

# A Study on the Impact of Temperature on the Efficiency of Li-Ion Battery With-Or-Without Phase Change Material Coating

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DOI: <https://doi.org/10.5281/zenodo.10078547>

Published Date: 07-November-2023

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**Abstract:** PCMs (Phase-Change Material) are the type of materials that tends to change its materialistic property when subjected to temperature change. They change into liquid form while absorbing heat at melting point and will regain its solid form under solidification temperature. i.e., Paraffin wax is a form of PCM and it changes to liquid form at 46 °C and will turn into solid when kept for some time at room temperature (Paraffin wax have a melting point in the range of 46°C - 68°C). These materials releases or absorbs energy during phase transition. These materials have a wide range of application in space technology. PCM's are used in heat sinks as it helps in the efficiency of thermal control systems.

**Keywords:** Phase change material, Phase transition, Latent heat thermal energy, PCM.

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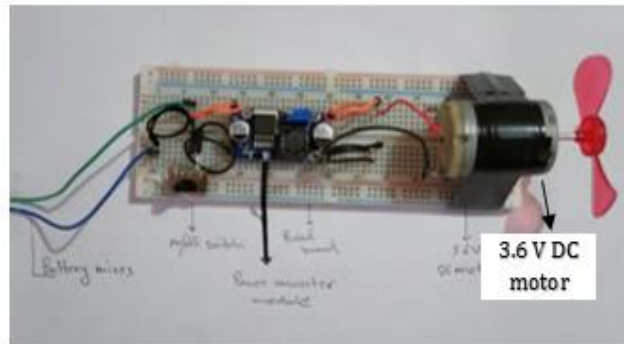
## 1. INTRODUCTION

Li-ion batteries are rechargeable batteries which are sources of power supply for various uses<sup>1,2</sup>. Changes in temperature may significantly affects its performance and limit their usage. Phase changing materials hence help in absorbing the excess heat and cold temperature under a controlled environment and may help for a long life and efficiency of the battery<sup>3</sup>. Latent heat thermal energy storage is the concept behind every PCM's<sup>4</sup>. A PCM under transition from liquid to solid release more heat and absorbs more heat during melting.

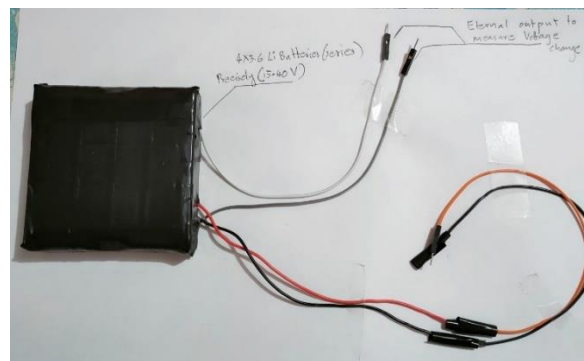
Latent heat thermal energy storage is a better method as it provides a relatively high energy storage density<sup>5</sup>. In this research article we have shared the results and data collected from the experimental observation of the behaviour of a battery under different climatic condition both with and without a PCM coating. As this observation was done during the quarantine time in the year 2020, we used aloe vera gel as a PCM as it had similar properties.

## 2. EXPERIMENTAL SETUP

The heat transfer characteristics of aloe-vera gel under different climatic conditions are studied. Fig. 1 shows the experimental setup. The efficiency of a Li-ion battery is studied by connecting it to a DC motor that runs on the battery power, and visible reduction of power delivery can be understood from the performance of the motor. Since the battery delivers more voltage to the DC motor than the given rating, a power converter is used to control the amount of voltage delivered. Fig. 2 shows the battery setup and its casing. A breadboard and a bunch of jumper wires were used to make the circuit. The PCM is filled in the plastic chamber on top of the battery as shown in Fig. 3. The temperature change over the battery is measured in subsequent intervals with the help of a temperature gun.



**Fig. 1 Schematic illustration of experimental setup.**



**Fig. 2 Battery setup**



**Fig. 3 PCM setup**

### 3. RESULT

The diffusion rate of the battery at different climate was recorded.

Initial temperature of the battery (under the sunlight) : 40.8°C

Time(min)	Temperature(°C)	Voltage(V)
0	40.8	11.90
2	38.9	13.22
4	39.0	11.69
6	45.1	14.95
8	45.3	14.45
10	47.0	14.18
12	45.1	14.15
14	47.3	13.97
16	46.7	12.61
20	48.7	10.95
22	52.2	7.26

**Table 1: Initial conditions:**

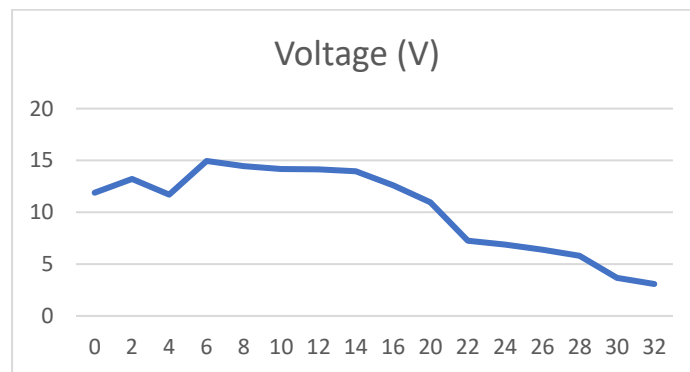
Weather: 31.9°C

Avg. rate of change in voltage : **-0.173 V/min (discharging)**

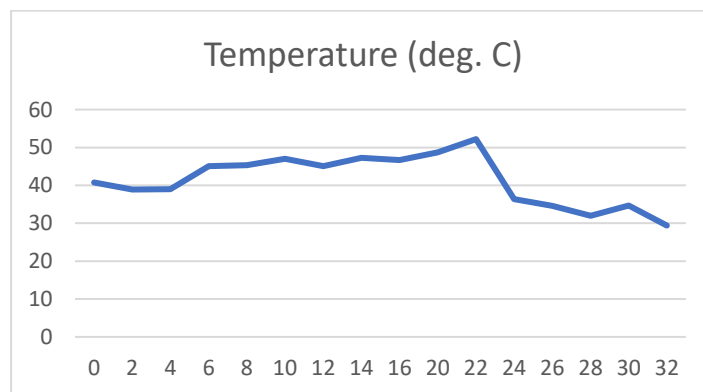
Time(min)	Temperature(°C)	Voltage(V)
24	36.4	6.89
26	34.6	6.39
28	32.0	5.80
30	34.7	3.67
32	29.4	3.08

Avg. rate of change in voltage : **-0.476 V/min (discharging)**

Voltage vs time:



Temperature vs time graph:



#### 4. CONCLUSION

Thermal energy storage is commonly called as heat and cold storage. It usually allows heat or cold to be used later. The division of Energy storage can be categorised into many types. The present article focuses mainly on thermal energy storage because it is supposed to be the key technology in energy systems for conserving energy and increasing energy efficiency. In this regard, the importance of energy storage and the different was investigated. The study shows that wax materials releases or absorbs energy during phase transition and have a wide range of application in space technology.

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