CALIFORNIA STATE SCIENCE FAIR
2005 PROJECT SUMMARY

Name(s)
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Project Number
J0701

Project Title
An Eye on Lithium Batteries

Abstract

Objectives/Goals
My objective was to learn about the underlying chemistries of the lithium ion and lead acid batteries in order to better understand why their discharge capacities were affected by different temperature extremes. I wanted to determine which chemistry would work best at very low temperatures. I hypothesized that the batteries would lose a large portion of their energy capacities due to the fact that most chemical reactions slow with a temperature drop.

Methods/Materials
The primary materials used were two identical lead acid batteries, A and B, that were both discharged at the same rate at 68 deg. F. Then, after being simultaneously charged up again, they were both submerged in 35 deg. F ice water for 30 minutes. The lead acid batteries were then separately discharged at 35 deg. F, and their voltages were recorded every minute. For the lithium ion batteries, I contacted a battery testing lab in Philadelphia where they were able to follow my instructions to duplicate my lead acid testing. They discharged three lithium ion cells at: 0 deg. C, 20 deg. C, and 40 deg. C and measured their voltage over time.

Results
The results of my testing proved my hypothesis correct. Both the lithium ion and lead acid batteries showed a decrease in their energy capacities as they were discharged in the colder temperatures. However, what was rather surprising was that the lead acid battery, as a percentage of its overall capacity, showed less of a drop than that of the lithium ion. The lithium ion battery is a very useful, high energy capacity battery that ran longer than the lead acid battery. But when the lithium battery was subjected to extreme cold, essentially, it failed to function as a battery whereas the lead acid showed a nominal drop in its energy capacity.

Conclusions/Discussion
In conclusion, though a lithium ion battery is a very light weight, high energy density battery that is commonly used, in a cold temperature, its energy capacity droped severely. However, the lead acid battery, a heavy and toxic battery with a low energy density, proved more efficient during cold temperatures. This project shows great social implications because primarily, most everything we depend upon today is battery powered. With the knowledge of what might affect the performance of a battery, such as temperature, certain precautions may be taken by battery companies in order to enhance their products.

Summary Statement
My project explores the effect of varying temperature extremes on the relative energy capacities of lithium ion and lead acid batteries as measured by their voltage drop over time when subjected to a constant, resistive load.

Help Received
Father helped build display and gather research; the services of a lithium ion battery testing lab were utilized in order to perform specific testing under my direction