Effect of electrode structure and electrolyte flow condition on performance of redox flow battery

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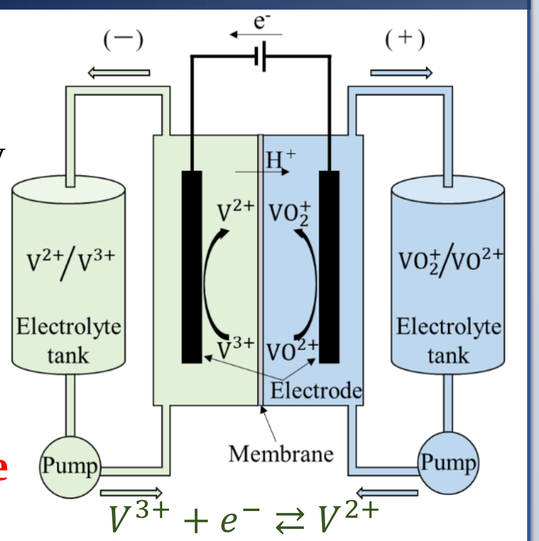
1. Introduction

Background

For leveling output of renewable energy
➡ **Redox flow battery**

Use pump to supply electrolyte
➡ **To reduce pump power is an issue**



$V^{3+} + e^- \rightleftarrows V^{2+}$

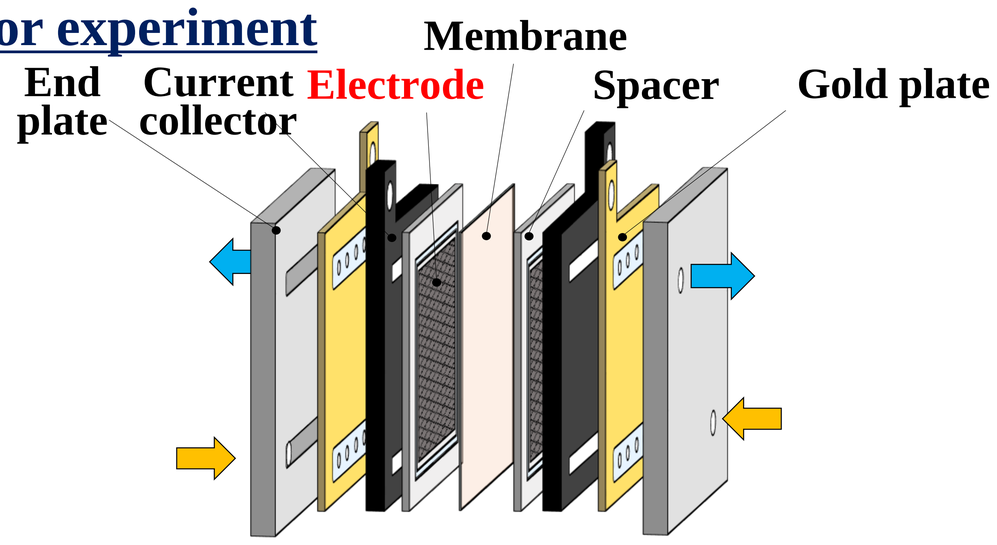
$VO^{2+} + H_2O \rightleftarrows VO_2^+ + 2H^+ + e^-$

Objective

Proposal of electrode structure that can reduce pressure loss and increase output

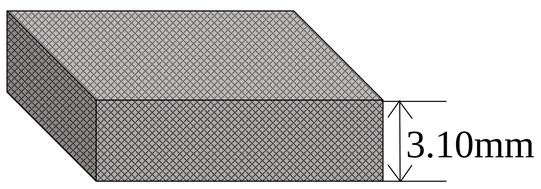
2. Experiment

Cell for experiment



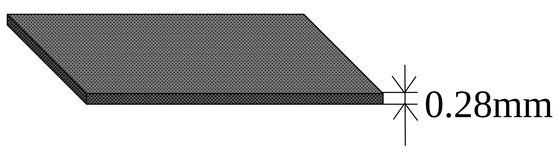
Porous electrode

Felt electrode



Porosity 97.3%
➡ Fiber density : **Low**

Paper electrode

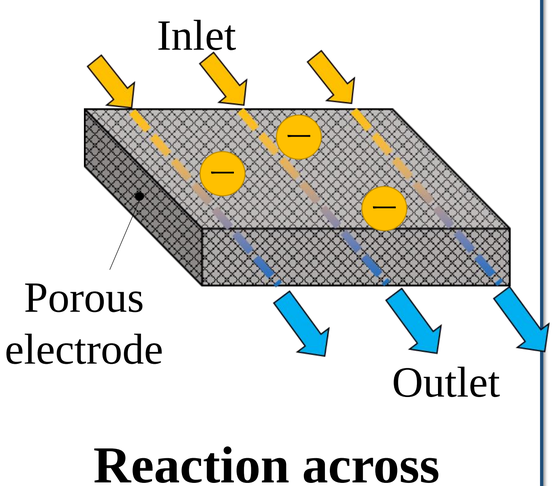


Porosity 89.0%
➡ Fiber density : **High**

Electrolyte channel

Flow through design (FTD)

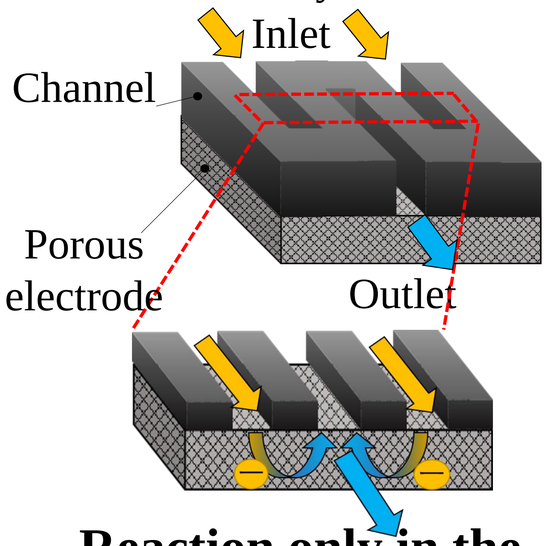
Flow velocity : Large
Pressure drop **:** **Large**



Reaction across the electrode

Interdigitated design (IDD)

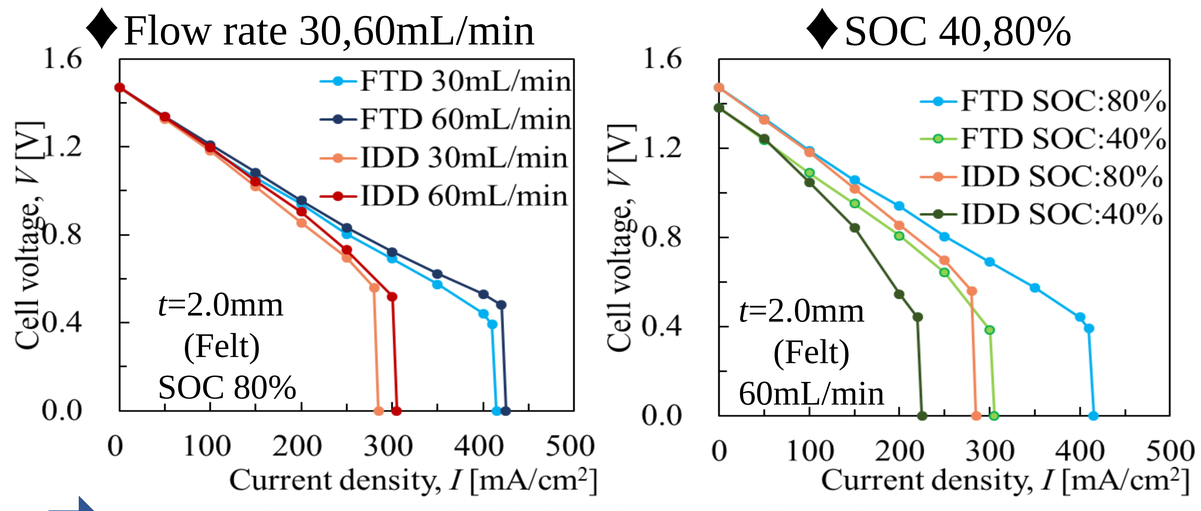
Pressure drop **:** **Small**
Flow velocity : Small



Reaction only in the area where it dives

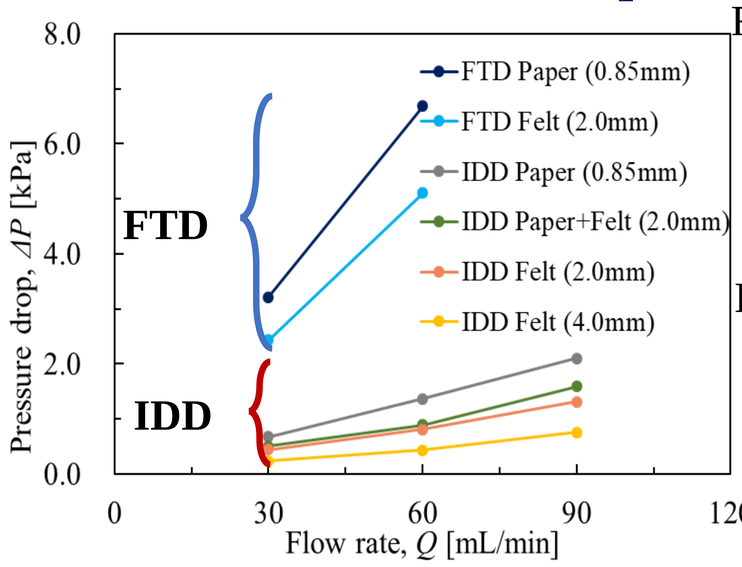
3. Results and discussion

Results of I-V measurement with FTD and IDD



➡ **I-V performance is higher in FTD than in IDD**

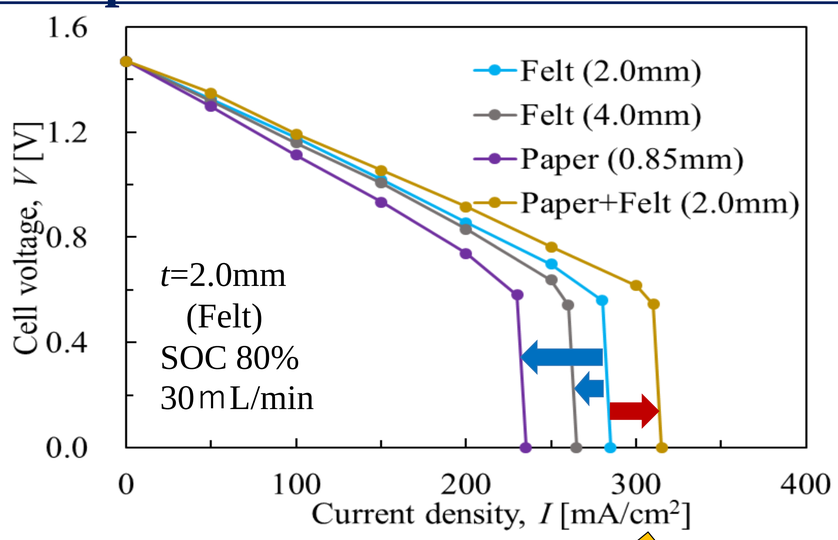
Results of measurement of pressure drop



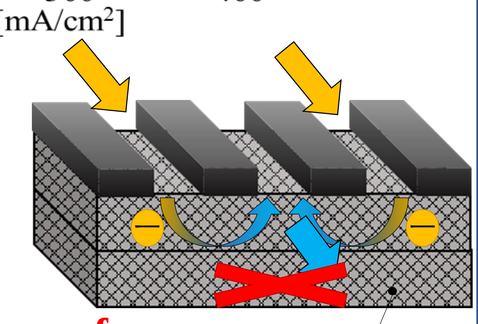
FTD : Pressure drop is Large
⬇
Pump power is Large
⬇
Not suitable for upsizing

IDD : Pressure drop is Small
⬇
Suitable for upsizing
⬇
Consider electrode structure with high output performance with IDD

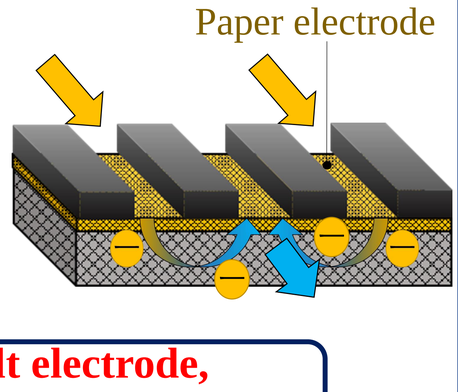
Proposal of optimum electrode structure with IDD



♦Stack two felt electrodes to increase reaction surface area
➡ I-V performance was **decreased**
Because the dip depth of the electrolyte didn't change
➡ **A structure that can ensure reaction surface area even if it is thin is need**



♦Combining paper electrode with large reaction surface area on felt electrode
➡ I-V Performance was **improved**
Because the reaction surface area could be secured even if it is thin



By combining the paper and felt electrode, the cell performance is improved than conventional

4. Conclusions

♦By using IDD as a conventional flow path, low pressure loss could be maintained using either felt electrode or paper electrode

♦By combining the felt and paper electrode, it was confirmed that the IV performance was improved and the lower pressure loss could be maintained.