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Cooling of Electric Vehicle Battery Using TEG Plate

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Abstract: ***Electric Vehicles (EVs) are rapidly emerging as a sustainable alternative to conventional vehicles. Battery overheating affects performance and lifespan. This paper presents a cooling method using a Thermoelectric Generator (TEG) plate based on the Seebeck effect to manage battery temperature while recovering small electrical energy.***
Keywords: Electric Vehicle (EV), Battery Thermal Management System (BTMS), Thermoelectric Generator (TEG), Seebeck Effect, Lithium-ion Battery.

I. INTRODUCTION

The rapid growth of Electric Vehicles has increased the importance of efficient battery systems. Lithium-ion batteries are widely used due to high energy density, but their performance is temperature dependent. Excess heat during charging and discharging reduces efficiency and lifespan. Therefore, an effective Battery Thermal Management System (BTMS) is essential.

II. LITERATURE REVIEW

Conventional battery cooling techniques include air cooling and liquid cooling systems. Air cooling is simple but less effective, while liquid cooling improves performance but increases cost and complexity. Thermoelectric modules provide compact cooling solutions with no moving parts and precise temperature control.

III. PROPOSED SYSTEM

The proposed system integrates a Thermoelectric Generator (TEG) plate between the battery and a heat sink. When the battery temperature rises, heat passes through the TEG plate, generating voltage due to the temperature difference while transferring heat to the heat sink for cooling.

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IV. WORKING PRINCIPLE

The TEG plate operates on the Seebeck effect. When there is a temperature difference between the hot side and cold side of the module, electrical voltage is generated. The hot side is attached to the battery and the cold side is connected to a heat sink with a cooling fan.

V. HARDWARE DESIGN

The hardware consists of a Lithium-ion battery pack, TEG plate, aluminum heat sink, cooling fan, temperature sensor, and microcontroller. Thermal paste is used to ensure effective heat transfer.

VI. EXPERIMENTAL RESULTS

Testing showed that without cooling, battery temperature reached 48°C under load. With TEG cooling, temperature was maintained between 38°C and 40°C, improving thermal stability by approximately 15–20%.

VII. CONCLUSION AND FUTURE SCOPE

The proposed TEG-based battery cooling system effectively reduces battery temperature and improves efficiency. Future work may include integration with liquid cooling systems, advanced thermoelectric materials, and AI-based temperature prediction models.

VIII. SOFTWARE AND CONTROL STRATEGY

The microcontroller continuously monitors battery temperature. If the temperature exceeds a preset limit, the cooling fan is activated. The TEG plate generates voltage during temperature difference, contributing to energy recovery.

REFERENCES

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[2] D. Linden and T. B. Reddy, Handbook of Batteries, McGraw-Hill.
[3] Thermoelectric Generator (TEG) Datasheets and Seebeck Effect studies.

Experimental Setup and Hardware Prototype

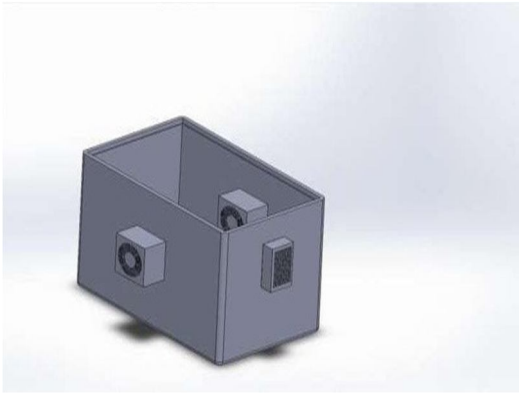


Figure 1. Design Of Model

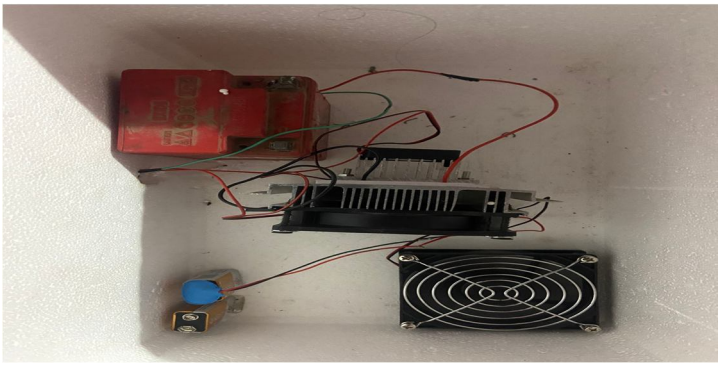


Figure 2. Top view showing Cooling System With Inner Components

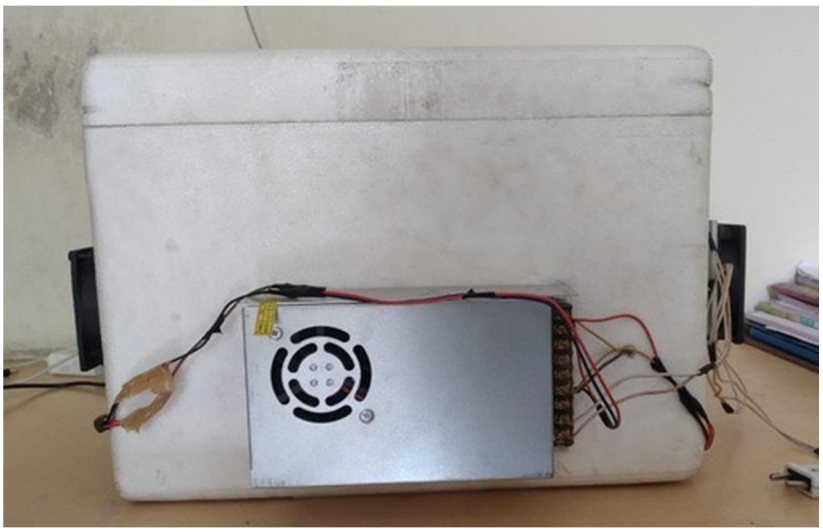
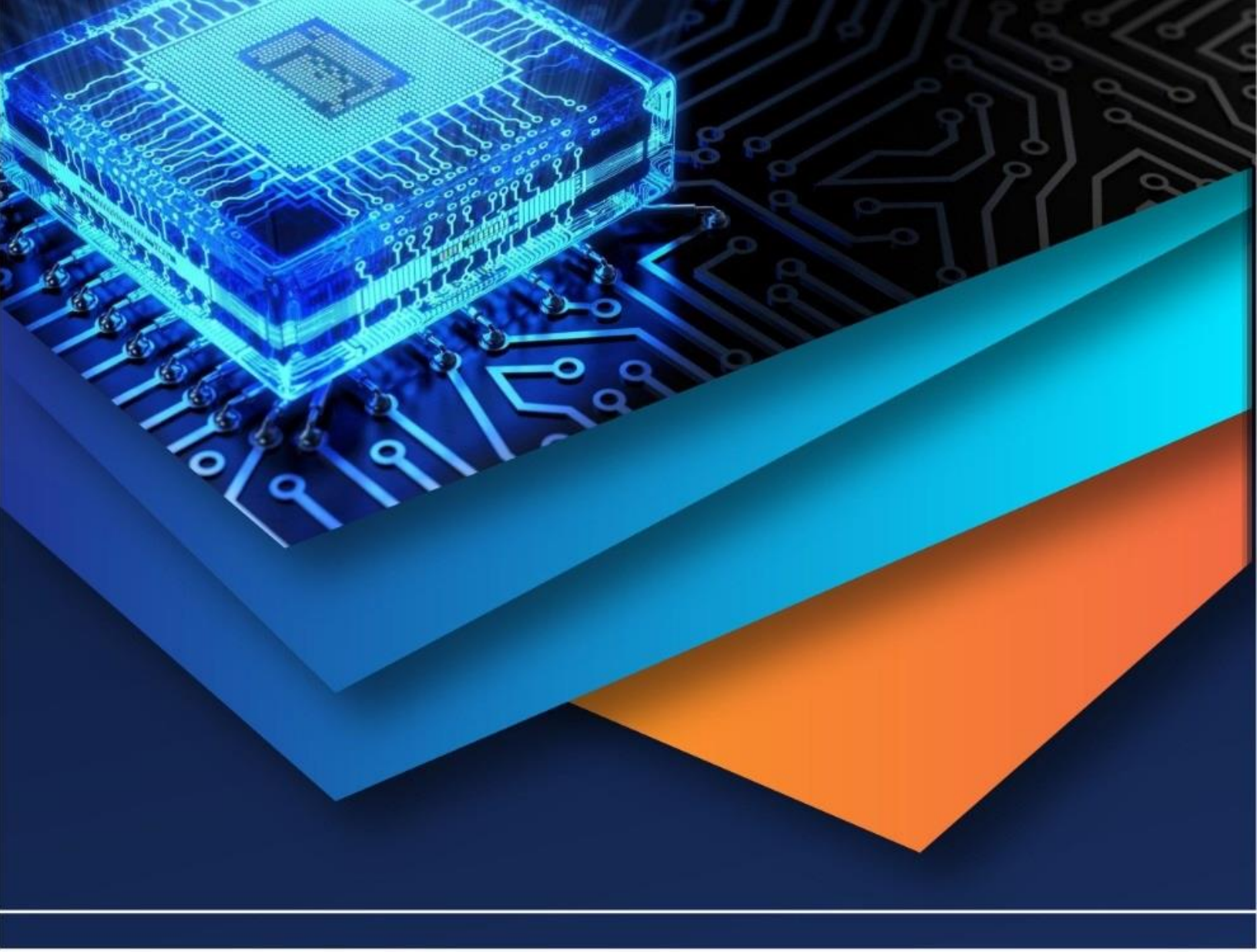


Figure 3. Actual Model



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