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APPENDICES

Appendix A Phase Behavior of Single Anionic Surfactant System at 30°C

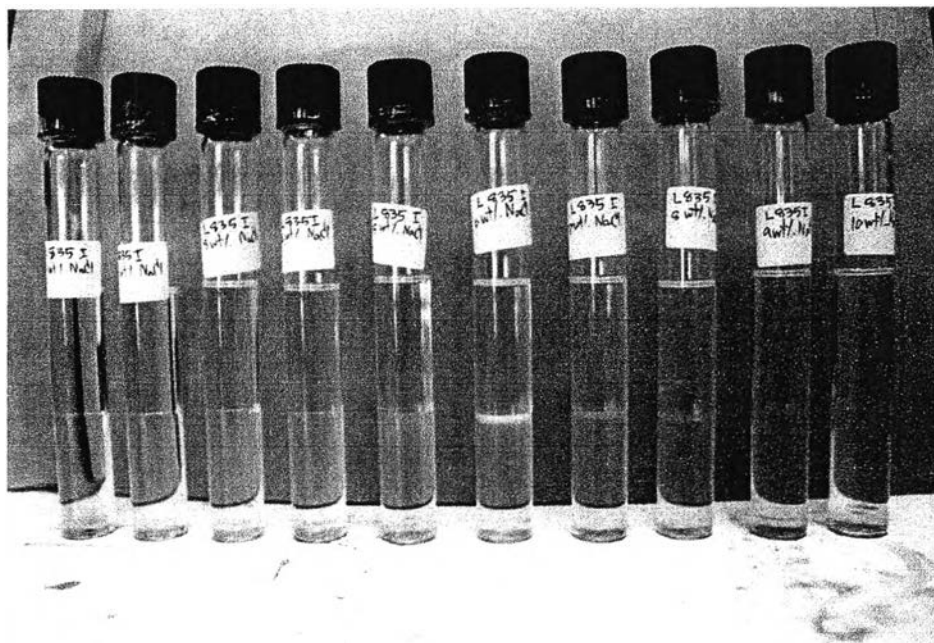


Figure A-1 Phase behavior of Lipal 835I systems at 1wt% to 10wt% NaCl (left to right).

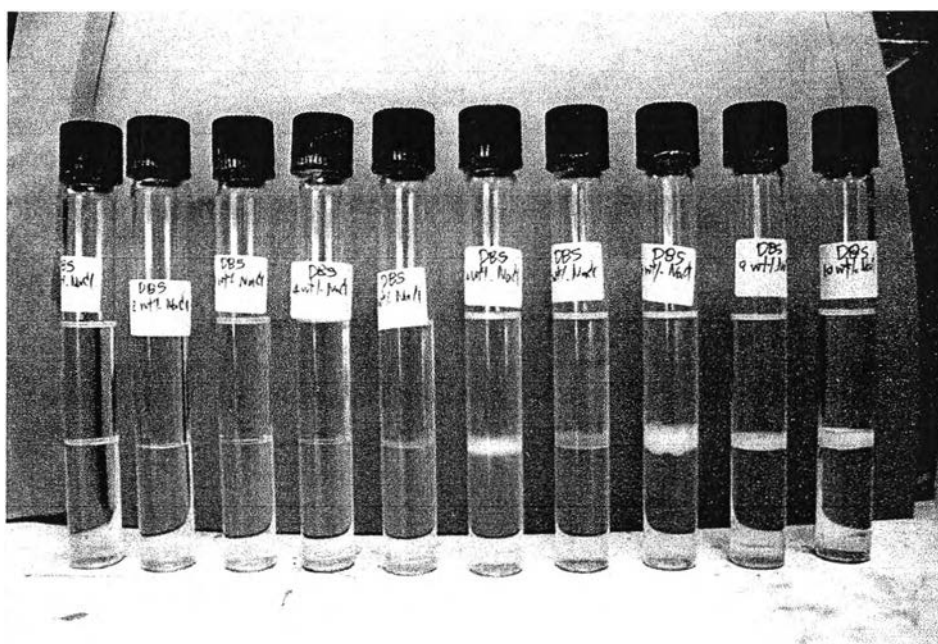


Figure A-2 Phase behavior of SDBS systems at 1wt% to 10wt% NaCl (left to right).

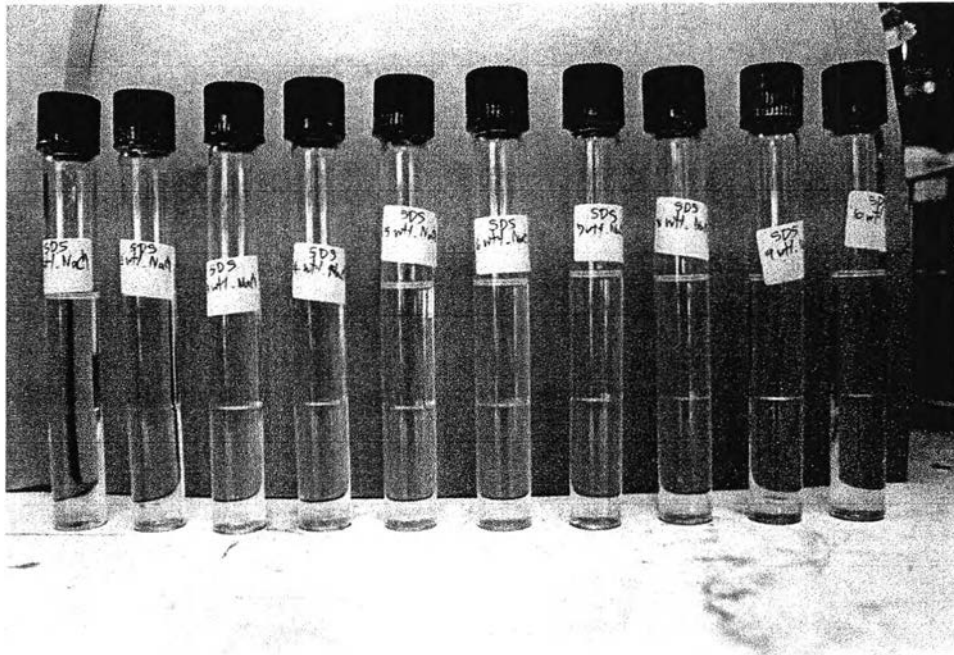


Figure A-3 Phase behavior of SDS systems at 1wt% to 10wt% NaCl (left to right).

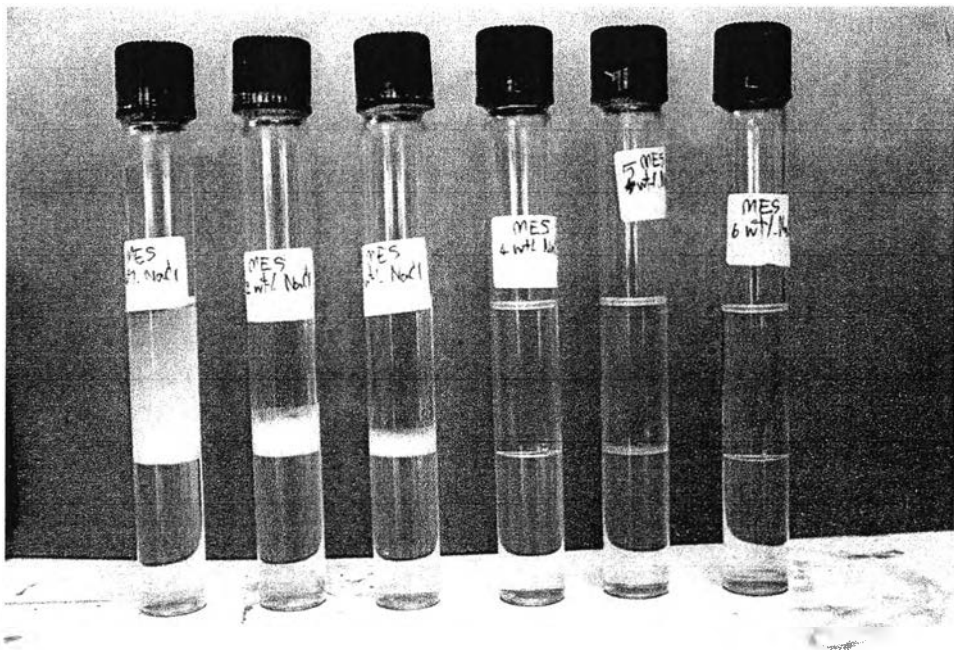


Figure A-4 Phase behavior of MES systems at 1wt% to 6wt% NaCl (left to right).

Appendix B Phase Behavior of mixed Anionic-Nonionic Surfactant System at 30°C

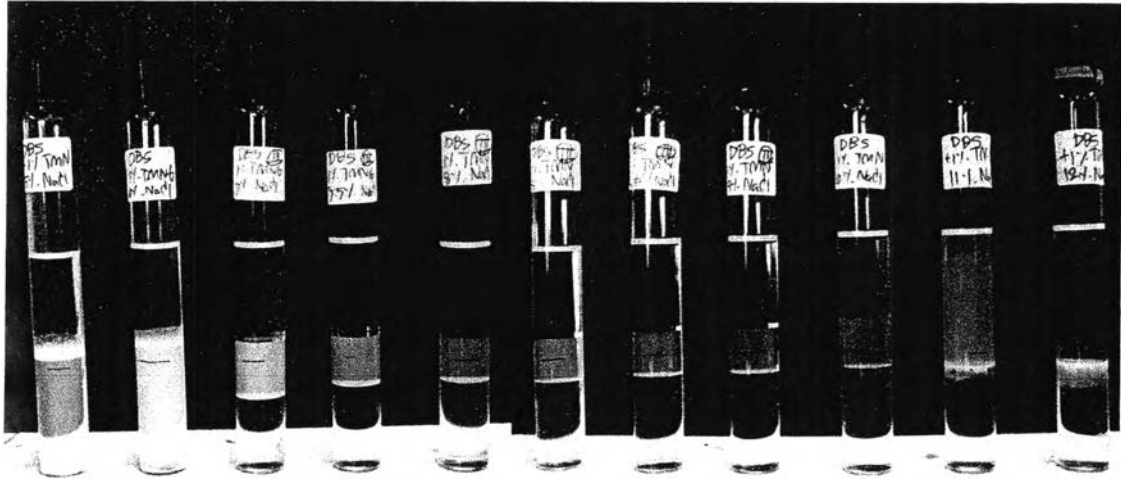


Figure B-1 Phase behavior of mixed SDBS/Tergitol® TMN6 systems at 5wt% to 12wt% NaCl (left to right).

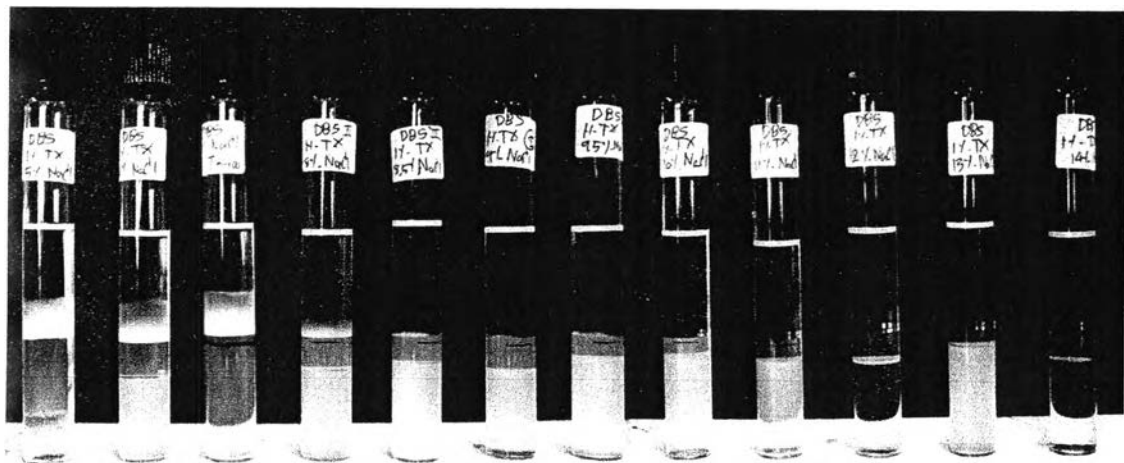


Figure B-2 Phase behavior of mixed SDBS/Triton® X-100 systems at 5wt% to 14wt% NaCl (left to right).

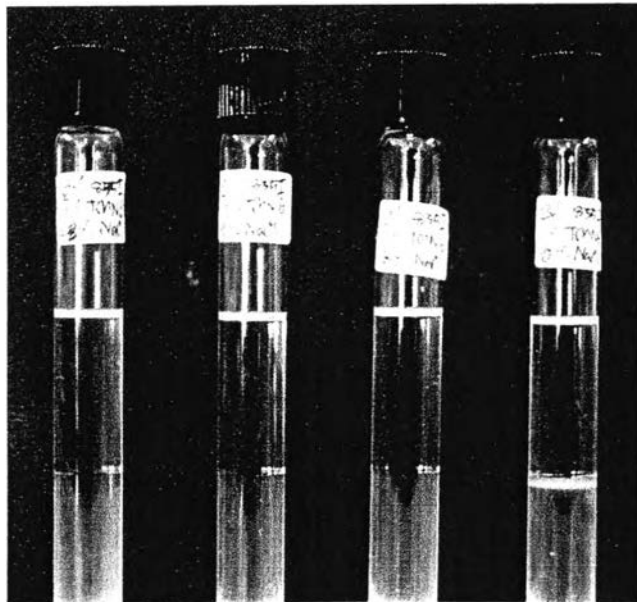


Figure B-4 Phase behavior of mixed Lipal 835I/Triton[®] X-100 systems at 4wt%, 6wt%, 8wt% and 10wt% NaCl (left to right).

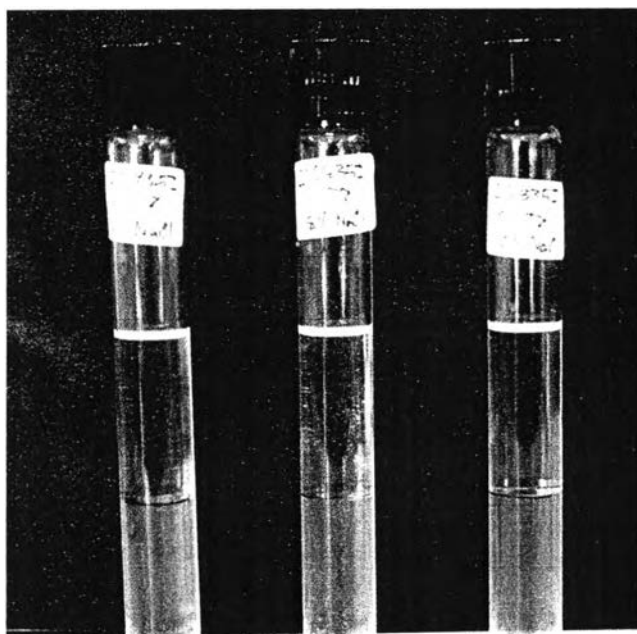


Figure B-4 Phase behavior of mixed Lipal 835I/Triton[®] X-100 systems at 6wt%, 8wt% and 10wt% NaCl (left to right).

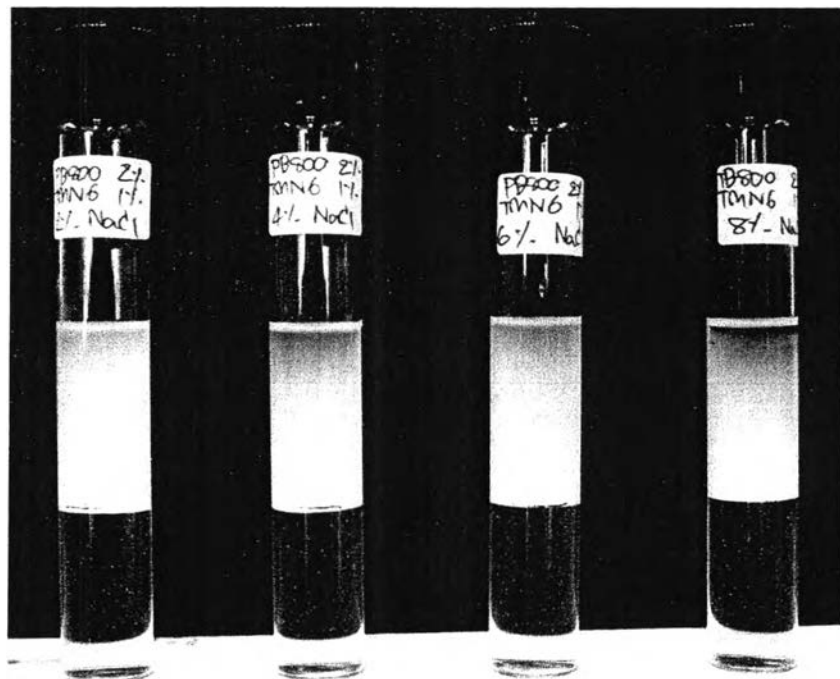


Figure B-5 Phase behavior of mixed Lipolan PB-800 CJ/Tergitol® TMN6 systems at 2wt%, 4wt%, 6wt% and 8wt% NaCl (left to right).

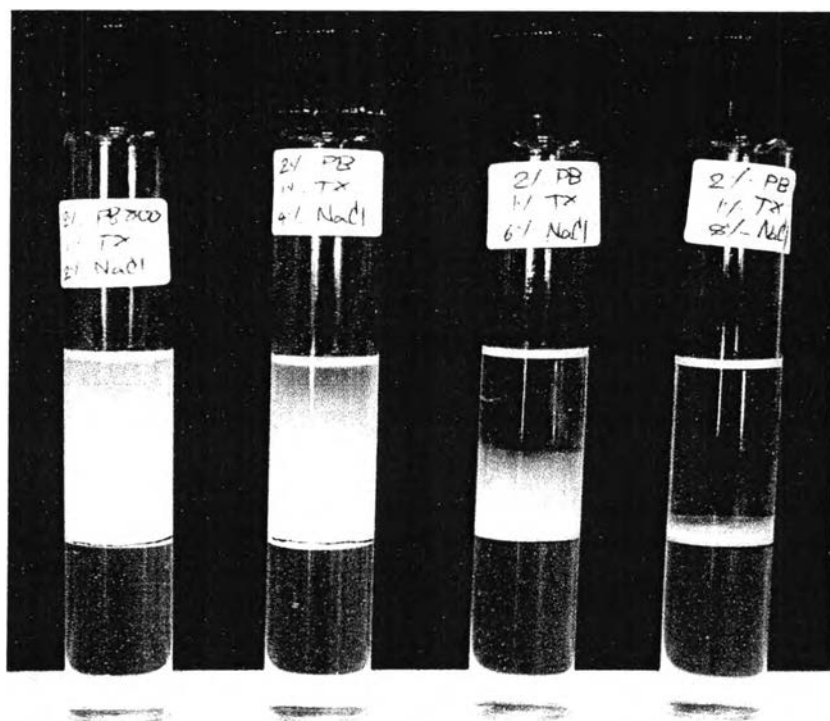


Figure B-6 Phase behavior of mixed Lipolan PB-800 CJ/Triton® X-100 systems at 2wt%, 4wt%, 6wt% and 8wt% NaCl (left to right).

Appendix C Phase Height and Phase Behavior Data of Mixed Anionic-Nonionic Surfactant Systems

Table C-1 Phase height and phase behavior of mixed SDBS/Triton[®] X-100 surfactant systems 30°C

NaCl (wt%)	Exposure time (day)										Phase Behavior 10 days exposure
	1		3		5		7		10		
	LL (mm)	UL (mm)	LL (mm)	UL (mm)	LL (mm)	UL (mm)	LL (mm)	UL (mm)	LL (mm)	UL (mm)	
5	0	-0.32	0	-0.26	0	-0.40	0	-0.39	0	-0.38	Winsor type I
6	0	0.03	0	0.03	0	0.06	0	0.14	0	0.14	Winsor type I
7	0	0.61	0	1.20	0	0.80	0	1.36	0	1.45	Winsor type I
8	-2.99	0.39	-5.69	0.79	-6.12	0.78	-6.33	0.97	-7.27	1.17	Winsor type III
8.5	-2.16	0.71	-3.17	1.04	-3.64	1.165	-3.95	1.23	-5.13	1.51	Winsor type III
9	-2.29	0.83	-2.59	1.08	-3.11	1.15	-3.49	1.35	-4.33	1.49	Winsor type III
9.5	-1.66	0.98	-2.2	1.41	-2.93	0.415	-3.07	1.51	-3.84	1.765	Winsor type III
10	-1.37	0.65	-1.86	1.01	-2.29	1.07	-2.28	1.21	-2.84	1.30	Winsor type III
11	-0.84	-0.25	-1.16	-0.18	-1.45	-0.21	-1.28	0.04	-1.5	0.02	Winsor type III
12	-0.43	1.04	-1.03	1.7	-1.61	1.67	-1.59	2.06	-1.66	2.23	Winsor type III
12.5	-0.81	1.07	-1.58	1.38	-1.7	1.78	-2.1	2.35	-2.1	2.35	Winsor type III
13	-1.94	1.72	-1.75	1.81	-2.04	1.89	-1.71	2.46	-2.31	1.98	Winsor type III
13.5	-2.03	0.59	-2.24	0.54	-2.27	0.93	-2.31	1.28	-2.31	1.28	Winsor type III
14	0.68	9.25	-12.5	7.42	-3.28	6.09	-3.41	5.94	-3.65	5.91	Winsor type III
15	0.71	10.69	-2.2	7.2	-2.71	7.18	-2.56	7.02	-2.56	7.02	Winsor type III
16	2.01	11.7	-2.38	7.16	-2.55	6.96	-2.76	6.92	-2.76	6.92	Winsor type III

Table C-2 Phase height and phase behavior of mixed SDBS/Tergitol[®] TMN6 surfactant systems 30°C

NaCl (wt%)	Exposure time (day)										Phase Behavior 10 days exposure
	1		3		5		7		10		
	LL (mm)	UL (mm)	LL (mm)	UL (mm)	LL (mm)	UL (mm)	LL (mm)	UL (mm)	LL (mm)	UL (mm)	
5	0	2.03	0	2.24	0	2.19	0	2.19	0	2.12	Winsor type I
6	0	3.44	0	3.47	0	3.58	0	3.67	0	3.74	Winsor type I
7	-25.26	-7.01	-16.09	2.05	-13.88	4.05	-12.32	4.42	-12.17	4.80	Winsor type III
7.5	-9.93	4.595	-8.91	5.515	-8.935	5.625	-8.99	5.605	-8.965	5.62	Winsor type III
8	-7.35	5.90	-7.31	5.82	-7.51	5.79	-7.12	5.85	-7.20	5.93	Winsor type III
8.5	-6.46	6.96	-6.42	7.07	-6.325	6.885	-6.205	6.905	-6.3	6.94	Winsor type III
9	-2.31	11.03	-5.71	7.86	-5.64	7.81	-5.55	7.62	-5.79	7.68	Winsor type III
10	0	15.69	-4.04	11.90	-4.51	11.65	-4.70	10.82	-4.58	10.09	Winsor type III
11	-1.77	0	-2.84	0	-3.04	0	-3.36	0	-3.61	0	Winsor type II
12	-0.30	0	-3.09	0	-3.03	0	-3.42	0	-3.44	0	Winsor type II

Table C-3 Phase height and phase behavior of mixed Lipal 835I/Triton[®] X-100 surfactant systems 30 °C

NaCl (wt%)	Exposure time (day)										Phase Behavior 10 days exposure
	1		3		5		7		10		
	LL (mm)	UL (mm)	LL (mm)	UL (mm)	LL (mm)	UL (mm)	LL (mm)	UL (mm)	LL (mm)	UL (mm)	
2	0	0	0	0	0	0	0	0	0	0	No phase interaction
4	0	0	0	0	0	0	0	0	0	0	No phase interaction
6	0	0	0	0	0	0	0	0	0	0	No phase interaction
8	0	0	0	0	0	0	0	0	0	0	No phase interaction
10	0	0	0	0	0	0	0	0	0	0	No phase interaction

Table C-4 Phase height and phase behavior of mixed Lipal 835I/Tergitol[®] TMN6 surfactant systems 30 °C

NaCl (wt%)	Exposure time (day)										Phase Behavior 10 days exposure
	1		3		5		7		10		
	LL (mm)	UL (mm)	LL (mm)	UL (mm)	LL (mm)	UL (mm)	LL (mm)	UL (mm)	LL (mm)	UL (mm)	
2	0	0	0	0	0	0	0	0	0	0	No phase interaction
4	0	0	0	0	0	0	0	0	0	0	No phase interaction
6	0	0	0	0	0	0	0	0	0	0	No phase interaction
8	0	0	0	0	0	0	0	0	0	0	No phase interaction
10	0	0	0	0	0	0	0	0	0	0	No phase interaction

Table C-5 Phase height and phase behavior of mixed Lipolan PB-800CJ/Triton[®] X-100 surfactant systems 30 °C

NaCl (wt%)	Exposure time (day)										Phase Behavior 10 days exposure
	1		3		5		7		10		
	LL (mm)	UL (mm)	LL (mm)	UL (mm)	LL (mm)	UL (mm)	LL (mm)	UL (mm)	LL (mm)	UL (mm)	
2	-1.15	0	-1.15	0	-1.11	0	-1.2	0	-1.04	0	Winsor type II
4	-1.37	0	-0.86	0	-1.23	0	-1.28	0	-1.51	0	Winsor type II
6	-0.059	16.14	-0.37	16.32	-0.6	16.34	-0.48	16.41	-0.48	16.29	Gel/sponge at the middle
8	-0.49	3.92	-0.18	4.27	-0.2	4.16	-0.26	3.93	-0.2	4.26	Gel/sponge at the middle

Table C-6 Phase height and phase behavior of mixed Lipolan PB-800CJ/Tergitol[®] TMN6 surfactant systems 30 °C

NaCl (wt%)	Exposure time (day)										Phase Behavior 10 days exposure
	1		3		5		7		10		
	LL (mm)	UL (mm)	LL (mm)	UL (mm)	LL (mm)	UL (mm)	LL (mm)	UL (mm)	LL (mm)	UL (mm)	
2	-1.7	0	-1.7	0	-1.73	0	-1.5	0	-0.15	0	Winsor type II
4	-1.13	0	-1.05	0	-1.05	0	-0.83	0	-0.83	0	Winsor type II
6	-0.81	0	-0.7	0	-0.6	0	-0.58	0	-0.57	0	Winsor type II
8	-0.64	0	-0.52	0	-0.47	0	-0.4	0	-0.39	0	Winsor type II

Table C-7 Phase height and phase behavior of mixed SDBS/Triton[®] X-100 surfactant systems at 50°C

NaCl (wt%)	Exposure time (day)										Phase Behavior 10 days exposure
	1		3		5		7		10		
	LL (mm)	UL (mm)	LL (mm)	UL (mm)	LL (mm)	UL (mm)	LL (mm)	UL (mm)	LL (mm)	UL (mm)	
5	0	0	0	0.14	0	0.24	0	0.27	0	0.27	Winsor type I
6	0	0.89	0	0.9	0	1.32	0	1.35	0	1.35	Winsor type I
7	0	2.23	0	2.15	0	2.44	0	2.31	0	2.3	Winsor type I
8	-2.99	0.39	-5.69	0.79	-6.12	0.78	-6.33	0.97	-7.27	1.17	Winsor type III
8.5	-2.16	0.715	-3.165	1.04	-3.635	1.165	-3.95	1.23	-5.125	1.51	Winsor type III
9	-12.53	1.45	-11.89	2.19	-11.67	2.35	-11.59	2.55	-11.62	2.57	Winsor type III
9.5	-15.17	-0.341	-9.48	2.07	-8.57	3.05	-8.48	3.1	-8.5	3.13	Winsor type III
10	-10.71	-0.021	-8.47	1.68	-8.33	2.05	-8.41	2.02	-8.5	1.98	Winsor type III
11	-8.14	0	-7.78	0.13	-7.73	0.07	-7.3	0.4	-7.32	0.4	Winsor type III
12	-3.96	3.87	-3.69	3.91	-3.58	3.93	-3.73	4.04	-3.73	4.04	Winsor type III
12.5	-0.81	1.07	-1.58	1.38	-1.7	1.78	-2.1	2.35	-2.1	2.35	Winsor type III
13	-3.79	4.39	-3.7	4.11	-3.56	4.2	-3.7	4.15	-3.71	4.18	Winsor type III
13.5	-2.03	0.59	-2.24	0.54	-2.27	0.93	-2.31	1.28	-2.31	1.28	Winsor type III
14	-1.13	5.76	-2.4	4.56	-2.49	4.41	-2.69	4.34	-2.69	4.34	Winsor type III
15	0.71	10.69	-2.2	7.2	-2.71	7.18	-2.56	7.02	-2.56	7.02	Winsor type III
16	2.01	11.7	-2.38	7.16	-2.55	6.96	-2.76	6.92	-2.76	6.92	Winsor type III

Table C-8 Phase height and phase behavior of mixed SDBS/Tergitol[®] TMN6 surfactant systems at 50 °C

NaCl (wt%)	Exposure time (day)										Phase Behavior 10 days exposure
	1		3		5		7		10		
	LL (mm)	UL (mm)	LL (mm)	UL (mm)	LL (mm)	UL (mm)	LL (mm)	UL (mm)	LL (mm)	UL (mm)	
5	0	1.11	0	2.2	0	2.02	0	2.01	0	2.01	Winsor type I
6	0	-0.58	0	1.79	0	3.11	0	3.63	0	3.63	Winsor type I
7	-13.2	0.16	-8.77	5.06	-8.49	5.01	-8.41	4.93	-8.39	4.9	Winsor type III
7.5	-7.51	4.94	-7.25	5.08	-7.22	5.09	-7.23	5.05	-7.21	5.05	Winsor type III
8	-5.92	5.67	-5.86	5.65	-5.63	5.41	-5.82	5.38	-5.83	5.35	Winsor type III
8.5	-5.06	5.2	-5.14	5.14	-5.24	5.01	-5.39	5.01	-5.38	5.02	Winsor type III
9	-1.2	9.02	-4.31	6.79	-4.25	6.3	-4.5	6.16	-4.5	6.16	Winsor type III
10	-3.74	8.09	-3.74	7.5	-3.74	7.15	-3.89	7.06	-3.89	7.1	Winsor type III
11	0	0	-2.62	0	-2.57	0	-2.78	0	-2.78	0	Winsor type II
12	-2.01	0	-3.19	0	-3.47	0	-3.38	0	-3.38	0	Winsor type II

Table C-9 Phase height and phase behavior of mixed Lipal 835I/Triton[®] X-100 surfactant systems at 50 °C

NaCl (wt%)	Exposure time (day)										Phase Behavior
	1		3		5		7		10		
	LL (mm)	UL (mm)	LL (mm)	UL (mm)	LL (mm)	UL (mm)	LL (mm)	UL (mm)	LL (mm)	UL (mm)	
4	0	0	0	0	0	0	0	0	0	0	No phase interaction
6	0	0	0	0	0	0	0	0	0	0	No phase interaction
8	0	0	0	0	0	0	0	0	0	0	No phase interaction
10	0	0	0	0	0	0	0	0	0	0	No phase interaction
4	0	0	0	0	0	0	0	0	0	0	No phase interaction

Table C-10 Phase height and phase behavior of mixed Lipal 835I/Tergitol[®] TMN6 surfactant systems at 50 °C

NaCl (wt%)	Exposure time (day)										Phase Behavior
	1		3		5		7		10		
	LL (mm)	UL (mm)	LL (mm)	UL (mm)	LL (mm)	UL (mm)	LL (mm)	UL (mm)	LL (mm)	UL (mm)	
2	0	0	0	0	0	0	0	0	0	0	No phase interaction
4	0	0	0	0	0	0	0	0	0	0	No phase interaction
6	0	0	0	0	0	0	0	0	0	0	No phase interaction
8	0	0	0	0	0	0	0	0	0	0	No phase interaction
10	0	0	0	0	0	0	0	0	0	0	No phase interaction

Table C-11 Phase height and phase behavior of mixed Lipolan PB-800CJ/Triton[®] X-100 surfactant systems at 50 °C

NaCl (wt%)	Exposure time (day)										Phase Behavior 10 days exposure
	1		3		5		7		10		
	LL (mm)	UL (mm)	LL (mm)	UL (mm)	LL (mm)	UL (mm)	LL (mm)	UL (mm)	LL (mm)	UL (mm)	
2	-1.1	0	-1.07	0	-1.05	0	-1.05	0	-1.04	0	Winsor type II
4	-1.35	0	-1.2	0	-1.22	0	-1.34	0	-1.32	0	Winsor type II
6	-0.03	15.15	-0.35	16	-0.42	16.34	-0.44	16.38	-0.47	16.29	Gel/sponge at the middle
8	-0.45	3.92	-0.18	4.27	-0.2	4.16	-0.28	3.96	-0.23	4.26	Gel/sponge at the middle

Table C-12 Phase height and phase behavior of mixed Lipolan PB-800CJ/Tergitol[®] TMN6 surfactant systems at 50 °C

NaCl (wt%)	Exposure time (day)										Phase Behavior 10 days exposure
	1		3		5		7		10		
	LL (mm)	UL (mm)	LL (mm)	UL (mm)	LL (mm)	UL (mm)	LL (mm)	UL (mm)	LL (mm)	UL (mm)	
2	-1.7	0	-1.7	0	-1.73	0	-1.5	0	-0.15	0	Winsor type II
4	-1.13	0	-1.05	0	-1.05	0	-0.83	0	-0.83	0	Winsor type II
6	-0.81	0	-0.7	0	-0.6	0	-0.58	0	-0.57	0	Winsor type II
8	-0.64	0	-0.52	0	-0.47	0	-0.4	0	-0.39	0	Winsor type II

Appendix D Solubilization Parameter Data of Microemulsion Systems

Oil solubilization parameter: $SP_o = \frac{V_o}{M_s}$

Water solubilization parameter: $SP_w = \frac{V_w}{M_s}$

Where SP_o , V_o , V_w and M_s are represented as oil solubilization parameter, oil solubilized volume, water solubilized volume and total mass of surfactant(s) respectively

Table D-1 Solubilization parameter of mixed SDBS/Triton® X-100 surfactant systems

NaCl (wt%)	Relative height (mm)	Solubilized volume		Solubilization parameter	
		V_o (ml)	V_w (ml)	(SP_o)	(SP_w)
5	0.38	-0.055498596	5	-0.485127585	43.70629371
6	0.14	0.020446851	5	0.178731215	43.70629371
7	1.45	0.211770957	5	1.851144731	43.70629371
8	6.103333333	0.170877255	1.062262595	1.4936823	9.28551219
8.5	3.615	0.220533893	0.748500797	1.927743823	6.542839135
9	2.836666667	0.218099744	0.632391893	1.906466297	5.527901162
9.5	2.07	0.257776372	0.56009767	2.253289965	4.89595865
10	1.543333333	0.188889957	0.414292148	1.65113599	3.621434864
11	1.48	0.002920979	0.219073404	0.025533031	1.914977308
12	0.57	0.325689127	0.242441234	2.846932931	2.119241554
12.5	0.25	0.343215	0.306702766	3.000131115	2.680968231
13	0.33	0.289176893	0.337373042	2.527770046	2.949065054
13.5	1.03	0.186942638	0.337373042	1.634113969	2.949065054
14	2.26	0.863149212	0.533078616	7.545010592	4.659778115
15	4.46	1.025263531	0.373885276	8.9620938	3.268227938
16	4.16	1.010658637	0.403095063	8.834428646	3.523558246

Table D-2 Solubilization parameter of mixed SDBS/ Tergitol[®] TMN6 surfactant systems

NaCl (wt%)	Relative height (mm)	Solubilized volume		Solubilization parameter	
		V _o (ml)	V _w (ml)	(SP _o)	(SP _w)
5	2.12	0.309623744	5	2.619490223	42.30118443
6	3.74	0.546223021	5	4.621176148	42.30118443
7	7.366666667	0.701034893	2.027159232	5.930921259	17.15024731
7.5	3.345	0.82079502	1.304947243	6.944120307	11.0401628
8	1.27	0.86655702	1.097314339	7.331277667	9.283539248
8.5	0.64	1.013579616	0.92375952	8.575123653	7.815224367
9	1.893333333	1.121655828	0.824202829	9.489474014	6.972951175
10	5.51	1.473633764	0.658680701	12.46729073	5.572594766
11	3.61	5	0.443988765	42.30118443	4.46054703
12	3.44	5	0.442528276	42.30118443	4.250493569

Appendix E Experiment Data from Interfacial Tension Measurement

Table E The interfacial tension between anionic-nonionic mixed surfactant and decane for varying NaCl concentration

NaCl (wt%)	SDBS/Triton® X-100 : Decane	SDBS/Tergitol® TMN6 : Decane
	(mN/m)	(mN/m)
5	-	0.0003488
6	0.00244327	0.00033125
7	0.00139539	0.00014125
7.5	-	0.000175345
8	0.001399325	0.00013185
8.5	-	6.25295E-05
9	0.001036045	0.000110314
10	0.000704074	0.00016874
11	0.000637933	0.000317819
12	0.000566903	0.00046525
12.5	0.000488858	-
13	0.001023967	-
13.5	0.00101341	-
14	0.00110567	-

Appendix F Decane recovered from Spontaneous Imbibition Test by the Determined Surfactant Formulas

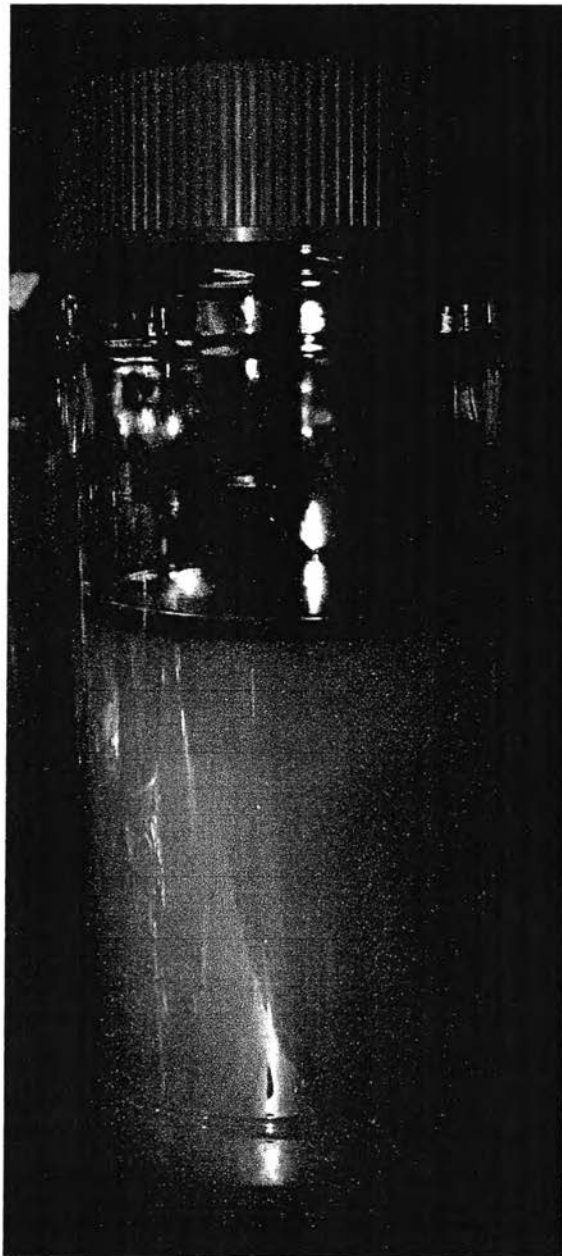


Figure F-1 Decane recovered from spontaneous imbibition test by mixed SDBS/Tergitol® TMN6 with 8.5wt% NaCl for 10 days.

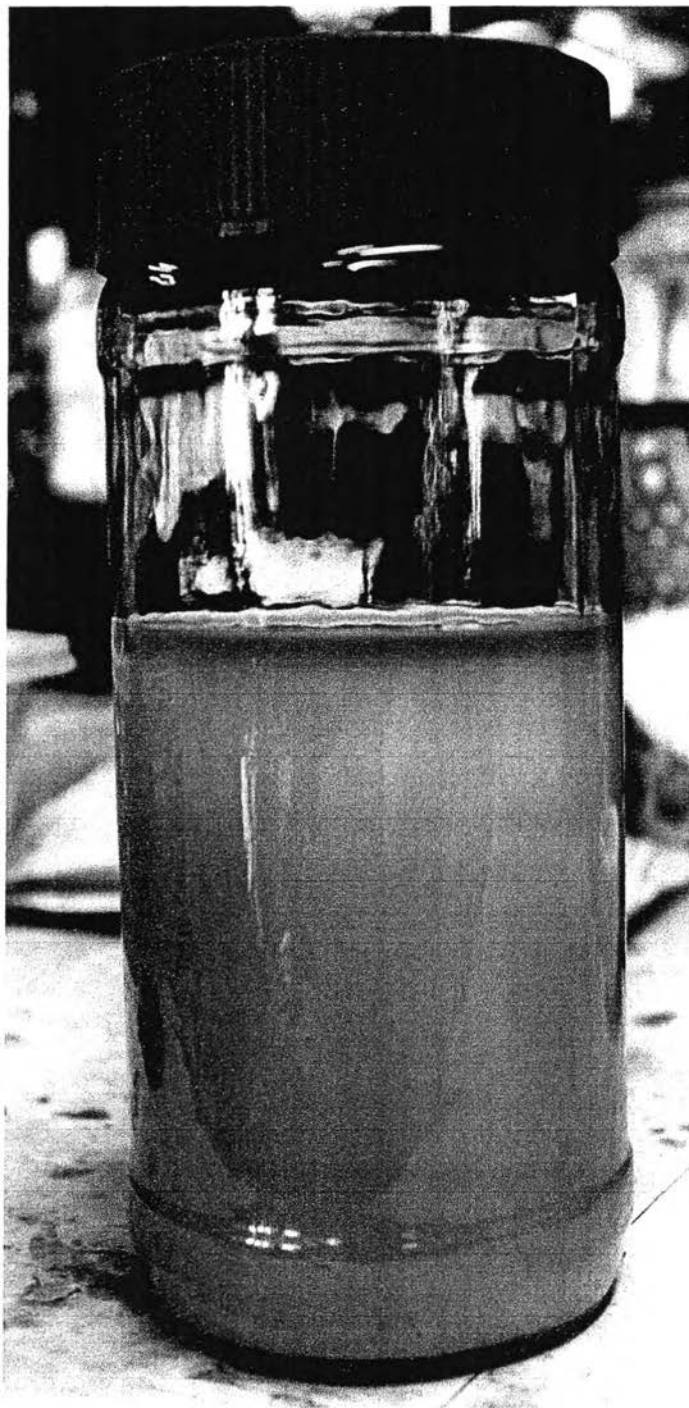


Figure F-2 Decane recovered from spontaneous imbibition test by mixed SDBS/ Triton® X-100 with 12.5wt% NaCl for 10 days.

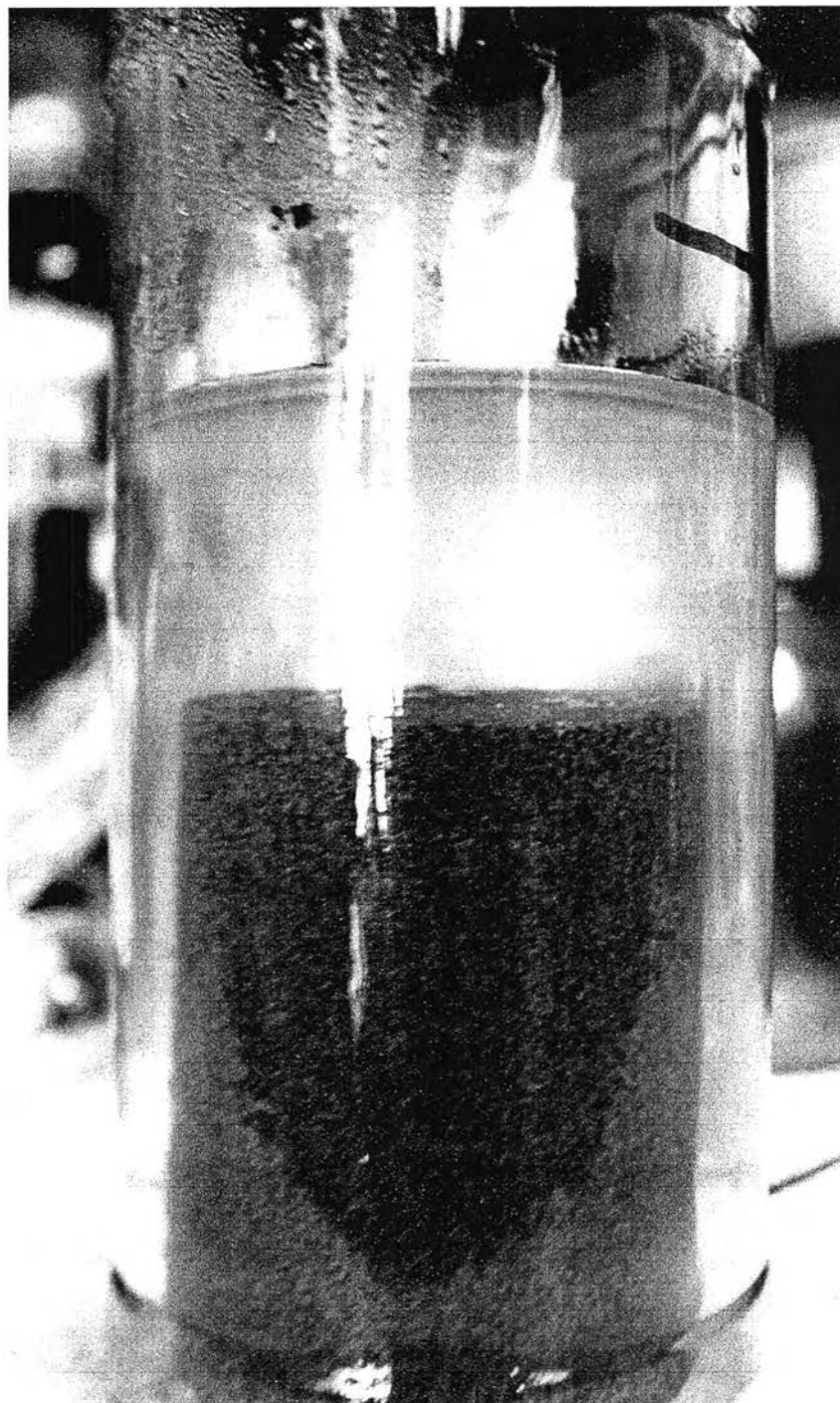


Figure F-3 Decane recovered from spontaneous imbibition test by pure water for 10 days.

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1. Khomsanit, N.; Kitiyanan, B.; and Harwell, J. (2013, April 23) Mixed Anionic-Nonionic Surfactant Microemulsion with Decane and Spontaneous Imbibition Test for Enhanced Oil Recovery. Poster presented at The 4th Research Symposium on Petrochemical, and Materials Technology and the 19th PPC Symposium on Petroleum, Petrochemicals, and Polymers, Bangkok, Thailand.