Water Activity Characteristics in Electrolyte Membrane of Air-Breathing PEM Fuel Cell and its Water Management

Laboratory of Energy Conversion System
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Daiwa Satoh
Objective:

1. The differences between normal type fuel cell

   1) The oxygen supply method at the cathode without the compressor → using the natural convection

   2) The hydrogen supply method is dead-end mode

      normal method → through mode
      without outlet → dead-end mode

These points are important in the fuel cell miniaturizing.
In this study, two points have been changed.
Supply method of oxygen:

Normal fuel cell use the compressor.

The fuel cell miniaturizing need to remove the compressor.

Using the natural convection
Air-Breathing type:

Open type

Channel type

GDL

cathode end plate

Air \((O_2)\)

Air \((O_2)\)
Fuel cell stack:

Open type

Channel type

The channel type can be layer stack for cell. So, in this study we will use the “Channel type”.
Operating principle:

1. The ambient air is warmed by heat generation of cell.
2. The Oxygen reacts with proton and the water vapor produced.

→ The natural convection occurs by density change.
Dead-end mode:

Through mode

Dead-end mode
<table>
<thead>
<tr>
<th>Experiment condition</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambient temperature</td>
<td>around 26 °C</td>
</tr>
<tr>
<td>Relative humidity</td>
<td>around 70 %</td>
</tr>
<tr>
<td>Hydrogen gas</td>
<td>no humid</td>
</tr>
<tr>
<td>MEA</td>
<td>PRIMEA5570</td>
</tr>
<tr>
<td>Catalyst layer</td>
<td>0.4 mg/cm²</td>
</tr>
<tr>
<td>GDL</td>
<td>CARBEL-CFP</td>
</tr>
<tr>
<td>GDL thickness</td>
<td>300 µm</td>
</tr>
</tbody>
</table>
The cathode channel:

Using two different channel depth “D”

2mm and 10mm
IV curves:

*solid line*: through mode
- mass flow 0.3 l/min
*dash line*: dead-end mode
- gage pressure 15 kPa

In dead-end mode, water is observed at the cathode GDL surface.
→ The performance is decrease due to flooding.
Study plan:

Using the fun, one of the oxygen supply method → Cell performance is improved.

Examining trend in dead-end mode

• dry out with fun
• flooding by dead-end mode