ZincFive

New Opportunities for Zinc Battery Commercialization

Nov. 10, 2022

Nickel-Zinc Batteries in the Commercial Market

From unknown to market acceptance

Nickel-zinc as an electrochemistry was invented around the tun of the 20th century. Thomas Edison received the first US patent on the technology in 1901, but the technology of the time wasn't advanced enough to provide a commercially feasible battery.

Solving the chemical and metallurgical issues required another 100 years of experimentation and development to be realized. Millions of US Dollars were invested by a wide variety of governments and corporations before a successful commercial product was achieved.

Today, there are over 100 patents covering everything from the electrode materials, to the electrolyte, to the manufacturing techniques that enable a commercially viable and highly reliable nickel-zinc battery product to be offered.

Leading Safety & Certifications Profile

Fail-safe operation with no thermal runaway and no hazardous materials

- No transportation restrictions via air, sea or ground
- Favorable treatment in regulatory codes and standards

- **Batteries certified to applicable UL standards**
- **Tested to UL 9540A Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems, Third Edition**
  - Tested at cell level and exhibited no thermal runaway

- **NFPA 855 Standard on the Installation of Stationary Energy Storage**
  - Nickel-zinc treated favorably with fewer restrictions than lithium-ion
  - NFPA 855 being considered by the International Code Council (ICC) as basis for updated International Fire Code (IFC)

- **Batteries compliant to applicable EU standards**

UL9540A Test Report Summary Detail

(Excerpt from UL Report)

Test	Test Method	Venting Time (mm:ss)	Venting Temperature (°C)	Thermal Runway Time (mm:ss)	Thermal Runway Temperature (°C)
1	Overdischarge	Not Observed	N/A	Not Observed	N/A
2	Overcharge	91:30	103.7	Not Observed	N/A
3A	Heating Trial 1	22:30	216	Not Observed	N/A
3B	Heating Trial 2	46:30	180.5	Not Observed	N/A
4	Nail Penetration	00:15	84.5	Not Observed	N/A
5	Short Circuit	00:18	99.6	Not Observed	N/A
6[3]	Gas Composition (Overcharge)	66:40	97.5	Not Observed	N/A

Gas Composition Results

(Excerpt from UL Report)

Venting for Gas Collection Results*	
Venting Time	01:06:40
Venting Temperature on Front Surface	97.5°C
Thermal Runaway Time	No thermal runaway, only venting
Thermal Runaway Temperature	No thermal runaway, only venting
*These results are not a direct comparison with the results from Cell Tests 1-4, as this test was conducted inside a pressure vessel with an inert gas atmosphere.	

Gas Composition Test	
Volume of Gas Generated (NTP Conditions)	226 L

Components Measured in Vented Battery Gas

(Excerpt from UL Report)

Gas		Measured %	Component LFL[1]
Carbon Monoxide	CO	<0.02	10.9%
Carbon Dioxide	CO_2	1.99	N/A
Hydrogen	H_2	98.01	4.0%
Methane	CH_4	<0.2	4.4%
Ethylene	C_2H_4	<0.2	2.4%
Ethane	C_2H_6	<0.2	2.4%
Propylene	C_3H_6	<0.2	1.8%
Propane	C_3H_8	<0.2	1.7%
Propadiene	C3H4	<0.04	1.9%
-	C_4 (Total)	<0.04	1.5%[2]
Pentane	n-C_5H_{12}	<0.04	1.1%
Total	-	100	-

Note: All values for gases other than Carbon Dioxide and Hydrogen were below the lowest detectable limit (LDL) of the measurement system and are not included in the total.

Construction/Materials Used

The Z5 13-80 HSF battery is valve-regulated, non-spillable, with a starved aqueous alkaline electrolyte.

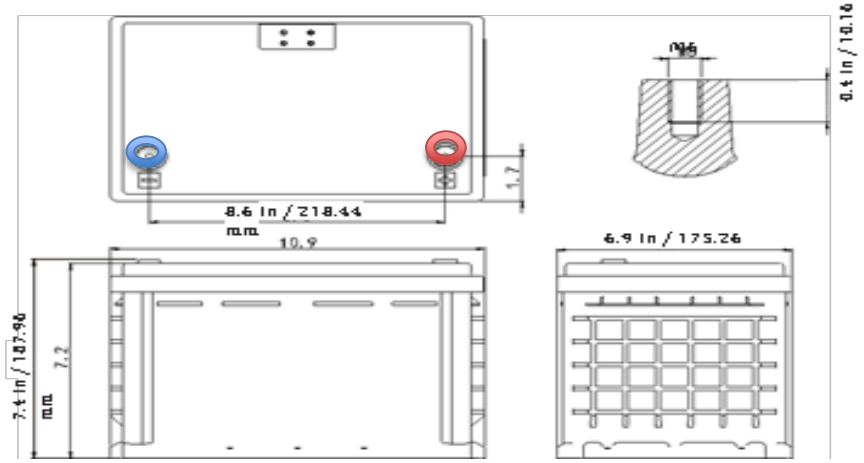
The relief valve is located on the center edge opposite the two terminals.

Under normal operation the relief valve will not open nor have any liquid discharge, but this area must never be covered.

The case material is flame retardant V1-rated.

The terminals have a color coated ring around base of the terminal and marked for polarity.

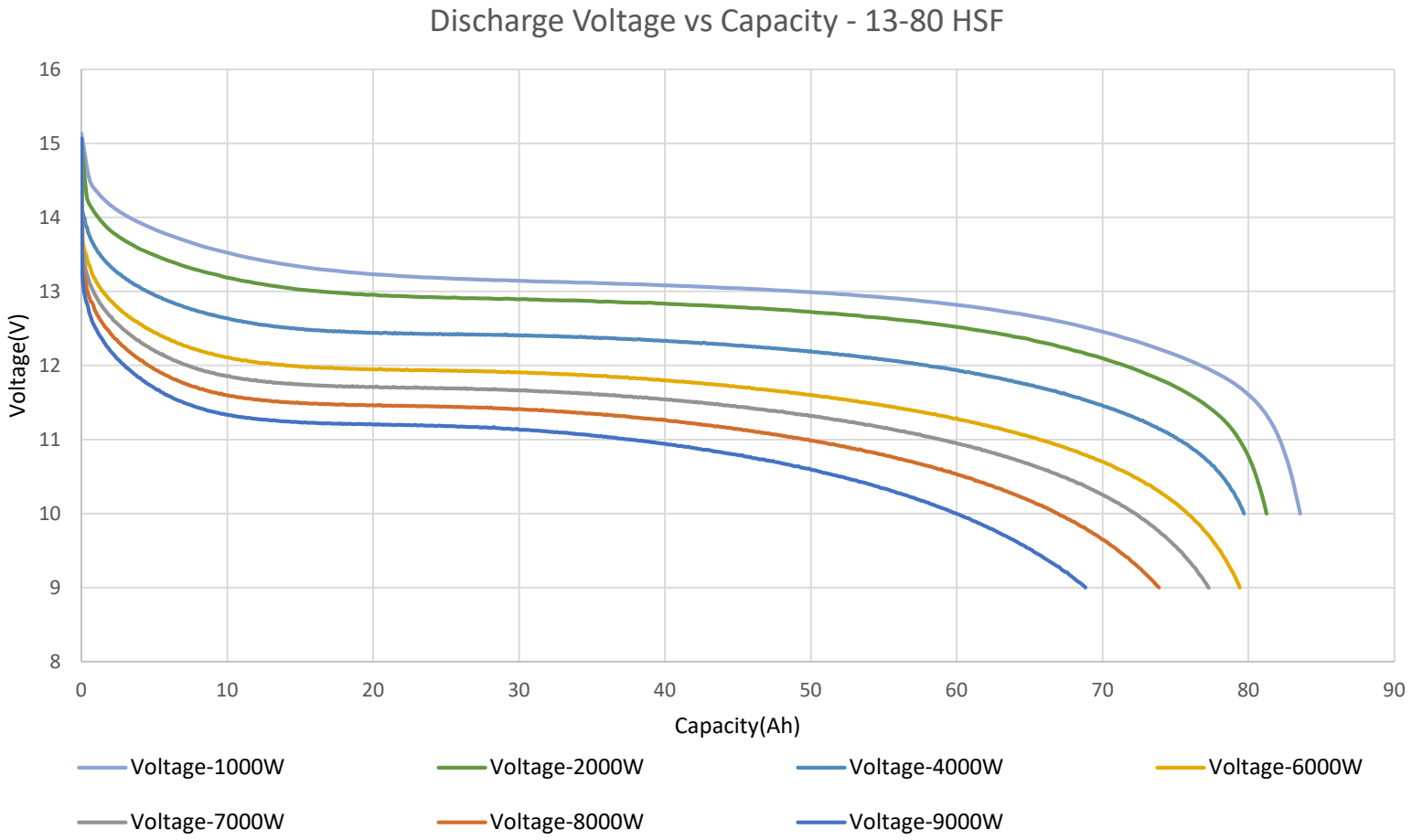
Positive terminal Red.
Negative terminal Blue.



Battery Size	LN3
Terminal /Torque	Ni Plated Copper Terminal with M6*10mm Bolt, Torque to 10Nm (90 in.-lb.)
Length (in/mm)	10.9 / 277
Width (in/mm)	6.9 / 175
Height (in/mm)	7.4 / 188
Weight (lbs/kg)	33 / 15

Cell Component	Description
Positive	Nickel Hydroxide, nickel metal
Negative	Zinc oxide, zinc metal, copper, tin
Separator	Polypropylene
Electrolyte	Proprietary KOH based water solution
Case	Noryl SE100X PPE+PS plastic

Discharge Performance (const P) – Single 13-80 HSF



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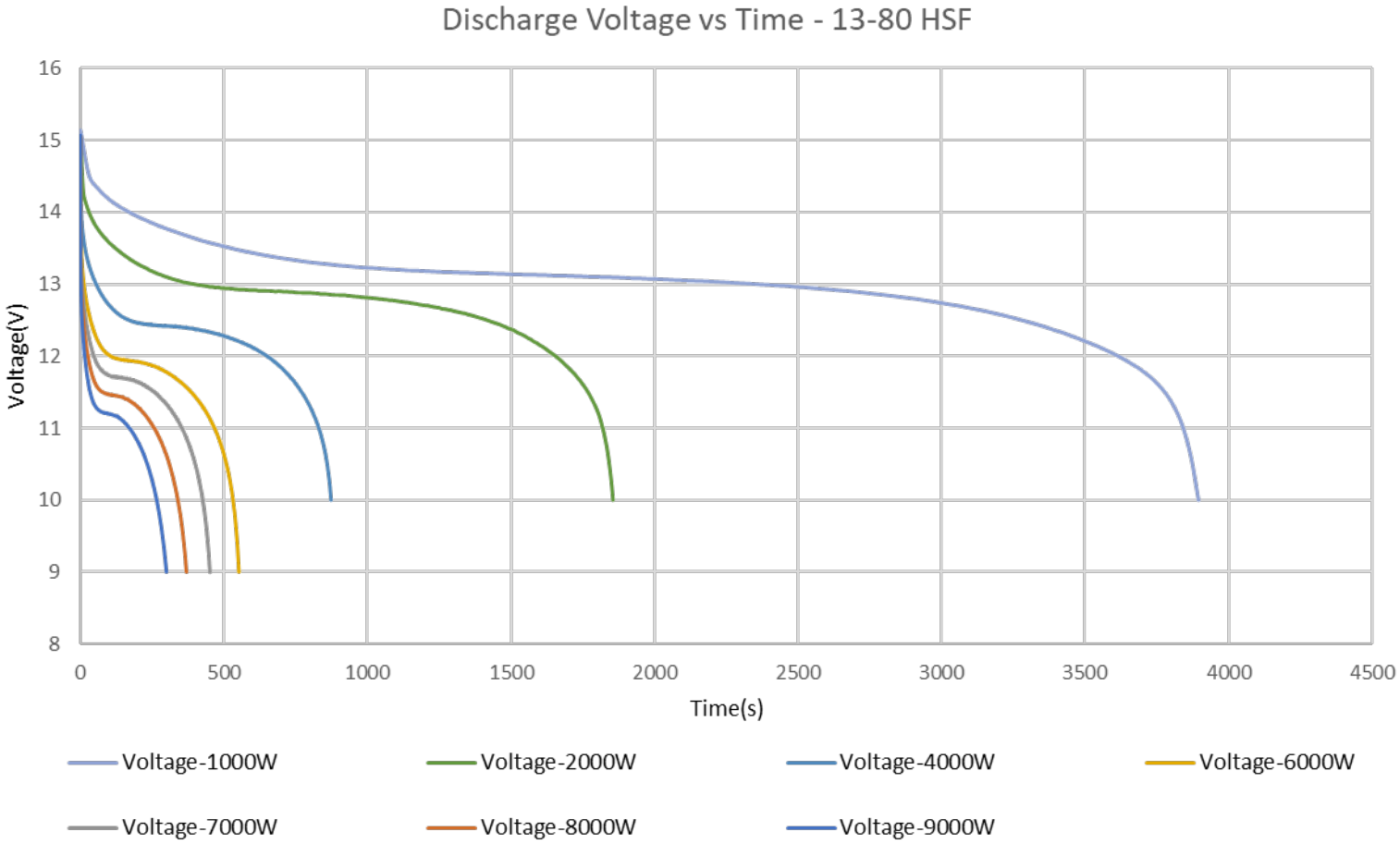

>90% Recyclable with no toxic chemicals, reducing toxic environmental impact and human injury

ZincFive NiZn Sustainability

- Can be recycled utilizing **existing recycling equipment and processes.**
  - Lithium battery volume recycling is still uncertain
  - Lead- acid batteries have a good recycling story in the developed countries due to legislation

- **No transportation restrictions: highway, air, overseas.**
  - Lithium batteries may be required to ship separately from their cabinets
  - Lead acid ships completely populated

- Manufactured with abundant, **readily available commodity materials**.
  - Lithium manufacturers prioritize automotive and grid storage battery solutions – leading to growing lead times
  - Lead acid lead times are consistent

Monobloc & Cylindrical Cell

ZincFive

Thank You