HIGREEW First Project Workshop

Building a new battery system (like a jigsaw!)

In Pilsen and Online

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Introduction

Upscaling a flow battery: 2 simple steps





Introduction

"It thus can be appreciated that designing a flow battery to maximize system energy efficiency is a somewhat complex process (...)"

> Final Report of the NASA Redox Storage System Development Project, 1984

What are the challenges?

- Homogeneous distribution of electrolyte
 → different flow behaviour in cell vs. stack
- Choosing the right materials, components
- Finding suitable power electronics



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HIGREEW INNOVATIONS & EXPECTED TARGETS





HIGREEW Prototype: Specifications

On-site requirement: 10-ft-container

Rated power:5 kWRated energy:20 kWh (4h)Efficiency:80 %



CURRENT RESULTS





Balance of Plant (BoP)

Prototype design

- Stack configuration
- Piping design 🗸
- Component selection \checkmark
- Prototype design freeze 🗸
- Prototype construction





HIGREEW Prototype: Container

Container features:

- 10-ft ISO container: 2.8 x 2.4 x 2.4 m
- Thermal insulation
- Wall ventilators for air exchange
- Electrical installations
- <u>Sensors</u> for:
 - Temperature
 - Gases





https://caru-tech.com/



HIGREEW Prototype: Tank(s)

ENERGY

Rectangular tanks due to limited space:

- Made from PE or PP
- Double walls to comply with safety regulations
- Space for thermal management
- <u>Sensors</u> for:
 - Filling level
 - Temperature
 - Leakage detection (double wall)





HIGREEW Prototype: Stacks

POWER

2 AORFB Stacks

- Power (each): ca. 2.5 kW
- With active materials as specified by project partners of WP2
- Located in plastic basins to protect from spillage
- <u>Sensors</u> for:
 - Leakage detection





Required flow rate \dot{V} (Faraday's law)

$$\dot{V} = \lambda \frac{I}{z \ F \ c \ (1 - SOC)}$$

Total pressure loss Δp in piping system

$$\Delta p = \frac{\rho}{2} (u_1^2 - u_0^2) + \rho g(h_1 - h_0) + \frac{\rho u_m^2}{2} \left(\lambda_R \frac{L}{d_i} + \sum_j \zeta_j \right)$$

$$Dynamic loss Hydrostatic loss Pipe friction /$$



Capacity (Q)

https://commons.wikimedia.org/wiki/File: Pump_curve_and_system_curve.png

Fittings, valves, etc.



HIGREEW Prototype: Pumps

2 vertical centrifugal pumps

• Positioned on top of tanks

Desired for RFB:

- High efficiency
- Designed for continuous operation
 - \rightarrow material compatibility



https://renner-pumpen.de





HIGREEW Prototype: Piping system

Piping system:

• Pipe material: PVC



Compatibility testing

- Stacks connected with flexible tubes
- <u>Sensors</u> for:
 - Pressure
 - Flow rate
 - Temperature





HIGREEW Prototype: Cooling system

Reaction heat flow (approximation) $\dot{Q} = \frac{P}{U}(OCV - U)$

Cooling system

- Recirculating chiller: water as cooling medium
- Submersible plastic heat exchangers



https://www.calorplastwaermetechnik.de





HIGREEW Prototype: Tank blanketing

Inert gas blanketing

- for protection of electrolyte solutions from air
- Nitrogen (or other inert gas) bottle outside of container
- Tank blanketing system







HIGREEW Prototype: (Power) Electronics

Electrical installations

- Electrical cabinet
 - Power supply for electrical components
 - Control system (BMS)
- Electrical appliances (Lighting, etc.)

PCS: AC/DC converter

- Challenges when selecting PCS for RFB:
 - Wide voltage range
 - Typically low voltage, high current





https://www.e-education.psu.edu/eme812/node/738

NEXT STEPS





HIGREEW Prototype: The next 6 months

1. Procurement of components:

- Container
- Stacks
- Tanks and piping system
- Sensors and other instrumentation
- 2. Construction of Prototype
- 3. Commissioning and testing
- Early system tests
- Performance testing and characterization





Thank you!





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