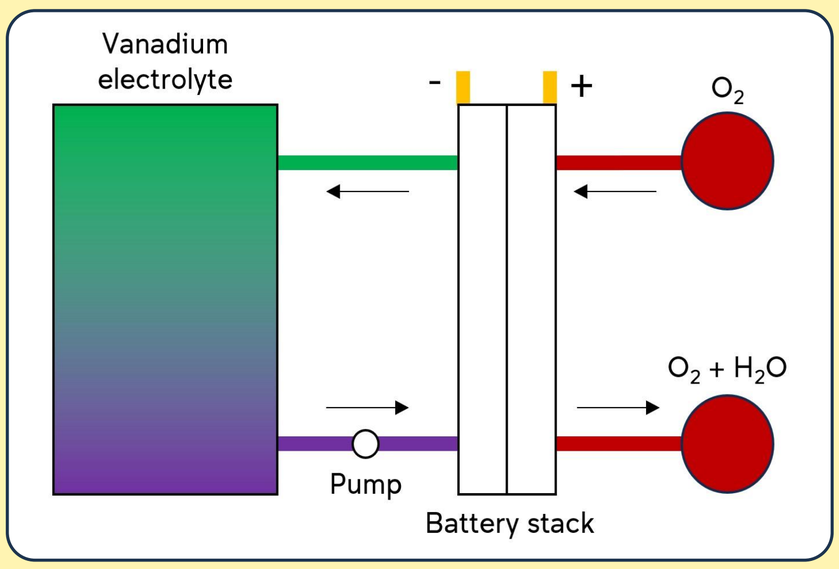
Powering Up Vanadium-Air Batteries

Flow properties in the Vanadium Oxygen Fuel Cell

Robert Turney, Jiangzhou Xie, Maria Skyllas-Kazacos, Chris Menictas

Introduction

- Vanadium Oxygen Fuel Cells (VOFCs) are a mix of VFBs and PEMFCs.
- They can reach >4x the energy density of VFBs when using electrolyte up to 4 M.
- Poor efficiency performance has led to limited adoption.
- Inefficiency comes from catalyst flooding when water is not effectively removed.



VOFC layout

Objective

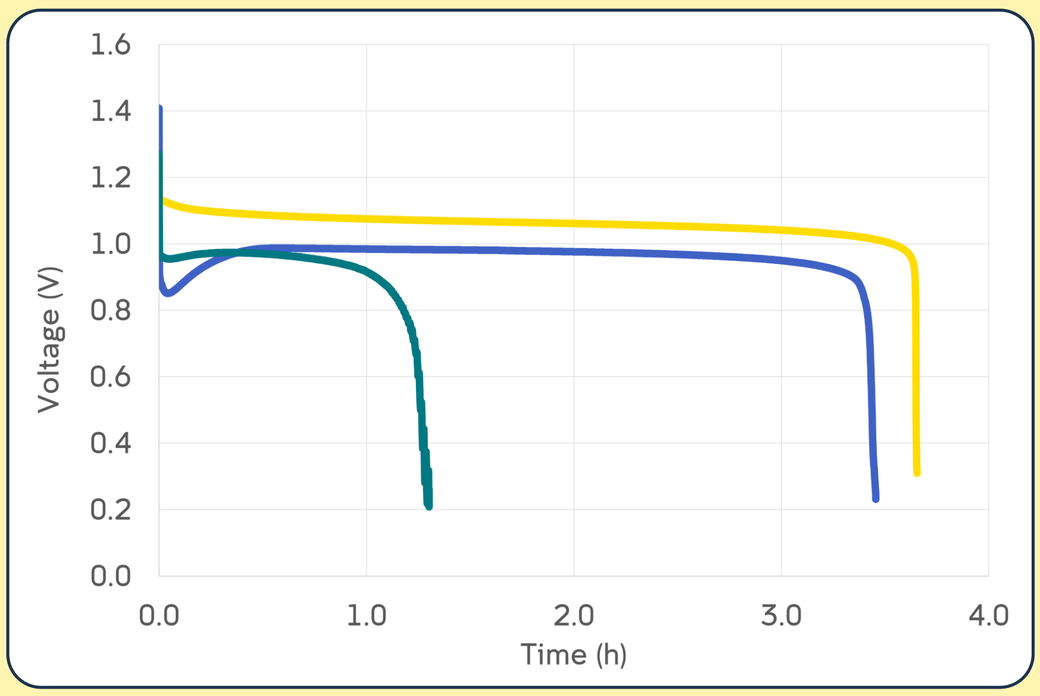
Identify the effect of flow parameters and cell design on performance.

Methods

- Discharge cycle for each design, from 100% to 0% state of charge.
- 3 designs tested with varying influence on gas flow path.
- Design 1 had copper current collector separated from flow. Design 2 and 3 with titanium mesh placed in oxygen path.
- Flow rates tested independently at 100% state of charge.
- 1.6 M vanadium in 5 M H2SO4 electrolyte.
- Pure oxygen supplied from gas tank, in practice oxygen would be utilized from the air.
- Evaluated at room temperature.

Results

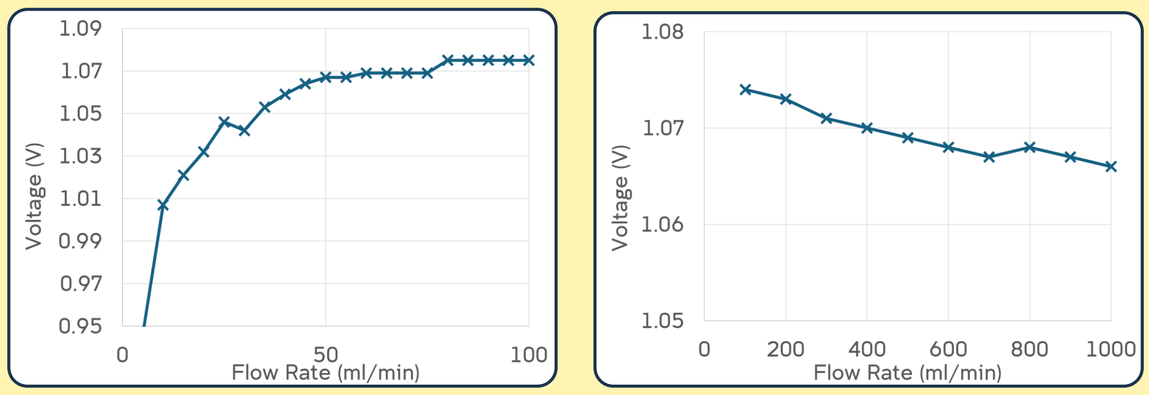
- Design 1 had both the highest voltage and coulomb efficiency. Highest reported value for VOFC in literature!
- Voltage loss due to use of copper rather than titanium.
- Coulomb loss due to mitigated flooding of catalyst.
- Design 2 somewhat hindered flow, leading to water buildup, and charge losses.
- Design 3 highly hindered flow, leading to flooding and drastic charge loss.



Discharge curves for each cell design

	Design 1	Design 2	Design 3
Line Colour			
Ah Capacity Utilisation (%)	85	81	30
Voltage Efficiency (%)	69	63	59
Wh Capacity Utilisation (%)	61	52	19

- Vanadium flow rate has diminishing improvements beyond 50 ml/min.
- Cell performance slightly decreases with oxygen flow rate.



Cell voltage against vanadium flow rate (left) and oxygen flow rate (right)

Acknowledgements: This work was supported by a PhD scholarship from the Faculty of Engineering, UNSW, Australia. This publication is supported by the Australian Government Department of Education through the Trailblazer Universities Program