Next Generation Membrane
F-8080 & F-8080HD

AGC 化学品カンパニー
旭硝子株式会社

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AGC Chemicals
Chemistry for a Blue Planet

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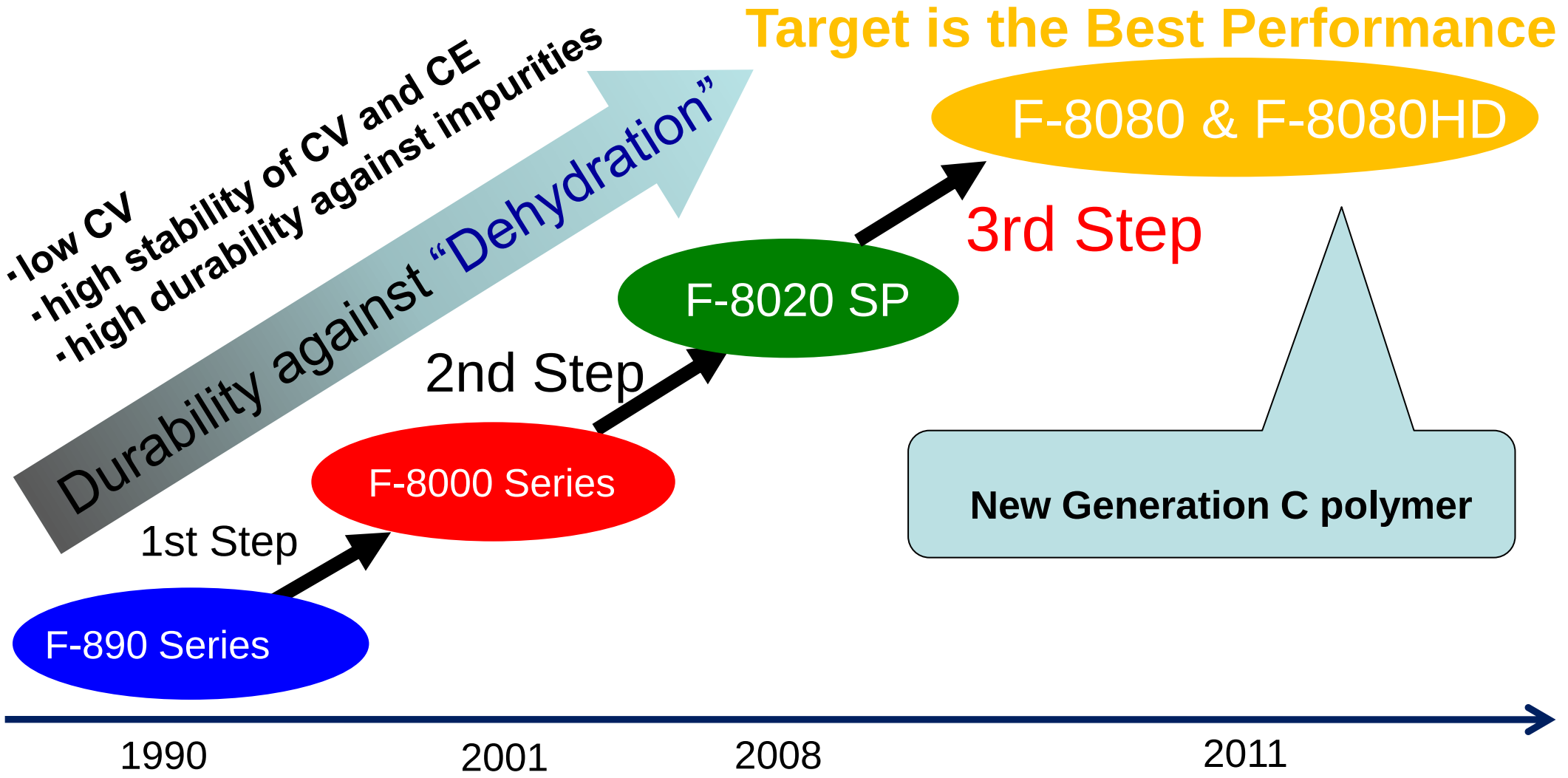
Developments of Flemion



Differences F8020SP vs. F8020

Second Step

1. Lower water content of S-layer
   → Higher Mechanical Strength & Stability
2. Minor increase of Ion-exchange capacity of C-polymer
   → Reduced sensitivity to brine impurities:
   → Extended stability of CE and CV also at high current density operation

AGC confirmed these improvements are very effective in commercial plants, then moved to the next step.

Third Step --- Enhance the Feature of F-8020SP

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

Line up of new Membranes

Membrane Types F-808XXX / Features & Properties

R&D Development Name	Type	Current Density (kA/m2) (*)	Cl- in NaOH	Current Efficiency (initial, expected)	Voltage at same CD
F-8080	S/P	**7 >**	**medium**	approx. 97%	lowest
F-8080HD	S/P	**6 >**	**low**	approx. 97%	medium
F-8081	P	**7 >**	medium	approx. 97%	low
F-8081HD	P	**5 >**	low	approx. 97%	medium

S/P: Sacrificial Fiber & Permanent Fibers
P: Permananet Fibers only (approx. 50% higher mechanical strength)
(*) Depending on Electrolyzer Types and Operating Conditions

Expected Performance Data of Flemion Membrane

	Current Efficiency (%)	Voltage Difference at 6 kA/m^2 (mV)	Resistance against Impurities
F-8020	approx. 97%	0	medium
F-8020SP	approx. 97%	-30	high
F-8051	approx. 97%	0	high
F-8080	approx. 97%	-60	highest
F-8080HD	approx. 97%	-10	highest

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Features of Next Generation Membrane F-8080 series

Compared with F-8020SP, F8000 series

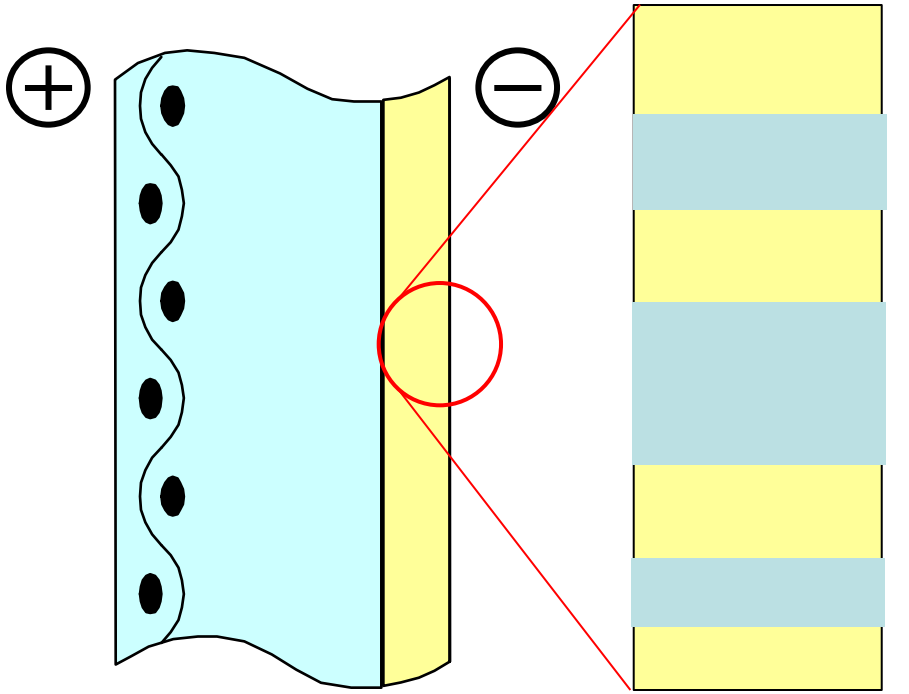
1. **High Durability against Brine Impurity**
   - **Especially, resistance against Ca upset is much better**
2. **Lower Cell Voltage (F-8080)** and **Stability**
3. Wider Operating Window

Uniform Channel by “Optimized C-polymer”

Conventional C-Polymer

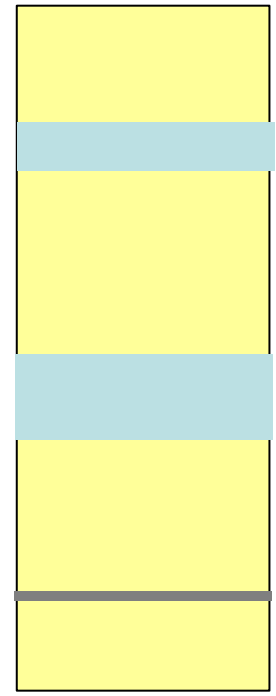
:Ion Channel

Cross Section



Dehydrated by: stronger brine, caustic, impurities or other operating conditions

Various size of ion channels



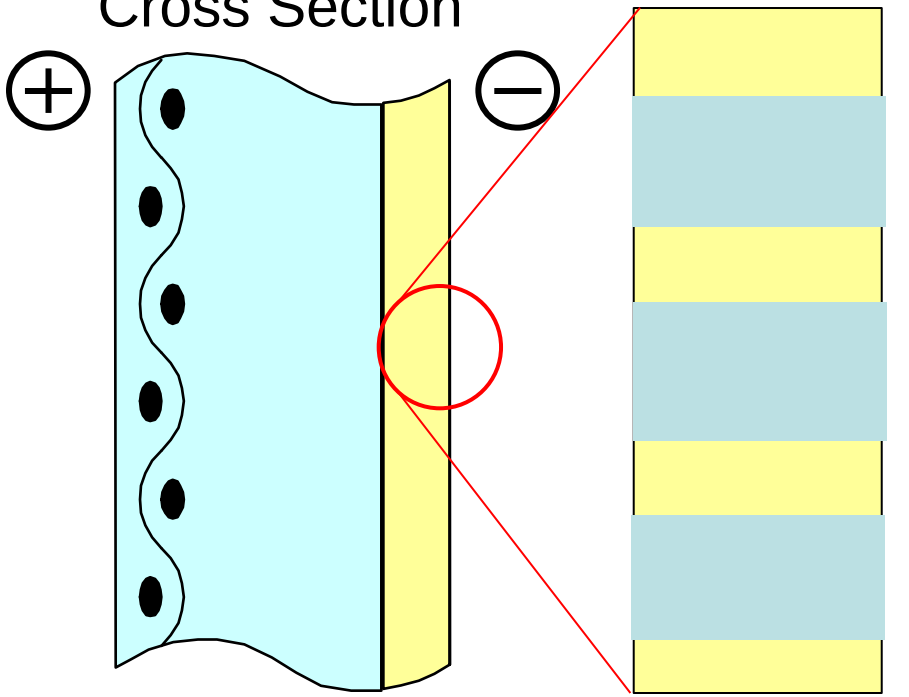
Relatively narrow channel will lose the function in strongly dehydrated state.

Optimized C-Polymer

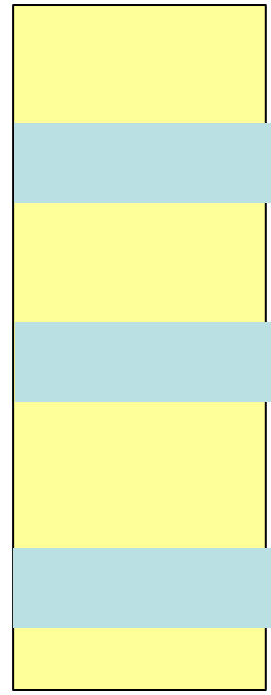
: Ion Channel

F-8080 & F-8080HD

Cross Section



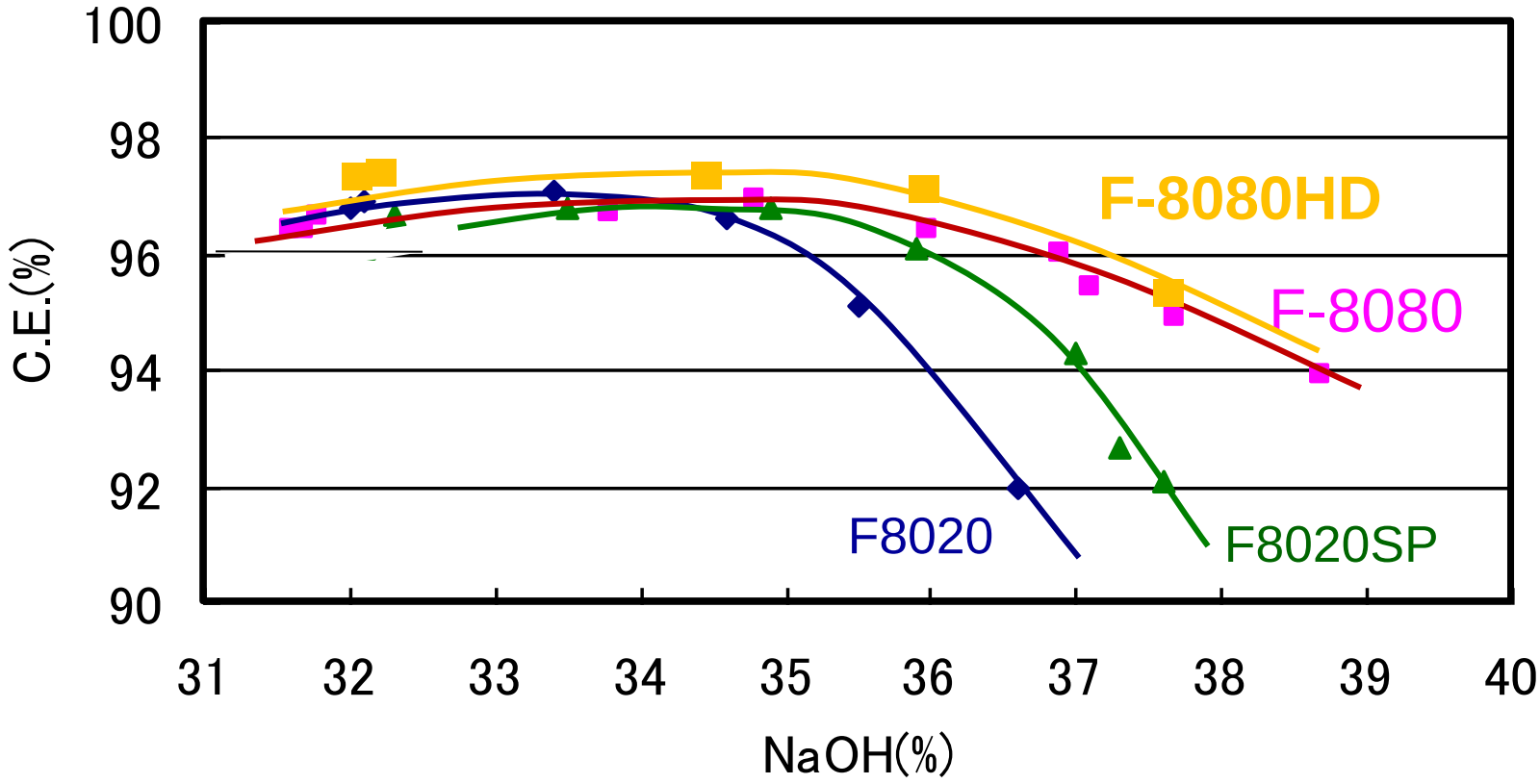
Dehydrated by: stronger brine, caustic, impurities or other operating conditions



Due to uniform channel size, ion channels with uniform size do not lose function

Current Efficiency vs. NaOH Strength

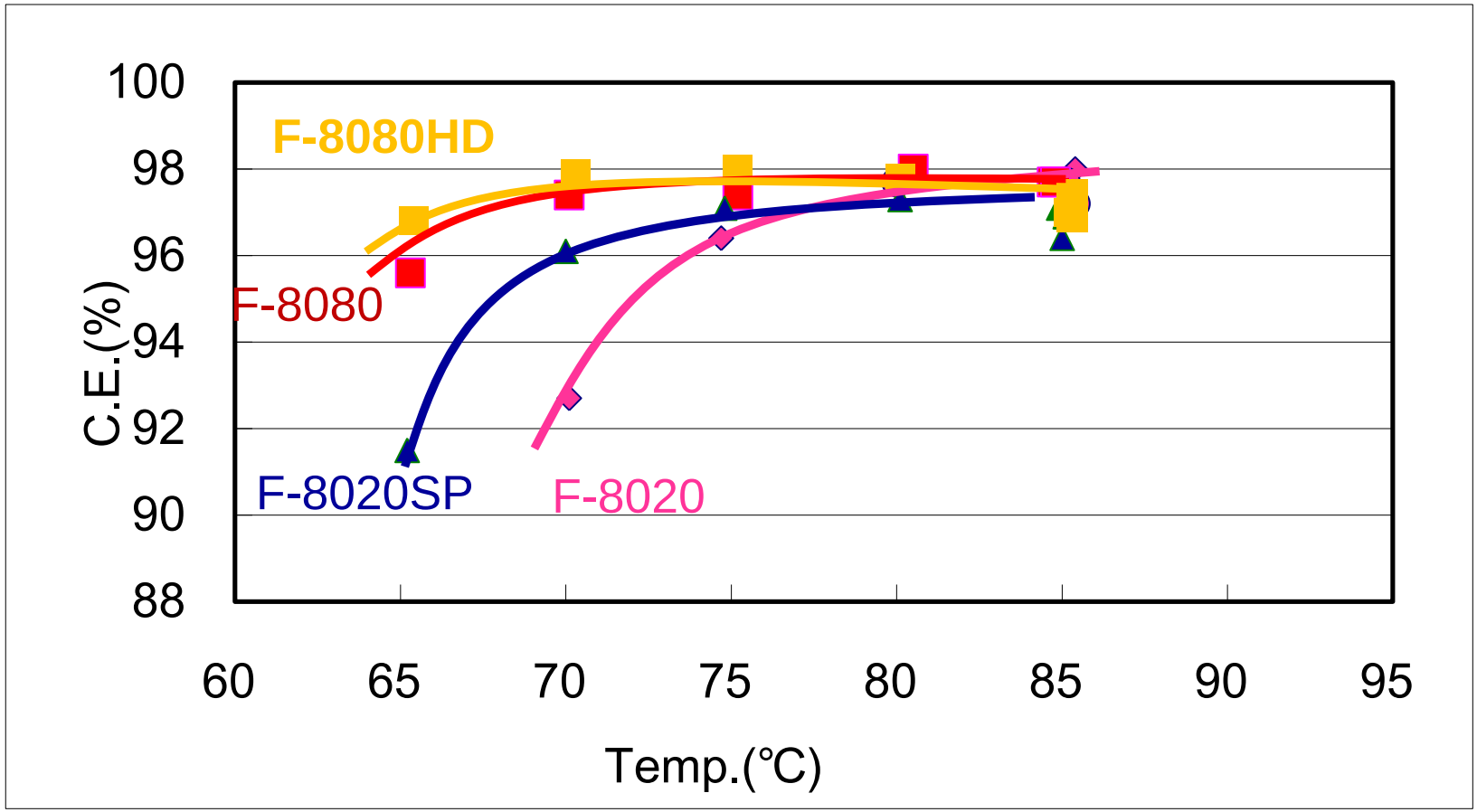
1.5 dm^2 Lab. Cell, 6 kA/m^2, 90 deg-C, 200 g/l



F-8080 series keep good current efficiency over widest range of NaOH strength

CE Curves vs. Temperature

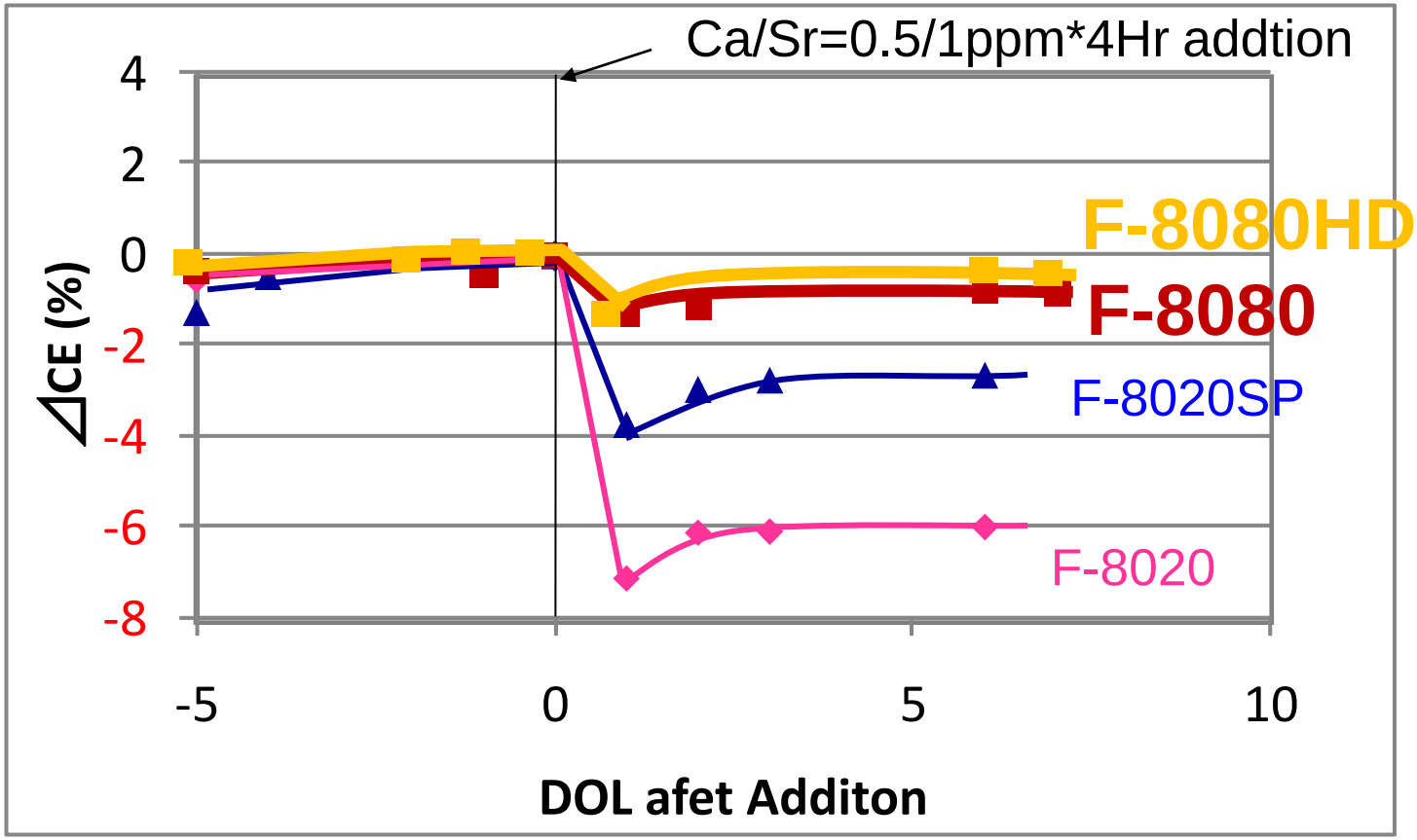
1.5dm^2 Lab. Cell, 4 kA/m^2, NaOH: 32%, NaCl:200g/l



F-8080 series have the widest range.

Ca / Sr upset

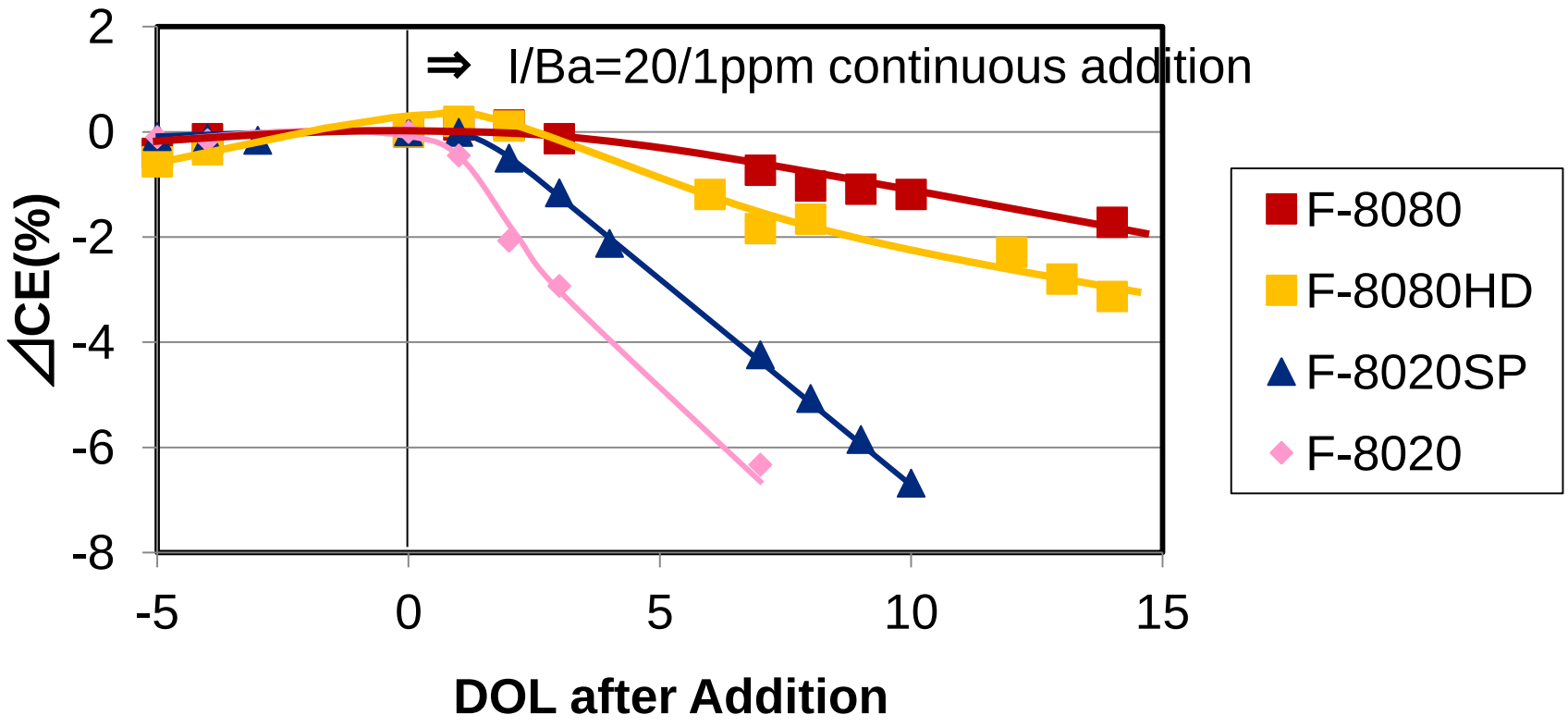
0.25 dm^2 Lab. Cell, 6 kA/m^2, **85 deg-C, NaOH : 33 %, NaCl : 230 g/l**



F-8080 series have the highest durability against Ca/Sr-upset

I / Ba Addition

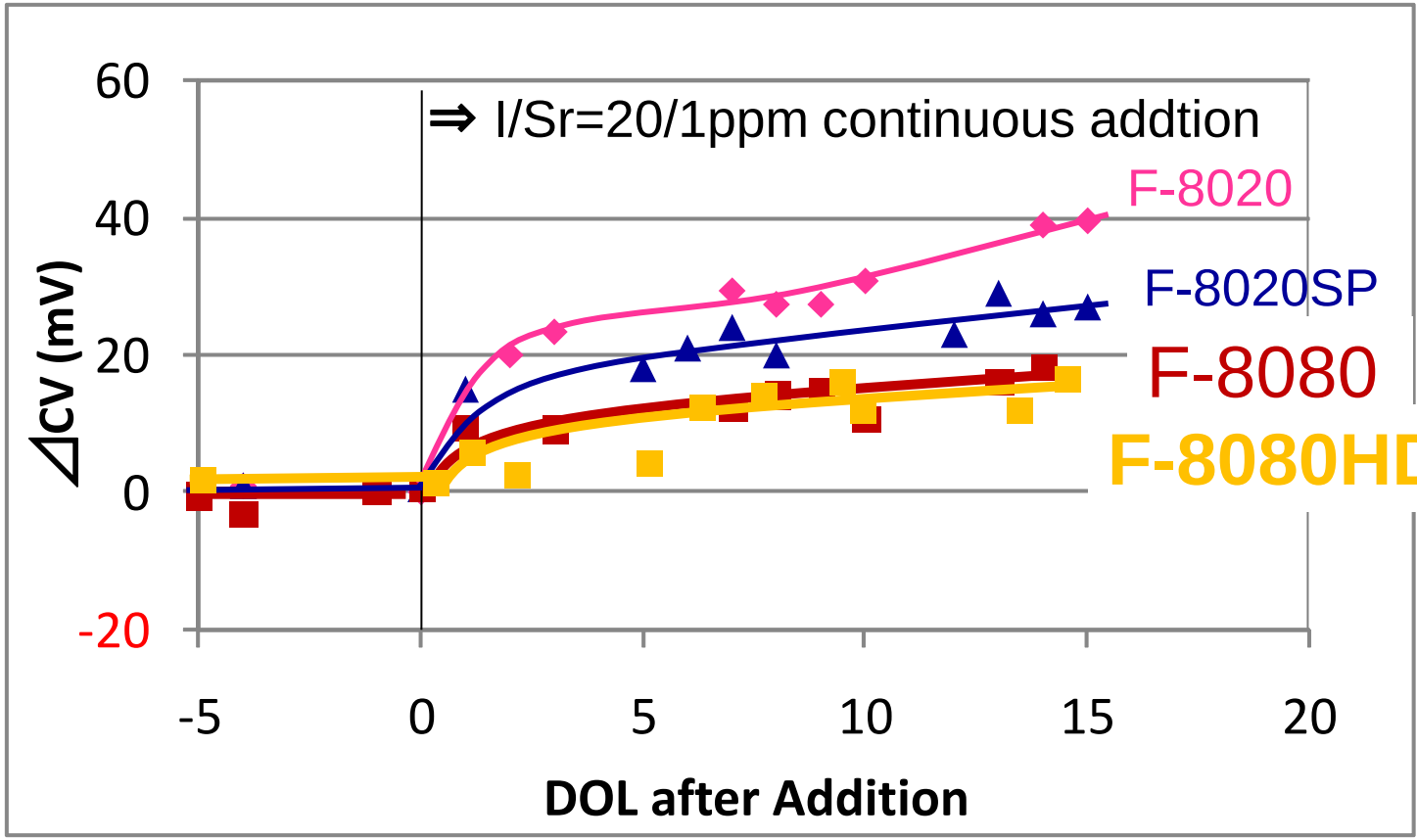
0.25 dm^2 Lab. Cell, 6 kA/m^2, **80 deg-C**, NaOH : 32%, NaCl :190g/l



F-8080 have the highest durability against I/Ba

Cell Voltage Stability (I / Sr addition)

1.5 dm^2 Lab. Cell, 6 kA/m^2, 90 deg-C, NaOH : 32 %, NaCl: 200 g/l



F-8080 series have the most stable C.V.

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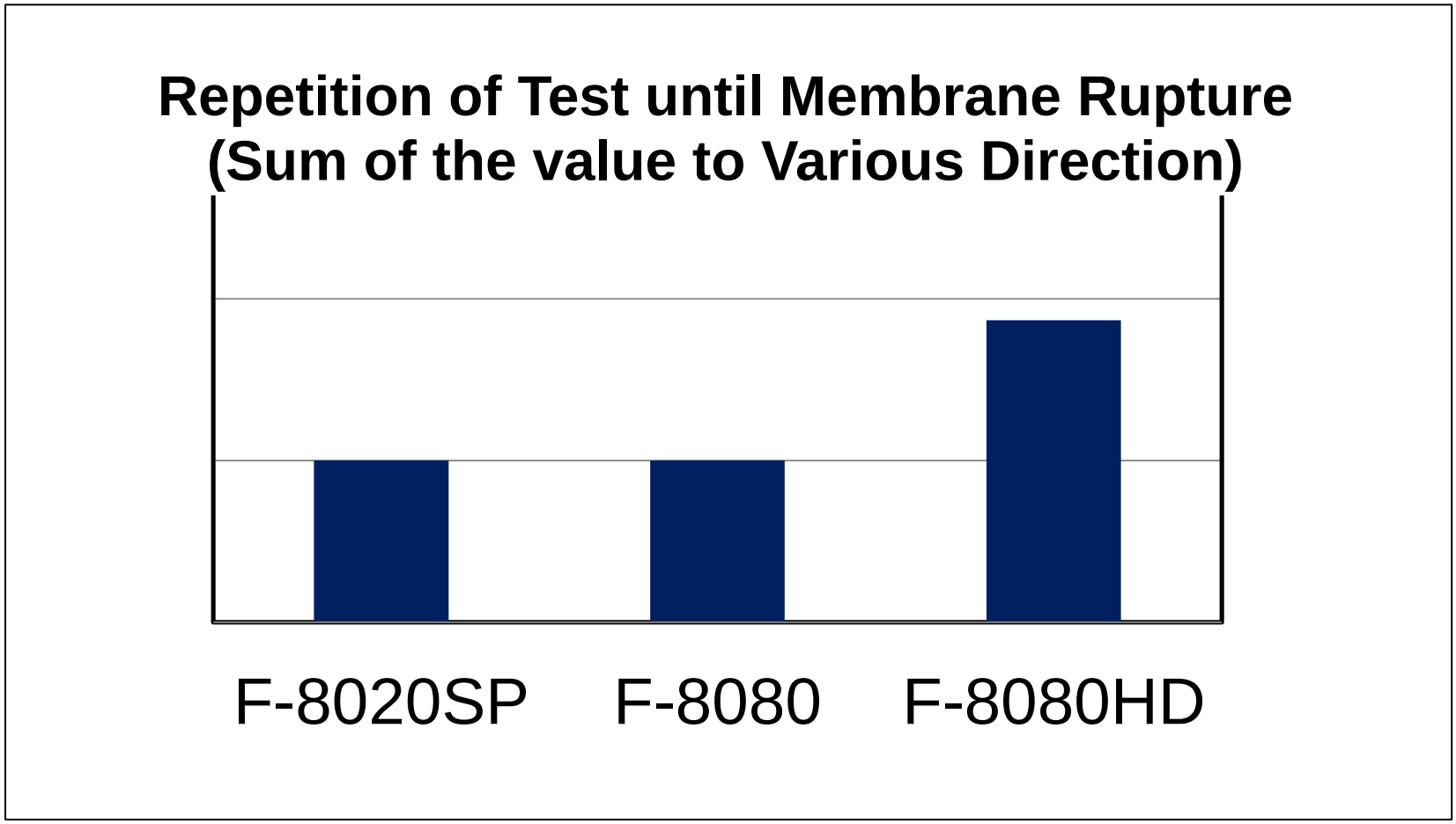
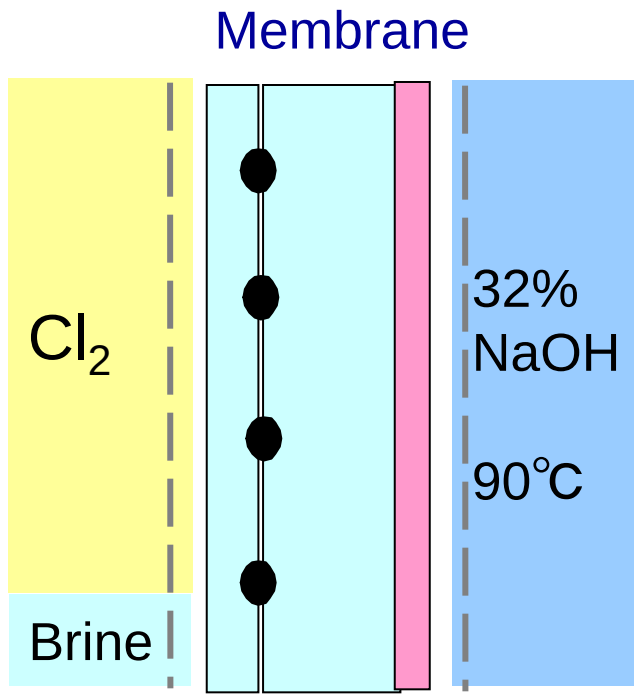
Frequent Load Tensile Test



F-8080HD is twice as robust for frequent load as F-8080

Test for Deterioration by Cl_2 Stagnation

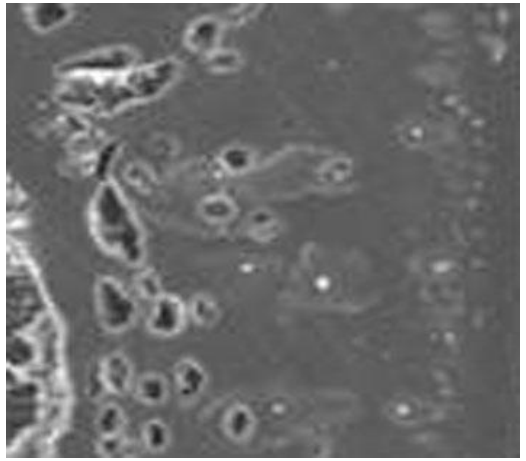
Test Method



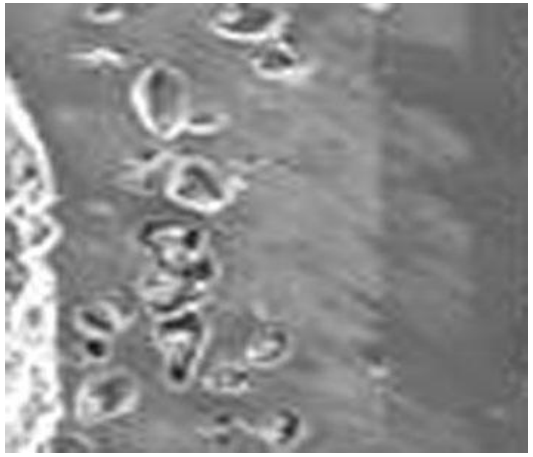
Cl_2 gas stagnation on anode side and high caustic strength on cathode side. In this condition, membrane will have salt crystals.

Test for Deterioration by Cl_2 Stagnation

F-8020SP

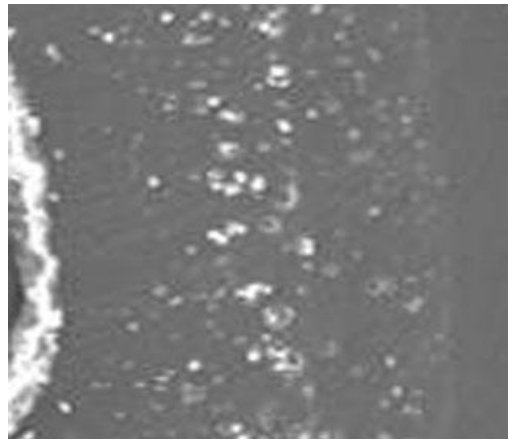


F-8080



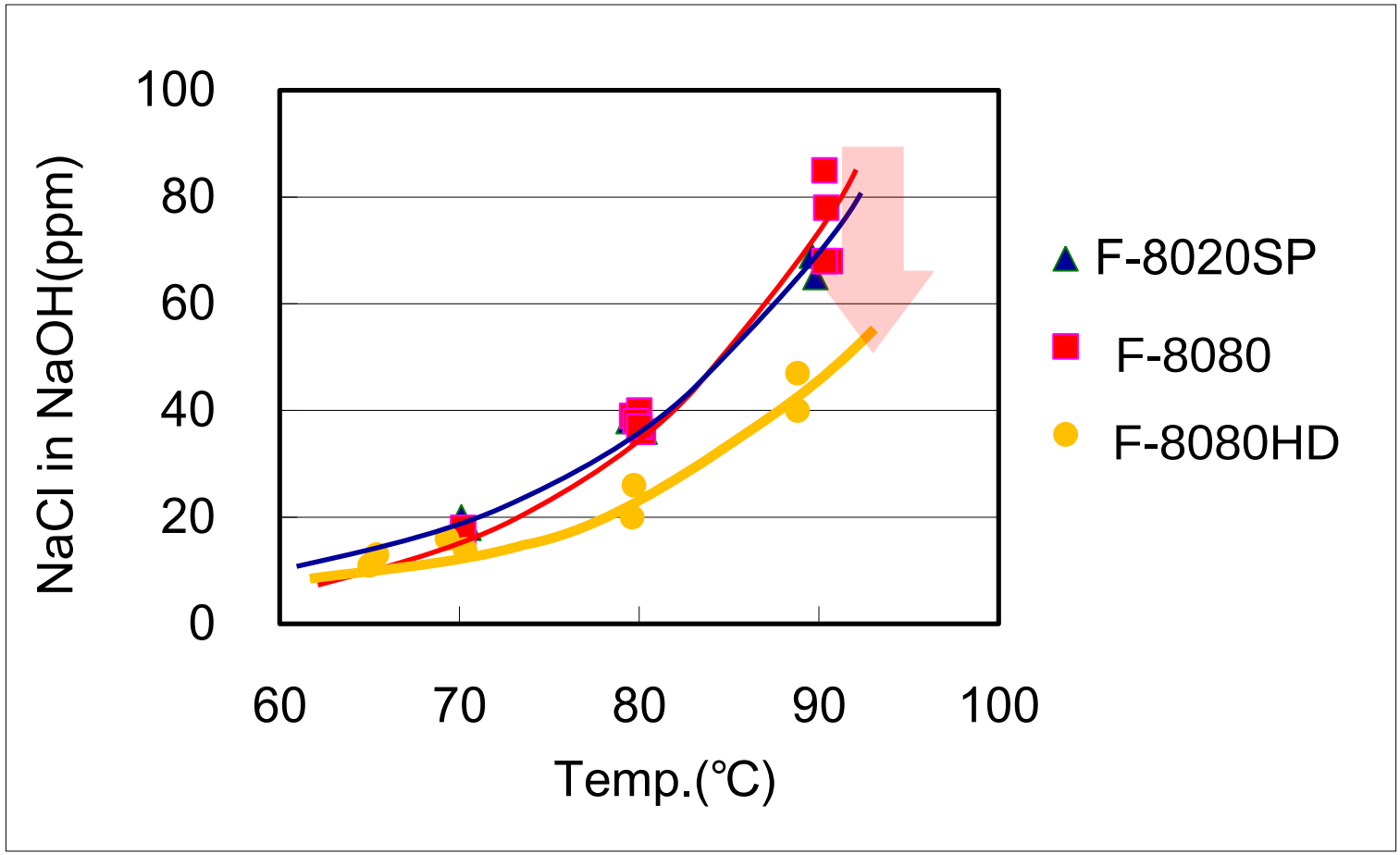
- F-8080 has same durability for Cl2 gas stagnation with very low voltage.
- F-8080HD has much higher durability for Cl2 gas stagnation with lower voltage.

F-8080HD



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

AZEC-M3 Pilot Cell, 2kA/m^2, 32% NaOH



F-8080HD has lower NaCl in NaOH.

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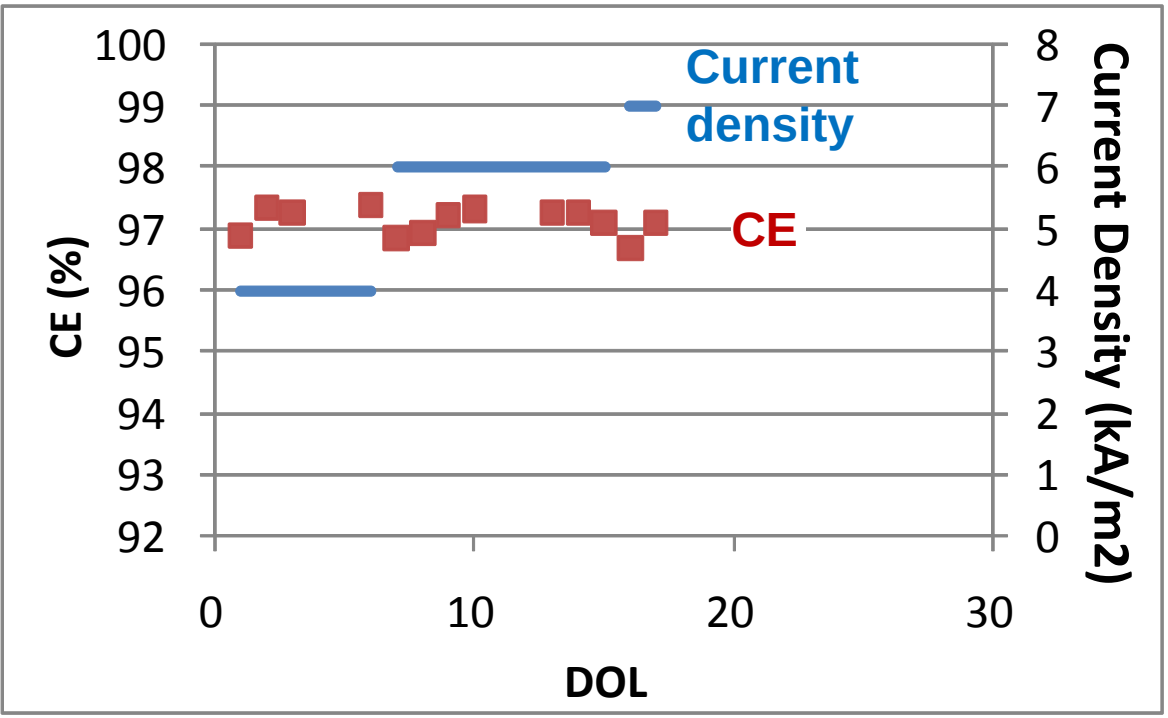
Commercial Size Pilot Cell

4-7kA/m^2, 83~88℃ NaOH:32%, NaCl:190~200g/l

Current Efficiency vs. Current Density



Voltage Comparison

Membrane	Cell Voltage
F-8020	+30～+60mV
F-8020SP	0
F-8080	**- 30mV**

6kA/m^2, 90℃, NaOH:32% corrected voltage

F-8080 has the lowest Cell Voltage!
And Good Efficiency at Current Density 4-7 kA/m2

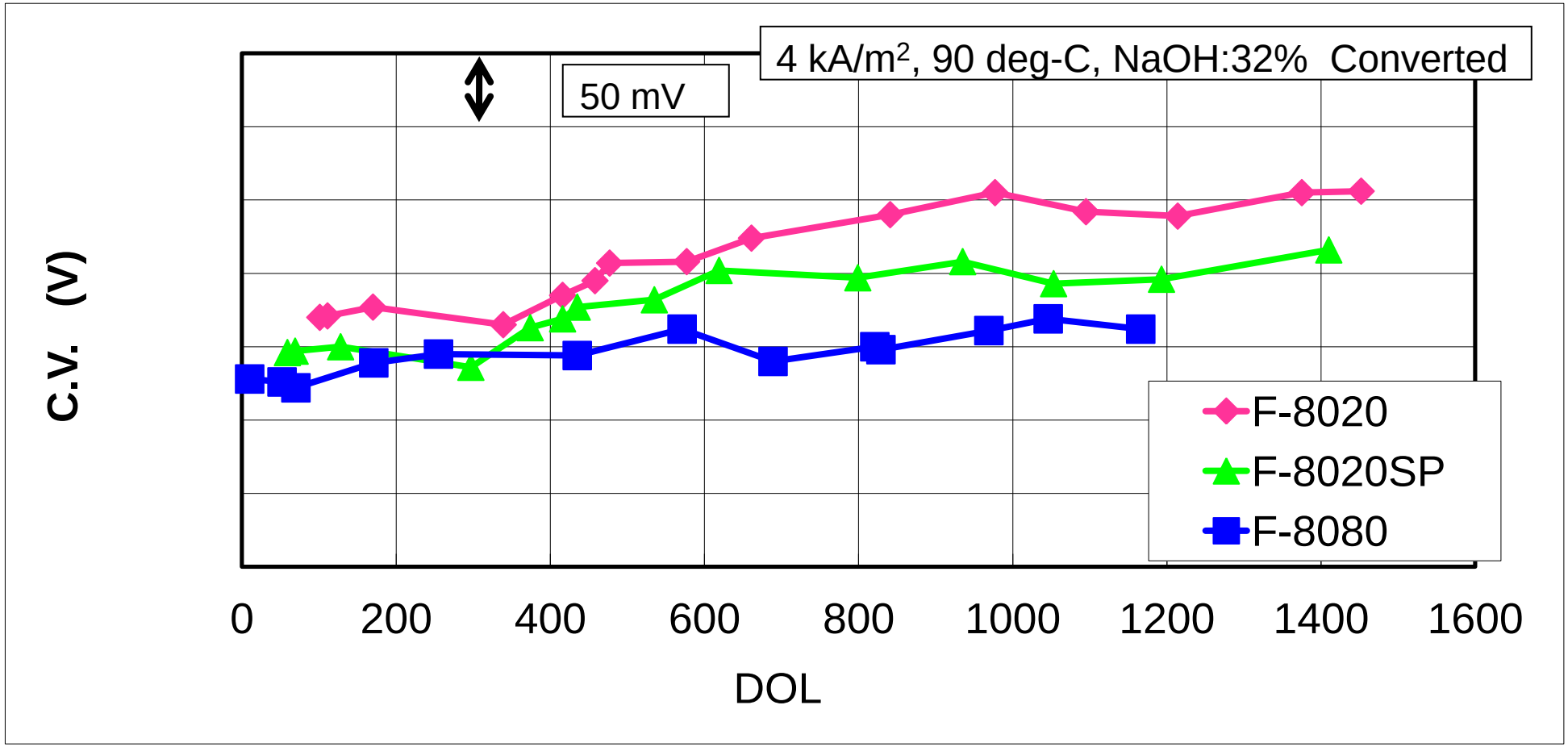
F-8080 Evaluation in Commercial Cell

(at Customers & AGC Plants)

Plant	CV against F-8020 (mV)	CV against F-8020SP (mV)	CE (%)	Current Density (kA/m2)	Remark
Plant-A	-50	-25		6	-
Plant-B		-30	(97%)*	6	-
Plant-C	-70	-25	96.5% <	4.2	less CV increase
Plant-D		-25		5.5	-
Plant-E		-50	97% <	6<	Lowest voltage
Plant-F	-50		96%	4.5	Lowest voltage
Plant-G	-60	-30	97.5% <	3	* Test Cell
Plant-H	-50			6	-

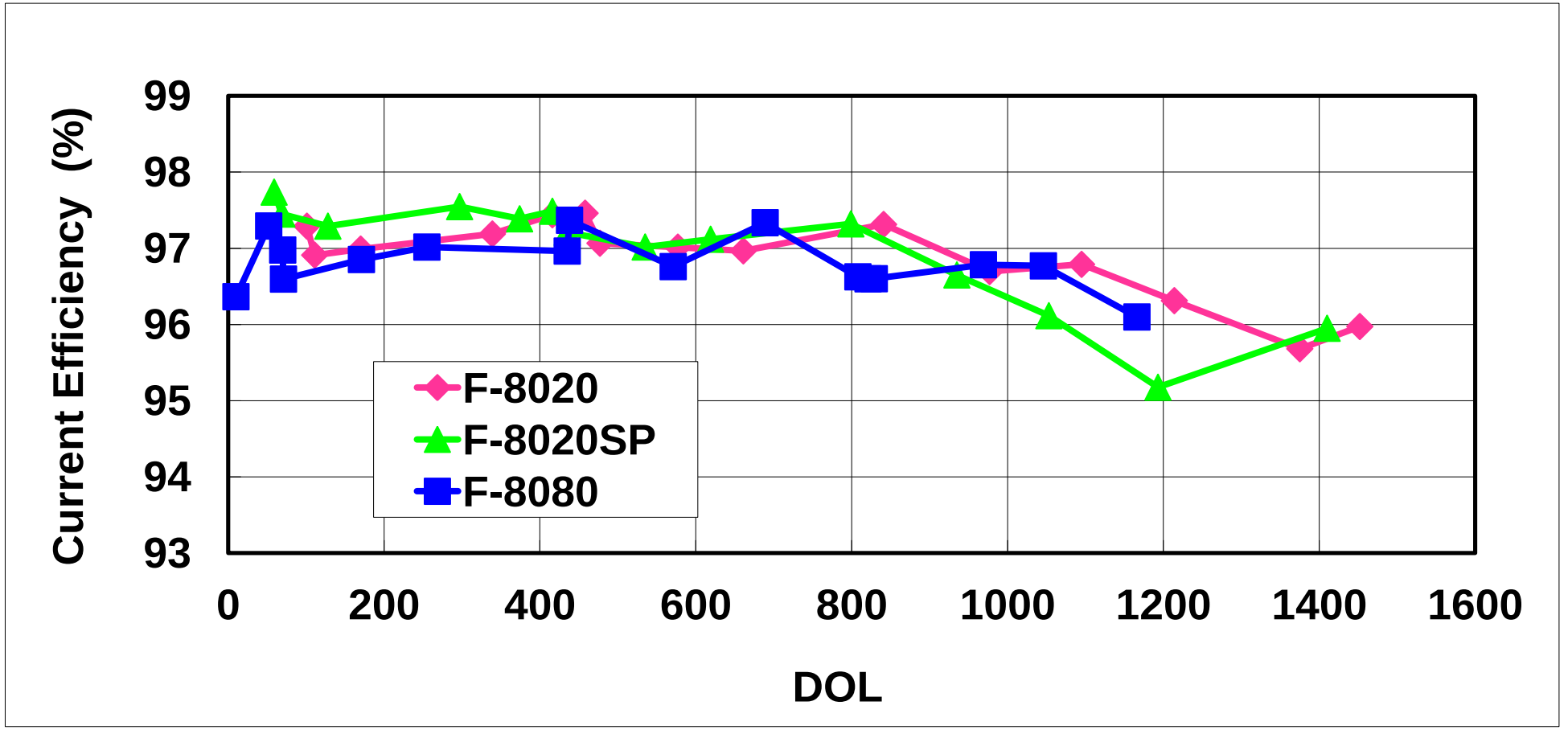
voltage : at 32%NaOH ,90℃

Voltage Stability in AGC Factory



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

Stable CE in AGC Factory



- F-8080 shows 96 % current efficiency more than three years.

Contents

Features of F-8080 series

1. **High Durability against Brine Impurity**
   - **Especially, resistance against Ca upset is much better**
2. **Lower Cell Voltage** and Stability
   - **30 mV lower than F-8020SP for F-8080**
3. Wider Operating Window

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Thank you