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Team Lithium Lumberjacks

Literature Review

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Overview: The purpose of this document is to provide a summarized review of the relevant literature to the team project from a personal perspective.

Characterization of Charging Technology: Lithium-ion Polymer Batteries

Research pertaining to the charging of lithium based battery technologies yields a mixed bag of tricks and ideas ranging from simple cell charger circuits to abstract control algorithms. It is the drawback of temperature dependence and physical volatility that makes lithium batteries a challenge to charge efficiently while maintaining good standards of safety and useability.

A recent standards document by the joint operation between the IEEE Power and Energy Society and the National Electrical Manufacturers Association provides insight into the build quality, safety, and reliability of new lithium-ion polymer battery chargers. It goes through great depth of safety due to the explosive nature of lithium batteries, defining recommended alarms, fail-safe practices, and ambient environmental conditions which contribute to the safety of charging these types of cells [1]. While it does not theorize on future technologies so much as it sets out to define codes and standards for modern technologies, the standards document suggests that above-grade mechanical stability is of utmost importance to any charging system which will handle lithium ion batteries [1]. Despite these large sectional swaths of text, safety is not the only concern of the document; best practices and even design criteria of power control devices used in charging are covered in great detail. These include surge withstand capability, AC and low voltage input protective measures, dynamic response, and even the efficiency of the devices themselves [1]. Voltage ripple has been studied at length for charging characteristics which are of acceptable tolerances for these applications; a table is provided of safe limits for output voltage ripple limits [1].

For documentation which is not attempting standardization, there is a wealth of optimization, efficiency gain experiments, and technologies being implemented to charge lithium ion polymer batteries better. A study from 2009 explored the technique of compensating for the impedance of the battery packs to better charge each individual cell and gain more efficient discharge characteristics from them [2]. The engineers were successful in this endeavor, and provided block diagrams, circuit analysis equations, and oscilloscope readings as part of their documentation of experimental data. In essence, they used a pulsating current source over a buck converter to better control the cell charging rate - noting the impedance of the cell as a function of input signal and formulating an automatic way to adjust their charging parameters to match the battery as it charged [2]. This impedance compensation resulted in a 12% increase in discharge ability and 10% increase in cell capacitive voltage [2].

In stationary applications of lithium-based energy storage technologies, a more complete standard document specifies practices for evaluating the suitability and reliability of charging technologies for the ever-volatile battery chemistry. This standard document is more extensive in providing environmental impact reduction including transportation of material, code compliances/certifications, and disposal of lithium ion battery cells [3]. While it describes the technologies involved in charging lithium batteries the primary purpose is to characterize the charging technologies into categories such as future proof mechanisms, qualified circuitry, and physical or mechanical design of commercial and industrial products [3]. The manufacturing life cycle costs in both monetary and environmental considerations is given as the final section of this standards document [3]. Helpful diagrams of physical structures necessary for meeting the relevant standards as well as experimental lab data that can be compared to product testing environments speaks to the extensiveness of this standards document [3].

In conclusion, there are many technologies and standards that are relevant for lithium ion battery charging methods. With new ideas and considerations for future applications in lithium based energy storage technologies it is clear that the literature will continue to be rich in practical information and theory.

References

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