Munitions Batteries: Taking Stock

Advanced Thermal Batteries Inc.

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Agenda

- Introduction: ATB and ASB Group
- Thermal battery
  - Applications
  - Description
  - Benefits and limitations
  - Example of batteries
  - Performance range
- Customer expectations
- Technology realistic expectations
- Discussion
ATB

- ATB is a US company incorporated in the State of Delaware.
- ATB has the capability and resources to independently develop, qualify and produce thermal batteries.
- ATB is part of ASB group
ASB Group

- ASB serves as headquarters to the Group.
- ASB is the #1 European supplier of Thermal Batteries.
- More than 60 years of experience.
- More than 3 million batteries produced to date.
- All sites ISO or AS certified. APS to be certified when the operations start.
Applications

Thermal batteries are primary reserve batteries used in the Defense and Space market for Missiles, Rockets, Bombs, Munitions, Torpedoes, Emergency systems, Launchers, etc.
What is a thermal battery

- Thermal batteries are similar to regular batteries but they have a solid electrolyte that melts and operates around 500°C.
- To activate them, the electrolyte must be molten. This is achieved with pyrotechnic compounds which are integral to the battery, burn at activation and melt the electrolyte in a very short time.
- The batteries operate until the capacity is depleted or the electrolyte reverts to a solid state (freezes).
- Shelf life of thermal batteries can exceed 20 years, because their electrolyte is solid and non-conductive.
- This is the perfect application for ordnance and emergency systems.
Thermal Battery Construction

Cell
- Lithium alloy anode
- Electrolyte
- Iron disulfide cathode
- Stainless steel electrode
- Pyrotechnic heat source

Finished thermal battery

Stack/battery assembly

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Benefits of thermal batteries

- Very long shelf-life, typically 20 years
- Very high power and high energy
- Fast activation
- High reliability
- Truly maintenance free
- Wide operating temperature range (typical -54 to 85°C)
- Rugged construction: operates under all missile & munition environments (shock, vibration, acceleration, spin, etc.)
- Proven safety under handling (no voltage) and abuse conditions (typically tested under NAVSEA 9310)
Limitations of thermal batteries

Today, thermal batteries are the only battery responding to and meeting all the requirements of ordnance applications. However, due to their construction, they have limitations:

- One shot device (Note: the electrochemistry can be used in rechargeable batteries but not with the pyrotechnic compounds)
- Limited operating life (around 1 hour due to thermal management)
- Limited energy content (by mass and volume due to the hardware burden and fabrication processes)
- Relative high battery cost due to the raw material and limited industrialization (small quantity / regulation)
Example of thermal batteries
Performance range

- **Battery Sizes:** Diameter from 0.55” to 10”; length as required
- **Voltage Range:** 2V to above 320V, single or multiple outputs
- **Current Range:** 0 to 310 amps, with densities up to 8 A/cm²
- **Power Range:** 0 to 25 kW
- **Specific Energy:** Up to 100 Wh/Kg
- **Configurations:** Parallel or series stack, based on requirements
- **Operating Life:** 0.5 seconds to 1.5 hours
- **Activation Time:** From 50 milliseconds
- **Storage Life:** From 20 years minimum

Note: *Not all characteristics can be obtained within the same battery.*
ATB technical expertise

- ATB offers a wide range of electrochemistries: 3 types of anode, typical and advanced cathodes, and a wide range of electrolytes. We can optimize battery design and offer our customers the best trade off between performance and cost.

- ATB is the only US company offering Lithium Anode (LAN): This technology offers the following benefits:
  - Particularly suited to batteries requiring very high power and very high voltage due to higher cell voltage and lower cell impedance
  - Flatter voltage profile (single plateau) throughout operating life compared to Li alloys
  - More tolerant to thermal abuse tests

- ATB has a thorough knowledge of thermal management and uses an electro-thermal simulation model to accelerate our developments.

- With support from our parent company, ATB is investing heavily in R&D on the yearly basis.
What do customers need or want?

- More performance
  - More energy and more power
  - Lower volume and mass
  - Longer battery life

- However, the battery price must be as low as possible.
Technology game changers are rare

Over the last 70 years of thermal battery business, game changers happened very few times (subjective statement):

- Development of Ca/WO2 chemistry
- Development of Ca/CaCrO4 chemistry
- Development of Li/FeS2 technology: more power and energy
- Understanding and improvement of manufacturing conditions and sealing technology: longer storage life
- Modeling and advanced insulation: Long life thermal batteries
- Development of advanced MS2 cathode

No one can predict the next game changer

However, steady R&D provides incremental improvement which over time becomes significant
Today, thermal batteries are the only battery responding to and meeting all the requirements of ordnance applications.

Any questions

Open Discussion
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