CALIFORNIA STATE SCIENCE FAIR
2008 PROJECT SUMMARY

Name(s)
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Project Number
S0812

Project Title
The Effects of Extreme Conditions on Primary and Secondary Cells

Abstract

Objectives/Goals
I studied the capacity of a dry cell battery to survive at extreme temperatures, in particular, that of Mars, -120 degrees Celsius, the North Pole, -60 C, the Mojave Desert, 50 C. Although extreme conditions exist in many areas, institutions such as NASA create rovers capable of surviving such conditions. Hence, I hypothesized that batteries function better at room temperature than at extreme temperatures. In the first additional set, I tested AA dry cells, focusing on nuances and discrepancies, such as varying voltages between individual batteries and exposure to the full temperature range of a day on Mars. In the second additional set, I tested the capacity of secondary cells with a similar strategy, instead focusing on electrochemical properties.

Methods/Materials
Through a thermal chamber, four sets of D cells, one for each temperature, were exposed to their respective temperatures and were then placed inside the flashlights, which were then left to discharge. I then measured the time each flashlight took to discharge. Another four sets of batteries were placed in the flashlights, which were operated at respective temperatures. I then measured the discharge times. The AA set followed similar procedures. In the study on rechargeable cells, I used a thermal chamber and with a multimeter, measured the voltage across the circuit while the batteries were operating.

Results
All the D cells discharged faster at lower temperatures. Flashlights tested within the thermal chambers stopped earlier than flashlights tested outside the chamber, although the cells had not discharged. The tests ran on the AA cells displayed no significant effects. Rechargeable cells exhibited the same effects of extreme temperatures.

Conclusions/Discussion
After observing the set of batteries operated at extreme conditions within the thermal chamber, I concluded that the time a battery takes to discharge is not unanimous with the time a flashlight takes to stop emitting light, for after the flashlights stopped emitting light at -120 C, they began to again emit light as the chamber approached 25 C, signaling that they had not completely discharged. Thus, the flashlights did not turn off because the batteries had run out of chemicals to create energy, but because they could not supply enough energy to satisfy the demand of the flashlights. Similarly, for the rechargeable cells, the voltage fluctuated in a similar pattern.

Summary Statement
When operated at extreme temperatures, primary and secondary cells fail to function as efficiently as at room temperature due to a failure to output enough energy to satisfy the demand of the appliance not due to complete discharge.

Help Received
used lab equipment at JPL under the supervision of Dr. Ramesham Rajeshuni