

# Introducing FORBLUE™ FLEMION™ F-8080 Series Membranes

**AGC**



# Developments of FLEMION



**2nd Step** (Enhance the feature of F-8020SP)

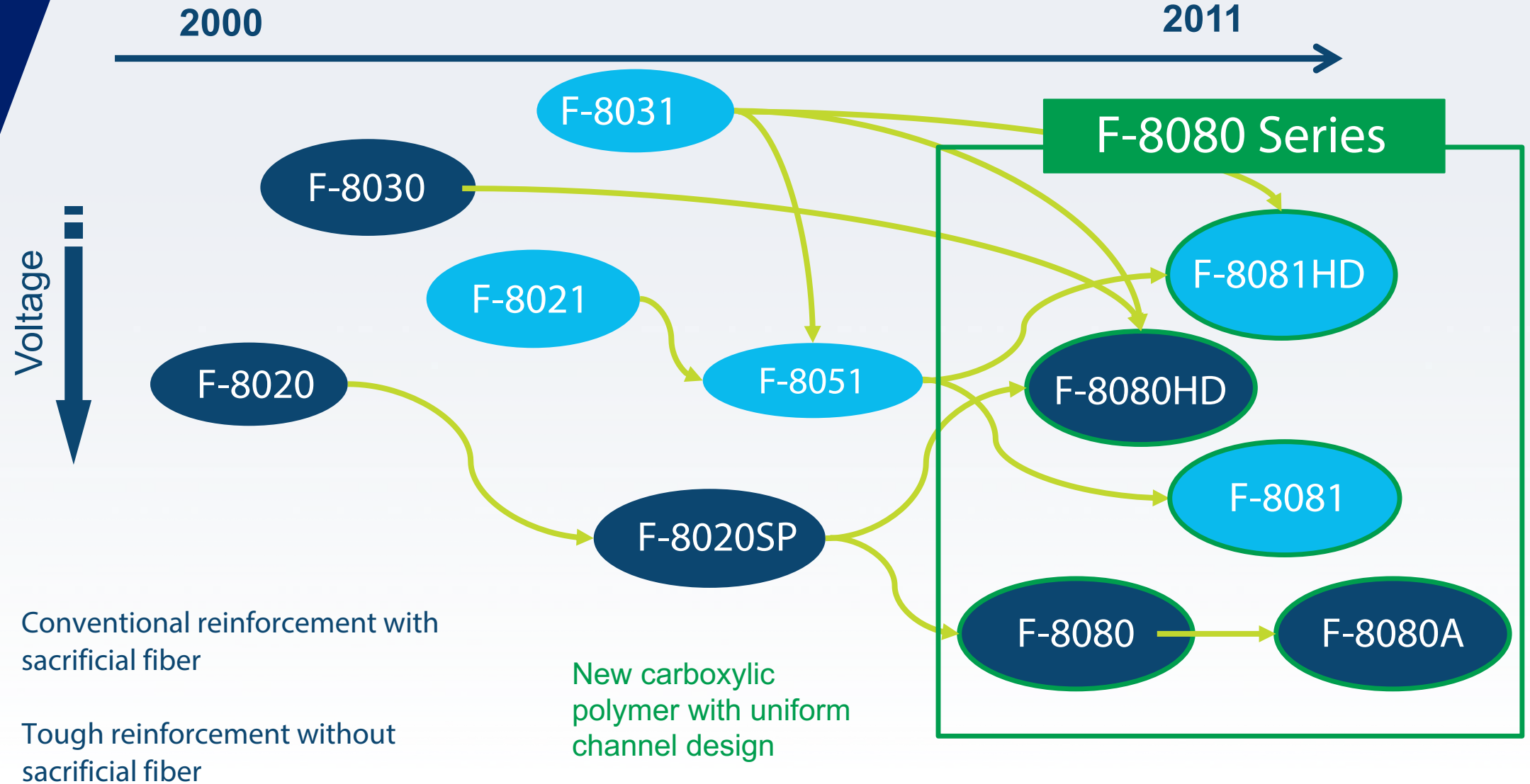
1. Much lower water content of S-layer:
  - Higher mechanical strength & stability
2. Further increase of of ion-exchange capacity of C-polymer and optimized uniformity of ion-channels:
  - Reduced sensitivity to brine impurities
  - Extended stability of CE and CV also at high current density operation

2000

2008

2011

## Development Steps



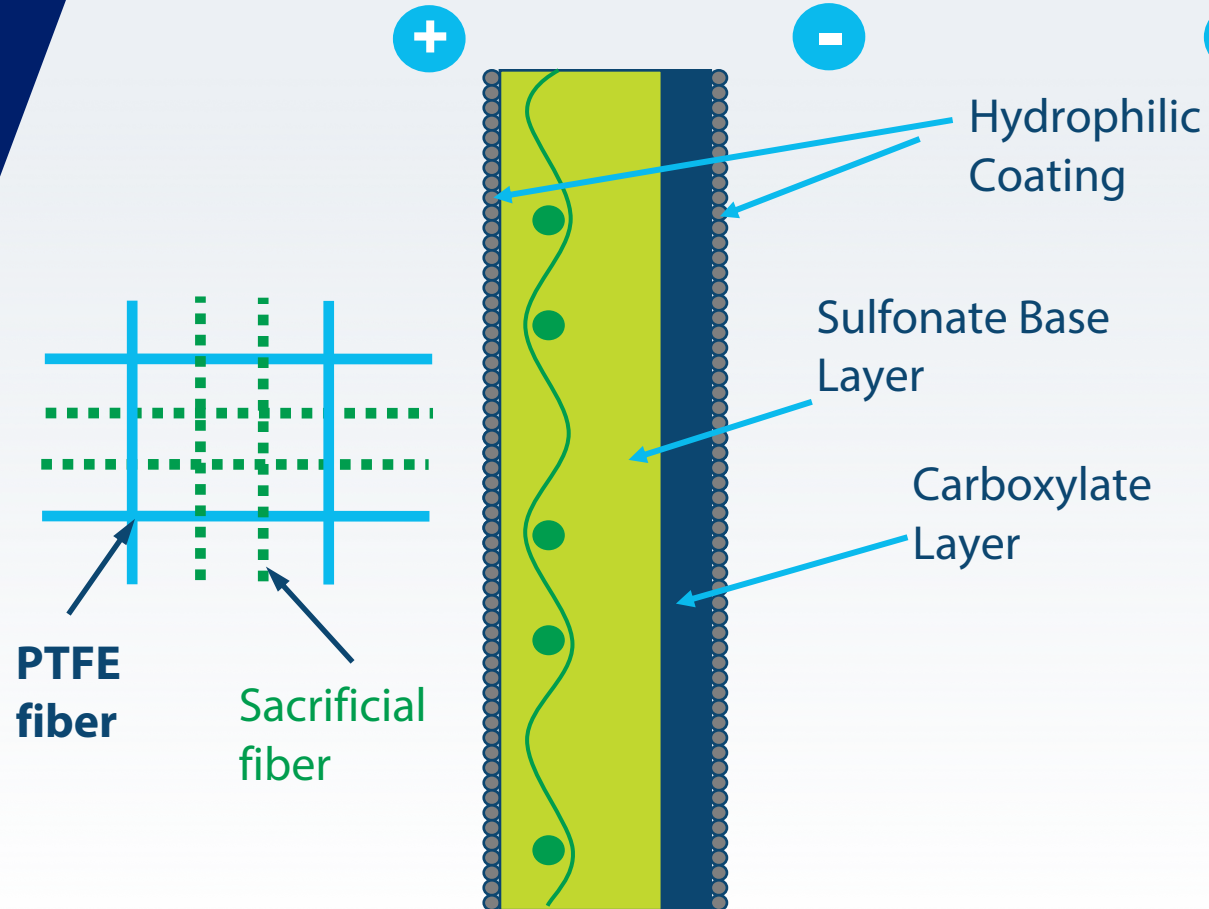
# Choice of FLEMION Membranes

	Cloth <b>with</b> Sacrificial Fibers Tensile Strength 45 N/cm	Cloth <b>without</b> Sacrificial Fibers Tensile Strength 70 N/cm
Higher current density Lower voltage Less impurity influence	Flemion F-8080/F-8080A <ul style="list-style-type: none"> <li>• Lowest voltage</li> <li>• -60 mV</li> </ul>	Flemion F-8081 <ul style="list-style-type: none"> <li>• Robust</li> <li>• Lower voltage</li> <li>• -20 mV</li> </ul>
Lower current density Smaller NaCl in NaOH Fewer salt blisters	Flemion F-8080HD <ul style="list-style-type: none"> <li>• Higher durability</li> <li>• -10 mV</li> </ul>	Flemion F-8081HD <ul style="list-style-type: none"> <li>• Most durable</li> <li>• Most robust</li> <li>• +30 mV</li> </ul>
	<ul style="list-style-type: none"> <li>• Lower voltage</li> </ul>	<ul style="list-style-type: none"> <li>• Fewer pinching issues</li> <li>• Durable for frequent tension</li> </ul>

# Type of Reinforcement Cloth

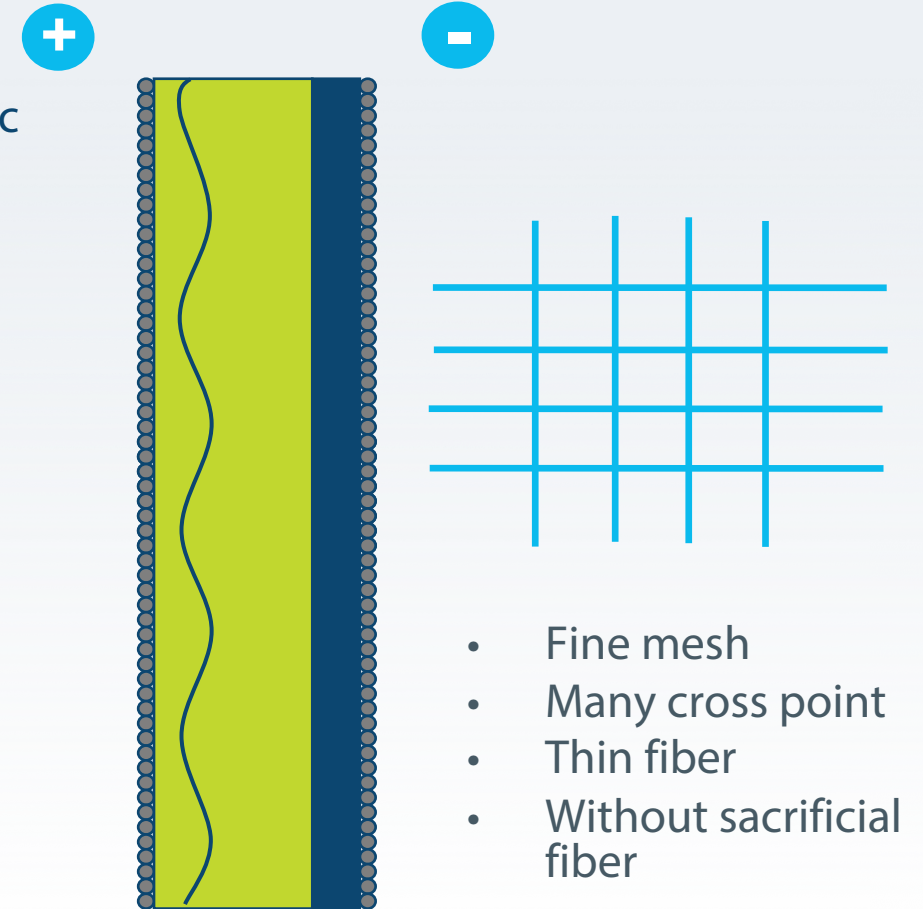
## With Sacrificial Fibers

F-8020SP / F-8080 / F-8080A / F-8080HD



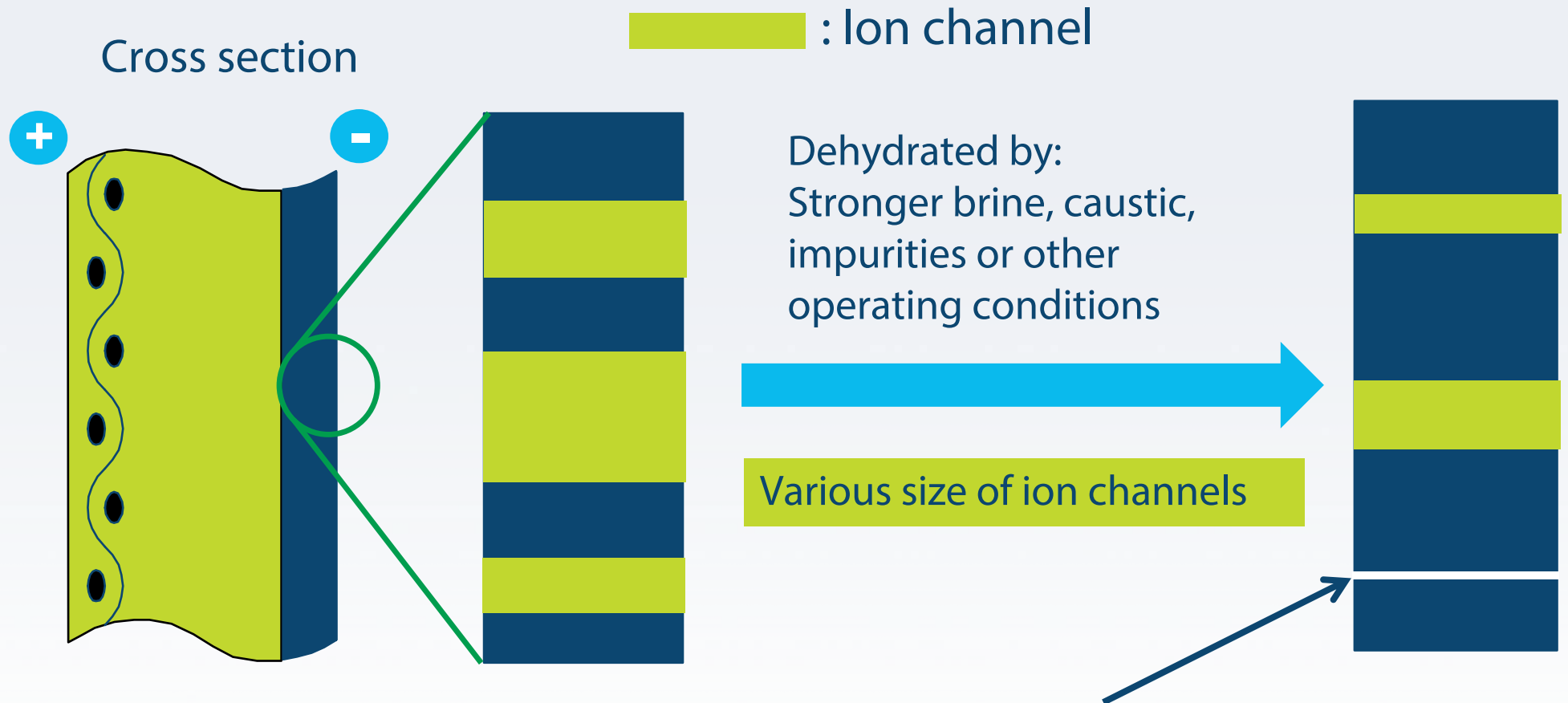
## Without Sacrificial Fibers

F-8051 / F-8081 / F-8081HD



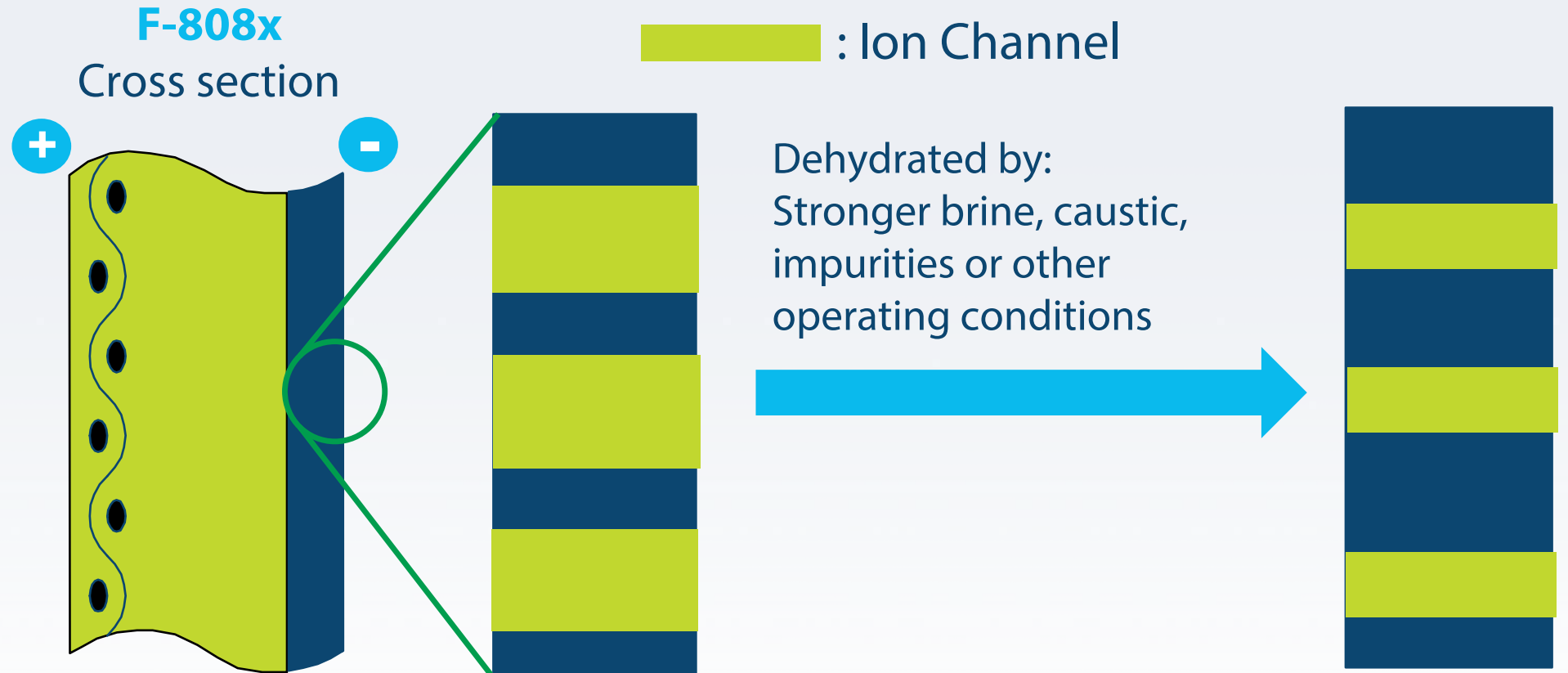
- Fine mesh
- Many cross point
- Thin fiber
- Without sacrificial fiber

# Earlier C-Polymer



Relatively narrow channel will lose the function in strongly dehydrated state.

# Optimized C-polymer with Uniform Channel Size

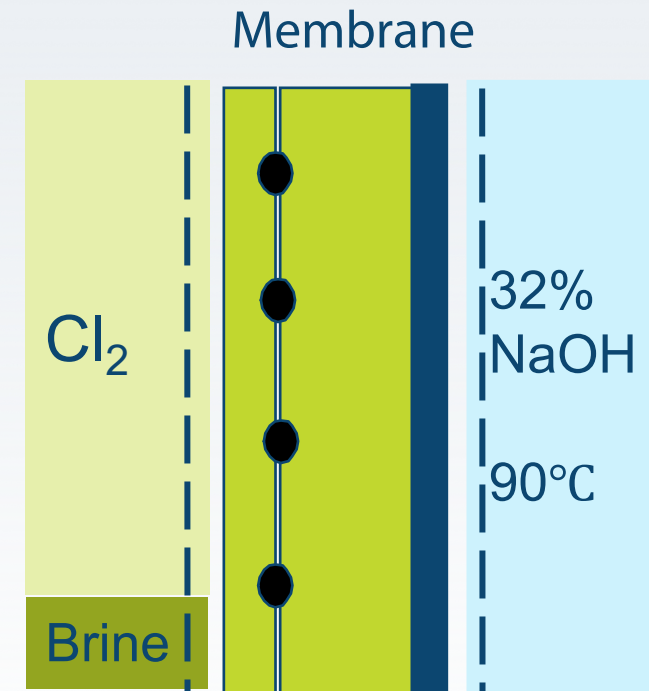


# Test for Deterioration by Cl<sub>2</sub> Gas Stagnation

## Special Test Conditions for F-8080HD Tests

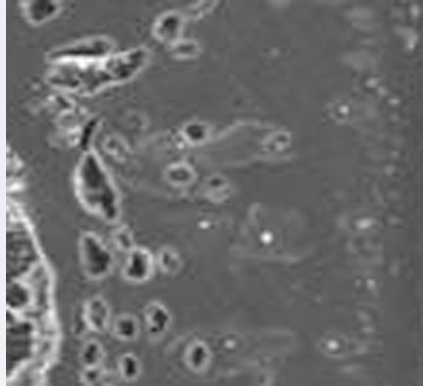
Cl<sub>2</sub> gas stagnation on anode side and high caustic strength on cathode side. Under these conditions salt crystals may be formed in membrane

### Test Method



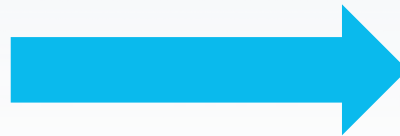
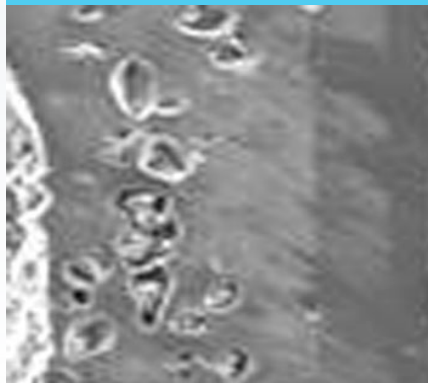
# Test for Deterioration by Cl<sub>2</sub> Gas Stagnation

F-8020SP

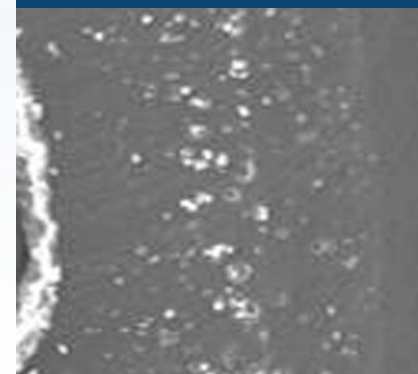


- F-8080 has same durability for Cl<sub>2</sub> gas stagnation with very low voltage.
- **F-8080HD** has much higher durability for Cl<sub>2</sub> gas stagnation with lower voltage than F-8020.

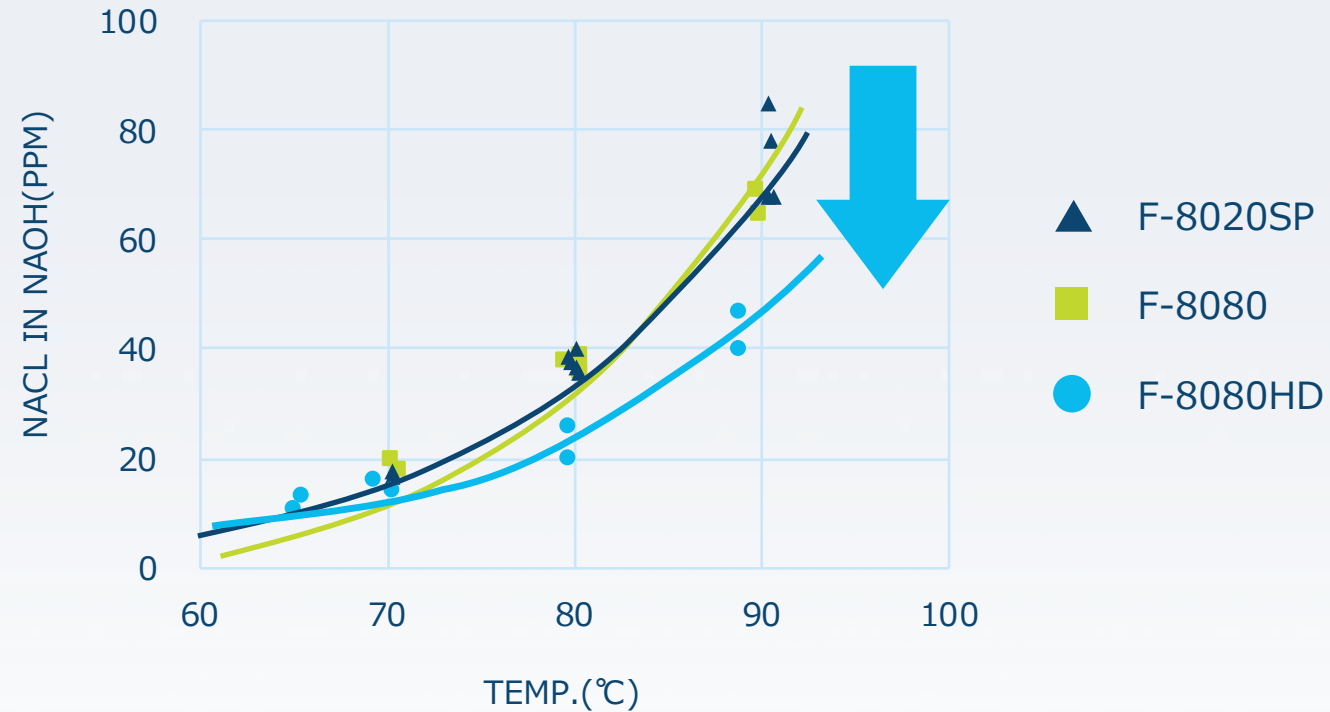
F-8080



F-8080HD



# Low NaCl in NaOH at Low C.D. and High Temp

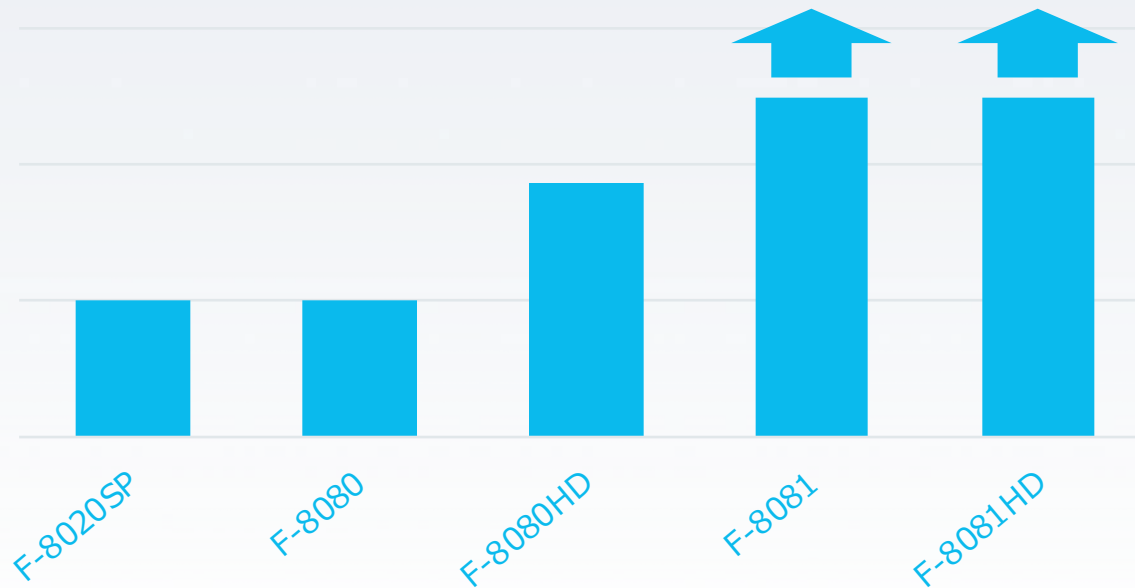


F-8080HD shows lower NaCl concentration in NaOH.

# Frequent Load Tensile Test

Comparison of F-8020SP, F-8080, F-8080HD, F-8081 and F-8081HD

**Repetition of Test until Membrane Rupture  
(Sum of the Value to Various Direction)**



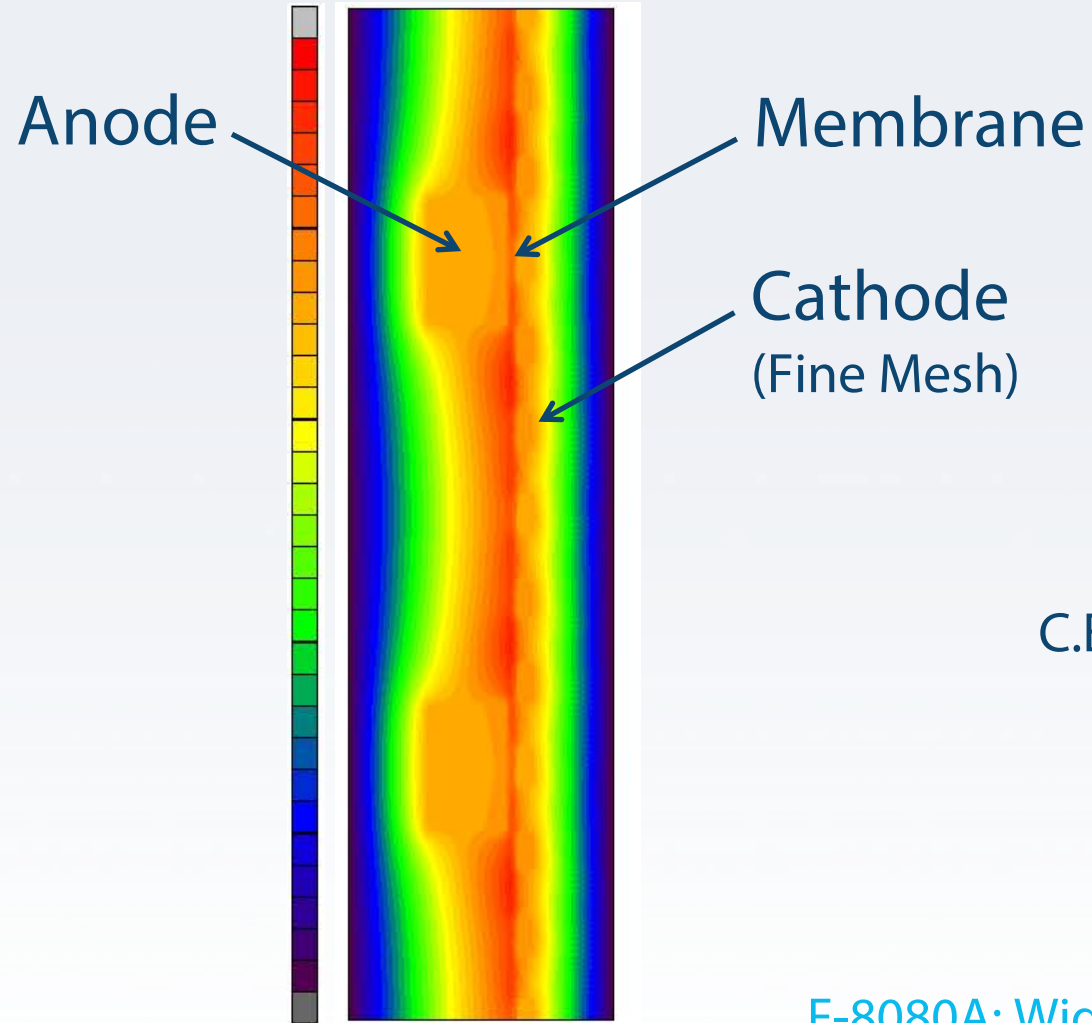
- F-8080HD is nearly twice as robust for frequent load as F-8080.
- F-8081 and F-8081HD could not be ruptured within certain period.

# Features of FLEMION F-8080A

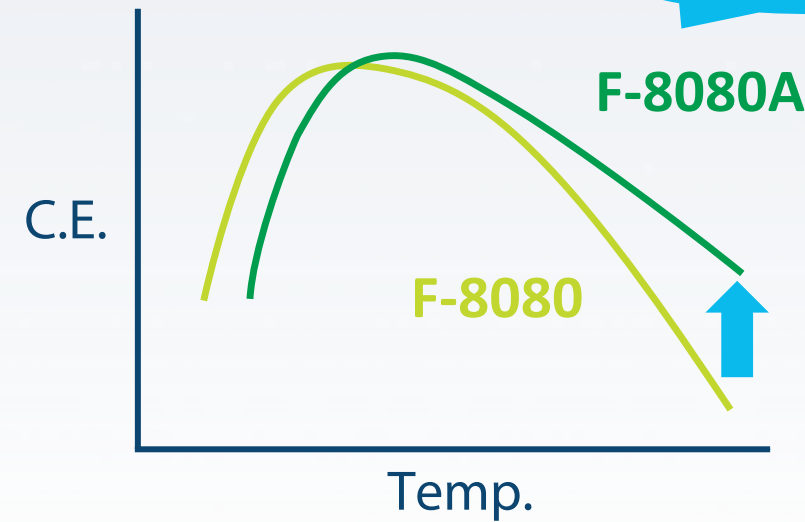
1. **CE stability in high temperature for latest zero gap electrolyzer**
2. Resistance for Ni
3. Higher CE in weak brine (by less circulation)

Controlled C-polymer for Zero Gap Design

# Stable C.E. for Zero Gap: F-8080A

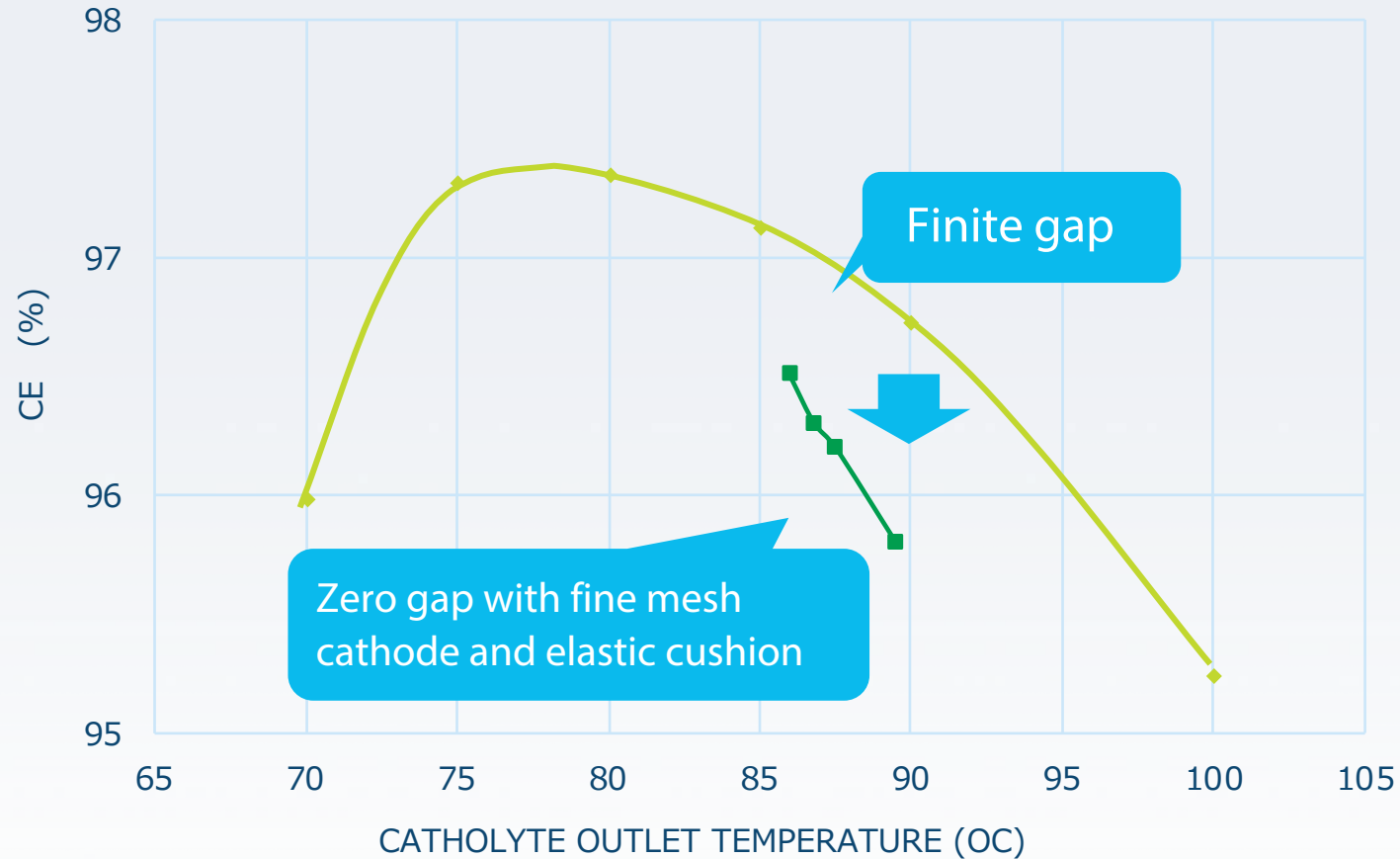


Higher Temp



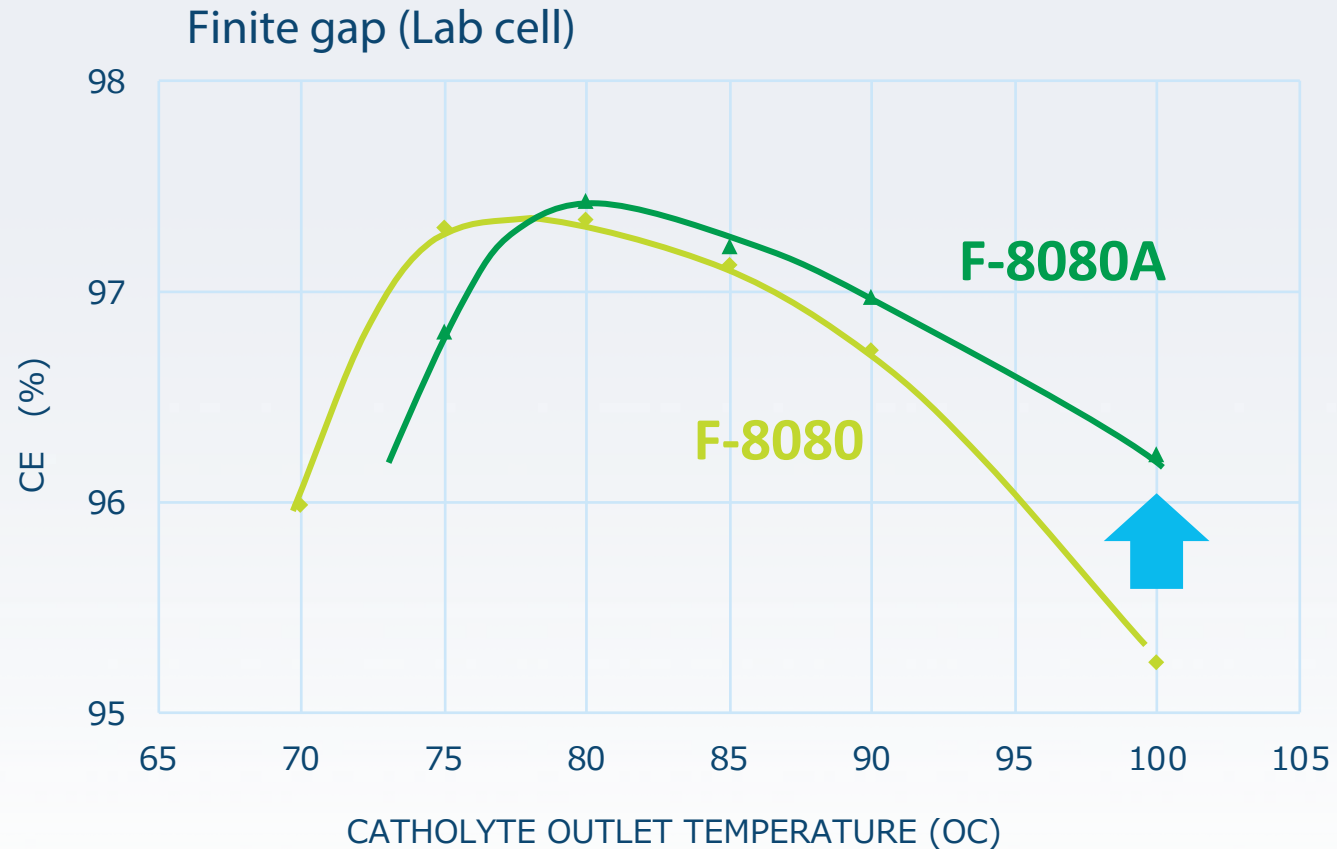
F-8080A: Wider operation range of high temperature

# FLEMION F-8080 : CE Decrease in Zero Gap



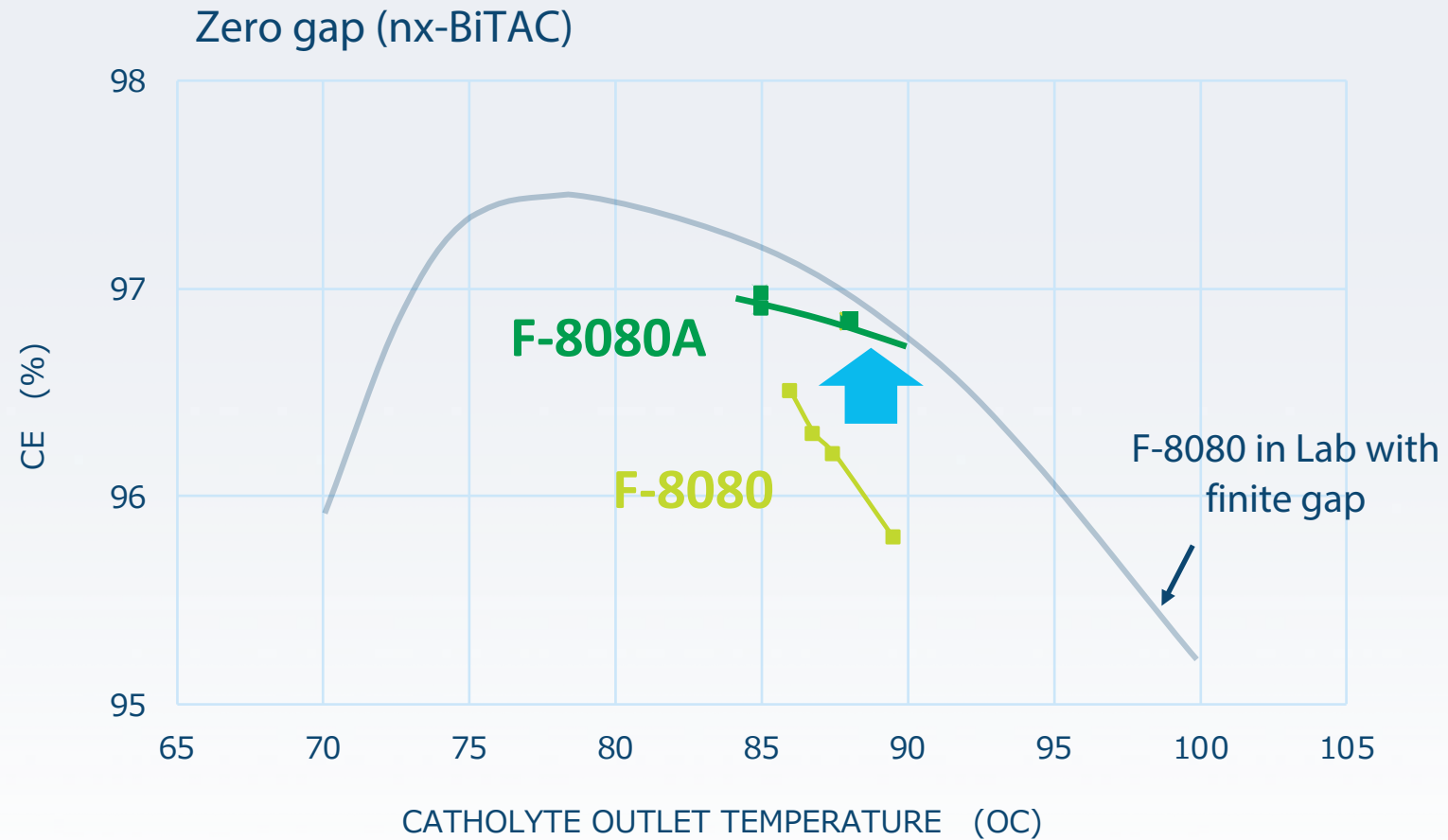
F-8080 in zero gap shows 0.5-1% lower CE than in finite gap at high temperature.

# FLEMION F-8080A : Higher CE at High Temperature



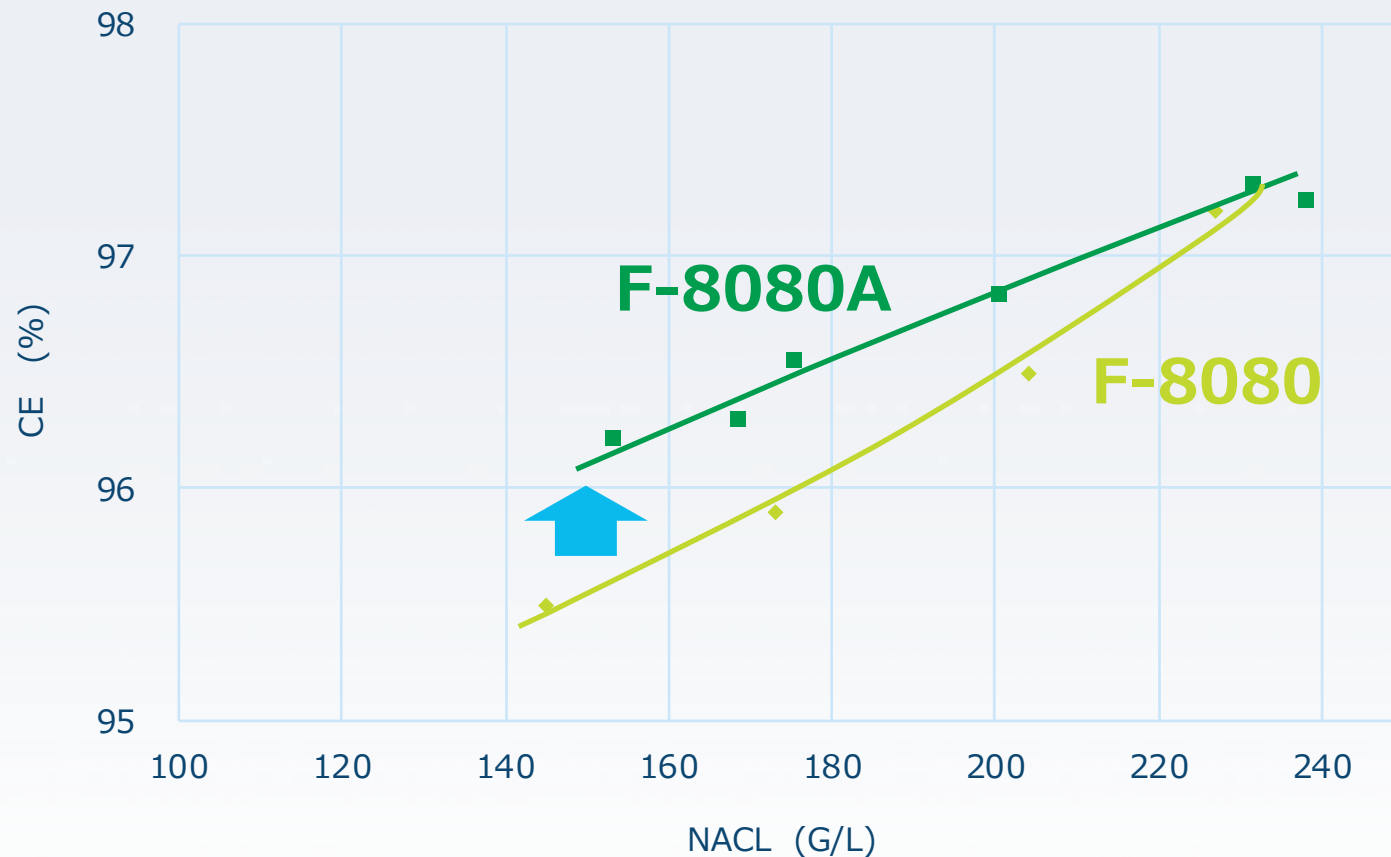
F-8080A shows more than 96% CE even at 100 °C.

# FLEMION F-8080A : Higher CE in nx-BiTAC



F-8080A in nx-BiTAC shows high enough CE at high temperature.

# FLEMION F-8080A : Higher CE in Hydrated Condition

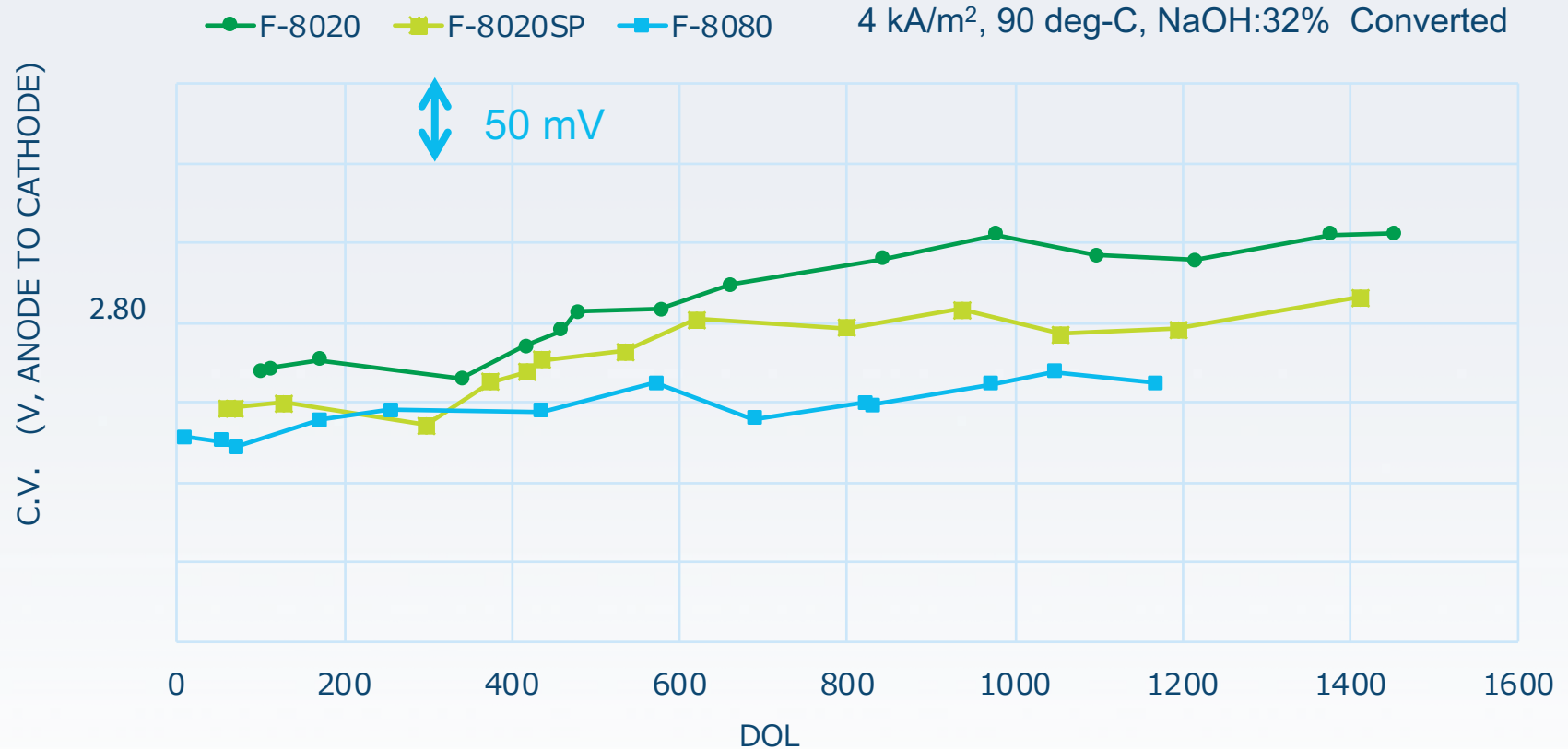


F-8080A shows higher CE in weak brine.

# Choice of Membranes

	Cloth With Sacrificial Fibers Tensile Strength 45 N/cm	Cloth Without Sacrificial Fibers Tensile Strength 70 N/cm
Higher Current Density Lower Voltage Less Impurity Influence	<ul style="list-style-type: none"> <li>• F-8080 / F-8080A</li> <li>• Lowest Voltage</li> <li>• -60 mV</li> </ul>	<ul style="list-style-type: none"> <li>• F-8081</li> <li>• Robust</li> <li>• Lower Voltage</li> <li>• -20 mV</li> </ul>
Lower Current Density Smaller NaCl in NaOH Fewer Salt Blisters	<ul style="list-style-type: none"> <li>• F-8080HD</li> <li>• Higher Durability</li> <li>• -10 mV</li> </ul>	<ul style="list-style-type: none"> <li>• F-8081HD</li> <li>• Most Durable</li> <li>• Most Robust</li> <li>• +30 mV</li> </ul>
	<ul style="list-style-type: none"> <li>• Lower Voltage</li> </ul>	<ul style="list-style-type: none"> <li>• Less Pinching Issues</li> <li>• Durable for Frequent Tension</li> </ul>

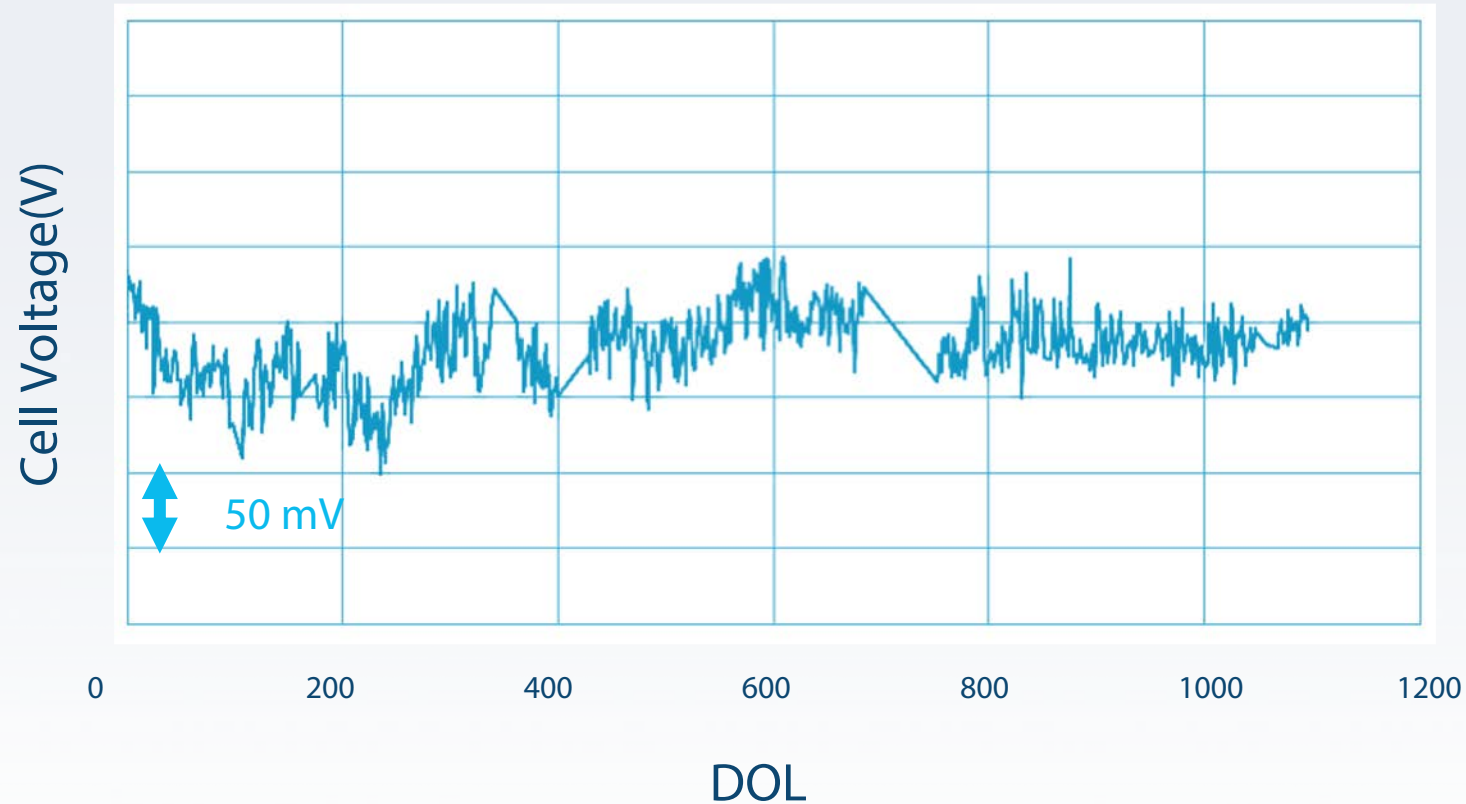
# Voltage Stability in AGC Plant



F-8080 shows most stable voltage more than three years operation.

# Voltage in AGC Plant

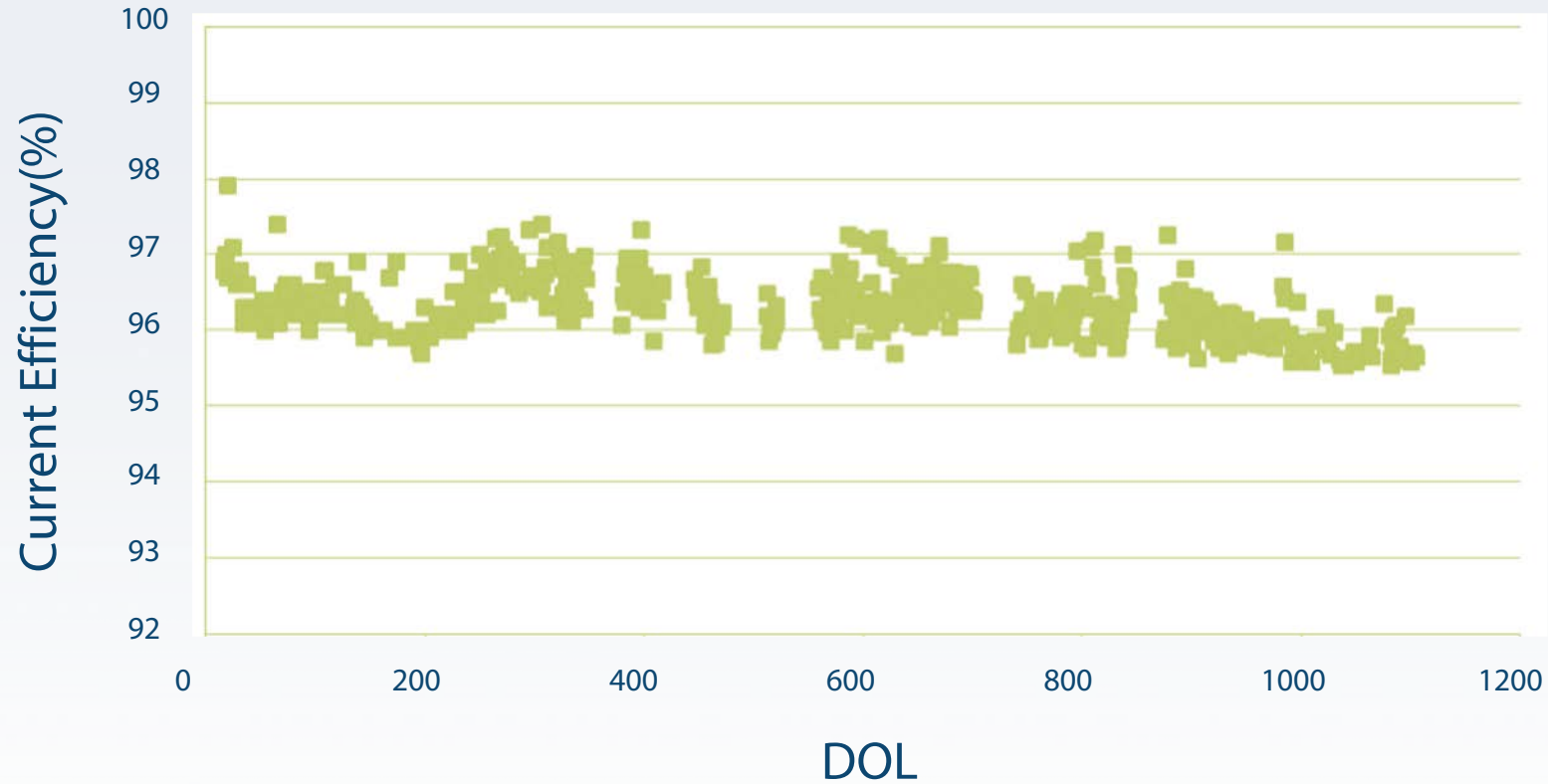
AGC Chiba Plant (F-8080,UHDE G5)



F-8080 shows most stable voltage more than three years operation.

# Stable CE in AGC Plant

AGC Chiba Plant (F-8080,UHDE G5)



F-8080 keeps stable current efficiency higher then 95.5% for more than three years operation.



**For More Information:**

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