Introduction of FORBLUE™
FLEMION™ F-9010 Membrane
Key Technologies of F-9010

Key Words

- High CD Operation
  - Cell Voltage
  - Mass Flow
  - Anolyte/Catholyte Concentrations

- Zero-Gap Electrolyzer
  - NaOH Concentration
  - High Membrane Temperature
  - Direct Touch to Cathode

Concept

- Low Voltage
- Wider Operational Range
- Higher Robustness
- Higher Durability Against Brine Impurities
- Suitability for Zero-Gap

Key Technologies

- New Cloth
- New Sulfonic Polymer Layer
- New Ion Channel
F-9010 membrane kept stable low voltage in AGC commercial electrolyzer more than 3 years.
## Voltage of F-9010 in Commercial Electrolyzers

<table>
<thead>
<tr>
<th>Area</th>
<th>Electrolyzer Type</th>
<th>MOL</th>
<th>Sheets</th>
<th>Comparison</th>
<th>Current Density (kA/m²)</th>
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</thead>
<tbody>
<tr>
<td>SEA</td>
<td>CEC n-BiTAC</td>
<td>20</td>
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<td>-80 mV vs. F-8080A</td>
<td>5.3 kA/m²</td>
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<td>-40 mV vs. Comp.-2</td>
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<td>Europe</td>
<td>UHDE Gen5</td>
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<td>-60 mV vs. F-8080A</td>
<td>6 kA/m²</td>
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<tr>
<td>SEA</td>
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<td>-40 mV vs. F-8080A</td>
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<td>Japan</td>
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<td>CEC BiTAC</td>
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<td>4</td>
<td>-100 mV vs. Comp-3</td>
<td>5 kA/m²</td>
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</tbody>
</table>
“Zero Gap” Advantages

1. Contacting Cathode parts
   - Ni stain

2. Less Catholyte Flow
   - High Temperature

3. Less Brine Supply
   - Weak brine
Durability Against Ni Stain (for Zero Gap)

Acceleration Test: 6 kA/m², 90 °C, 32 wt% NaOH, ç

F-9010 shows higher stability of CE against Ni stain.

“New Ion Channel” is applied.
F-9010 has higher stability of CV against Ni.
F-9010 shows higher CE at high and low temperatures.
Higher CE in wider range of caustic strength

F-9010 shows higher CE in weak and strong caustic.
Proper Surface Shape Causes Good Brine Supply

Oval type

Good Brine Supply

Circle type

Weak brine

F-8080
F-8080A

F-9010

Less Brine Supply
• F-9010 shows higher CE in weak brine.
• It is suitable for electrolyzers with less inner circulation of brine.
Membrane Design for Low Cell Voltage

- Reduced Membrane Thickness
- Improved Reinforcement
- Optimized Polymer
- Improved Surface Coating

"Shadow influence"

Reducing Shadow influence with "New Cloth"
Standard Cloth: Plain-woven fabric, PTFE and PET fiber.
Influence of Cloth on Cell Voltage

PTFE fiber interferes with the Na$^+$ migration, which increases cell voltage.

Two kinds of teeth reduces the shadow influence.
Reducing Shadow Influence (1)

Proper surface shape reduces cell voltage.

Conventional Cloth

Oval type

Flemion F-9010

Maintains membrane thickness...

Circle type
Reducing Shadow Influence (2)

PET fiber dissolves under the electrolysis and makes sacrificial fiber holes, which reduce the shadow influence.

New Cloth: PTFE

Circle type

Sacrificial Fiber Hole

New Cloth: PET
F-9010 cloth has 4 PET fibers between PTFE fibers, which further reduces the shadow influence.

F-9010 Cloth

F-8080/F-8080A Cloth

PTFE Fiber

PET Fiber
Reducing Shadow Influence (2)

F-8080/F-8080A Cloth

F-9010 Cloth

F-9010 cloth further reduces the shadow influence and makes F-9010 show lower voltage.
Durability Against Mg

8 kA/m², 90 °C, 32 wt% NaOH, Mg=0.1 ppm

F-9010 has higher stability of CV against Mg.
Durability Against Al/SiO$_2$

85 °C, 32wt% NaOH, Al/SiO$_2$ = 1/30ppm
Durability Against Ca/SiO₂

85 °C, 32wt% NaOH, Ca/SiO₂ = 0.05/15ppm

DOL after addition

- F-9010: 6kA/m²
- F-8080: 8kA/m²
Durability Against I/Ba

85 °C, 32wt% NaOH, I/Ba=20/1ppm

DOL after addition
85 °C, 32wt% NaOH, Ca=1.5ppm, 4hr

Durability Against Ca Upset

F-9010
F-8080

6kA/m²
8kA/m²

DOL after addition
DOL after addition
Frequent Load Tensile Test

F-9010 is more robust than F-8080 and F-8080A.
For More Information:

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