IONOMR INNOVATIONS

AEMION+® CO_2 ELECTROLYSIS OFFERINGS

Anion Exchange Membranes & Polymers

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PRODUCT INFORMATION

Ionomr designs and manufactures breakthrough advanced ion-exchange materials to enable rapid growth of the hydrogen economy. Ionomr Anion Exchange membranes are significantly tougher than their counterparts in industry, leading to thinner membranes, longer service life and reduced overall system costs.

Ionomr's advanced anion exchange membranes and polymers are a breakthrough in material science with a unique hydrocarbon structure and the strongest alkaline stability available, making it the only product of its kind. Aemion⁺® provides specialized solutions to OEMs with unique application challenges, including increasing permselectivity and reducing reactant crossover to achieve the highest Faradic efficiencies and reaction selectivities possible.

Aemion+® offers low ionic resistance, and strong chemical stability in solutions of both high and low pH, including concentrated alkaline solutions up to 3 M at 80 °C.

Aemion⁺® represents a fundamental shift in anion exchange technology. Through Aemion⁺®, we provide a platform to enable simultaneous performance and lifetime improvements in clean technologies while further reducing their environmental impact.

For use in electrolysis applications including AEM water electrolysis & CO_2 Electrolysis, hydrocarbon based Aemion⁺® membranes and polymers can be utilized in the harshest of conditions and paired with its high performance, unlocks many end use applications that were previously constrained by the membrane's integrity.

Aemion⁺® enables electrochemical carbon to value systems with the lifetime and efficiency needed for commercialization of e-fuels and carbon-negative chemicals, enabling profitable carbon capture and utilization technologies, a critical milestone for net-zero 2050.

AEMION+® REINFORCED MEMBRANES

Thickness and Reinforcement Properties

Membrane Type	Typical Thickness (µm)	IEC[1] (meq/g)	Reinforcement
AF2-CLF8-15-X	15	2.3 - 2.6	Fluorinated non-woven

Physical Properties[2]	MD	TD	Test Method
Tensile Strength, MPa	65 - 95	65 - 100	ASTM 638
Young's Modulus, MPa	500 - 1000	500 - 1000	ASTM 638
Elongation to break, %	50 - 70	50 - 70	ASTM 638

Hydrolytic Properties[3]		
Water Uptake		
to water soaked, 22 °C	< 30wt%	ASTM D570
to water soaked, 80 °C	< 50 wt%	ASTM D570
Linear Expansion		
to water soaked, 22 °C	< 1.5 %	ASTM D570
to water soaked, 80 °C	< 5 %	ASTM D570
Z-Expansion		
to water soaked, 22 °C	< 50 %	ASTM D570
to water soaked, 80 °C	< 60 %	ASTM D570

Electrochemical Properties		
Permselectivity (K^+, $KHCO_3$)	80% - 86%	Internal
Resistance in 1 M KOH	Not available	Internal

Chemical Stability		
Max. Recommended Condition	3 M KOH, 80 °C	Internal
Max. Temperature	1 M KOH, 100 °C	Internal

Other Properties	
Maximum Processing Temperature	150 °C
Polymer Tg	> 300 °C
Counter-ions	I^-/Cl^-

AEMION+® REINFORCED MEMBRANES

Thickness and Reinforcement Properties

Membrane Type	Typical Thickness (µm)	IEC[1] (meq/g)	Reinforcement
AF2-CLF8-25-X	25	2.3 - 2.6	Fluorinated non-woven

Physical Properties[2]	MD	TD	Test Method
Tensile Strength, MPa	65 - 90	60 - 90	ASTM 638
Young's Modulus, MPa	300 - 700	400 - 700	ASTM 638
Elongation to break, %	50 - 80	55 - 85	ASTM 638

Hydrolytic Properties[3]		
Water Uptake		
to water soaked, 22 °C	< 30 wt%	ASTM D570
to water soaked, 80 °C	< 50 wt%	ASTM D570
Linear Expansion		
to water soaked, 22 °C	< 5 %	ASTM D570
to water soaked, 80 °C	< 5 %	ASTM D570
Z-Expansion		
to water soaked, 22 °C	< 40 %	ASTM D570
to water soaked, 80 °C	< 60 %	ASTM D570

Electrochemical Properties		
Permselectivity (K^+, $KHCO_3$)	88% - 91%	Internal
Resistance in 1 M KOH	< 100 mΩ·cm²	Internal

Chemical Stability		
Max. Recommended Condition	3 M KOH, 80 °C	Internal
Max. Temperature	1 M KOH, 100 °C	Internal

Other Properties	
Maximum Processing Temperature	150 °C
Polymer Tg	> 300 °C
Counter-ions	I^-/Cl^-

AEMION+® REINFORCED MEMBRANES

Thickness and Reinforcement Properties

Membrane Type	Typical Thickness (µm)	IEC[1] (meq/g)	Reinforcement
AF2-CLF8-50-X	50	2.3 - 2.6	Fluorinated non-woven

Physical Properties[2]	MD	TD	Test Method
Tensile Strength, MPa	35 - 55	45 - 65	ASTM 638
Young's Modulus, MPa	380 - 560	300 - 500	ASTM 638
Elongation to break, %	55 - 85	60 - 90	ASTM 638
Hydrolytic Properties[3]			
Water Uptake			
to water soaked, 22 °C	< 30 wt%		ASTM D570
to water soaked, 80 °C	< 40 wt%		ASTM D570
Linear Expansion			
to water soaked, 22 °C	< 5 %		ASTM D570
to water soaked, 80 °C	< 30 %		ASTM D570
Z-Expansion			
to water soaked, 22 °C	< 30 %		ASTM D570
to water soaked, 80 °C	< 30 %		ASTM D570
Electrochemical Properties			
Permselectivity (K^+, $KHCO_3$)	88% - 96%		Internal[4]
Resistance in 1 M KOH	< 180 mΩ·cm²		Internal[5]
Chemical Stability			
Max. Recommended Condition	3 M KOH, 80 °C		Internal
Max. Temperature	1 M KOH, 100 °C		Internal
Other Properties			
Maximum Processing Temperature	150 °C		
Polymer Tg	> 300 °C		
Counter-ions	I^-/Cl^-		

AEMION+® IONOMERS: DRY RESIN

Ionomer Type	IEC[1] (meq/g)	Conductivity Cl^-/I^- (mS/cm)	Water Uptake[6] OH^- (wt%)	Water Uptake[6] Cl^-/I^- (wt%)
AP2-CNN8-00	2.3 - 2.6	8 - 11	95 - 100	20 - 60

Notes

1 Polymer IEC in the hydroxide (OH-) counter-ion form.
2 Measured from dried to equilibrated in DI water at 22 °C
3 Measured ex-situ by change in mechanical strength, conductivity & IEC after soaking electrolyte
4 Tested in permselectivity "H-Cell" at 22C 0.1M / 0.5M KHCO3
5 Measured in water electrolysis conditions at 60 °C, 1 M KOH, OCV
6 Approximate swelling properties at room temperature when cast into membrane form at 25 - 50 µm

These are prototype materials only intended to be used for early development activities and not intended for production items. Product information is to be used as a guide only, subject to change at any time.

Document ID	Title
FM-6035-B	Properties of Aemion^{+}™ CO_2 Electrolysis Membranes

Revision	Prepared By	Approved By	Effective Date
B	Tong Li	Andrew Belletti	May 4, 2022

This document is reviewed to ensure its continuing relevance to the systems and process that it describes.

REVISION HISTORY:

Revision	Date	Description of Changes	Approved By
A	August 17, 2021	Initial Draft	Ben Britton
B	May 04, 2022	Updated offerings and data	Andrew Belletti