperature of the battery exceeds 35-40°C or goes above 40°C

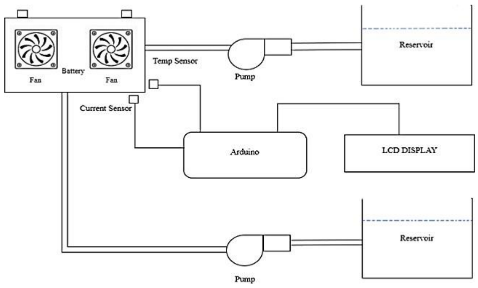

Fig 1 Battery Thermal Management System Block Diagram

When the temperature of the battery exceeds thenormal range, the cooling system is activated. Initially, the system uses air cooling to dissipatethe heat. If the temperature continues to rise, theliquid cooled tube is used to transfer the coolingliquid around the battery, which effectively reduces the temperature of the battery.

Coulomb Counting Method :

The most commonly used method for determining the state of charge (SOC) of a battery is known as coulomb counting. It is alsoreferred to as ampere hour checking and currentintegration. This method involves measuring thebattery current readings over a period of time and then integrating these readings to calculate the total amount of charge that has been delivered to or taken from the battery. Based on this information, the SOC of the battery can be estimated by dividing the amountof charge that has been removed from the initialcharge by the total charge that the battery can hold. The connected to a DC motor pump, which transfersthe liquid from one end of the battery to the

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$SOC \,\square\, SOC(t\ ) \,\square 0 t_0 \,\square I_b \,\square\, I_{loss}$ othereffectivelyreducingthebattery'sr t_0—

(1)temperature.Under normal operating conditions, the batteryoperates within a normal temperature range.Where SOC(t0 is the underlying SOC, C_r is therated value, I_b is the battery current, an the current devoured by the misfortune responses.The releasable limit of a battery, known as Crelease, is the discharged limit it reaches when itis fully discharged. The state of charge (SOC) ofa battery is defined as the percentage of the releasable limit relative to the rated value of thebattery(C_r)provide by he manufacturer. Mathematically, SOC can be calculated as$SOC \,\square\, C_{release} * 100\%$

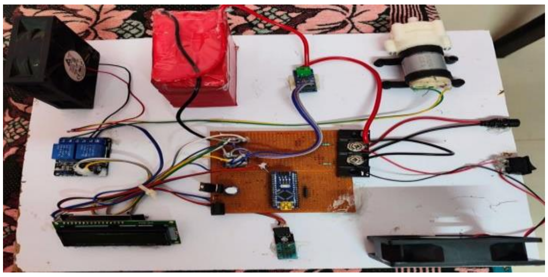
(2)When a battery is fully charged, it has its maximum releasable limit, denoted as C_{max}, which may differ from the rated capacity (C_r) stated by the manufacturer. Generally, C_{max} is slightly different from C_r for a newly manufactured battery and tends to decrease overtime as the battery is used. This equation can beutilized to evaluate the state of health (SOH) of a battery by determining the ratio of itsmaximum releasable limit to its rated capacity, expressed as$SOH \,\square\, C_{max} * 100\%$

maintain the temperature of the battery within anormal range. The first method involves air cooling at the outer surface of the battery, whilethe second method utilizes a liquid-cooled tube connected around the battery to transfer the heat away.During normal operation, the battery functions at a regular temperature zone.

PROTOTYPE

C_r

WORKING



Components:

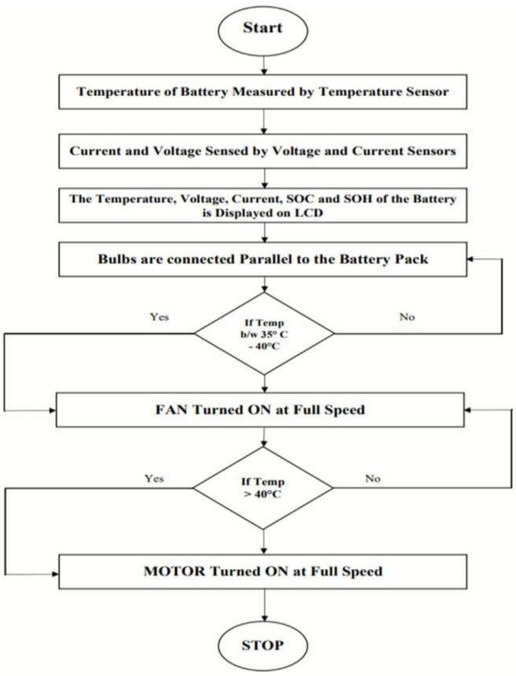


Fig2 work flowchart

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the battery thermal management systemprimarly employes to method to decrease

- Lithium-ion Battery
- Arduino NANO
- ACS712 Current Sensor
- DHT11 Temperature Sensor
- 7805 Voltage regulated IC.2- Channel Optical Isolated RelayModule
- R365 Diaphragm Mini Water Pump12VDC
- 2V DC Fan
- 16x2 LCD Display with I2CModule
- 1N4007 Diode
- Capacitor
- Resistors

RESULTS :

Fig 4 Output on Display

Fig 5 Fans at before and after Air Cooling Activation

CONCLUSION

The battery thermal management system uses aircooling and liquid-cooled tubes to maintain the battery's temperature within a normal range during regular operation. If there is an increase in temperature, the DHT11 temperature sensor, paired with the Arduino microcontroller, monitors and alerts the system. During overheating, the cooling system comes into operation, initially using air to dissipate the heatand then a pump that transfers the cooling liquidaround the battery system. This system has proved effective in reducing the temperature of the battery by up to 4°C and increasing its healthby 20 to 25 percent compared to a usual batterymaintained at varying room temperatures. This method has improved the battery's chargeretaining capacity and lifetime without compromising batterycurrent

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