The Power You Need

Presented by:
Doc Anderson - Director of Motive Power Training and Applications
Samer Elshafei - Vice President of Commercial and Industrial Sales
Agenda

• East Penn & Navitas Systems overview
• Battery technologies
• Battery performance
• The right battery for the right application
• Sustainability
• East Penn – Your energy storage solution provider
East Penn Overview
East Penn Today

• Largest single-site and largest privately-held battery company
• 3 U.S. Battery manufacturing locations
  • Lyon Station, PA - 520 Acres
  • Ann Arbor, MI
  • Corydon, IA
• Vertically integrated
• Quality culture
• Investment in our people
• Over 70 years in the industry
• Single source technology solutions

10,000+ Employees Globally
DEKA North American Dealer/Support Network

Our strength is in the Deka Network's ability to provide the technologies, products, & support to optimize customers’ operations.
Navitas Systems Overview

- Family owned company founded in 2012 with two generations in place.
- Headquarters: Woodbridge, IL
- R & D/Government Work: Ann Arbor, MI
  - 48,000 sq. ft.
  - 60 scientists & engineers
  - 100+ employees
- Battery manufacturing: Ann Arbor, MI
  - 100,000 sq. ft.
  - 50+ employees
- East Penn acquired majority share in 2019
Battery Technologies
Lead Battery Chemistry

- Two unlike metals in acidic solution
  - Positive plate = PbO$_2$ – lead dioxide
  - Negative plate = Pb - lead
  - Electrolyte = H$_2$SO$_4$/H$_2$O – dilute sulfuric acid
Lead Battery Chemistry

• Technology types
  • Flooded – Electrolyte that is liquid based.
  • Absorbed Glass Mat - A glass microfiber separator absorbs and retains the electrolyte in direct contact with the plate.
  • Gel - Electrolyte which has been immobilized by addition of silica powder or other gelling agent.
Li-ion Cell Chemistry

Cathode(+)  

- **LFP**  
  Iron Phosphate  
  Increasing Energy  

- **LMO**  
  Manganese Spinel

- **NCM**  
  Ni/Co/Mn

- **NCA**  
  Ni-Co-Al

Increasing Safety

**LFP Has the Greatest Life in Motive Power Applications**
Battery Performance
Understanding Lead & Lithium Batteries
Performance Characteristics of Lead Batteries

1000 AH capacity, 36 Volt Example

- We can use 80% or 800 AH over six hours
- For heavy and/or high lifting the truck consumes more amps
- Lead batteries are impacted by the rate of discharge
  - Think of a mix of drive and lifting
  - Think “put away” or, “elevator” operations

Key Point:
The greater the amps consumed, the fewer available AH
Performance Characteristics of Lead Batteries

1000 AH capacity, 36 Volt Example

- Conventional batteries are rated at 1 EBU per day
- Opportunity charge batteries are rated at 1.25 EBUs per day
- Fast charge batteries are rated at 1.6 EBUs per day

Key Point:
Equivalent Battery Unit (EBU) is defined as one discharge to 80% depth of discharge
1000 AH Lead Battery Dynamic Discharge
Performance Characteristics of Lithium Batteries

• Lithium batteries are not influenced by the rate of discharge
  • If a battery is rated at 700 AH the battery can be:
    • Discharged at 560 amps for one (1) hour
    • Discharged at 280 amps for two (2) hours
    • And so on…

Key Point:
The lithium battery will deliver full useable AH
1000 AH capacity, 36 Volt Example

• Our lithium equivalent battery will be measured in AH throughput
  • The battery is rated at 700 AH
    • We can use 80% or 560 AH
  • Regarding AH throughput…
    • The key focus with lithium is kWh throughput
      • As a result of higher discharge voltages, less Amps are required, and less AH
    • The kWh throughput is about 65,000 kWh
    • This is about 55% more lifetime kWh than the PSOC lead battery
Lithium Battery Dynamic Discharge
How Does the Truck React to a Battery?

• During discharge, the lithium battery voltage does not decrease as much as lead.
The Right Battery for the Right Application
Finding the Right Power Solution

• Understand your operations, costs, duty cycles, and goals
  • Site survey
  • Power study

• Deliverables
  • Performance modeling
  • Maintenance modeling
  • Financial modeling
  • Life modeling
Application Analysis

• Factor in each aspect of the process:
  • Acquisition and installation
  • Productivity
  • Charging
  • Changing
  • Maintenance
  • End of life
  • Duty cycle
  • Temperatures

• Power Study
  • Temperature of operations
    • Discharge & recharge
  • Duty cycle
    • AH throughput & rate of discharge
    • Time to recharge and equalize
  • Cables & connector(s) – single or double
  • Life
    • Ampere Hour (AH) throughput, years of service
    • Depreciation schedules
Understanding the Big Picture

• Needs are many and varied
  • One or two shifts
  • Cold storage
  • Three shifts

• There’s no single technology that serves all applications
  • The goal is to identifying all the business case dimensions and apply the right solution(s)
Determining the Best Solution

• Both lead and lithium batteries have applications, performance, life, and maintenance differences
  • Lead Batteries
    • Low cost
    • Wide ranging applications
    • Proven technologies
      • Conventional or Partial State of Charge
    • Affordable to very low maintenance
    • Efficient recycling streams
  • Lithium Batteries
    • Higher initial acquisition cost
    • Partial state of charge
    • Higher discharge voltages
    • Very low maintenance
    • Highly efficient recharge
Applications Targets and Summary

• Lead “shines” in
  • Initial cost
  • Conventional and PSOC charging applications
    • \( \leq 1.6 \) EBU’s per day
  • Multiple shifts
  • Flooded and maintenance free

• Lithium “shines” in:
  • Cold storage applications
  • High AH throughput
    • >1.6 EBU’s per day
  • Multiple shifts
  • Customers desiring zero watering
  • Customers desiring zero equalize charging
Financial Modeling

• Comparison of the total cost of ownership of both lead and lithium batteries
  • Acquisition
  • Operations
  • Maintenance
  • End of life

• Financial analysis
  • To determine the value of the financial investment of the technologies
    • Return on Investment (ROI) - Payback period
    • Internal Rate of Return (IRR) – What is the “Interest Rate” of the investment
    • Net Present Value (NPV) – Consolidation of the costs, savings, and value of the saving
    • Total Cost of Ownership (TCO) – Entire cost over the life of the project
TCO Comparison

Key factors:

- AH throughput
  - 1.2 lead EBU’s
- Shifts per week
  - 10 shifts
- Cost of electricity
  - $.06 kwh
- Fully loaded operator costs
  - $22.50 PH/PP
- Battery fleet size
  - 150 batteries
TCO Comparison

Key factors:
- AH throughput
  - >1.6 lead EBU’s
- Shifts per week
  - 18 shifts
- Cost of electricity
  - $.08 kwh
- Fully loaded operator costs
  - $70 PH/PP
- Battery fleet size
  - 226 batteries
Battery Solution Development – Lead & Lithium

• Compare and contrast both technologies:
  • Acquisition and installation
  • Cycle life
  • Charging
  • Changing
  • Maintenance
  • End of life

Key Point:
Make the data driven solution that is optimal for the customers’ needs
End of Life Solutions - Lead

LEAD BATTERIES ARE 99% RECYCLABLE

LEAD BATTERIES are the MOST RECYCLED PRODUCT in the United States

1 National Recycling Rate Study, Battery Council International, 2017
End of Life Solutions – Lithium

• Current lithium end of life solution:
  • Many elements can be reused/recycled
    • Counterweight tray - Steel
    • Battery pack case - Steel
    • Cables - Copper
    • Hardware - Steel

Key Point:
East Penn is committed to receiving all Deka Ready Power units back at the end of their life for proper disposal.
East Penn – Your Energy Storage Solution Provider
We are Specialists

• Lead and lithium battery specialists
• Focused on providing factual data for various power solutions
• Sales tools, solution proposal development, ease of ordering
• Focused on helping you reach your material handling goals
Product Attributes

• Lead
  • Rugged flat plate design
  • Proprietary oxide
  • 5-step retention system
  • Exclusive formation process
  • Quality system

• Lithium
  • Widest range of 24/36/48 volt products
  • Exclusive
    • BMS
    • BMS software
  • UL Listing
  • Lithium iron phosphate chemistry
  • Safety certified
    • UL drop test
    • Nail penetration
Summary

• Find a partner who is committed to:
  • Provide **reliable and powerful** solutions
  • Provide **financial solutions** for our customers to consider
  • Provide a **safe solution**
  • Provide an **end of life solution** for both Deka lead and lithium batteries
  • Provide the tools to **help customers** optimize their operations
For more information:

Doc Anderson – Director of Motive Power Training and Applications
Speaker email: danderson@dekabatteries.com
Website: www.dekabatteries.com

Samer Elshafei – Vice President of Commercial and Industrial Sales
Speaker #2 email: selshafei@navitassys.com
Website: www.navitassys.com

Visit MODEX Booth 6629