EaglePicher®

Thermal Batteries

A Bundle of Energy

EAGLEPICHER TECHNOLOGIES

How Thermal Batteries Work

For more than 70 years, EaglePicher has produced high quality, reliable and cost effective thermal batteries. In 1982, EaglePicher became the first company to produce LiSi/FeS_2 thermal batteries for the U.S. Department of Energy on a production basis. To date, we have produced millions of batteries for a variety of defense applications.

EaglePicher thermal batteries deliver high-energy density in low volume systems. Our batteries can be stored for up to 20 years without performance degradation, perform without preparation and provide power instantaneously upon initiation.

EaglePicher's thermal battery technology is comprised of a stacked series cells. Each cell consists of a cathode, an electrolyte, an anode and a pyrotechnic thermal energy source. Our state-of-the-art thermal battery designs utilize lithium silicon iron disulfide (LiSi/FeS_2) couple, supplying the highest energy capacity per unit volume. A eutectic mixture of inorganic salts with inorganic binder serves as the electrolyte between the anode and the cathode. A conductive heat source, consisting of iron and potassium perchlorate, is placed between each cell.

When initiated, the heat pellets ignite, releasing heat and melting the eutectic electrolyte producing voltage and current. Tight design and manufacturing controls of the heat pellet weight ensures the proper electrical performance is obtained over the required temperature range.

Our thermal batteries are completely inert and non-reactive until activated. Once activated, the battery functions until the critical active material is exhausted or until the battery cools below the electrolyte's melting point, ensuring full mission functionality of the system.

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The Next Generation of Thermal Batteries

EaglePicher produces high quality, reliable and cost-effective thermal batteries for a variety of defense markets. EaglePicher is currently the leading thermal battery manufacturer for the Department of Defense's missile applications. EaglePicher continues to dedicate resources towards advancing thermal battery technology. These improvements span across materials, manufacturing processes and modeling.

EaglePicher's engineering team works with alternative cathode formulations leading to higher operating temperature, higher voltage, higher density, higher capacity and lower impedance.

We are developing high-voltage cathode materials to increase output voltage of the cells. This voltage increase will result in a higher battery output voltage while reducing the batteries' size and weight.

EaglePicher works with advanced insulation materials to extend the operating life, reduce weight and lower overall case temperature of the battery. For weight critical applications, EaglePicher has the capability of manufacturing batteries using titanium headers, containers and bracket assemblies.
Thermal batteries offer the advantage of long-shelf life through their electrochemistry design and use of hermetic seals.

In addition, EaglePicher is developing a new thin film manufacturing technology. With the thin film technology,

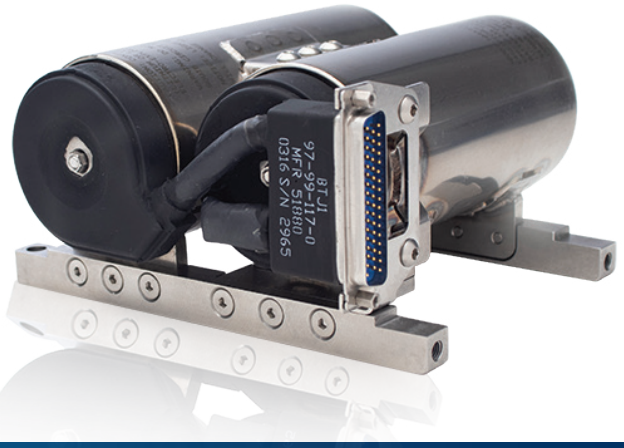
thermal battery active materials can be cast into thin sheets and then die cut into cylindrical or prismatic shapes. Depending on the performance requirements, the size and weight of batteries can be reduced.

Along with the above advancements, EaglePicher utilizes a physics-based electrochemical and thermal modeling program for predicting thermal battery performance at extreme operating temperatures. This advanced modeling program is extensively used in the design and development of all new thermal battery designs.

Battery Advancements	Features and Benefits
Enhanced cathode	Higher pellet density: lowers cell resistance
High-voltage cathode	Increases volts per cell: reduces battery size and weight
Thin film technology	Thinner pellets: increases power density and shape options
Advanced insulation	High-performance thermal insulation: lengthens operating life, lowers case temperature and reduces battery weight
Ceramic header	Improves insulation materials and potiing: reduces battery weight
Titanium header and container	Stronger materials: reduces battery weight
Ceramic seals	Stronger seals: increases battery shelf life
Modeling	Utilizes electrochemical and thermal: provides predictive performance
Production capability	Manufacturing automation: increase battery output
In-house testing capabilities	Electrical discharge and environmental testing: ensures product reliability

Thermal Battery Characteristics

- Reserve system
- Length up to 15 in. (38.1 cm)
- Diameter 0.5 to 6 in. (13 to 152 mm)
- 20+ year shelf life
- Circular cylinder
- Typical density of 0.1 lb/in^3
- Energy density up to 45 Wh/kg
- Power density up to 19,000 W/kg
- Volumetric density up to 130 Wh/L



Thermal Battery Applications

Thermal batteries are used in military and aerospace applications that require a long, maintenance-free shelf life in a full range of temperatures, climates and dynamic environments. EaglePicher has qualified and manufactured more than 400 unique thermal battery designs to support a variety of markets including missiles, guided munitions, underwater, fuzes, aircraft, space and launchers.

- ACES II ejection seat
- Advanced Capability (ADCAP) torpedo
- Aegis Ballistic Missile Defense (ABMD)
- Advanced Medium Range Air-to-Air (AMRAAM) missile
- Excalibur artillery projectile
- Guided Bomb Unit (GBU) small diameter bomb weapon system
- Hellfire precision strike, guided missile
- High-Altitude Anti-Submarine Warfare Weapon Capability (HAAWC)
- High-Speed Anti-Radiation Missile (HARM)
- Javelin weapon system
- Joint Direct Attack Munition (JDAM)
- Maverick missile
- Paveway laser-guided bomb
- Patriot missile defense system
- SM-3 Interceptor
- Small Diameter Bomb (SDB)
- Sonobuoy
- Sparrow missile
- Stinger missile
- Tomahawk cruise missile
- TOW heavy anti-tank missile weapon system