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APPENDICES

Appendix A Experimental Data of Critical Micelle Concentration (CMC)

1. Average Liquid/Vapor Surface Tension (γ_{LV}) of Single AEs, NPE-9, and MES System for CMC Calculation

Table A1 Average Liquid/Vapor surface tension (γ_{LV}) (mN/m) as a function of concentration of $C_{12-14}EO_5$, $C_{12-14}EO_7$, $C_{12-14}EO_8$, $C_{12-14}EO_9$, and NPE-9 single system at 30 °C

Conc (%w/v)	EO5		EO7		EO8		EO9		NPE-9	
	μM	γ_{LV}	μM	γ_{LV}	μM	γ_{LV}	μM	γ_{LV}	μM	γ_{LV}
0.0002	5	59.7	4	54.6	4	58.9	3	57.1	3	52.6
0.0003	7	49.2	6	51.0	6	53.0	5	55.0	5	49.0
0.0004	10	45.0	8	50.6	7	49.6	7	53.3	6	47.2
0.0005	12	42.0	10	47.8	9	45.6	9	50.8	8	47.0
0.0006	15	37.8	12	43.8	11	45.4	10	48.2	10	44.9
0.0007	17	36.3	14	39.0	13	41.7	12	47.7	11	43.6
0.0008	20	35.4	16	37.0	15	38.7	14	46.3	13	43.0
0.0009	22	33.0	18	35.0	17	37.0	16	43.4	15	42.2
0.001	25	31.8	20	34.1	19	36.4	17	40.5	16	41.1
0.002	50	28.3	40	30.1	37	33.0	35	35.0	32	36.1
0.003	74	28.0	60	30.0	56	31.7	52	33.2	49	33.0
0.004	99	27.8	81	29.8	74	30.8	69	31.8	65	31.1
0.006	149	27.7	121	29.6	111	30.1	104	31.8	97	31.0
0.008	198	27.5	161	29.5	149	29.7	138	32.7	130	31.1
0.01	248	27.5	201	29.4	186	30.0	173	32.4	162	31.3
0.02	496	27.4	403	29.5	371	30.1	346	32.4	325	31.3
0.04	991	27.4	806	29.0	743	29.8	692	32.2	649	31.2
0.06	1487	27.2	1209	29.1	1114	29.8	1037	32.2	974	31.2
0.08	1982	27.1	1611	28.7	1486	29.7	1383	32.2	1299	31.2
0.1	2478	27.2	2014	28.8	1857	29.7	1729	32.3	1623	31.2

Table A2 Average Liquid/Vapor surface tension (γ_{LV}) as a function of concentration of Methyl Ester Sulfonate single system at 30°C

Conc (%w/v)	MES	
	μM	γ_{LV}
0.0005	13	50.9
0.001	26	46.7
0.002	52	42.3
0.004	105	39.5
0.006	157	38.4
0.008	209	38.8
0.01	261	38.7
0.012	314	39.3
0.014	366	39.1
0.016	418	39.1
0.018	470	39.1
0.02	523	39.2
0.04	1045	39.2
0.06	1568	39.1
0.08	2090	39.0
0.1	2613	39.0

Appendix B Adsorption Isotherm of Surfactant Solution

Table B1 Adsorption Isotherm on polymer powders of $C_{12-14}EO_5$

EO5							
Initial Conc		PTFE		PVC		PMMA	
C_i (%w/v)	C_i (μM)	C_f (μM)	Ads (μmol/m^2)	C_f (μM)	Ads (μmol/m^2)	C_f (μM)	Ads (μmol/m^2)
0.0003	7	5	0.011	5	0.062	7	0.010
0.0005	12	6	0.035	8	0.119	9	0.157
0.0007	17	9	0.046	12	0.133	11	0.258
0.0009	22	11	0.061	14	0.207	12	0.415
0.001	25	7	0.100	17	0.205	14	0.453
0.002	50	14	0.201	28	0.540	21	1.230
0.003	74	26	0.252	41	0.884	30	1.803
0.004	99	27	0.377	54	1.183	37	2.568
0.006	149	31	0.624	92	1.470	81	2.814
0.008	198	41	0.857	144	1.424	133	2.716
0.01	248	55	1.062	179	1.746	182	2.750
0.04	991	762	1.248	925	1.796	922	2.839
0.1	2478	2256	1.219	2413	1.658	2407	2.850

Table B2 Adsorption Isotherm on polymer powders of $C_{12-14}EO_7$

EO7							
Initial Conc		PTFE		PVC		PMMA	
C_i (%w/v)	C_i (μM)	C_f (μM)	Ads (μmol/m^2)	C_f (μM)	Ads (μmol/m^2)	C_f (μM)	Ads (μmol/m^2)
0.0003	6	0	0.030	3	0.089	4	0.107
0.0005	10	2	0.045	5	0.128	5	0.226
0.0007	14	3	0.060	7	0.188	7	0.304
0.0009	18	5	0.071	9	0.254	8	0.422
0.001	20	5	0.080	8	0.334	9	0.475
0.002	40	17	0.133	21	0.522	19	0.895
0.003	60	26	0.190	30	0.804	31	1.222
0.004	81	34	0.254	40	1.100	49	1.265
0.006	121	47	0.397	66	1.409	84	1.461
0.008	161	55	0.584	116	1.211	114	1.933
0.01	201	89	0.602	155	1.271	164	1.509
0.04	806	665	0.747	757	1.333	754	2.169
0.1	2014	1862	0.856	1962	1.352	1961	2.228

Table B3 Adsorption Isotherm on polymer powders of $C_{12-14}EO_8$

EO8							
Initial Conc		PTFE		PVC		PMMA	
C_i (%w/v)	C_i (μM)	C_f (μM)	Ads (μmol/m^2)	C_f (μM)	Ads (μmol/m^2)	C_f (μM)	Ads (μmol/m^2)
0.0002	4	1	0.014	3	0.028	0	0.135
0.0004	7	1	0.036	3	0.132	4	0.153
0.0006	11	2	0.049	1	0.276	6	0.207
0.0008	15	8	0.035	1	0.363	7	0.327
0.001	19	9	0.057	5	0.361	10	0.330
0.002	37	19	0.096	16	0.589	18	0.791
0.003	56	23	0.186	29	0.723	23	1.360
0.004	74	29	0.249	44	0.775	32	1.733
0.006	111	44	0.353	78	0.899	68	1.795
0.008	149	61	0.476	114	0.944	103	1.902
0.01	186	92	0.524	140	1.185	139	2.001
0.04	743	611	0.759	695	1.262	691	2.102
0.1	1857	1714	0.766	1811	1.271	1808	2.110

Table B4 Adsorption Isotherm on polymer powders of $C_{12-14}EO_9$

EO9							
Initial Conc		PTFE		PVC		PMMA	
C_i (%w/v)	C_i (μM)	C_f (μM)	Ads (μmol/m^2)	C_f (μM)	Ads (μmol/m^2)	C_f (μM)	Ads (μmol/m^2)
0.0002	3	1	0.016	2	0.040	2	0.048
0.0004	7	3	0.025	3	0.093	5	0.076
0.0006	10	3	0.038	4	0.183	6	0.187
0.0008	14	4	0.054	7	0.189	7	0.269
0.001	17	5	0.065	7	0.264	10	0.303
0.002	35	16	0.102	20	0.384	25	0.407
0.003	52	25	0.152	29	0.585	34	0.748
0.004	69	29	0.224	40	0.782	48	0.873
0.006	104	45	0.319	67	0.973	76	1.152
0.008	138	74	0.366	102	0.912	110	1.219
0.01	173	98	0.414	134	1.016	146	1.151
0.04	692	576	0.647	651	1.048	651	1.597
0.1	1729	1598	0.725	1686	1.109	1688	1.621

Table B5 Adsorption Isotherm on polymer powders of NPE-9

NPE-9							
Initial Conc		PTFE		PVC		PMMA	
C_i (%w/v)	C_i (μM)	C_f (μM)	Ads (μmol/m^2)	C_f (μM)	Ads (μmol/m^2)	C_f (μM)	Ads (μmol/m^2)
0.0002	3	1	0.015	1	0.066	1	0.090
0.0004	6	3	0.022	2	0.110	2	0.192
0.0006	10	3	0.037	3	0.182	4	0.214
0.0008	13	3	0.056	4	0.230	4	0.361
0.001	16	4	0.066	5	0.284	7	0.367
0.002	32	13	0.110	15	0.440	16	0.652
0.003	49	18	0.172	32	0.430	22	1.149
0.004	65	21	0.247	40	0.679	29	1.466
0.006	97	29	0.374	65	0.841	44	2.260
0.008	130	42	0.501	100	0.754	64	2.802
0.01	162	61	0.566	131	0.815	98	2.726
0.04	649	515	0.749	605	1.146	580	2.744
0.1	1623	1487	0.753	1577	1.213	1553	2.795

Table B6 Adsorption Isotherm on polymer powders of MES

MES							
Initial Conc		PTFE		PVC		PMMA	
C_i (%w/v)	C_i (μM)	C_f (μM)	Ads (μmol/m^2)	C_f (μM)	Ads (μmol/m^2)	C_f (μM)	Ads (μmol/m^2)
0.0005	13	9	0.026	12	0.020	11	0.080
0.001	26	22	0.026	24	0.048	23	0.132
0.002	52	39	0.073	45	0.195	41	0.442
0.004	105	73	0.170	88	0.447	81	0.993
0.006	157	126	0.169	138	0.473	123	1.364
0.008	209	165	0.242	181	0.762	175	1.425
0.01	261	218	0.241	233	0.784	225	1.456
0.012	314	269	0.252	284	0.788	283	1.249
0.014	366	328	0.214	335	0.787	324	1.792
0.016	418	394	0.135	392	0.700	386	1.381
0.018	470	440	0.160	443	0.731	436	1.399
0.02	523	484	0.214	497	0.680	493	1.207
0.04	1045	1015	0.168	1023	0.599	1013	1.289
0.06	1568	1540	0.156	1538	0.751	1533	1.400
0.08	2090	2067	0.129	2063	0.725	2055	1.522
0.1	2613	2585	0.156	2586	0.696	2582	1.312

Appendix C Contact Angle of Surfactant Solution

Table C1 Contact Angle on polymer surfaces of $C_{12-14}EO_5$

EO5				
Conc		PTFE	PVC	PMMA
%w/v	μM			
0.0003	7	98.67	80.38	72.75
0.0005	12	97.35	77.35	72.57
0.0007	17	96.35	74.30	71.13
0.0009	22	94.31	74.60	73.57
0.001	25	92.05	75.03	72.07
0.002	50	87.47	71.55	66.08
0.003	74	79.50	67.90	63.05
0.004	99	75.52	57.80	59.15
0.006	149	57.80	49.14	59.18
0.008	198	56.28	39.78	49.30
0.01	248	49.14	39.96	37.80
0.04	991	45.98	29.10	26.53
0.1	2478	42.90	33.46	27.20

Table C2 Contact Angle on polymer surfaces of $C_{12-14}EO_7$

EO7				
Conc		PTFE	PVC	PMMA
%w/v	μM			
0.0003	6	100.79	80.14	81.85
0.0005	10	100.12	80.15	80.70
0.0007	14	97.98	74.33	79.92
0.0009	18	95.70	74.75	78.13
0.001	20	93.58	72.82	76.83
0.002	40	87.35	69.51	73.33
0.003	60	78.43	67.83	66.56
0.004	81	72.38	57.86	59.10
0.006	121	64.98	52.07	49.92
0.008	161	60.20	51.05	41.02
0.01	201	54.25	52.25	41.47
0.04	806	51.73	39.15	31.05
0.1	2014	47.17	36.28	27.65

Table C3 Contact Angle on polymer surfaces of $C_{12-14}EO_8$

EO8				
Conc		PTFE	PVC	PMMA
%w/v	μM			
0.0002	4	100.87	83.37	70.87
0.0004	7	99.60	84.63	80.50
0.0006	11	97.64	90.30	75.20
0.0008	15	94.67	85.94	74.85
0.001	19	93.43	83.23	73.12
0.002	37	80.42	77.48	64.40
0.003	56	79.53	76.44	65.45
0.004	74	71.83	64.77	53.98
0.006	111	63.25	65.20	51.48
0.008	149	59.18	57.92	42.45
0.01	186	58.03	49.55	41.83
0.04	743	53.30	39.47	31.50
0.1	1857	53.14	38.00	29.00

Table C4 Contact Angle on polymer surfaces of $C_{12-14}EO_9$

EO9				
Conc		PTFE	PVC	PMMA
%w/v	μM			
0.0002	3	95.96	93.06	72.49
0.0004	7	101.06	77.51	73.33
0.0006	10	100.00	77.83	75.68
0.0008	14	96.84	75.85	73.76
0.001	17	95.20	75.13	73.80
0.002	35	86.60	73.70	67.84
0.003	52	80.86	70.22	66.27
0.004	69	71.43	64.08	62.97
0.006	104	60.93	56.10	55.30
0.008	138	63.18	52.23	48.53
0.01	173	57.78	45.28	48.03
0.04	692	57.80	35.75	35.77
0.1	1729	52.78	32.33	29.68

Table C5 Contact Angle on polymer surfaces of NPE-9

NPE-9				
Conc		PTFE	PVC	PMMA
%w/v	μM			
0.0002	3	98.85	90.00	77.90
0.0004	6	100.84	78.98	75.47
0.0006	10	93.03	77.48	79.05
0.0008	13	98.10	79.98	79.78
0.001	16	94.68	83.43	79.00
0.002	32	83.30	66.65	71.03
0.003	49	72.87	63.63	71.28
0.004	65	66.55	61.53	63.76
0.006	97	60.54	58.50	53.57
0.008	130	53.42	46.06	42.00
0.01	162	53.00	46.00	38.00
0.04	649	54.10	47.00	37.00
0.1	1623	53.00	42.40	36.93

Table C6 Contact Angle on polymer surfaces of MES

MES				
Conc		PTFE	PVC	PMMA
%w/v	μM			
0.0005	13	98.43	84.44	78.87
0.001	26	98.40	80.90	75.56
0.002	52	98.03	81.71	73.01
0.004	105	97.60	79.72	74.27
0.006	157	94.46	80.72	72.60
0.008	209	90.10	75.88	69.53
0.01	261	85.83	74.85	65.67
0.02	523	71.22	66.15	60.20
0.04	1045	71.10	67.20	56.25
0.06	1568	71.50	63.72	55.83
0.08	2090	73.89	61.25	55.57
0.1	2613	73.12	60.10	55.12

Appendix D Example of Calculation for Surfactant Adsorption Isotherm

Adsorption for solution of $C_{12-14}EO_5$ on PMMA

$$Ads = \frac{C_i - C_f \times V_{sol}}{1000 \times W_{plastic} \times a_s}$$

where

Ads	=	Adsorption of Surfactant, (μmole/m^2 plastic)
C_i	=	Initial Surfactant solution concentration, (μM)
C_f	=	Final Surfactant solution concentration, (μM)
V_{sol}	=	Volume of solution, (ml)
$W_{plastic}$	=	Weight of plastic, (g)
a_s	=	Specific surface area of plastic, (m^2/g)

The adsorption isotherm was a plot between adsorption of surfactant on PMMA (μmole/m^2 PMMA) and concentration of surfactant solution (μM)

Ci = 0.1 %w/v (or 2478 μM)

Equilibrium concentration of surfactant was converted from

Total Organic Carbon analyzer (Carbon concentration) → μM

Calibration equation for $C_{12-14}EO_5$ solution from Total Organic Carbon analyzer,

Y = 6361.7X

Where

X = C_f (%w/v)

Y = TOC (mg/l or ppm) = 579.2 mg/l

Substituting into calibration equation,

X = 579.2/6361.7 = 0.09 %w/v (or 2407 μM)

Thus, surfactant adsorption for solution of $C_{12-14}EO_5$ on PMMA at 2478 μM, initial concentration is

$$Ads = \frac{(2478 - 2407) \times 20}{1000 \times 0.2575 \times 1.939} = 2.85 \text{ μmole/m}^2 \text{ PMMA}$$

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