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APPENDICES

APPENDIX A Experiment Data of Cloud Point Determination

Table A1 Cloud Point of mixed surfactants at different weight ratio of MES

1% of mixed surfactants of MES and AE		
AE	Ratio(MES:AE)	Cloud Point (°C)
3	1 : 9	11
	2 : 8	10
	3 : 7	11
	4 : 6	13
	5 : 5	15
	6 : 4	15
	7 : 3	16
	8 : 2	15
	9 : 1	14
5	1 : 9	8
	2 : 8	9
	3 : 7	13
	4 : 6	18
	5 : 5	19
	6 : 4	19
	7 : 3	19
	8 : 2	18
	9 : 1	17
7	1 : 9	55
	2 : 8	54
	3 : 7	55
	4 : 6	58
	5 : 5	59
	6 : 4	59
	7 : 3	60
	8 : 2	59
	9 : 1	57
9	1 : 9	72
	2 : 8	70
	3 : 7	73
	4 : 6	75
	5 : 5	77
	6 : 4	77
	7 : 3	78
	8 : 2	77
	9 : 1	76

APPENDIX B Experiment Data of CMC Determination

Table B1 Surface tension of mixed surfactants MES: AE7 (2:8)

MES+AE7 (2:8)		
Conc(%)	Conc($\mu\text{mol/l}$)	IFT(mN/m)
0.0001	2.1340	58.3
0.0002	4.268	57.0
0.0004	8.536	53.1
0.0006	12.804	47.2
0.0008	17.072	44.1
0.001	21.34	41.2
0.002	42.68	37.8
0.004	85.36	34.4
0.006	128.04	33.3
0.008	170.72	32.8
0.01	213.4	32.7
0.02	426.8	32.7
0.04	853.6	32.6
0.06	1280.4	32.4
0.08	1707.2	32.2
0.1	2134	32.2
0.2	4268	32.2
0.4	8536	31.8
0.6	12804	31.6
0.8	17072	31.5
1	21340	31.3

Table B2 Surface tension of mixed surfactants MES: AE7 (3:7)

MES+AE7 (3:7)		
Conc(%)	Conc(μmol/l)	IFT(mN/m)
0.0001	2.1939	50.8
0.0002	4.3877	50.6
0.0004	8.7755	49.0
0.0006	13.163	49.1
0.0008	17.551	43.1
0.001	21.939	41.7
0.002	43.877	36.4
0.004	87.755	35.0
0.006	131.63	34.1
0.008	175.51	34.4
0.01	219.39	34.0
0.02	438.77	34.3
0.04	877.55	34.5
0.06	1316.3	34.5
0.08	1755.1	34.4
0.1	2193.9	34.5
0.2	4387.7	34.1
0.4	8775.5	33.3
0.6	13163	33.0
0.8	17551	32.9
1	21939	32.7

Table B3 Surface tension of mixed surfactants MES: AE7 (4:6)

MES+AE7 (4:6)		
Conc(%)	Conc($\mu\text{mol/l}$)	IFT(mN/m)
0.0001	2.2537	55.5
0.0002	4.5075	50.2
0.0004	9.0149	50.1
0.0006	13.522	50.0
0.0008	18.03	47.5
0.001	22.537	42.2
0.002	45.075	37.7
0.004	90.149	36.1
0.006	135.22	34.9
0.008	180.3	34.9
0.01	225.37	35.1
0.02	450.75	35.4
0.04	901.49	35.3
0.06	1352.2	35.2
0.08	1803	34.6
0.1	2253.7	35.1
0.2	4507.5	34.5
0.4	9014.9	33.6
0.6	13522	33.6
0.8	18030	33.4
1	22537	33.1

Table B4 Surface tension of mixed surfactants MES: AE7 (5:5)

MES+AE7 (5:5)		
Conc(%)	Conc(μmol/l)	IFT(mN/m)
0.0001	2.3136	62.1
0.0002	4.6272	55.8
0.0004	9.2544	50.9
0.0006	13.882	46.3
0.0008	18.509	45.5
0.001	23.136	43.2
0.002	46.272	37.5
0.004	92.544	36.1
0.006	138.82	34.7
0.008	185.09	34.9
0.01	231.36	34.9
0.02	462.72	35.3
0.04	925.44	35.9
0.06	1388.2	36.0
0.08	1850.9	35.8
0.1	2313.6	35.8
0.2	4627.2	35.3
0.4	9254.4	34.5
0.6	13882	34.5
0.8	18509	34.0
1	23136	34.0

Table B5 Surface tension of mixed surfactants MES: AE7 (6:4)

MES+AE7 (6:4)		
Conc(%)	Conc(μmol/l)	IFT(mN/m)
0.0001	2.3735	65.8
0.0002	4.7469	60.5
0.0004	9.4939	54.0
0.0006	14.241	50.5
0.0008	18.988	43.8
0.001	23.735	42.6
0.002	47.469	36.1
0.004	94.939	35.8
0.006	142.41	35.0
0.008	189.88	36.2
0.01	237.35	36.0
0.02	474.69	37.0
0.04	949.39	37.0
0.06	1424.1	37.1
0.08	1898.8	37.0
0.1	2373.5	36.9
0.2	4746.9	35.9
0.4	9493.9	35.0
0.6	14241	34.5
0.8	18988	34.5
1	23735	34.5

Table B6 Surface tension of mixed surfactants MES: AE7 (7:3)

MES+AE7 (7:3)		
Conc(%)	Conc(μmol/l)	IFT(mN/m)
0.0001	2.433	60.3
0.0002	4.8667	55.3
0.0004	9.7334	49.0
0.0006	14.6	46.3
0.0008	19.467	44.9
0.001	24.333	39.6
0.002	48.667	36.5
0.004	97.334	36.3
0.006	146	36.0
0.008	194.67	36.0
0.01	243.33	36.3
0.02	486.67	36.9
0.04	973.34	37.6
0.06	1460	37.6
0.08	1946.7	36.9
0.1	2433.3	37.0
0.2	4866.7	36.3
0.4	9733.4	35.3
0.6	14600	34.9
0.8	19467	34.7
1	24333	34.5

Table B7 Surface tension of mixed surfactants MES: AE7 (8:2)

MES+AE7 (8:2)		
Conc(%)	Conc(μmol/l)	IFT(mN/m)
0.0001	2.4932	62.1
0.0002	4.9864	57.6
0.0004	9.9728	53.6
0.0006	14.959	48.3
0.0008	19.946	45.0
0.001	24.932	44.2
0.002	49.864	37.7
0.004	99.728	36.7
0.006	149.59	36.5
0.008	199.46	36.4
0.01	249.32	36.7
0.02	498.64	36.3
0.04	997.28	36.5
0.06	1495.9	36.3
0.08	1994.6	36.2
0.1	2493.2	36.6
0.2	4986.4	36.1
0.4	9972.8	35.8
0.6	14959	35.5
0.8	19946	35.0
1	24932	35.0

Table B8 Surface tension of mixed surfactants MES: AE7 (9:1)

MES+AE7 (9:1)		
Conc(%)	Conc($\mu\text{mol/l}$)	IFT(mN/m)
0.0001	2.5531	68.5
0.0002	5.1062	64.1
0.0004	10.212	58.0
0.0006	15.318	54.9
0.0008	20.425	50.9
0.001	25.531	48.5
0.002	51.062	40.5
0.004	102.12	38.1
0.006	153.18	37.1
0.008	204.25	37.2
0.01	255.31	37.0
0.04	1021.2	37.7
0.08	2042.5	37.6
0.1	2553.1	37.4
0.4	10212	37.0
0.8	20425	36.2
1	25531	35.9

Table B9 Surface tension of mixed surfactants MES: AE9 (2:8)

MES+AE9 (2:8)		
Conc(%)	Conc(μmol/l)	IFT(mN/m)
0.0001	1.9058	61.5
0.0002	3.8117	60.5
0.0004	7.6233	54.0
0.0006	11.435	49.3
0.0008	15.247	47.4
0.001	19.058	46.3
0.002	38.117	41.2
0.004	76.233	37.5
0.006	114.35	37.5
0.008	152.47	37.5
0.01	190.58	36.6
0.02	381.17	37.8
0.04	762.33	37.6
0.06	1143.5	37.9
0.08	1524.7	37.9
0.1	1905.8	37.9
0.2	3811.7	37.5
0.4	7623.3	37.2
0.6	11435	36.3
0.8	15247	36.2
1	19058	35.9

Table B10 Surface tension of mixed surfactants MES: AE9 (3:7)

MES+AE9 (3:7)		
Conc(%)	Conc(μmol/l)	IFT(mN/m)
0.0001	1.9942	56.3
0.0002	3.9884	57.4
0.0004	7.9769	49.5
0.0006	11.965	48.5
0.0008	15.954	46.8
0.001	19.942	45.8
0.002	39.884	40.1
0.004	79.769	37.9
0.006	119.65	37.4
0.008	159.54	37.4
0.01	199.42	37.6
0.02	398.4	37.4
0.04	797.69	37.5
0.06	1196.5	37.0
0.08	1595.4	37.1
0.1	1994.2	37.0
0.2	3988.4	36.8
0.4	7976.9	36.2
0.6	11965	36.0
0.8	15954	35.7
1	19942	35.6

Table B11 Surface tension of mixed surfactants MES: AE9 (4:6)

MES+AE9 (4:6)		
Conc(%)	Conc($\mu\text{mol/l}$)	IFT(mN/m)
0.0001	2.0826	61.5
0.0002	4.1652	60.5
0.0004	8.3304	49.6
0.0006	12.496	48.4
0.0008	16.661	47.4
0.001	20.826	46.3
0.002	41.652	41.2
0.004	83.304	37.5
0.006	124.96	37.5
0.008	166.61	37.5
0.01	208.26	37.6
0.02	416.52	37.8
0.04	833.04	37.6
0.06	1249.6	37.9
0.08	1666.1	37.9
0.1	2082.6	37.9
0.2	4165.2	36.5
0.4	8330.4	36.2
0.6	12496	36.3
0.8	16661	36.2
1	20826	35.9

Table B12 Surface tension of mixed surfactants MES: AE9 (5:5)

MES+AE9 (5:5)		
Conc(%)	Conc(μmol/l)	IFT(mN/m)
0.0001	2.171	68.3
0.0002	4.342	61.0
0.0004	8.684	55.0
0.0006	13.026	52.2
0.0008	17.368	49.4
0.001	21.71	46.2
0.002	43.42	42.7
0.004	86.84	37.6
0.006	130.26	37.3
0.008	173.68	37.4
0.01	217.1	36.9
0.02	434.2	37.7
0.04	868.4	38.8
0.06	1302.6	38.8
0.08	1736.8	38.6
0.1	2171	38.3
0.2	4342	38.3
0.4	8684	38.0
0.6	13026	37.0
0.8	17368	36.6
1	21710	36.3

Table B13 Surface tension of mixed surfactants MES: AE9 (6:4)

MES+AE9 (6:4)		
Conc(%)	Conc(μmol/l)	IFT(mN/m)
0.0001	2.2594	63.0
0.0002	4.5188	59.5
0.0004	9.0376	55.0
0.0006	13.556	49.0
0.0008	18.075	47.7
0.001	22.594	46.5
0.002	45.188	38.6
0.004	90.376	37.9
0.006	135.56	37.4
0.008	180.75	37.8
0.01	225.94	38.3
0.02	451.88	38.4
0.04	903.76	38.6
0.06	1355.6	38.8
0.08	1807.5	38.6
0.1	2259.4	38.8
0.2	4518.8	38.0
0.4	9037.6	37.3
0.6	13556	37.1
0.8	18075	36.4
1	22594	36.1

Table B14 Surface tension of mixed surfactants MES: AE9 (7:3)

MES+AE9 (7:3)		
Conc(%)	Conc(μmol/l)	IFT(mN/m)
0.0001	2.3478	55.6
0.0002	4.6956	55.4
0.0004	9.3911	55.0
0.0006	14.087	52.4
0.0008	18.782	50.1
0.001	23.478	48.7
0.002	46.956	39.3
0.004	93.911	38.9
0.006	140.87	38.6
0.008	187.82	38.3
0.01	234.78	38.6
0.02	469.56	39.4
0.04	939.11	39.2
0.06	1408.7	39.1
0.08	1878.2	38.9
0.1	2347.8	38.7
0.2	4695.6	38.1
0.4	9391.1	37.1
0.6	14087	36.7
0.8	18782	36.7
1	23478	36.5

Table B15 Surface tension of mixed surfactants MES: AE9 (8:2)

MES+AE9 (8:2)		
Conc(%)	Conc(μmol/l)	IFT(mN/m)
0.0001	2.4362	59.2
0.0002	4.8723	55.5
0.0004	9.7447	51.1
0.0006	14.617	46.8
0.0008	19.489	45.8
0.001	24.362	44.1
0.002	48.723	40.7
0.004	97.447	38.3
0.006	146.17	38.3
0.008	194.89	38.4
0.01	243.62	38.9
0.02	487.23	38.9
0.04	974.47	39.1
0.06	1461.7	39.1
0.08	1948.9	38.9
0.1	2436.2	38.9
0.2	4872.3	38.1
0.4	9744.7	36.9
0.6	14617	36.3
0.8	19489	36.0
1	24362	35.9

Table B16 Surface tension of mixed surfactants MES: AE9 (9:1)

MES+AE9 (9:1)		
Conc(%)	Conc($\mu\text{mol/l}$)	IFT(mN/m)
0.0001	2.5246	66.3
0.0002	5.0491	63.9
0.0004	10.098	56.7
0.0006	15.147	52.3
0.0008	20.196	51.9
0.001	25.246	49.1
0.002	50.491	45.2
0.004	100.98	38.2
0.006	151.47	38.6
0.008	201.96	38.5
0.01	525.46	38.6
0.04	1009.8	39.5
0.08	2019.6	38.9
0.1	2524.6	38.4
0.4	10098	37.4
0.8	20196	36.6
1	25246	36.5

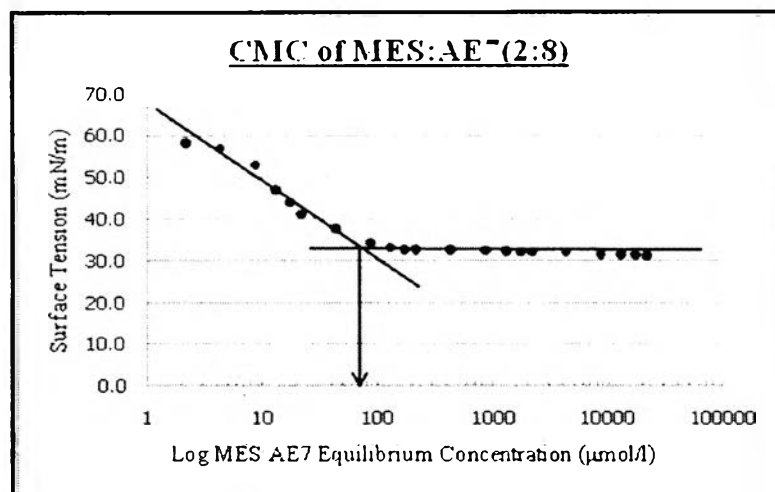


Figure B1 Surface tension vs. Log equilibrium concentration of MES: AE7 in the ratio of 2:8.

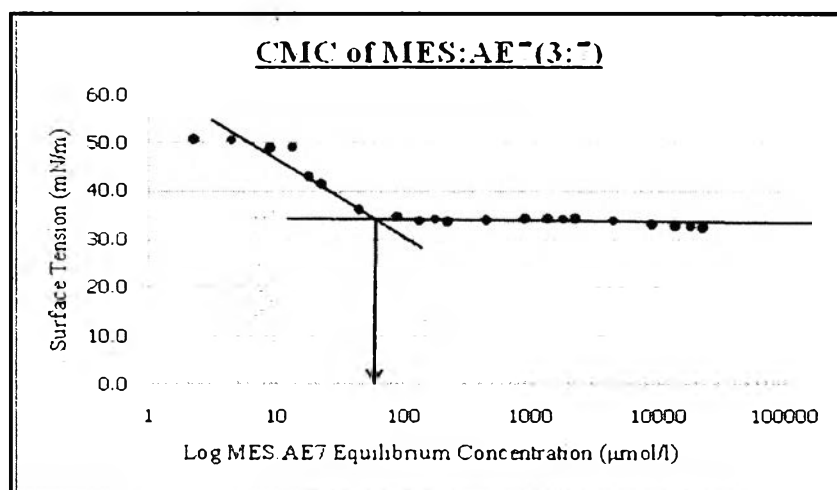


Figure B2 Surface tension vs. Log equilibrium concentration of MES: AE7 in the ratio of 3:7.

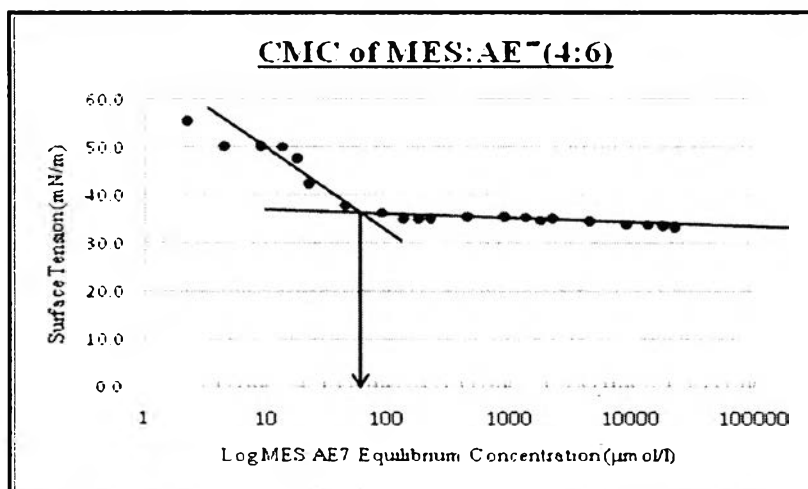


Figure B3 Surface tension vs. Log equilibrium concentration of MES: AE7 in the ratio of 4:6.

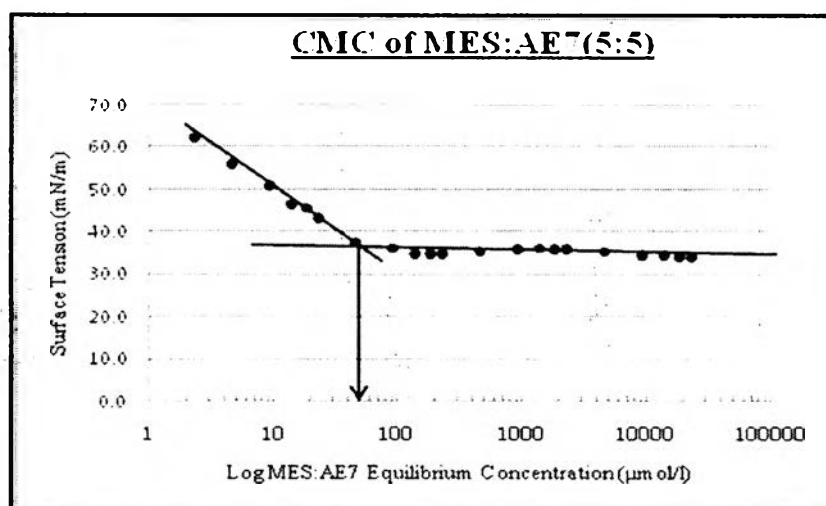


Figure B4 Surface tension vs. Log equilibrium concentration of MES: AE7 in the ratio of 5:5.

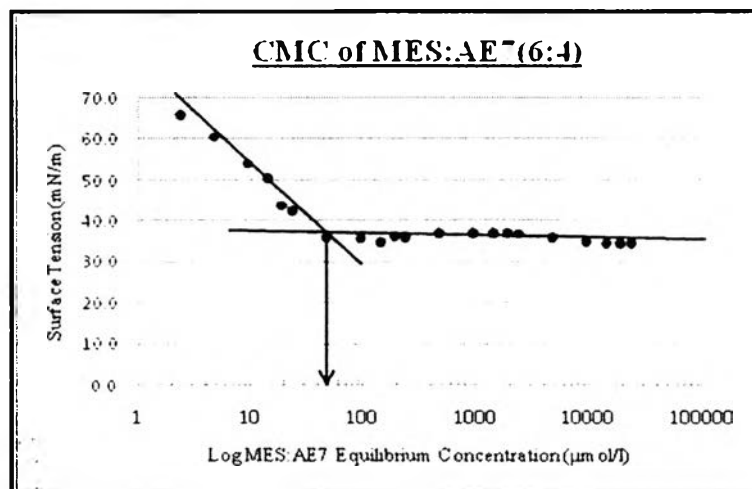


Figure B5 Surface tension vs. Log equilibrium concentration of MES: AE7 in the ratio of 6:4.

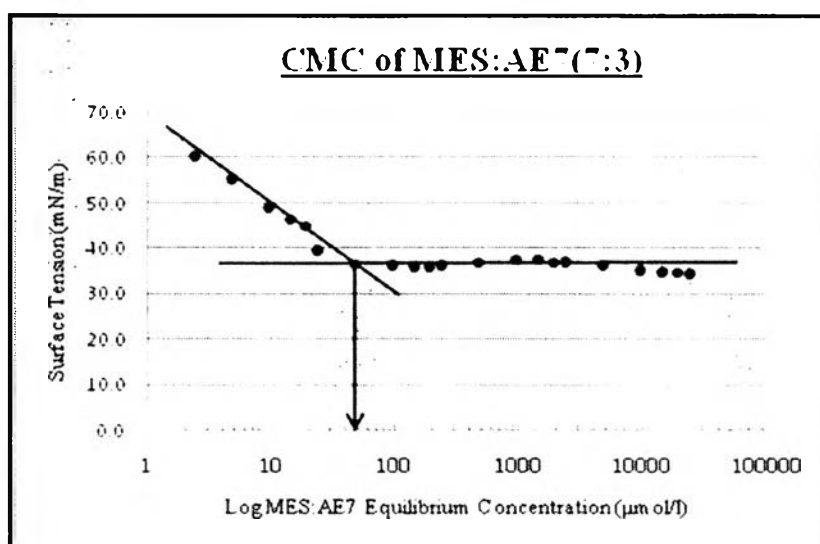


Figure B6 Surface tension vs. Log equilibrium concentration of MES: AE7 in the ratio of 7:3.

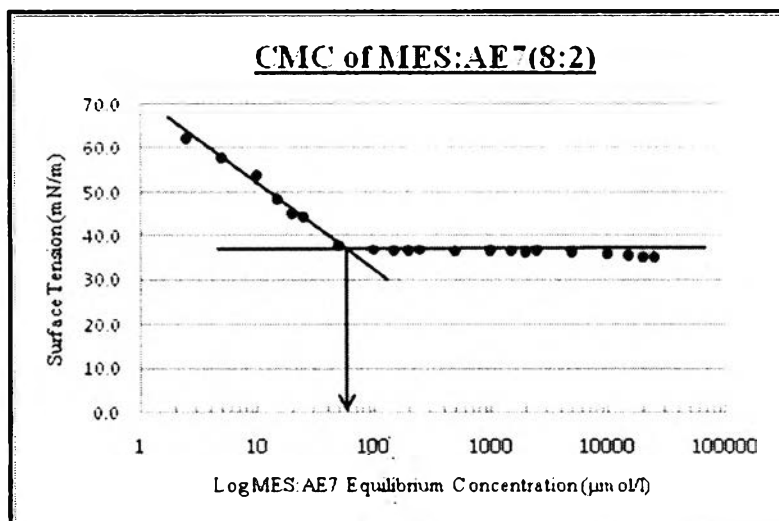


Figure B7 Surface tension vs. Log equilibrium concentration of MES: AE7 in the ratio of 8:2.

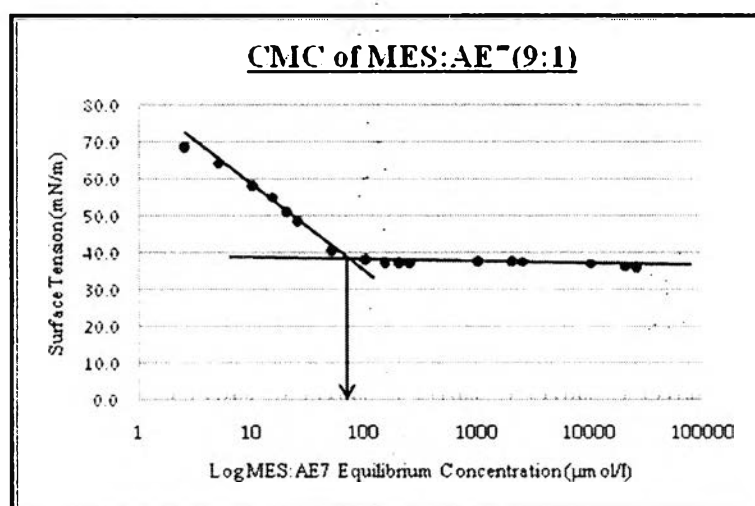


Figure B8 Surface tension vs. Log equilibrium concentration of MES: AE7 in the ratio of 9:1.

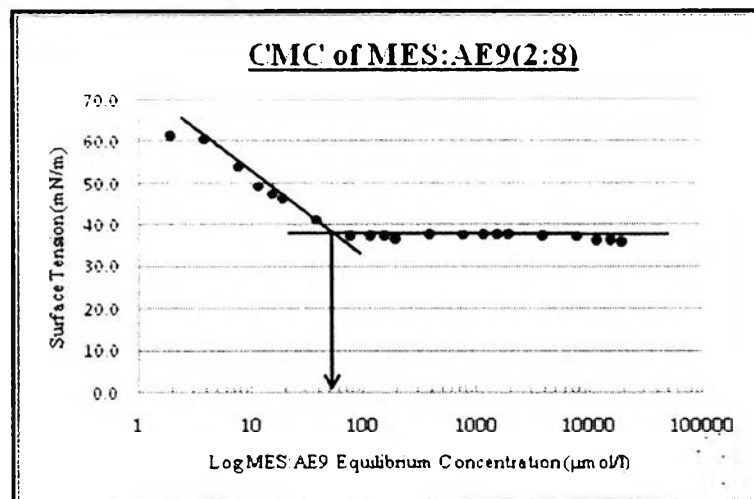


Figure B9 Surface tension vs. Log equilibrium concentration of MES: AE9 in the ratio of 2:8.

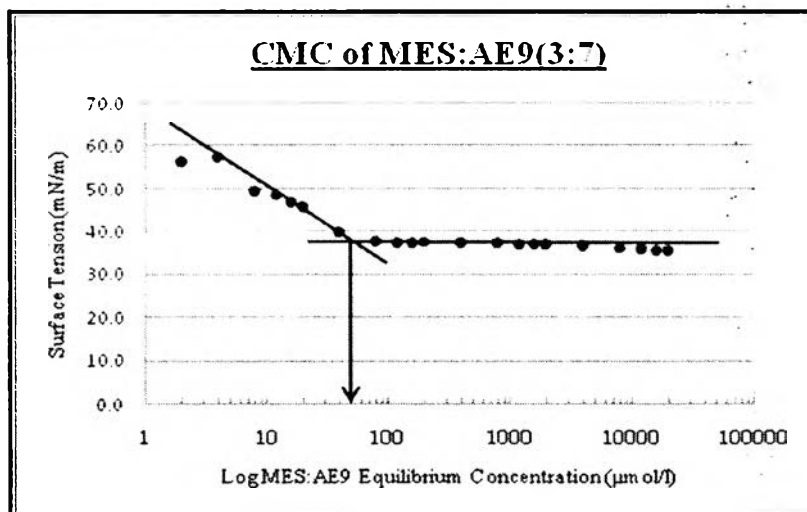


Figure B10 Surface tension vs. Log equilibrium concentration of MES: AE9 in the ratio of 3:7.

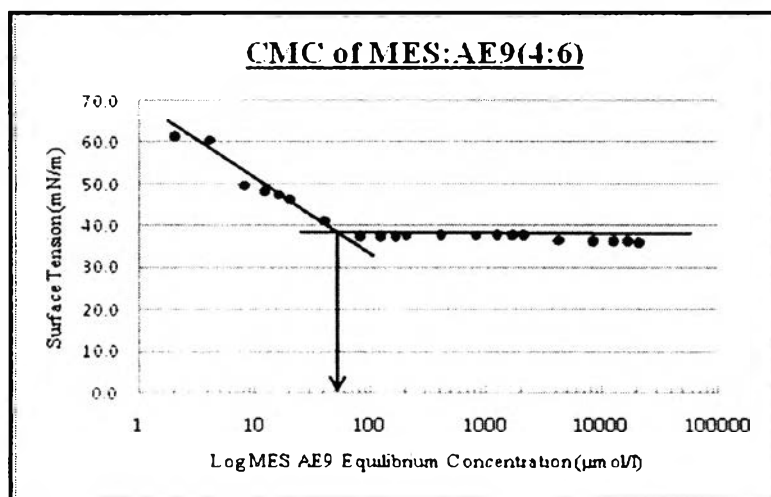


Figure B11 Surface tension vs. Log equilibrium concentration of MES: AE9 in the ratio of 4:6.

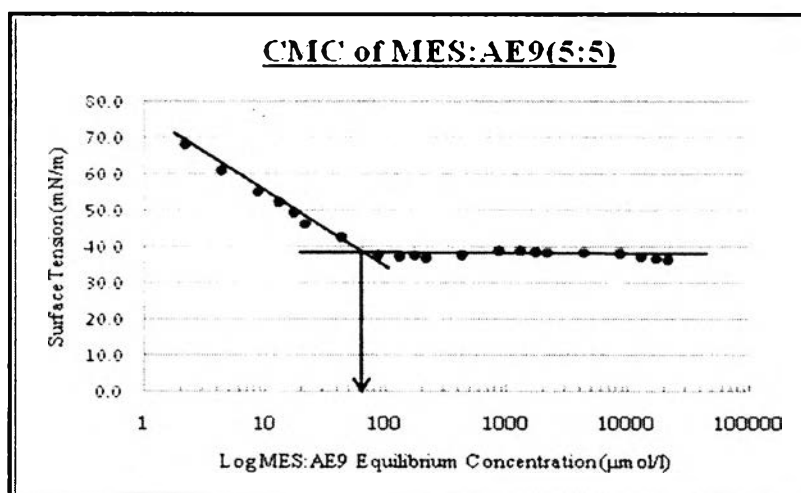


Figure B12 Surface tension vs. Log equilibrium concentration of MES: AE9 in the ratio of 5:5.

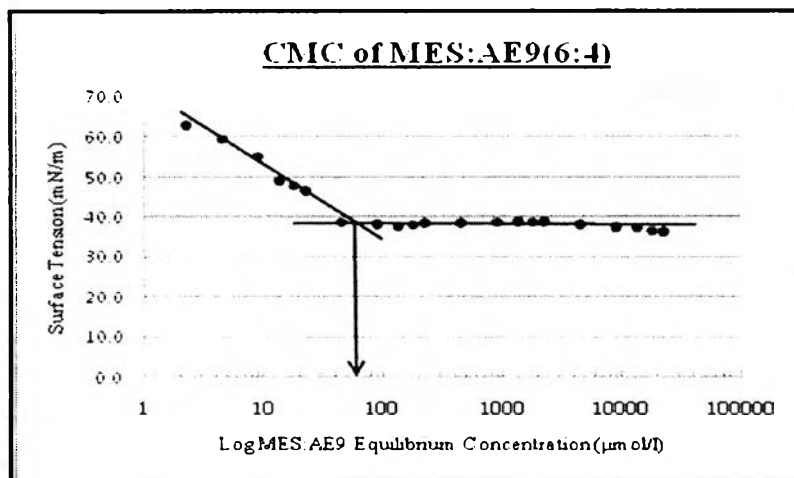


Figure B13 Surface tension vs. Log equilibrium concentration of MES: AE9 in the ratio of 6:4.

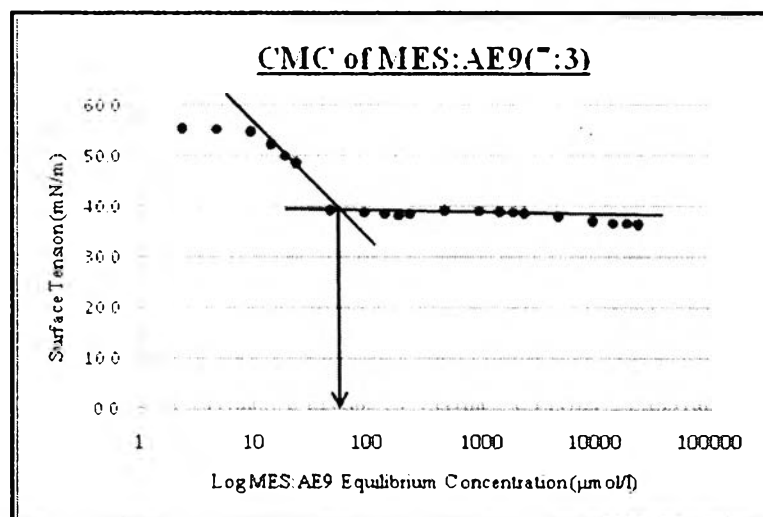


Figure B14 Surface tension vs. Log equilibrium concentration of MES: AE9 in the ratio of 7:3.

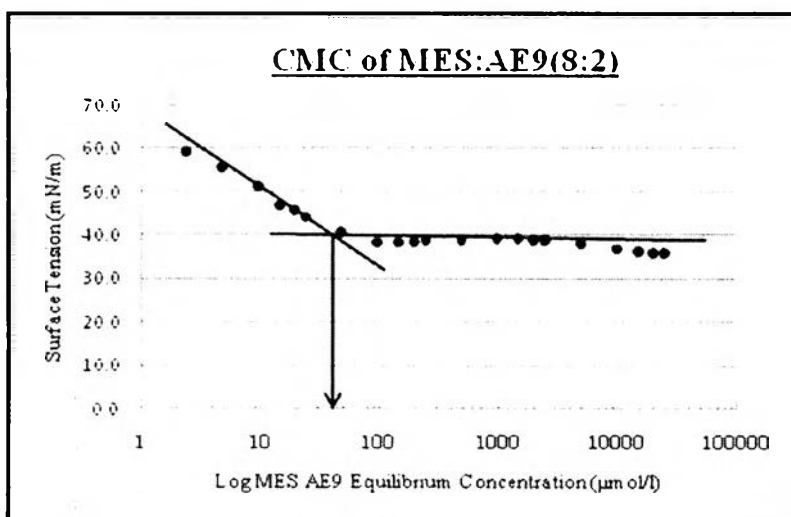


Figure B15 Surface tension vs. Log equilibrium concentration of MES: AE9 in the ratio of 8:2.

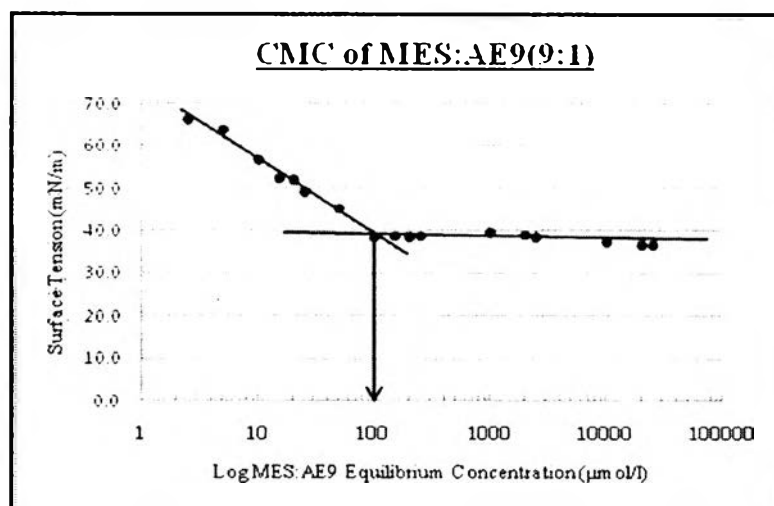


Figure B16 Surface tension vs. Log equilibrium concentration of MES: AE9 in the ratio of 9:1.

APPENDIX C Experiment data of detergency performance

Table C1 Oily soil removal (%) of mixed surfactant of 1:9 of MES: AE7 at different concentration on cotton fabric

Surfactant concentration (%w/v)	Sample No.	Extracted soil before washing (ppm)	Residual soil after washing (ppm)	Soil removal (%)	Average soil removal (%)
0.02	1	190.420	59.771	68.611	69.434
	2	190.420	56.782	70.181	
	3	190.420	58.056	69.512	
0.05	1	190.420	56.616	70.268	70.333
	2	190.420	56.457	70.351	
	3	190.420	56.404	70.379	
0.1	1	190.420	55.177	71.024	70.716
	2	190.420	55.352	70.932	
	3	190.420	56.760	70.192	
0.2	1	190.420	55.144	71.041	70.718
	2	190.420	54.970	71.132	
	3	190.420	54.532	71.362	
0.3	1	190.420	52.973	72.181	72.458
	2	190.420	52.998	72.168	
	3	190.420	51.365	73.025	
0.5	1	190.420	52.312	72.528	72.493
	2	190.420	52.458	72.458	

Table C2 Oily soil removal (%) of mixed surfactant of 1:9 of MES: AE7 at different concentration on polyester fabric

Surfactant concentration (%w/v)	Sample No.	Extracted soil before washing (ppm)	Residual soil after washing (ppm)	Soil removal (%)	Average soil removal (%)
0.02	1	155.84	68.303	56.171	56.630
	2	155.84	66.407	57.388	
	3	155.84	68.056	56.330	
0.05	1	155.84	65.885	57.723	57.739
	2	155.84	66.221	57.507	
	3	155.84	65.471	57.988	
0.1	1	155.84	63.790	59.067	59.180
	2	155.84	63.221	59.432	
	3	155.84	63.829	59.042	
0.2	1	155.84	60.513	61.170	61.580
	2	155.84	58.279	62.603	
	3	155.84	60.829	60.967	
0.3	1	155.84	52.899	66.065	64.668
	2	155.84	56.317	63.862	
	3	155.84	55.970	64.085	
0.5	1	155.84	56.249	63.906	64.357
	2	155.84	56.411	63.802	
	3	155.84	53.978	65.363	

Table C3 Particulate soil removal (%) of mixed surfactant of 1:9 of MES: AE7 at different concentration on cotton fabric

Surfactant concentration (%w/v)	Sample No.	Concentration of soil before washing (ppm)	Residual soil after washing (ppm)	Soil removal (%)	Average soil removal (%)
0.02	1	84.01	75.100	10.606	37.944
	2	84.01	48.500	48.220	
	3	84.01	37.800	55.005	
0.05	1	84.01	42.600	49.292	40.563
	2	84.01	50.900	39.412	
	3	84.01	56.300	32.984	
0.1	1	84.01	47.400	43.578	46.673
	2	84.01	41.300	50.839	
	3	84.01	45.700	45.602	
0.2	1	84.01	35.400	57.862	51.514
	2	84.01	38.100	54.648	
	3	84.01	48.031	42.031	
0.3	1	84.01	40.900	51.315	56.493
	2	84.01	32.200	61.671	
0.5	1	84.01	37.100	55.839	55.680
	2	84.01	35.800	57.386	
	3	84.01	38.800	53.815	

Table C4 Particulate soil removal (%) of mixed surfactant of 1:9 of MES: AE7 at different concentration on polyester fabric

Surfactant concentration (%w/v)	Sample No.	Concentration of soil before washing (ppm)	Residual soil after washing (ppm)	Soil removal (%)	Average soil removal (%)
0.02	1	84.01	52.400	20.627	20.223
	2	84.01	54.700	17.143	
	3	84.01	50.900	22.899	
0.05	1	84.01	48.900	25.928	24.918
	2	84.01	50.500	23.505	
	3	84.01	49.300	25.322	
0.1	1	84.01	47.900	27.443	27.140
	2	84.01	48.100	27.140	
	3	84.01	48.300	26.837	
0.2	1	84.01	42.200	36.077	33.502
	2	84.01	45.300	31.381	
	3	84.01	44.200	33.048	
0.3	1	84.01	42.700	35.320	38.854
	2	84.01	40.300	38.955	
	3	84.01	38.100	42.288	
0.5	1	84.01	40.500	38.652	37.895
	2	84.01	39.400	40.318	
	3	84.01	43.100	34.714	

Table C5 Re-deposition of oily soil using the selected formulation (1:9 MES:AE7) on cotton and polyester fabric

Surfactant concentration (%w/v)	Re-deposition of oily soil on the cotton (%)	Re-deposition of oily soil on the polyester (%)
0.02	10.235	22.795
0.05	10.001	21.350
0.1	7.693	20.187
0.2	7.949	19.969
0.3	6.567	17.454
0.5	5.527	16.365

Table C6 Re-deposition of particulate soil using the selected formulation (1:9 MES:AE7) on cotton and polyester fabric

Surfactant concentration (%w/v)	Re-deposition of particulate soil on the cotton (%)	Re-deposition of particulate soil on the polyester (%)
0.02	6.071	8.028
0.05	4.404	5.908
0.1	3.690	5.756
0.2	2.857	4.696
0.3	1.428	2.272
0.5	1.071	1.212

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Proceedings:

1. Thiengchanya, O., Chavadej, S., Scamehorn, J.F., and Tantayakom, V. (2011, April 26). Detergency of Mixed Soil Removal Using Methyl Ester Sulfonate and Alcohol Ethoxylate. Proceedings of the 2nd Research Symposium on Petroleum, Petrochemical, and Advanced Materials and 17th PPC Symposium on Petroleum, Petrochemical, and Polymers, Bangkok, Thailand.