ABSTRAK

DETEKSI *THERMAL RUNAWAY* PADA *CELL* BATRE *$LiFePO_4$* AKIBAT PEMBEBANAN EKSTRIM

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Thermal Runaway merupakan kondisi berbahaya pada baterai lithium-ion yang ditandai dengan peningkatan suhu secara drastis dan tak terkendali. Meskipun baterai Lithium Iron Phosphate ($LiFePO_4$) dikenal lebih aman dibanding jenis lithium lainnya, namun potensi *Thermal Runaway* tetap ada, terutama akibat pembebanan ekstrem. Penelitian ini bertujuan untuk mendeteksi karakteristik *Thermal Runaway* pada baterai $LiFePO_4$ akibat overdischarge menggunakan dua skema pengujian: bertahap (0.5C, 1C, 1.5C, 2C) dan gabungan (0.5C hingga 2C berkelanjutan). Sistem monitoring dirancang menggunakan Arduino Uno yang terhubung dengan sensor suhu DS18B20, sensor arus ACS712 30A, sensor tegangan 25V, dan beban ET5410A+.

Hasil eksperimen menunjukkan bahwa laju overdischarge yang lebih tinggi menyebabkan peningkatan suhu yang lebih cepat dan signifikan. Pada skema bertahap, kenaikan suhu masih tergolong aman (maksimum 17°C). Namun, pada skema gabungan, suhu melonjak hingga 88°C disertai penurunan tegangan drastis menuju tegangan cut-off, yang mengindikasikan terjadinya *Thermal Runaway*. Pola kenaikan suhu eksponensial menjadi indikator kuat *Thermal Runaway*. Dengan demikian, pemantauan suhu secara real-time terbukti efektif sebagai metode deteksi awal *Thermal Runaway*, dan dapat diterapkan dalam sistem manajemen baterai untuk mencegah kegagalan termal.

Kata kunci: *Thermal Runaway*, $LiFePO_4$, *overdischarge*, sensor suhu, C-rate, Arduino

ABSTRAK

DETECTION OF THERMAL RUNAWAY IN LIFEPO$_4$ BATTERY CELLS DUE TO EXTREME LOADING

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Thermal runaway is a hazardous condition in lithium-ion batteries characterized by a rapid and uncontrollable temperature rise. Although Lithium Iron Phosphate ($LiFePO_4$) batteries are known to be safer than other lithium-based chemistries, the potential for thermal runaway remains, especially under extreme load conditions. This study aims to detect the characteristics of thermal runaway in $LiFePO_4$ batteries under overdischarge through two test schemes: stepwise (0.5C, 1C, 1.5C, 2C) and combined (continuous discharge from 0.5C to 2C). The monitoring system was built using Arduino Uno connected to a DS18B20 temperature sensor, ACS712 30A current sensor, 25V voltage sensor, and an ET5410A+ electronic load.

Experimental results show that higher overdischarge rates lead to faster and more significant temperature increases. In the stepwise scheme, the temperature rise remained within safe limits (maximum 17°C). However, in the combined discharge scheme, temperature spiked up to 88°C along with a drastic voltage drop approaching the cut-off point, indicating the occurrence of thermal runaway. The exponential temperature rise pattern served as a strong indicator of this event. Therefore, real-time temperature monitoring proves to be an effective early detection method for thermal runaway and can be implemented in battery management systems to enhance safety and prevent thermal failure.

***Keywords**: Thermal runaway, $LiFePO_4$, overdischarge, temperature sensor, C-rate, Arduino*