WORLD CLASS HEALTH & SAFETY EVENT

Michigan Safety Conference

Implementing a PSM Program at a Battery Manufacturing Plant

Andrea Maurer,
Ford Battery and Powertrain Manufacturing Engineering Safety Manager
Scott Houghton,
Ford Global Battery & Electric Vehicle Safety Manager

94 Years - Find Your Safety _____!

INTRODUCTION

Our experience implementing Process Safety Management at a new battery cell manufacturing plant

- Lots of experience in building vehicles.
- Limited previous experience with PSM
- Implementation of our PSM system is ongoing

Instructions

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LITHIUM-ION BATTERY RESEARCH & MANUFACTURING

CURRENT STATE

- Ongoing battery research at Dearborn R&E Center
- Ford Ion Park pilot plant in Romulus, MI opened in 2024
- Currently purchase batteries from suppliers such as LG and SK

NEW LITHIUM-ION BATTERY MANUFACTURING PLANTS

COMING SOON

Blue Oval – SK (BOSK)

- Joint venture with SK-On
- Glendale, KY and Stanton, TN
- Lithium Nickel Manganese Cobalt (NMC) batteries

Blue Oval Battery Park (BOBPM)

- Marshall, Michigan
- Wholly-owned subsidiary
- Technology licensed from CATL
- Lithium Iron Phosphate ($LiFePO_4$) batteries

LITHIUM-ION BATTERY RESEARCH & MANUFACTURING

dilbert-risk-21.gif (640×199)

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§ 1910.119 Process safety management of highly hazardous chemicals.

Covered processes:

1. Process which involves a chemical at or above the specified threshold quantities listed in Appendix A of this section
2. A process which involves a Category 1 flammable gas
   - Ignitable when in a mixture of 13% or less by volume in air, or
   - Have a flammable range with air of at least 12 percentage points regardless of the lower flammability limit
3. A process which involves a flammable liquid with a flashpoint below 100 °F (37.8 °C)

§ 1910.119 Process safety management of highly hazardous chemicals.

Exceptions:

- Hydrocarbon fuels used solely for workplace consumption as a fuel (e.g., propane used for comfort heating, gasoline for vehicle refueling), if such fuels are not a part of a process containing another highly hazardous chemical covered by this standard
- Flammable liquids stored in atmospheric tanks or transferred which are kept below their normal boiling point without benefit of chilling or refrigeration.
- Retail facilities
- Oil or gas well drilling or servicing operations
- Normally unoccupied remote facilities

§ 1910.119 Process safety management of highly hazardous chemicals.

Threshold Quantities:

- Appendix A chemicals – varies by substance
- Flammable gases and liquids:
  - A quantity of 10,000 pounds (4536 kg) **on site in one location**

OSHA interprets "on site in one location" to mean that coverage extends to vessels within contiguous areas controlled by an employer or group of affiliated employers.

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OSHA PSM VS. EPA RMP

- OSHA's Process Safety Management (PSM) focuses on protecting workers from hazardous chemicals **in the workplace**, while EPA's Risk Management Program (RMP) aims to protect **the community and environment** from accidental releases.

  - EPA list of covered chemicals is similar to OSHA Appendix A but not exactly the same

  - EPA RMP covers 63 specific flammable chemicals but not those used at battery manufacturing plants

BENEFITS OF IMPLEMENTING PSM

Understanding Process Safety Management (PSM) in Malaysia - Elements, Requirements & More

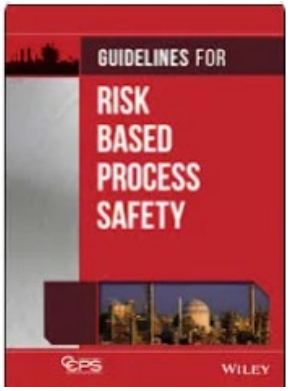
GETTING STARTED ON PSM

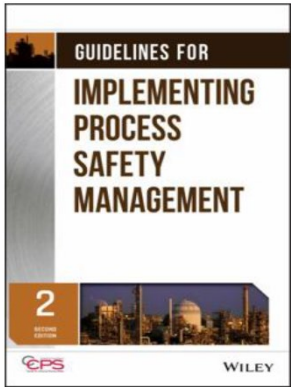
We go to PSM Boot Camp

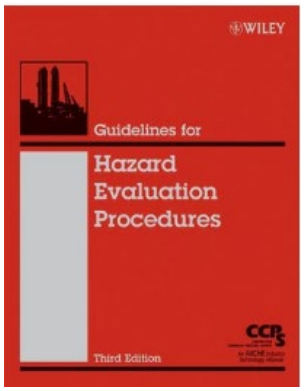
We read a bunch of PSM books

We start looking for a PSM consultant

Forrest Gump (1994) - Afemo Omilami as Drill Sergeant - IMDb



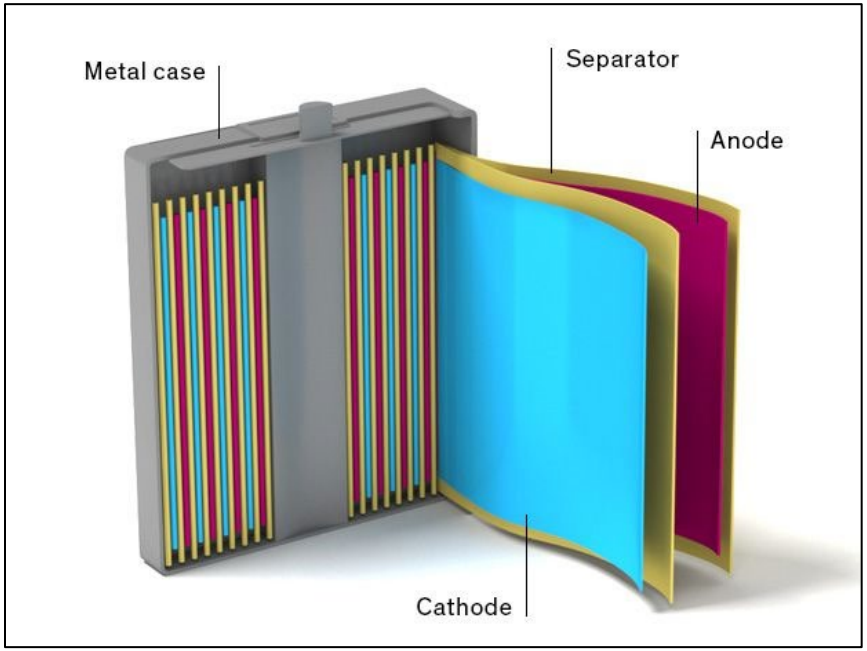




CCPS and Process Safety Publications | AIChE

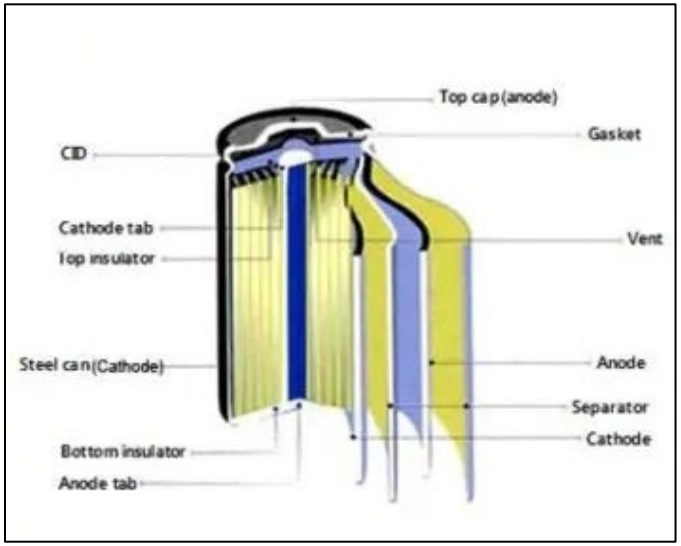
BATTERY TYPES

Prismatic Battery

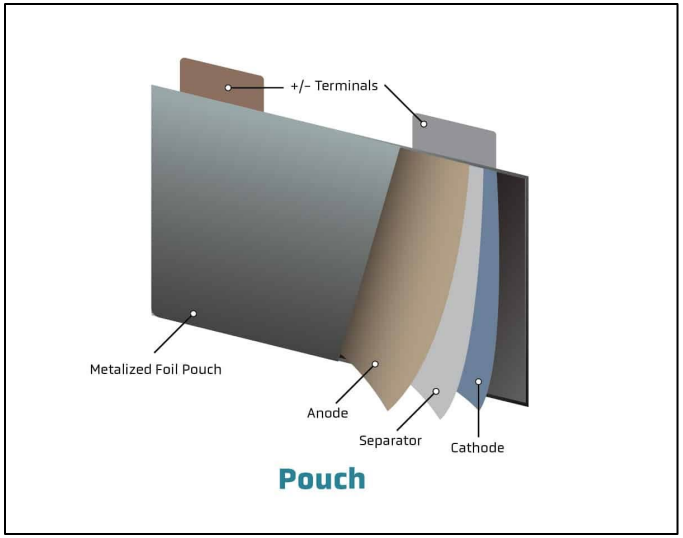


[How to Build a Safer, More Energy-Dense Lithium-ion Battery - IEEE Spectrum]

Cylindrical Battery



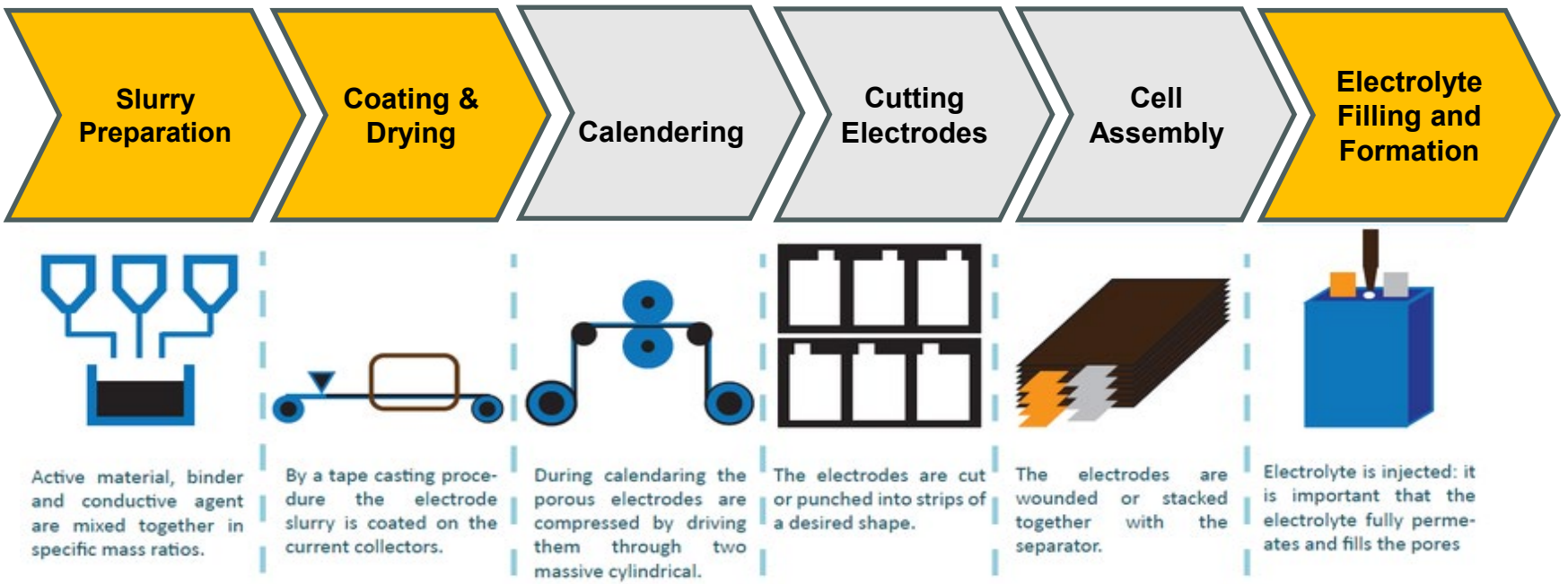
Pouch Battery



Common Features:

- Anode (-): Coated copper
- Cathode (+): Coated aluminum
- Separator

BATTERY MANUFACTURING OVERVIEW



https://vdma-industryguide.com/batteryproduction/downloads

Slurry Preparation

Electrode manufacturing

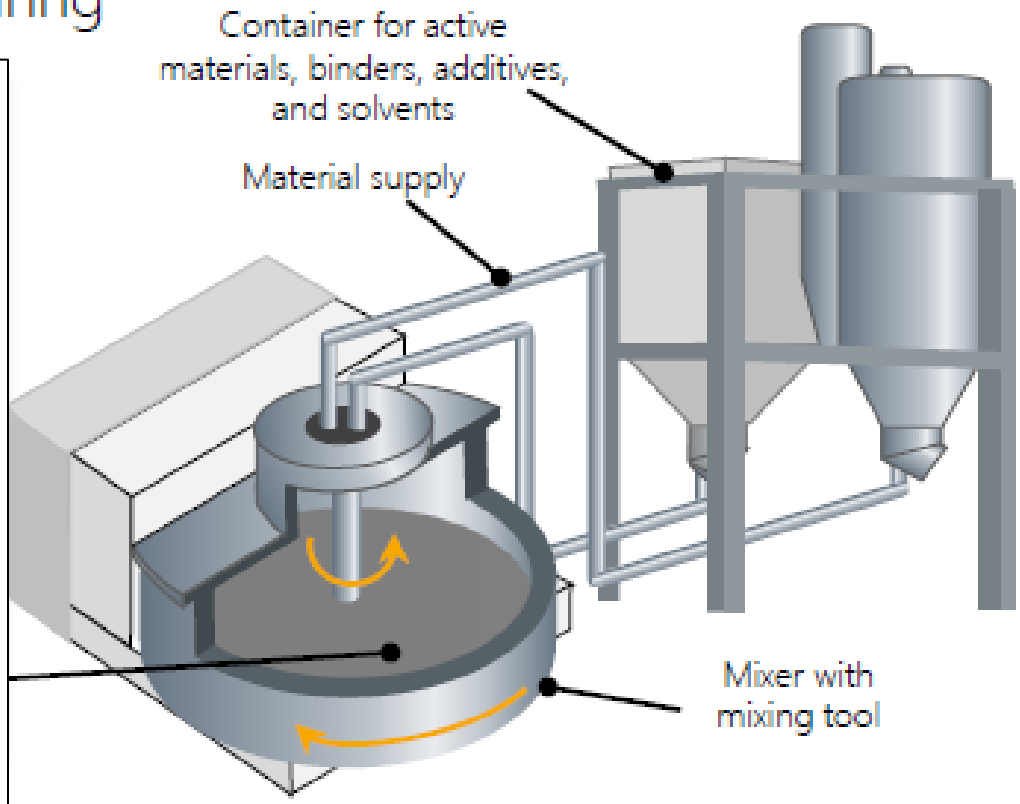
Typical Materials:

Anode

- **Powder: Graphite**
- **Solvent: DI Water**

Cathode

- **Powder: $LiNiMnCoO_2$ $LiFePO_4$**
- **Solvent: NMP**



Cell assembly | Cell finishing

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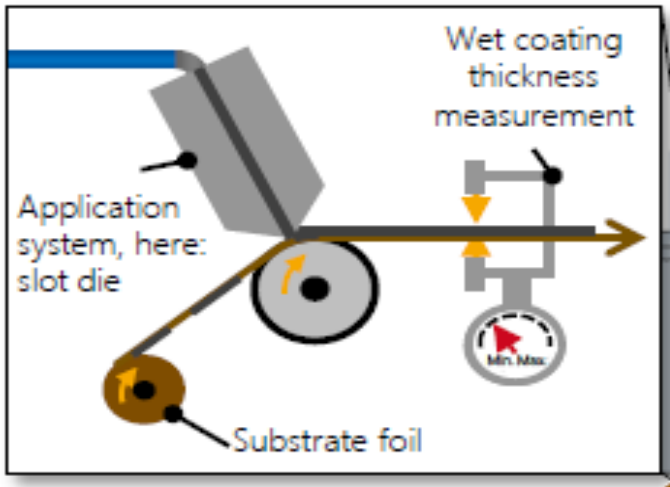
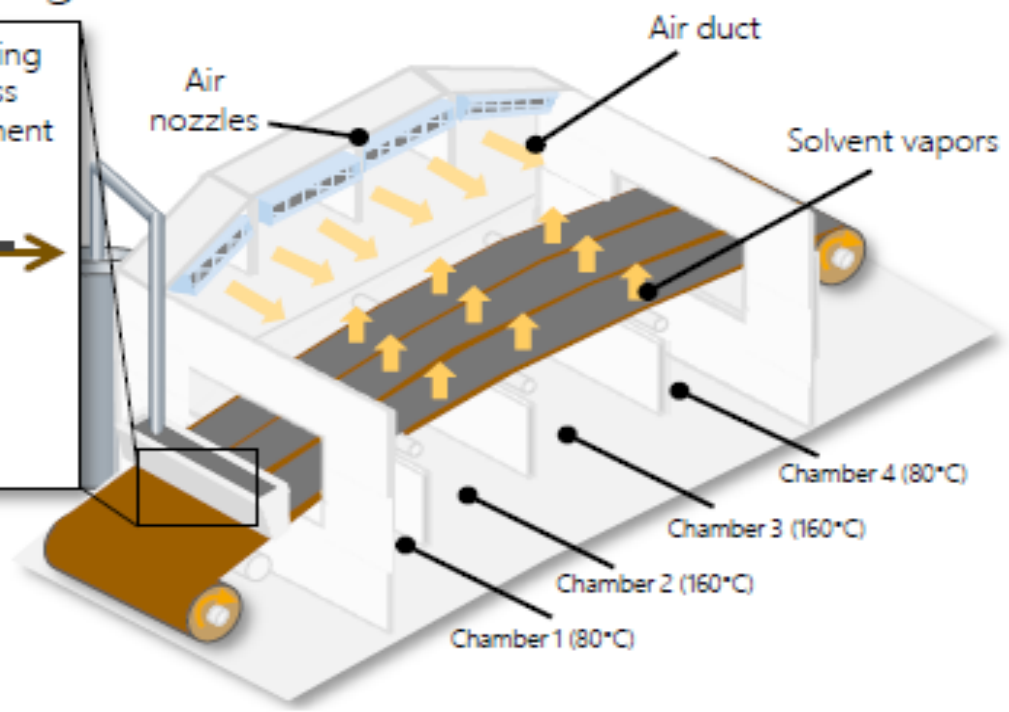
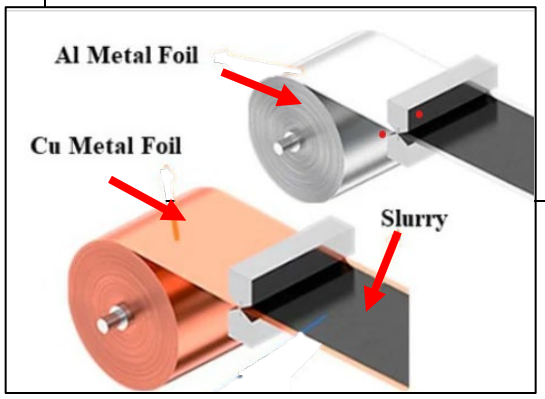
BATTERY MANUFACTURING OVERVIEW

Coating & Drying

Electrode manufacturing







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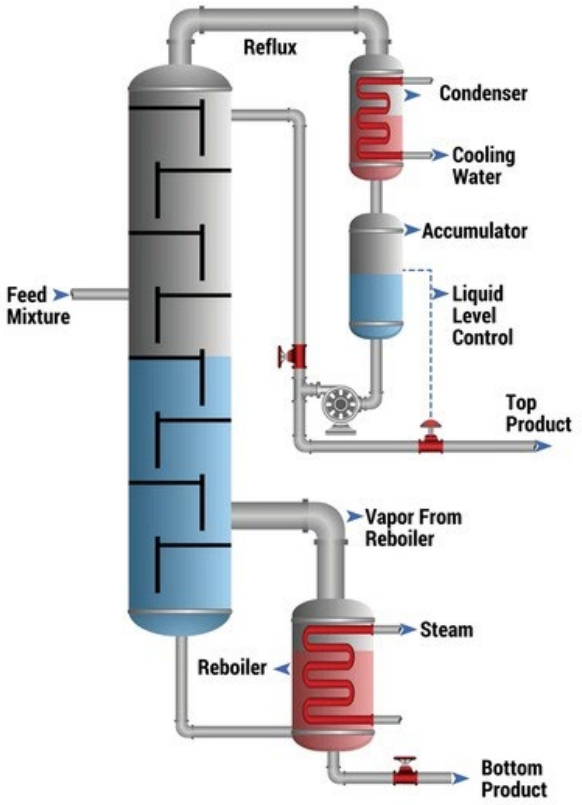
NMP Reclamation

NMP solvent removed during the cathode drying process can be reclaimed using a distillation process

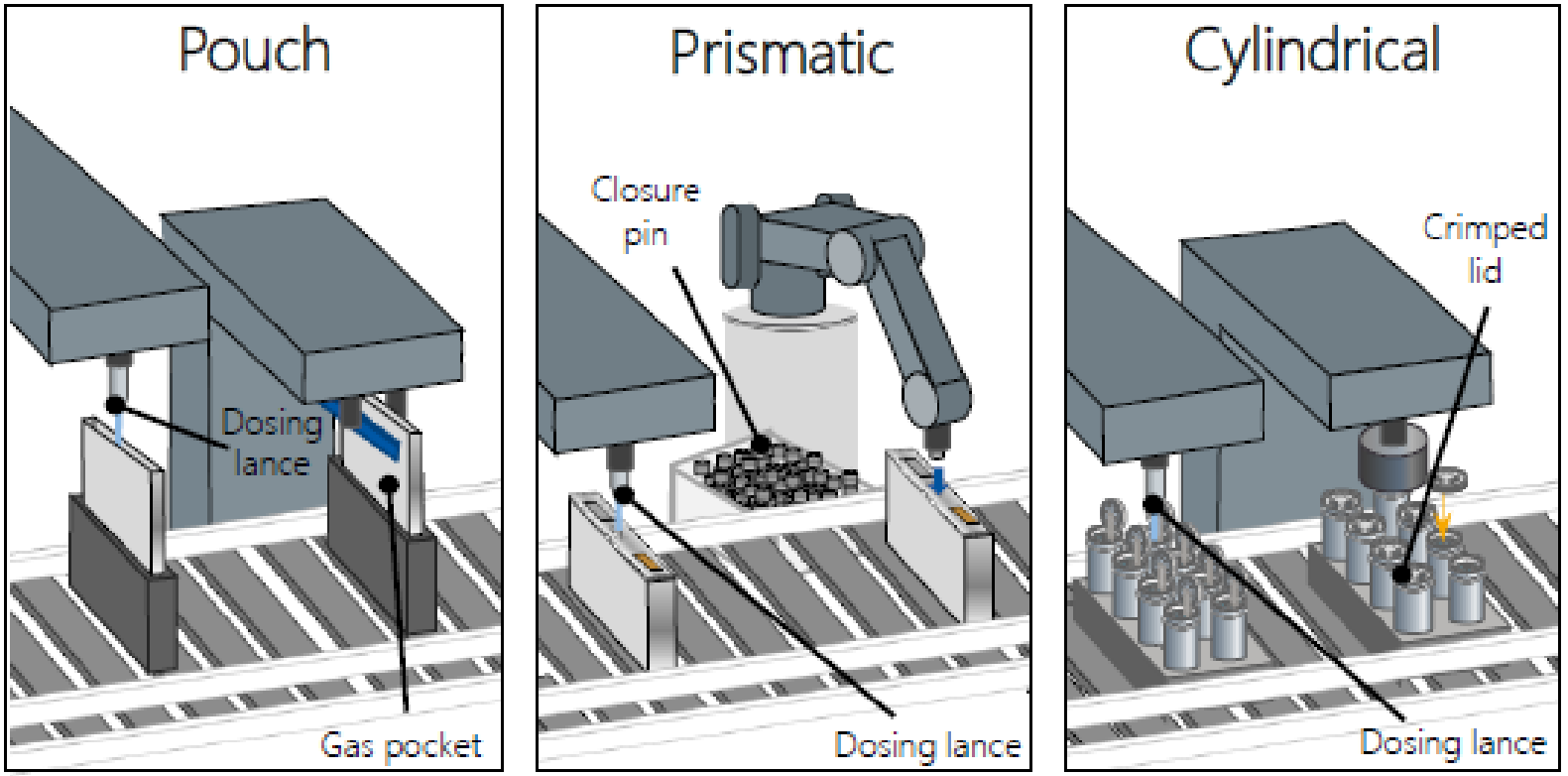


Vector Illustration Distillation Column Eps10 Stock Vector (Royalty Free) 2207077179 | Shutterstock

BATTERY MANUFACTURING OVERVIEW

Electrolyte filling

Cell assembly

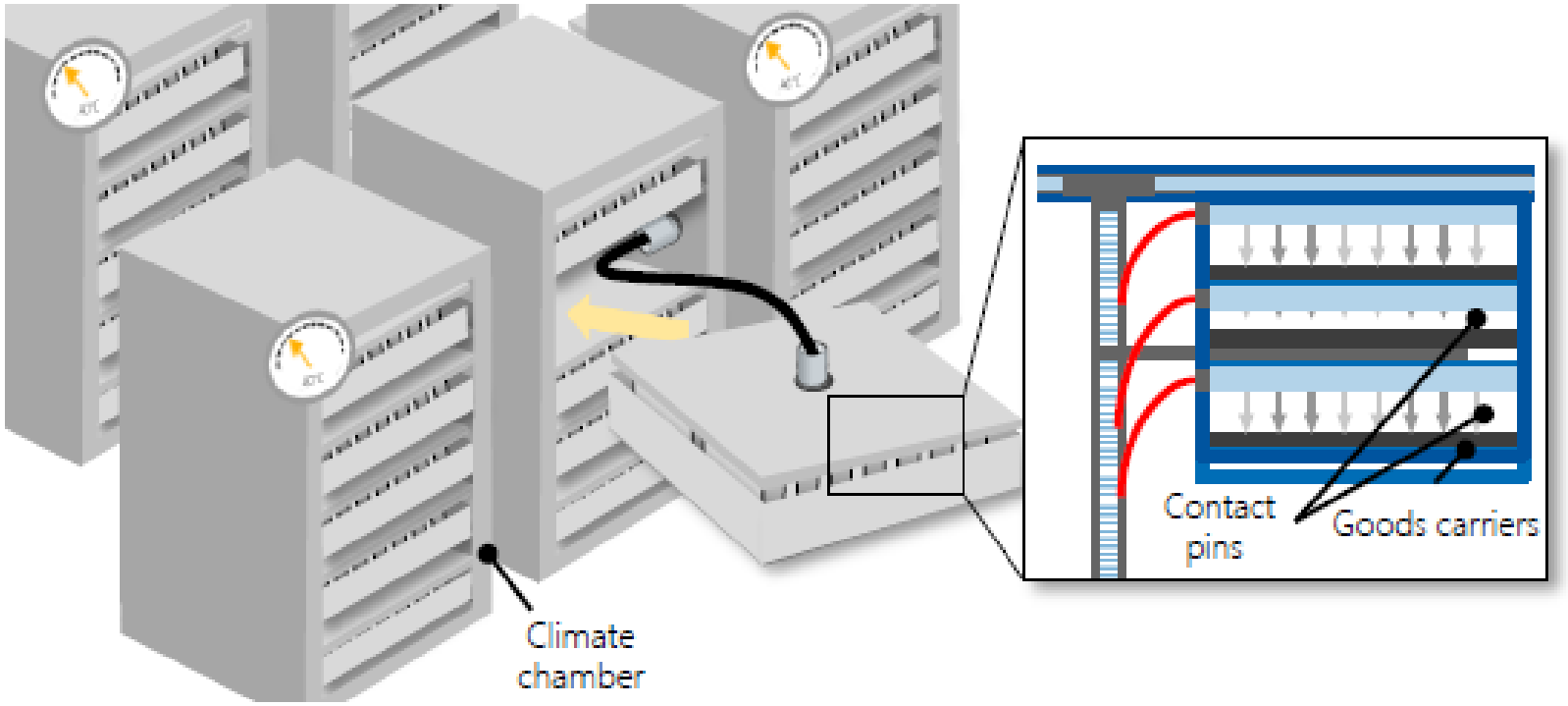


Electrode manufacturing → Cell finishing

https://vdma-industryguide.com/batteryproduction/downloads

Formation

Cell finishing



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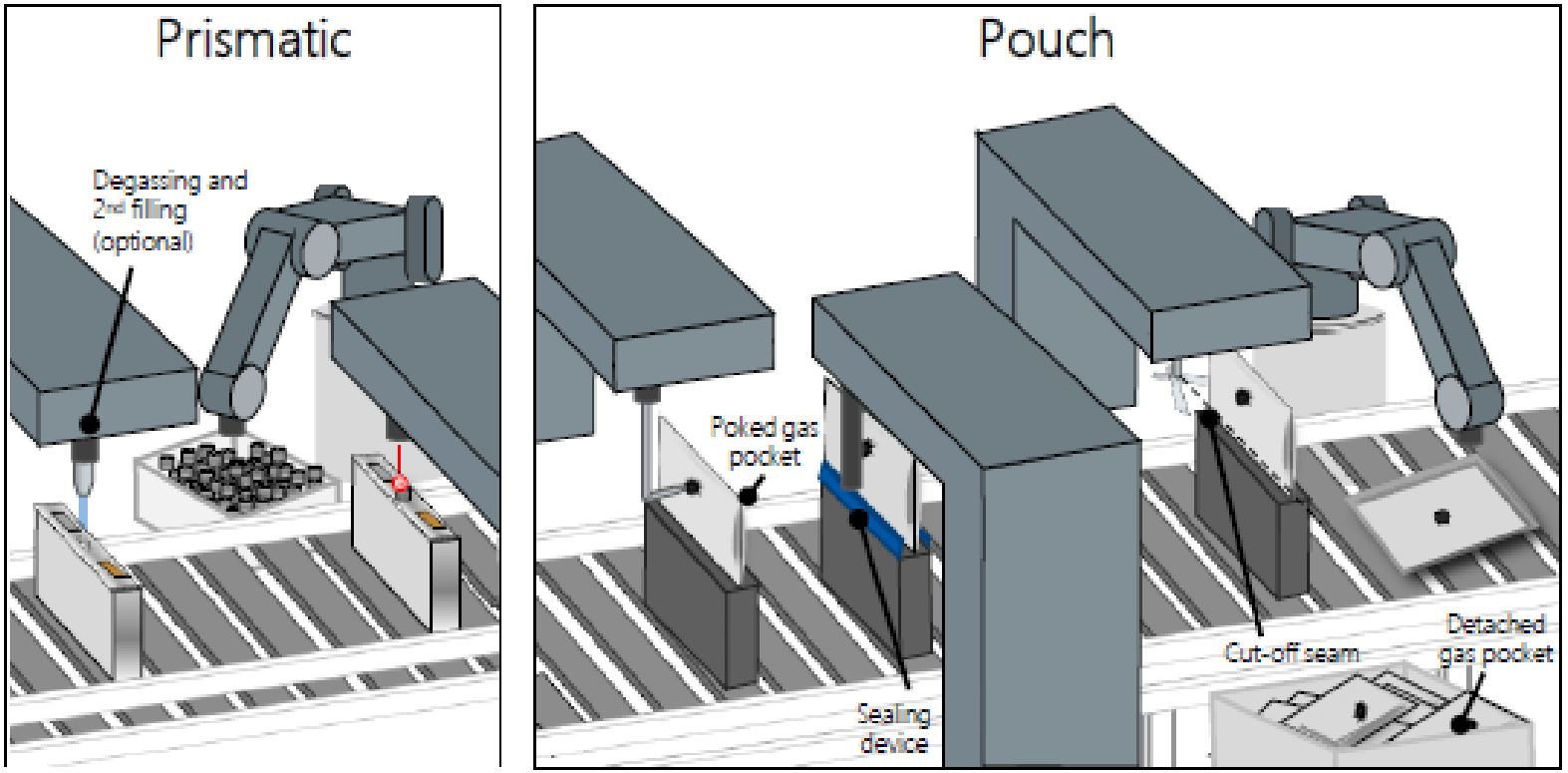
BATTERY MANUFACTURING OVERVIEW

Degassing

Cell finishing



Electrode manufacturing | Cell assembly

https://vdma-industryguide.com/batteryproduction/downloads

TYPICAL BATTERY MFG CHEMICALS THAT ARE COVERED BY PSM

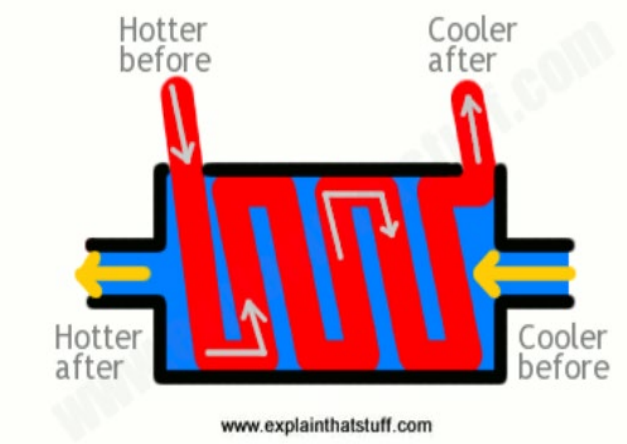
N-Methyl Pyrrolidone

- Combustible liquid: flash point = 196°F (91°C)
- Heated above flash point during distillation process
- > 10,000 pounds in process

NMP Impianti Di Abbattimento E Recupero

“Hot Oil” Heat Exchanger Fluid

- Combustible liquid: flash point > 300°F (148°C)
- Heated above flash point during cathode drying
- > 10,000 pounds in process



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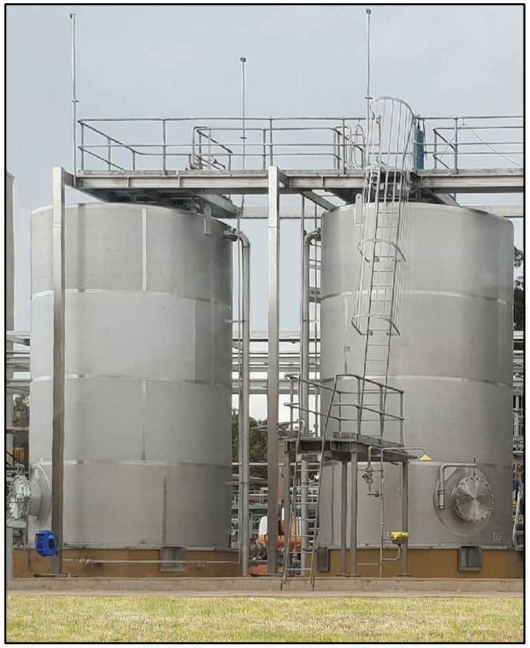
TYPICAL BATTERY MFG CHEMICALS THAT ARE COVERED BY PSM

Battery Electrolyte

- Primary components are flammable liquids
- Alkyl carbonates are typically the primary ingredients, such as:
  - Ethyl methyl carbonate
  - Diethyl carbonate
- Typical battery plants have >> 10,000 pounds, stored in pressurized tanks



Tank farms | Lycopodium

CHALLENGES & LESSONS LEARNED – JOINT VENTURE PARTNERS

Battery OEMs

- Battery process knowledge and plant design
- Input on equipment specifications and procurement

Ford

- Knowledge of U.S. safety standards
- Primarily responsible for leading PSM implementation

Potential Challenges

- Language
- Distance/travel
- National/corporate cultures
- Different national safety regulations
- Confidentiality

CHALLENGES & LESSONS LEARNED – FIND A GOOD CONSULTANT

Lots of PSM Consultants:

- We talked to 4 or 5 of them – you would probably recognize their names

Selection Criteria:

- Experience with non-traditional clients
- Experience outside of oil/gas/chemicals
- Flexible on scope of work – turnkey vs. a-la-carte
- Willing to provide advice outside of scope of work

Objectives:

- Complete preliminary hazard analysis
- Assist with “difficult” PSM elements, such as Mechanical Integrity

Software for PHAs (used by consultants)

- PHAWorks Lite (Primatech)
- PHA Pro 8 (Sphera)

Software for management of other PSM Elements

- Integration with existing business processes
- IT approval, cybersecurity

Reviewing options

- Input welcome

https://techcrunch.com

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Do Process Hazard Analyses as early as possible

- Availability of Piping & Instrumentation Diagrams (P&IDs) limits early start time
- Preliminary PHA after 60% Design Review

Risks of Starting Late

- Availability of people to participate in PHAs during launch
- Resolving issues after process is already constructed

CHALLENGES & LESSONS LEARNED – PHA EXPERIENCE

Cover "ground rules" first

Alignment on Probability and Severity

- Focus on each aspect of risk separately
- Consider severity first – without controls
- Choose credible scenarios
- No double-jeopardy
- The risk of human error is never zero

Use a "parking lot" to capture issues and move on

Word recommendations carefully – firm but flexible

Don't redesign the system during the PHA

Don't underestimate the value of an experienced PHA leader!

It's going to take longer than you expected!

Boil's Laws: Process Hazards Analysis (PHA) | AIChE

CHALLENGES & LESSONS LEARNED – DEFINING BOUNDARIES OF PSM

PSM applies to specific processes, not the entire plant

- Majority of facility is not covered by PSM

For some processes, only a portion of the process is covered

- NMP distillation – covered due to high temperature
- NMP storage/distribution – not covered

Challenges to Having Only a Portion of the Plant Covered by PSM:

- Requirements vary by area/process
- People move internally

CHALLENGES & LESSONS LEARNED – COMBUSTIBLE LIQUIDS

How to Manage Combustible Liquids > Flash Point

Inconsistent guidance from OSHA standards

NFPA standard is most conservative:

- Treat combustible liquids heated above their flashpoints as flammable liquids

We opted to follow the NFPA approach, so these processes are included in our PSM system:

- Hot oil heat exchanger fluid
- NMP distillation

1. OSHA PSM

"…flammable liquid with a flashpoint below 100 °F"

2. OSHA 1910.10 Flammable Liquids

When a liquid with a flashpoint is heated for use to within 30 °F (16.7 °C) of its flashpoint, it shall be handled in accordance with the requirements the next lower category.

3. OSHA Letter of Intent

1994: Dowtherm is not intended to be covered by 1910.119.

4. NFPA 30

Storage, handling, and use of Class II and Class III liquids [FP ≥ 100°F (37.8°C)] heated at or above their flash point shall follow the requirements for Class I liquids [FP < 100°F (37.8°C)] …

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Integrating PSM with Existing Programs & Practices

Least Challenging*

Most Challenging*

Hot Work Permits
Trade Secrets
Contractor Safety
Emergency Planning & Response
Incident Investigations
Training
Compliance Audits
Process Safety Information
Employee Participation
Operating Procedures
Management of Change
Mechanical Integrity
Process Hazard Analysis

* In our opinion

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Questions?

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Thank You for your participation.

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