

INNOVATIVE CONCEPTS FOR POWDER HANDLING, MIXING, AND POSTPROCESSING IN DRY BATTERY ELECTRODE PRODUCTION

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AGENDA



Introduction



Flow Sheet



Concepts for Dry Mixing



Material Properties



Calender Feeding

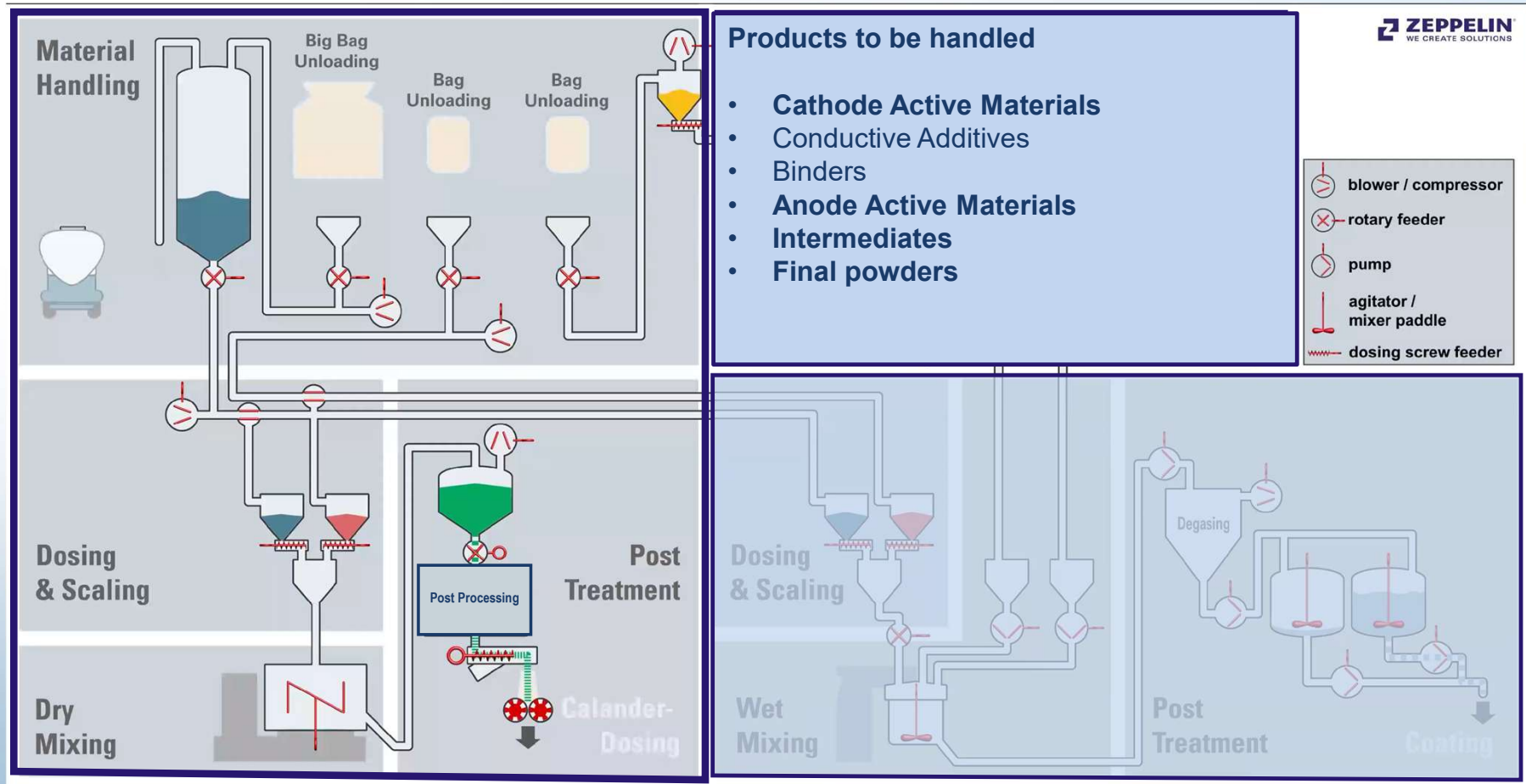


Improving of Flowability

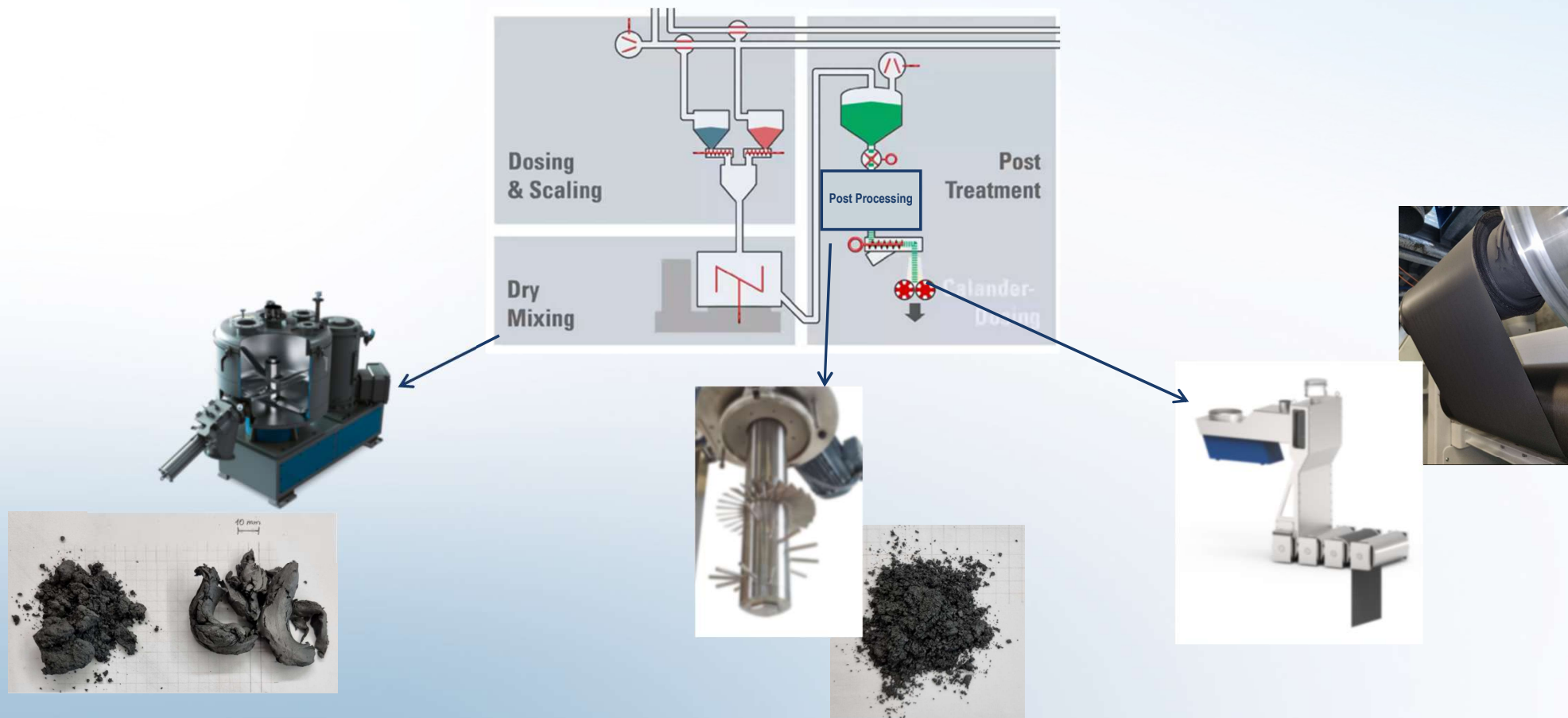


Conclusion

PROCESS FLOW SHEET



KEY STEPS IN MIXING AND POST PROCESSING



KEY PROCESS STEPS

- Complete downstream process covered with Zeppelin equipment – one stop shopping
- Dymomix used for deagglomeration and milling, possibly other process steps possible
- Direct control of quality, timeline and costs

Mixing



Feeding /
Dosing



Conditioning
/ Milling

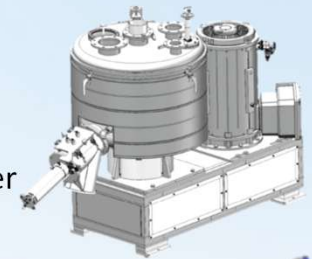


Feeding /
Dosing

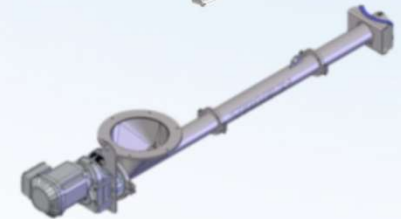


Coating

ZEPPELIN High intensity mixer



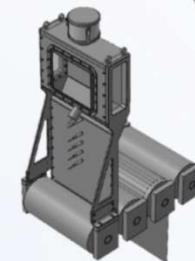
ZEPPELIN screw feeder



ZEPPELIN Dymomix



ZEPPELIN dosing unit



Calender

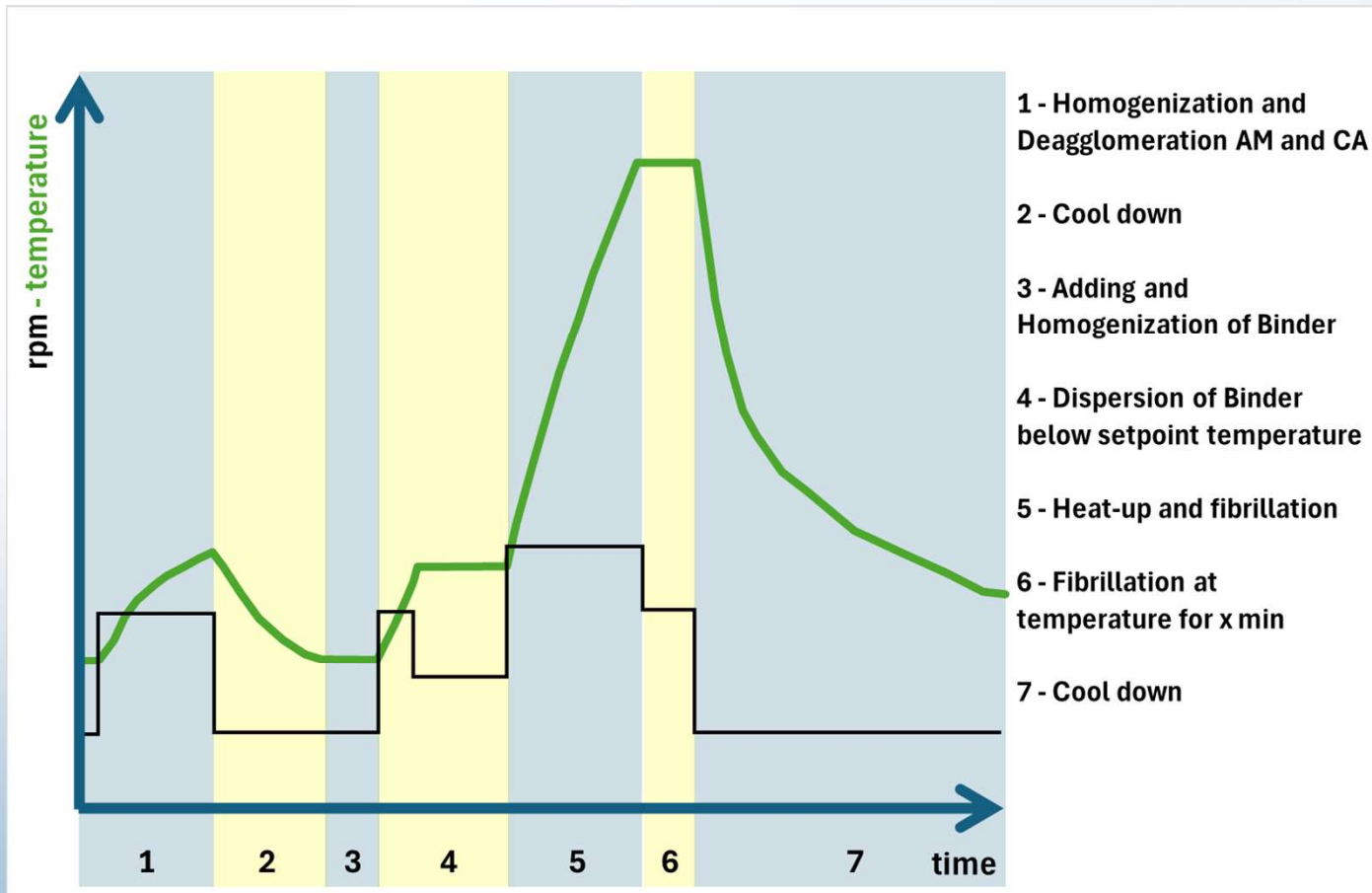
DRYROOM WITH MIXING AND LAB-CALENDER OPERATIONAL

Mixing Lab in Kassel Germany

- Dewpoint < $-30\text{ }^{\circ}\text{C}$
- Conditioned air with H14 filtering system
- Dedusting system with two stages H13/H14 on OEB4-level
- Two airlocks to avoid cross-contamination



EXAMPLE FOR MIXING PROCESS

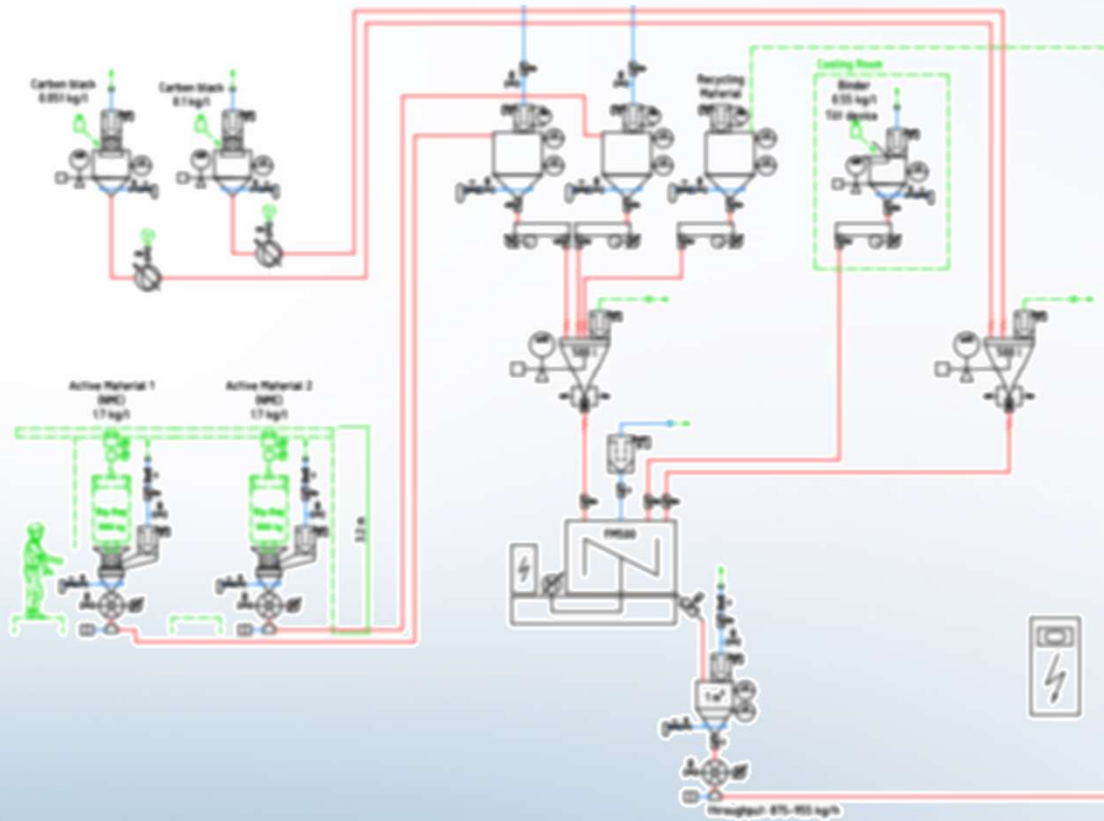


Mixing

ZEP High intensity mixer



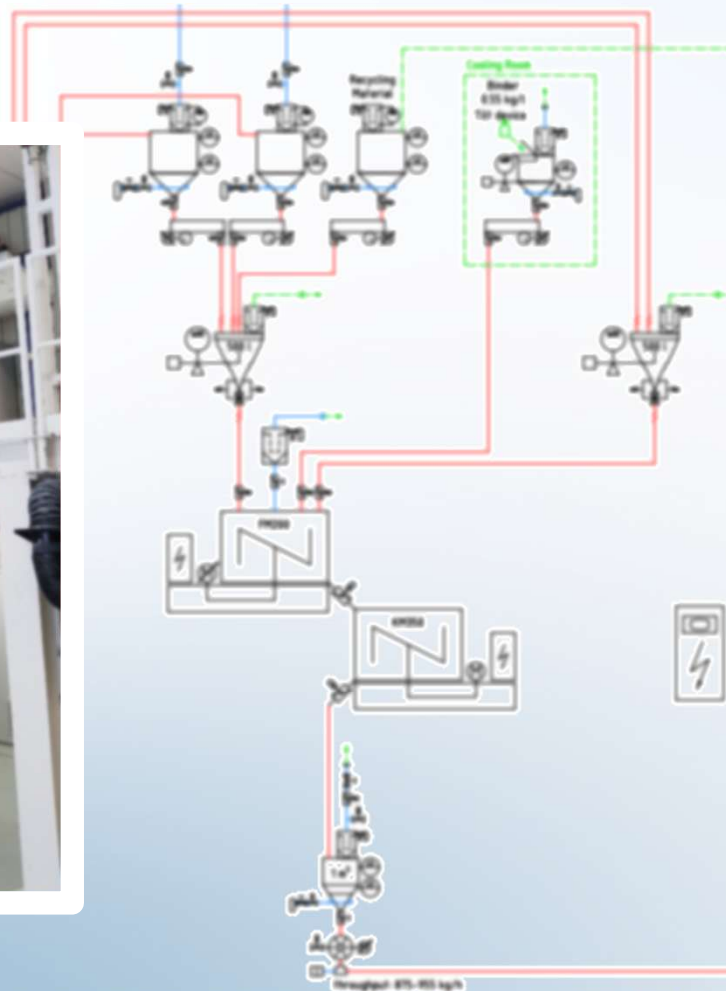
HEATING –MIXER (SINGLE STAGE)



HEATING – COOLING MIXER COMBINATION (2 STAGE)



Carbon Black
0.055 kg/l
0.055 kg/l



Advantages:

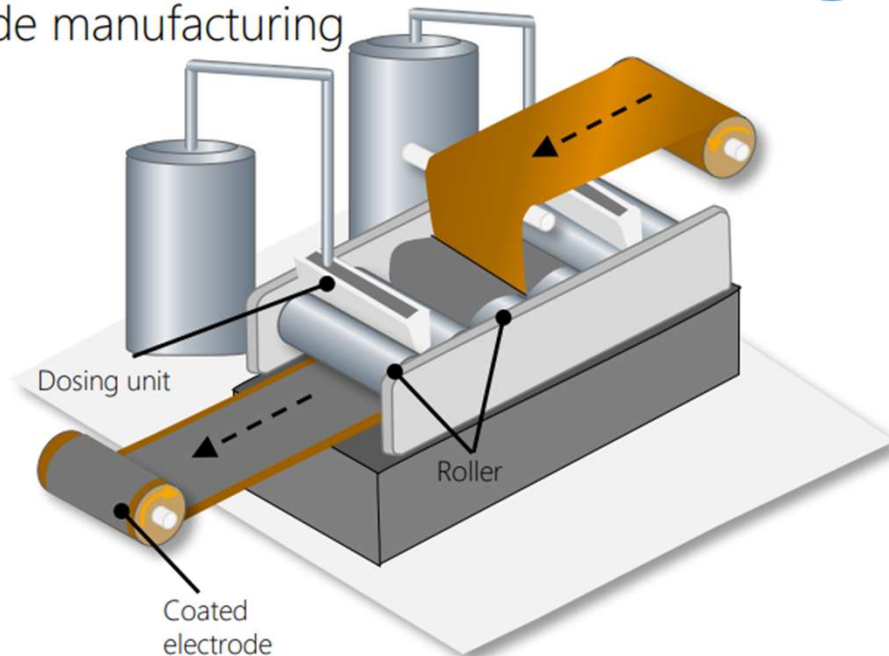
- Better process control
- Improved material structure
- Higher throughput
- Better overall use of the powder handling system
- Cost neutral or lower than single mixer

CHALLENGE FOR EVEN CALENDER FEEDING

Source: https://vdma-industryguide.com/fileadmin/battprod/downloads/Production_Process_of_a_Lithium-Ion_Battery_Cell.pdf

Dry Coating

Electrode manufacturing



- Flowability often very poor (material is made to form film at low compression, tendency to bridging)
- Risk of interlocking of agglomerates
- Temperature sensitivity
- Time consolidation



FEEDING AND DOSING UNIT FDU

Design and working principle

Consisting of

- Vibration chute with activator
- Hopper with level monitoring

Options:

- Additional activators
- Cooling of the product
- ATEX execution

Throughput

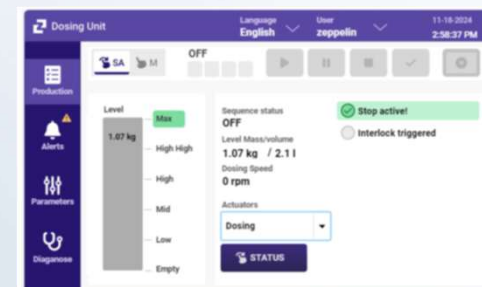
- up to 1000 kg/h per m film width

- One-sided and double-sided coating of the conductor foil possible
- Calender rolls cannot run empty of product due to continuous material storage inside the hopper
- Hopper is equipped with level monitoring
- No bridging due to special geometry of the hopper
- No dust emission of hopper and vibration chute
- Decoupling of vibrations between hopper and vibration chute
- Hopper is directly coupled to a calender roll and can move linearly with the roll



NEW FEATURES OF THE FDU

- Ready unit for lab calender
- Adjustable width
- Cooling or heating device for hopper available
- By design easy scale up to pilot lines and beyond
- Fully automated operation of calendaring



INLINE DEAGGLOMERATION UNIT



- **Still the problem of flowability**
- New post processing step
- Inline deagglomeration unit
- Flowability improved to flow in the FDU

CALENDERING TRIALS WITH IDU AND FDU

With Inline Deagglomeration and Feeding Dosing Unit – LFP Cathode



CALENDERING TRIALS WITH IDU AND FDU

With Inline Deagglomeration and Feeding Dosing Unit – Graphite Anode



CONCLUSION

- Powder handling, mixing, and postprocessing are critical process steps for DBE production.
- With experience from R&D efforts and executed industrial lines a closed solution can be offered.
- New solutions have been industrialized from challenges in the battery industry. (calendar feeding, mixer post processing,...).
- Test facilities in pilot and industrial scale and proven procedures for characterization of raw materials and intermediates are available at Zeppelin. This reduces the risk for implementing the technology in industrial scale.
- Test and rental equipment is available
- System design and scale up for large factories has been executed based on test results and long-term experience in solids mechanics, powder flow and pneumatic conveying design.

FOR MORE INFORMATION, PLEASE GO TO:
zeppelin-systems.com

 **Grafen get others on board**

 Grafen leave their footprint

 **Grafen move your heart**

 **Grafen stay on course**

 Grafen receive support

 Grafen overcome boundaries

 Grafen attract Grafen

 Grafen tip their hats

 Grafen make you think

 **Grafen fail successfully**

Thank you for your attention!

Questions?

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