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Effect of Fixed Charge Group Concentration on Equilibrium Ion Sorption in Ion Exchange Membranes

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Supporting Information

S1. Photographs of ion exchange membranes.

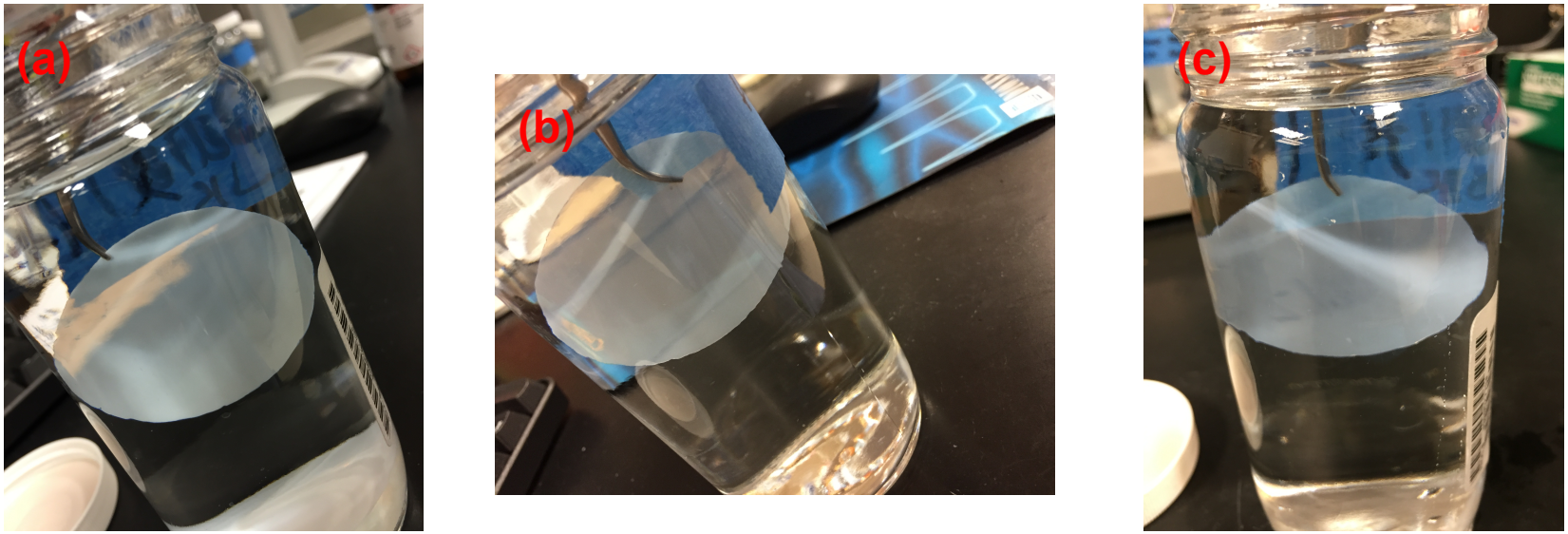

Figure S1. Photographs of: (a) CA200, (b) CA238, and (c) CA267 cation exchange membranes showing the cloudy nature of these membranes, suggesting structural inhomogeneity.

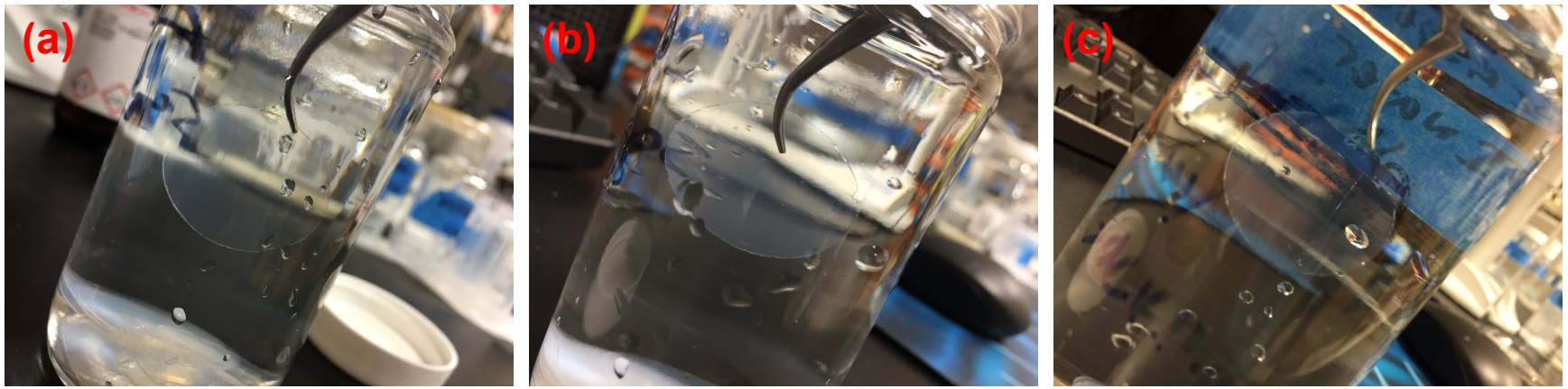

Figure S2. Photographs of: (a) AA200, (b) AA238, and (c) AA267 anion exchange membranes. These samples are essentially transparent, which is believed to reflect a more homogeneous structure than that of the CEMs shown in Figure S1.

S2. Membrane water content

Table S1. Water content in cation exchange membranes.

	CA200		CA238		CA267	
C_s^s **[mol/L]**	w_u	ϕ_w	w_u	ϕ_w	w_u	ϕ_w
1	0.861 ± 0.007	0.542 ± 0.006	0.851 ± 0.014	0.541 ± 0.012	0.843 ± 0.004	0.541 ± 0.003
0.3	0.914 ± 0.005	0.556 ± 0.005	0.922 ± 0.010	0.561 ± 0.008	0.919 ± 0.005	0.563 ± 0.004
0.1	0.943 ± 0.009	0.564 ± 0.007	0.945 ± 0.016	0.567 ± 0.012	0.941 ± 0.009	0.568 ± 0.007
0.03	0.951 ± 0.005	0.566 ± 0.004	0.953 ± 0.013	0.569 ± 0.010	0.957 ± 0.007	0.573 ± 0.005
0.01	0.957 ± 0.006	0.568 ± 0.005	0.955 ± 0.013	0.570 ± 0.010	0.953 ± 0.004	0.572 ± 0.003

Table S2. Water content in anion exchange membranes.

	AA200		AA238		AA267	
C_s^s **[mol/L]**	w_u	ϕ_w	w_u	ϕ_w	w_u	ϕ_w
1	0.744 ± 0.003	0.484 ± 0.003	0.733 ± 0.002	0.479 ± 0.002	0.723 ± 0.009	0.475 ± 0.009
0.3	0.781 ± 0.003	0.496 ± 0.003	0.776 ± 0.003	0.493 ± 0.003	0.767 ± 0.005	0.490 ± 0.005
0.1	0.787 ± 0.008	0.498 ± 0.008	0.788 ± 0.003	0.497 ± 0.003	0.782 ± 0.004	0.495 ± 0.004
0.03	0.798 ± 0.004	0.501 ± 0.004	0.795 ± 0.007	0.499 ± 0.007	0.793 ± 0.005	0.498 ± 0.005
0.01	0.787 ± 0.009	0.498 ± 0.009	0.798 ± 0.003	0.500 ± 0.003	0.789 ± 0.007	0.497 ± 0.007

S3. Membrane co-ion concentration

Table 3. Membrane co-ion concentration as a function of external NaCl concentration.

	C_c^m **[mol/L(sorbed water)]**					
C_s^s **[mol/L]**	**CA200**	**CA238**	**CA267**	**AA200**	**AA238**	**AA267**
1	$3.56 \pm 0.06 \times 10^{-1}$	$2.66 \pm 0.04 \times 10^{-1}$	$2.55 \pm 0.10 \times 10^{-1}$	$4.70 \pm 0.16 \times 10^{-1}$	$4.17 \pm 0.01 \times 10^{-1}$	$3.84 \pm 0.11 \times 10^{-1}$
0.3	$5.07 \pm 0.07 \times 10^{-2}$	$3.95 \pm 0.06 \times 10^{-2}$	$3.46 \pm 0.08 \times 10^{-2}$	$7.22 \pm 0.21 \times 10^{-2}$	$6.52 \pm 0.27 \times 10^{-2}$	$5.94 \pm 0.18 \times 10^{-2}$
0.1	$7.98 \pm 0.10 \times 10^{-3}$	$6.68 \pm 0.14 \times 10^{-3}$	$5.61 \pm 0.14 \times 10^{-3}$	$1.44 \pm 0.03 \times 10^{-2}$	$1.21 \pm 0.01 \times 10^{-2}$	$1.19 \pm 0.03 \times 10^{-2}$
0.03	$1.04 \pm 0.03 \times 10^{-3}$	$9.17 \pm 0.52 \times 10^{-4}$	$7.67 \pm 0.28 \times 10^{-4}$	$1.92 \pm 0.10 \times 10^{-3}$	$1.69 \pm 0.04 \times 10^{-3}$	$1.70 \pm 0.12 \times 10^{-3}$
0.01				$2.88 \pm 0.23 \times 10^{-4}$	$2.76 \pm 0.12 \times 10^{-4}$	$2.62 \pm 0.17 \times 10^{-4}$

S4. Modeling results.

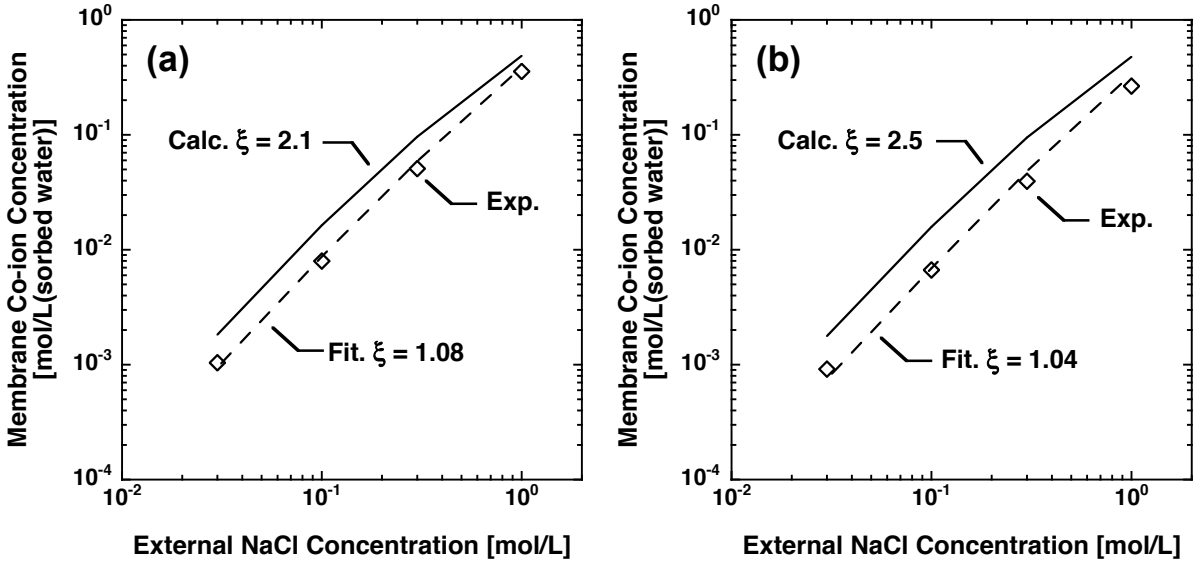

Figure S3. Experimental and calculated membrane co-ion concentrations as a function of external NaCl concentration for: (a) CEM CA200 and (b) CEM CA238. The solid lines represent co-ion concentrations calculated using ξ values estimated assuming a homogeneous membrane, and the dashed lines represent co-ion concentrations calculated by treating ξ as an adjustable parameter.

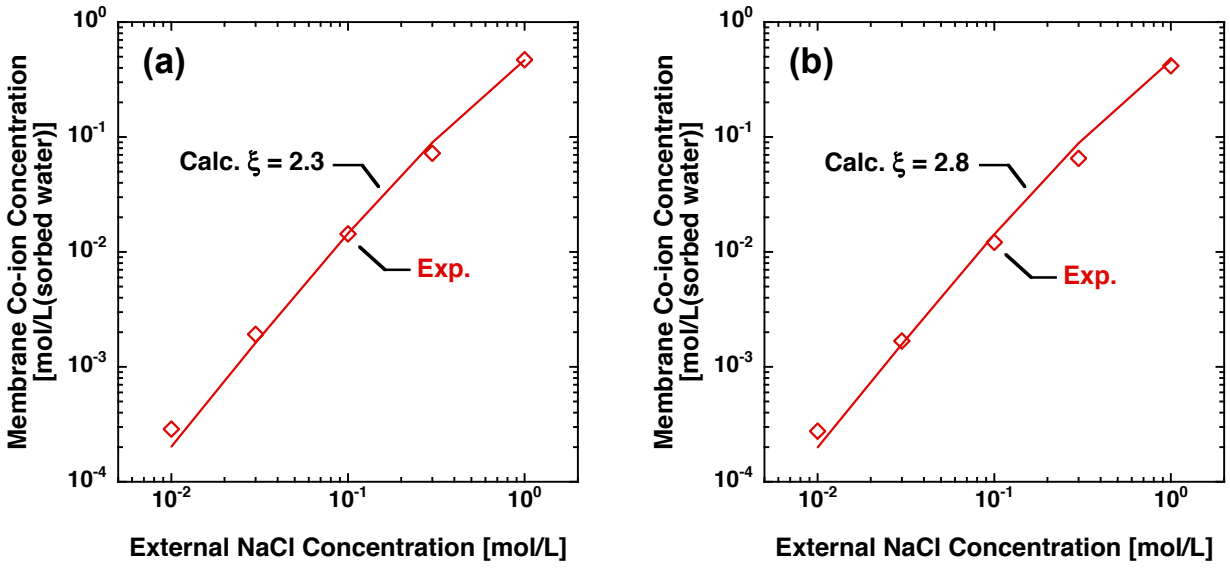

Figure S4. Experimental and calculated membrane co-ion concentrations as a function of external NaCl concentration for: (a) AEM AA200 and (b) AEM AA238. The solid lines represent co-ion concentrations calculated using ξ values estimated based on the membranes being homogeneous.