



Amperometric State-of-Charge Monitoring for VFB

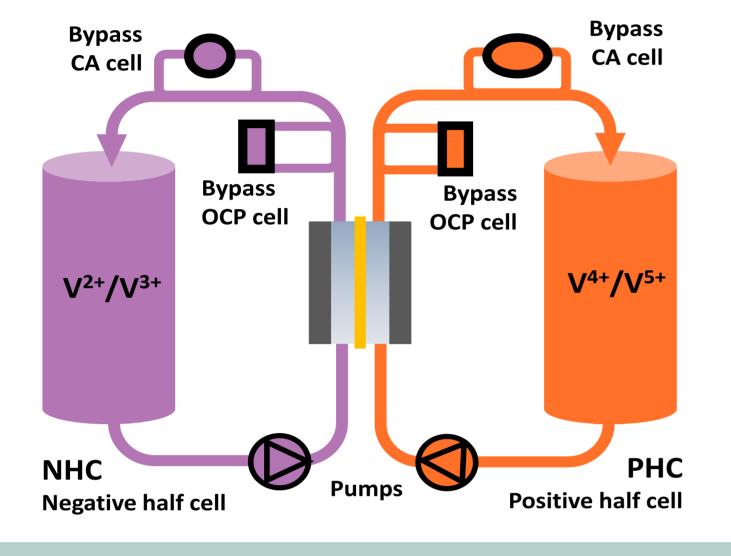
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Scope

- Several analytical methods have already been used in order to predict the State-of-Charge (SoC) for Vanadium-Flow-Batteries (VFB). [1] [4]
- We show the feasibility of Amperometric monitoring for SoC determination in VFB half cells under operation.
- Results are in good accordance to SoC determined from Open Circuit Potential (OCP) measurements and titration of electrolyte samples.

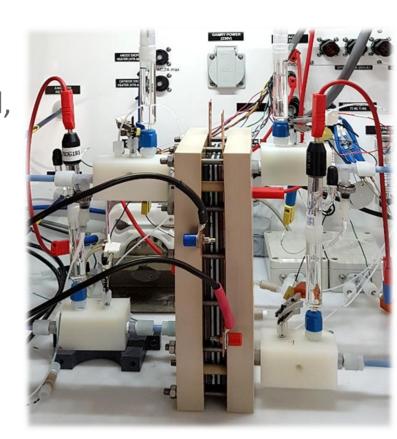
Battery

Electrolyte: 1.6 M V in 2 M H₂SO₄GfE



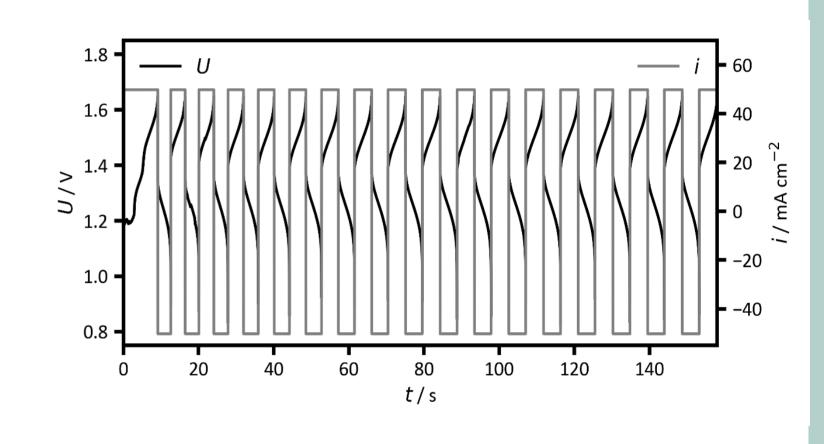
Battery cell

 20 cm^2 manufactured, fumasep FAP450® fumatech, Sigracell® GFD 4.6 SGL



Battery operation

Charge / Discharge 50mAcm⁻¹ Electrolyte flow 50 mL min⁻¹



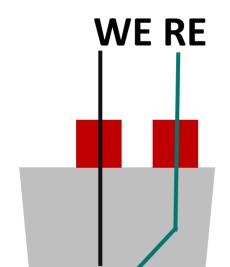
Test setup for Open Circuit Potential and amperometric monitoring

Amperometry (CA)

WE

CE

Open Circuit Potential (OCP)

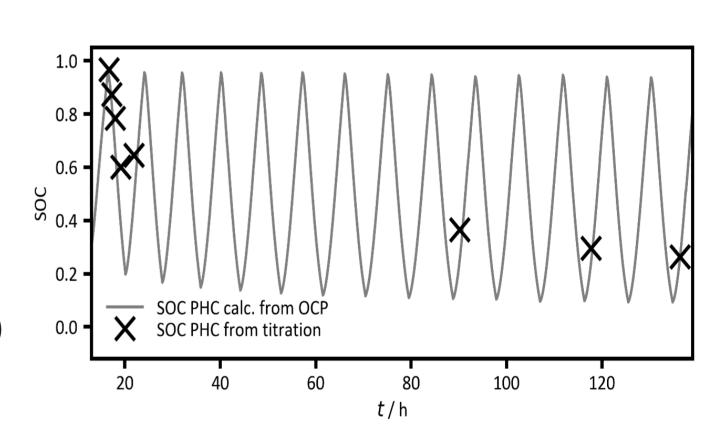


Manufactured flow-cell

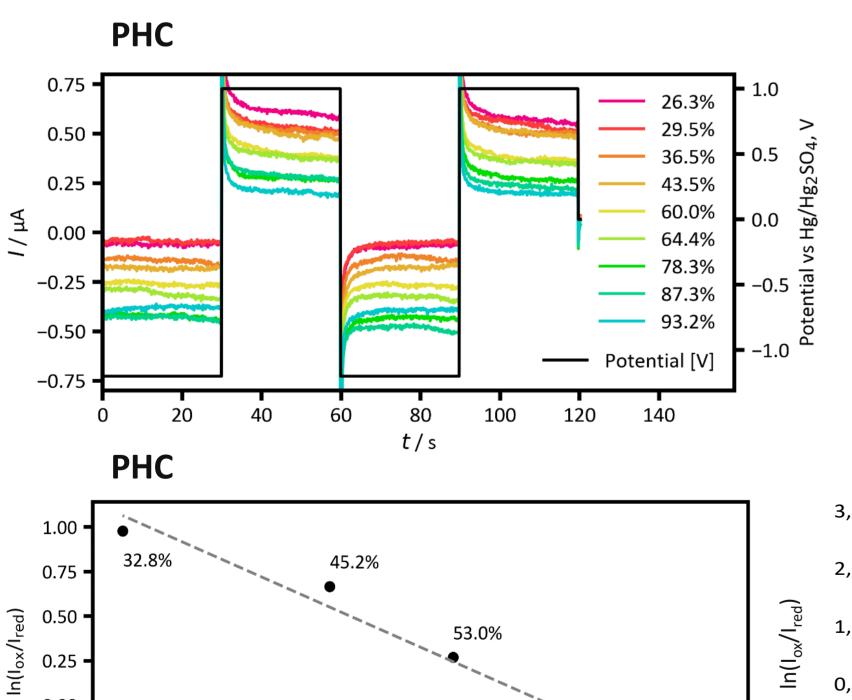


Experiment

- WE: GC rod $(2mm \emptyset)$ CE: GC rod $(2mm \emptyset)$
- **OCP** WE: GC rod $(2mm \emptyset)$ RE: Hg/Hg₂SO₄
- Amperometric measurements (30 s interval)
- Potentiometric titration (5ml samples)

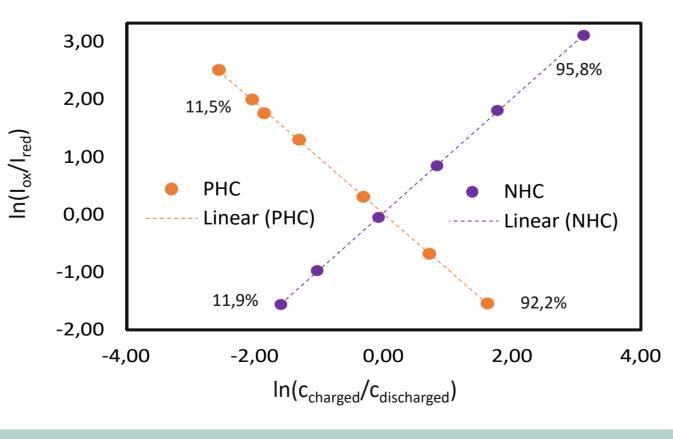


Amperometric half cell measurement



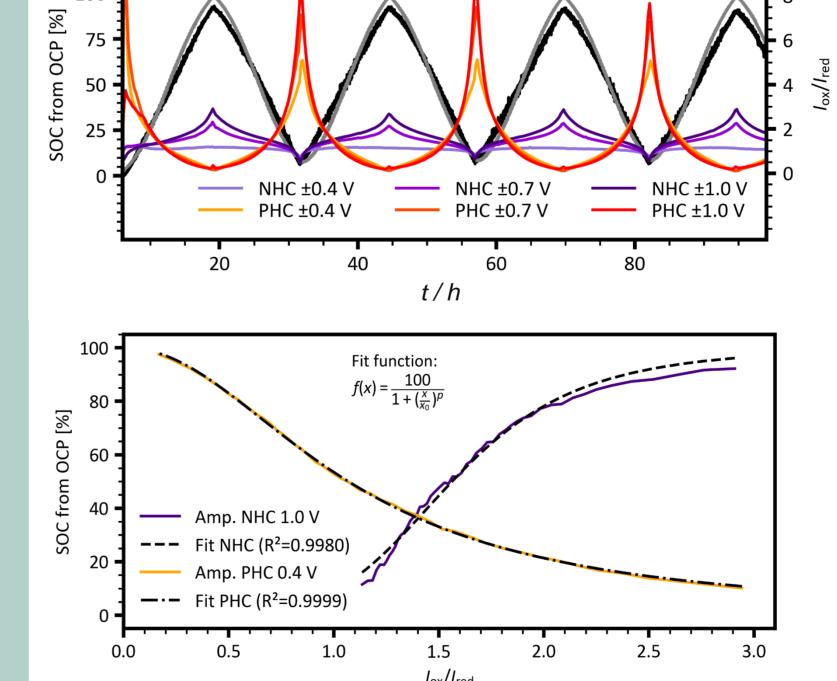
- > Oxidation: currents (I_{ox}) assigned to V⁴ decrease with increasing SOC
- ➤ Reduction: currents (I_{red}), assigned to V⁵⁺ increase with increasing SOC > Linear correlation between In of the
- ratio I_{lox}/I_{red} and the concentration ratio of V^{5+}/V^{4+}
- > Feasibility established for positive and negative half cell [6]

PHC and NHC

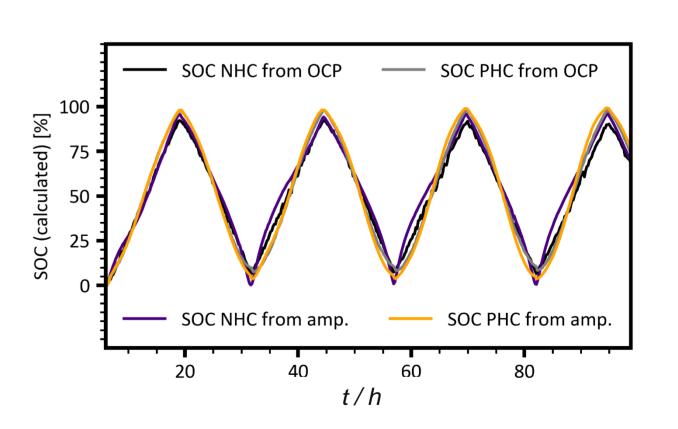


Amperometric monitoring in situ at PHC and NHC

Battery under operation



- > Amperometric monitoring during charging and discharging using different potentials (+/-0.4 V to +/-1.0 V): Resulting (I_{lox}/I_{red}) and half cell SOC calculated from OCP
- \triangleright Logistic fit function for SOC(I_{ox}/I_{red}) found
- > SOC from OCP and amperometric monitoring using ±1.0V (NHC) and ±0.4V (PHC)



Literature

Slope: -0.978

0.00

- [1] T. Haisch, Electrochimica Acta, Bd. 336, 35573, 2020. [2] S. Ressel, Journal of Power Sources, 776-783, 2018. [3] T. Struckmann, Electrochimica Acta, p. 137174, 2020.
- [4] T. Haisch, Membranes, Bd. 11, 232, 2021. [5] C. Stolze, Chemistry of Materials, 5363-5369, 2019.
- [6] C. Weidlich, F. Lulay, M. Wieland, Journal of Electrochemical Science and Engineering, 13, 5, 2023.

