IONOMR INNOVATIONS

AEMION+® 3rd Generation 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's Aemion+® anion exchange membranes are significantly more durable than our competitors' leading to thinner membranes, longer service life and reduced overall system costs.

Our membranes have low ionic resistance, high electrical resistance, and strong chemical stability in solutions of both high and low pH, including alkaline solutions (KOH preferred) **from 0.1 M to 2 M at 90°C.**

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. Aemion+® provides specialized solutions for OEMs with unique application challenges.

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 required conditions and paired with its high performance, unlocks many end use applications that were previously constrained by the membrane's instability.

Aemion+® enables electrochemical systems without the need for precious metals (commonly platinum and iridium), providing a pathway for the production of energy-efficient and low-cost green hydrogen as well as profitible carbon capture and utilization technologies.

AEMION+® REINFORCED MEMBRANES — PRELIMINARY

Thickness and Reinforcement Properties			
Membrane Type	**Typical Thickness (µm)**	**IEC[1] (meq/g)**	**Reinforcement**
AF3-CLF9-25-X	25	1.9-2.7	Non-Woven PTFE

Physical Properties[2]	**MD**	**TD**	**Test Method**
Tensile Strength, MPa	> 85	> 80	ASTM 638
Young's Modulus, MPa	> 480	> 480	ASTM 638
Elongation to break, %	> 80	> 80	ASTM 638

Hydrolytic Properties[3]		
Water Uptake		
to water soaked, 80 °C	< 15%	ASTM D570
Linear Expansion		
to water soaked, 80 °C	< 2%	ASTM D570
Z-Expansion		
to water soaked, 80 °C	< 15%	ASTM D570

Electrochemical Properties	
In-Plane Cl^- Conductivity, mS/cm 22°C Liquid Water	7 - 8.5
Thru-Plane Cl^- Conductivity, mS/cm 22°C Liquid Water	4.5 - 5.5
Permselectivity 22°C 0.1/0.5M $KHCO_3$	> 93%

Chemical Stability		
Recommended Condition	0.1 - 2 M KOH, ≤ 90 °C	Internal[4]

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

Notes

1. Polymer IEC in the hydroxide (OH-) counter-ion form.
2. Measured at 22 °C fully hydrated.
3. Measured from dried to equilibrated in DI water at 22 °C.
4. Measured ex-situ by determining steady-state mechanical strength, conductivity, & IEC at specified temperature and regularly exchanged KOH electrolyte.

AEMION+® REINFORCED MEMBRANES — PRELIMINARY

Thickness and Reinforcement Properties			
Membrane Type	**Typical Thickness (µm)**	**IEC[1] (meq/g)**	**Reinforcement**
AF3-CLF9-50-X	50	1.9-2.7	Non-Woven PTFE

Physical Properties[2]	**MD**	**TD**	**Test Method**
Tensile Strength, MPa	> 80	> 75	ASTM 638
Young's Modulus, MPa	> 450	> 400	ASTM 638
Elongation to break, %	80 - 120	80 - 120	ASTM 638
Hydrolytic Properties[3]			
Water Uptake			
to water soaked, 80 °C	< 15%		ASTM D570
Linear Expansion			
to water soaked, 80 °C	< 2%		ASTM D570
Z-Expansion			
to water soaked, 80 °C	< 17%		ASTM D570
Electrochemical Properties			
In-Plane Cl^- Conductivity, mS/cm 22°C Liquid Water	7 - 8		
Thru-Plane Cl^- Conductivity, mS/cm 22°C Liquid Water	5 - 6.5		
Permselectivity 22°C 0.1/0.5M $KHCO_3$	> 93%		
Chemical Stability			
Recommended Condition	0.1 - 2 M KOH, ≤ 90 °C		Internal[4]
Other Properties			
Maximum Processing Temperature	150 °C		
Polymer Tg	> 300 °C		
Counter-ions as produced	I^-/Cl^-		

Notes

1. Polymer IEC in the hydroxide (OH-) counter-ion form.
2. Measured at 22 °C fully hydrated.
3. Measured from dried to equilibrated in DI water at 22 °C.
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AEMION+® IONOMERS: DRY RESIN

Ionomer Type	IEC[1] (meq/g)	Conductivity Cl^- (mS/cm)	Water Uptake[2] OH^- (%)	Water Uptake[2] Cl^-/I^- (%)
AP3-HNN9-00-X	1.9-2.7	4 - 9	20 - 50	10 - 15

Notes

1 IEC in the hydroxide (OH^-) counter-ion form, calculated by NMR. Recommend silver nitrate titration for measurement by titration.
2 Approximate swelling properties when cast into membrane form at 25 - 50 µm, at 80°C.

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-6065-02	Properties of Next-Gen Aemion+™ Water Electrolysis Membranes		
Revision	**Prepared By**	**Approved By**	**Effective Date**
2	Tong Li	Andrew Belletti	Jan 11, 2023

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
1	Sept 15, 2022	Initial Draft	Scott McDermid
2	Jan 11, 2023	Updated data and added 25 um, 50 um membrane specs	Andrew Belletti

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