The Flammable Gasses Produced by Lithium Button Cells in Thermal Runaway





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Introduction

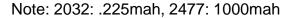
- Ongoing tests have been conducted to study the gasses vented by lithium cells and their effect on an aircraft.
 - Effect of vent gas combustion (with and without halon 1301)
 - Vent gas composition/volume
 - Minimum quantity of cells capable of producing enough gas to compromise aircraft safety.
 - Hazard of gasses from lithium-metal button cells.



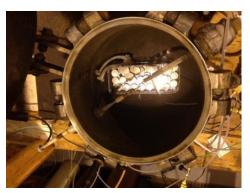
Li-Metal Button Cell Tests

 5 tests were conducted to evaluate the vent gasses of button cells in thermal runway.

- Oven Tests (gas analysis)
 - 2032 button cells strapped together
 - 2032 button cells not strapped together
 - 2477 button cells not strapped together
- Heat Plate Tests (combustion)
 - 2477 button cells on hotplate
 - 2477 button cells on hotplate with enclosure (similar to oven)







Procedure (Oven Tests)

- Cells were placed into the chamber in two configurations (strapped together and not strapped together)
- Chamber was sealed and vacuumed to .1psia
- The chamber was filled to 10psia N₂
- The entire chamber was then placed in an oven at about 250°C
- After sufficient time (a few hours) the chamber cooled and gas was analyzed.



Cells Strapped



Chamber



Oven



Results - oven tests



- CR2032 strapped together
 - THC: 19.83% H₂: 18.53% CO: 2.66% CO₂: 50.88% Volume: .077 liters/cell
- CR2032 not strapped together
 - THC: 13.84% H₂: 1.99% CO: 4.27% CO₂: 79.16% Volume: .108 liters/cell
- CR2477 not strapped
 - THC: 6.18% H₂: 7.67% CO: 2.41% CO₂: 85.04% Volume: .526 liters/cell

Procedure (heat plate tests)

- Cells were placed on a heat plate in two configurations.
 - No enclosure around heat plate.

Enclosure around heat plate.



Results - heat plate tests

- 26 CR2477 Without enclosure around hotplate
 - .115 liters/cell
 - 10.2% battery gas → no combustion
- 45 CR2477 With enclosure around hotplate
 - .916 liters/cell
 - 25% battery gas → combustion maximized the pressure transducer at 41psia.



Additional Test

- 2477 button cell test conducted at .16 psia on hotplate yielded .03 liters/cell
 - → Cell popped open much sooner because of lower ambient pressure preventing significant reaction.



Fresh Cell Cathode Lithium Anode

Summary

- Volume and composition of button cell vent gasses vary depending on environment.
 - Oven test (heated surroundings) showed that cells can produce up to 900% more gas volume.
 - Cells that were strapped together produced more flammable gas
 - Cells that were heated with higher pressure produced a greater volume of gas.

