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APPENDICES

Appendix A Data of Particle Size Distribution

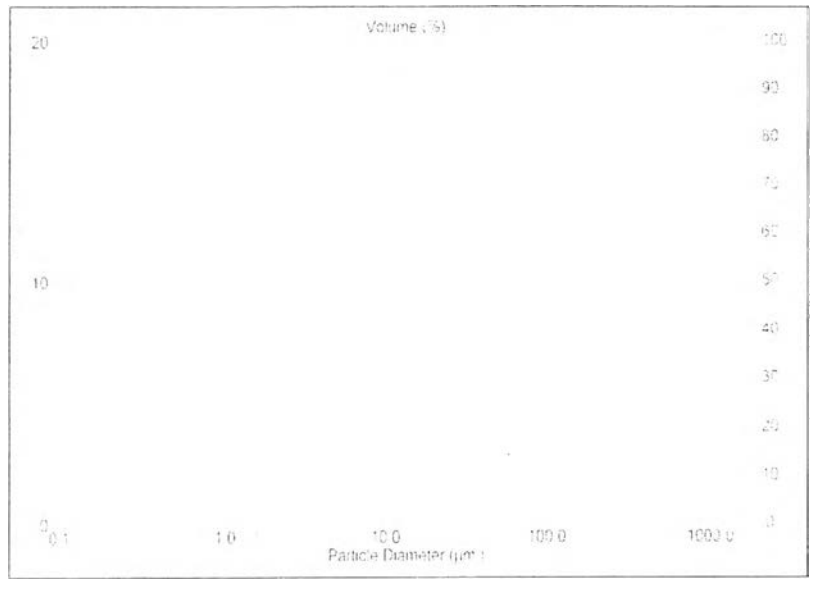

Figure A1 Histogram showing the particle size distribution by volume of the natural rubber latex.

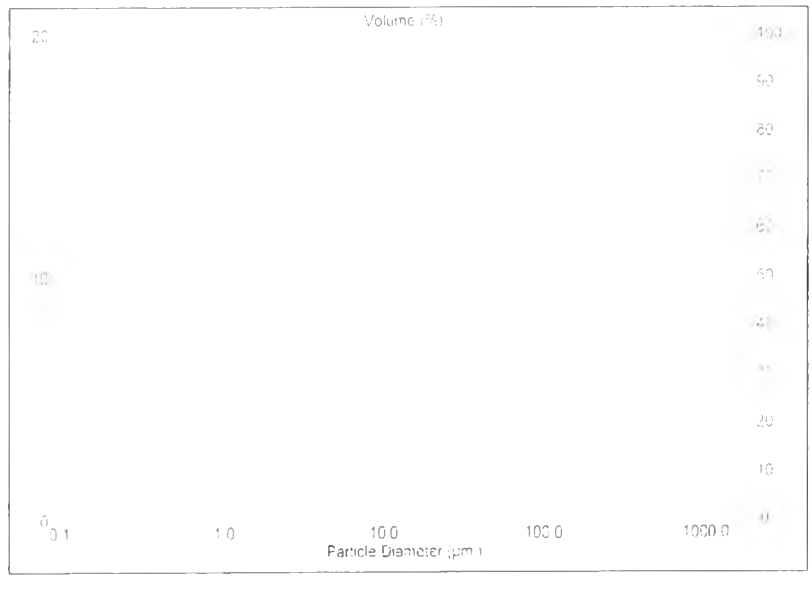

Figure A2 Histogram showing the particle size distribution by volume of PMPS-ad-NR 50 mM MPS using cationic surfactant (CPC).

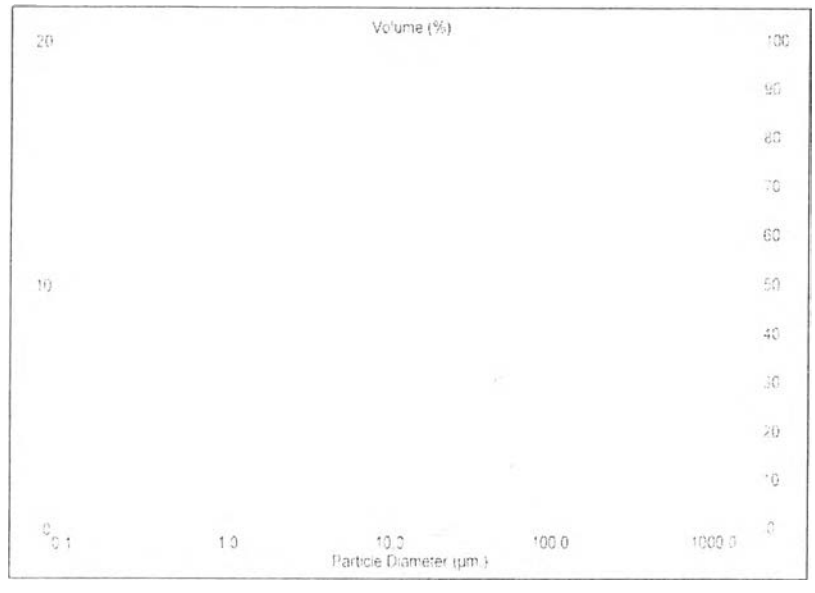

Figure A3 Histogram showing the particle size distribution by volume of PMPS-ad-NR 100 mM MPS using cationic surfactant (CPC).

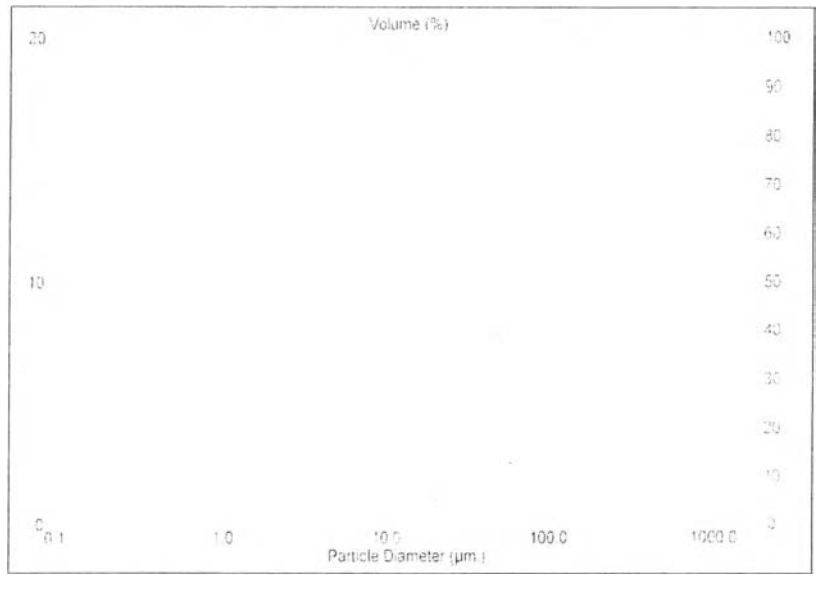

Figure A4 Histogram showing the particle size distribution by volume of PMPS-ad-NR 200 mM MPS using cationic surfactant (CPC).

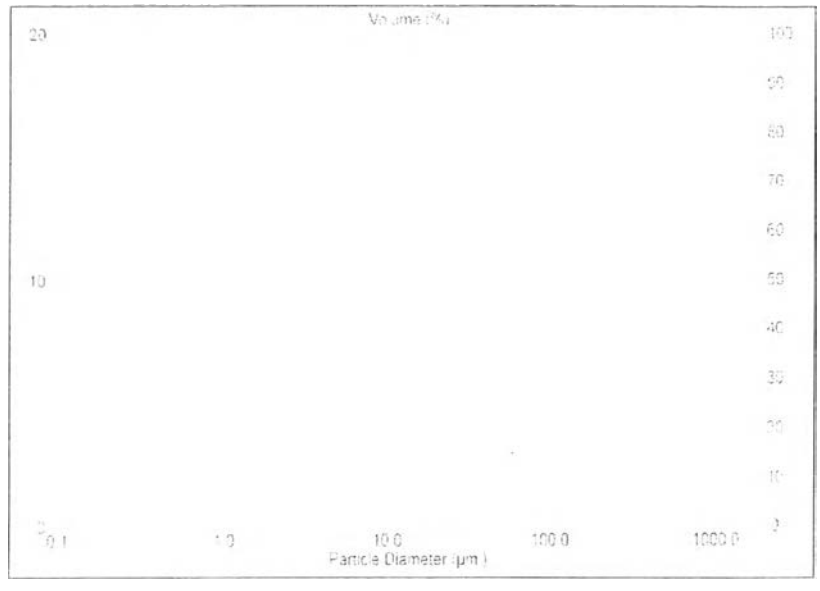

Figure A5 Histogram showing the particle size distribution by volume of PMPS-ad-NR 50 mM MPS using anionic surfactant (DBSA).

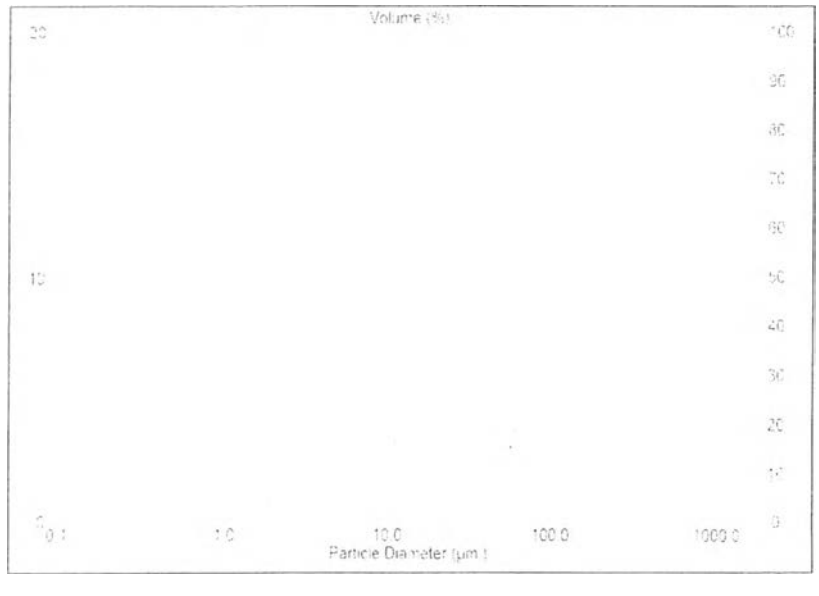

Figure A6 Histogram showing the particle size distribution by volume of PMPS-ad-NR 100 mM MPS using anionic surfactant (DBSA).

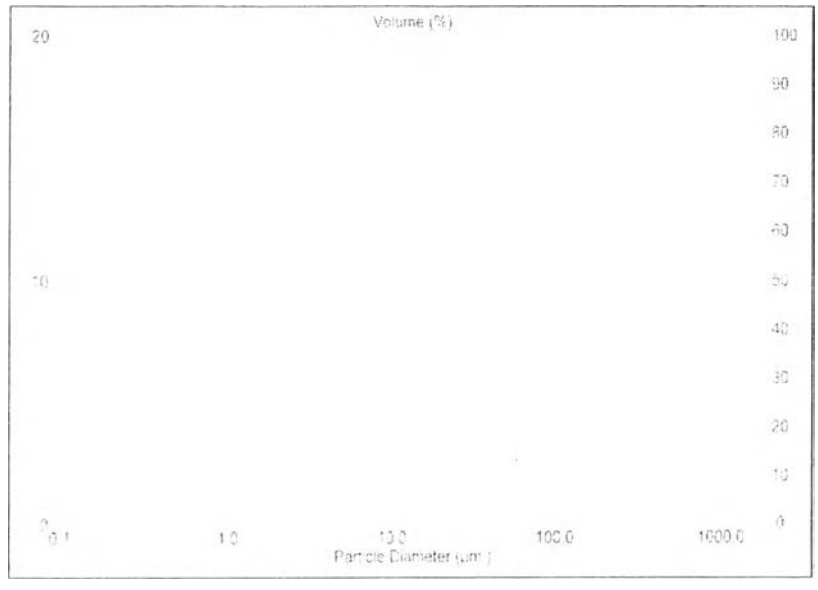

Figure A7 Histogram showing the particle size distribution by volume of PMPS-ad-NR 200 mM MPS using anionic surfactant (DBSA).

Appendix B Calibration Curve of Surfactant Solution

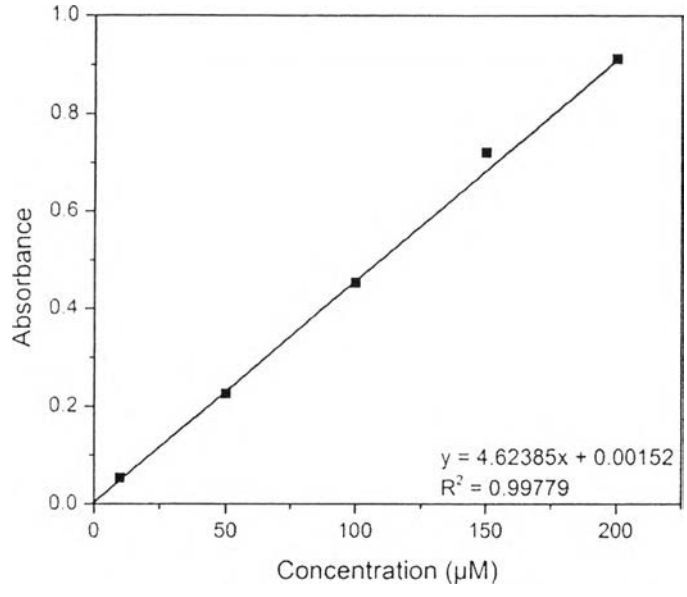

Figure B1 Calibration curve of CPC solution at pH 8.

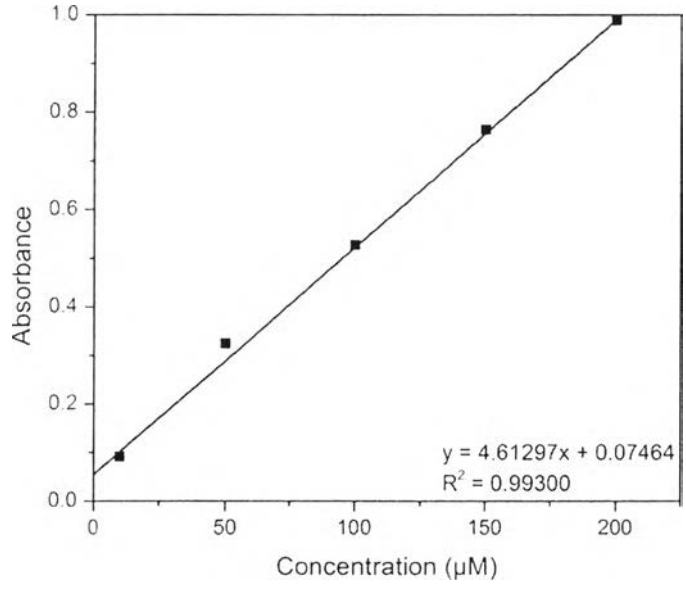

Figure B2 Calibration curve of DBSA solution at pH 3.

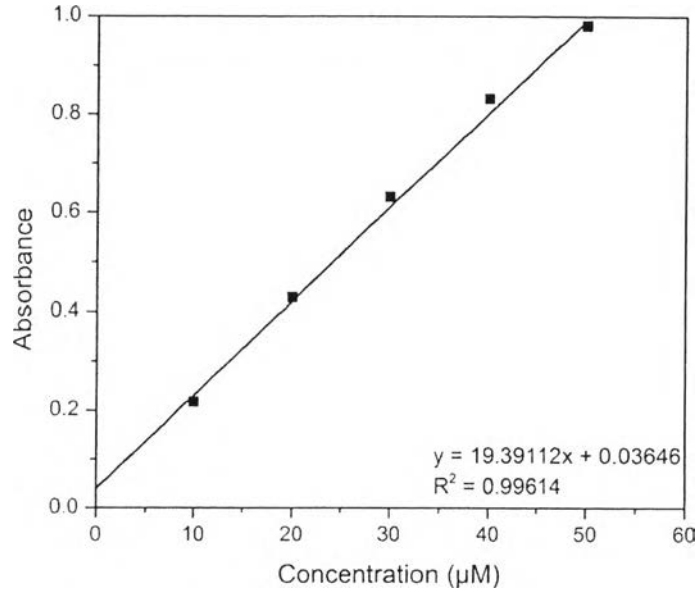

Figure B3 Calibration curve of NP30 solution at pH 3.

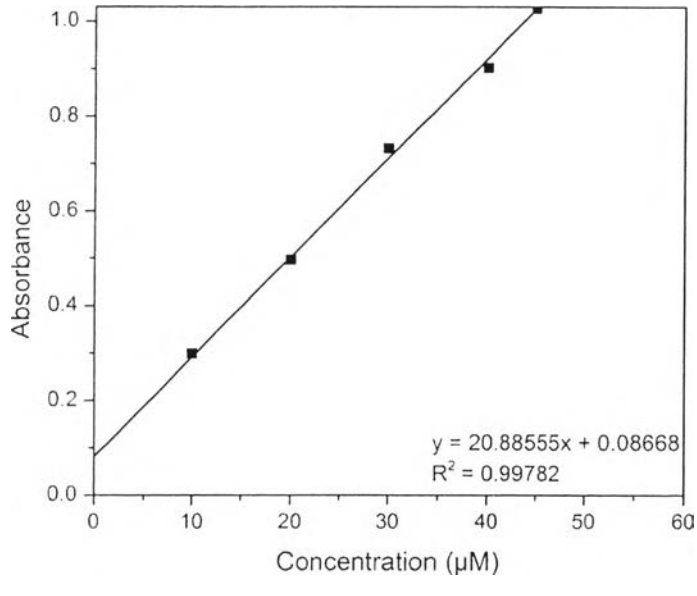

Figure B4 Calibration curve of NP30 solution at pH 3.9.

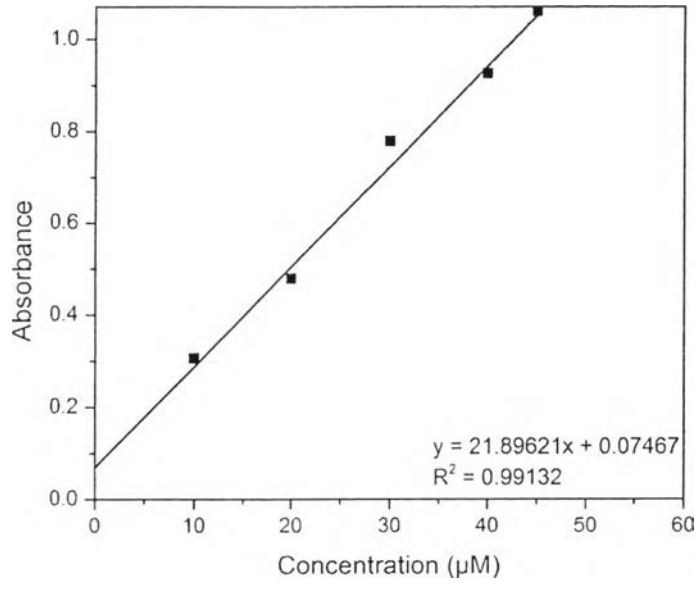

Figure B5 Calibration curve of NP30 solution at pH 8.

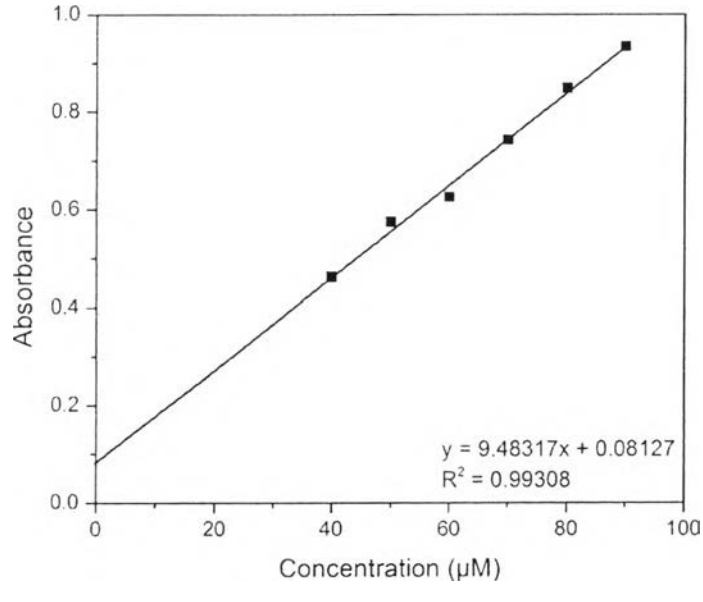

Figure B6 Calibration curve of C7BzO solution at pH 3.

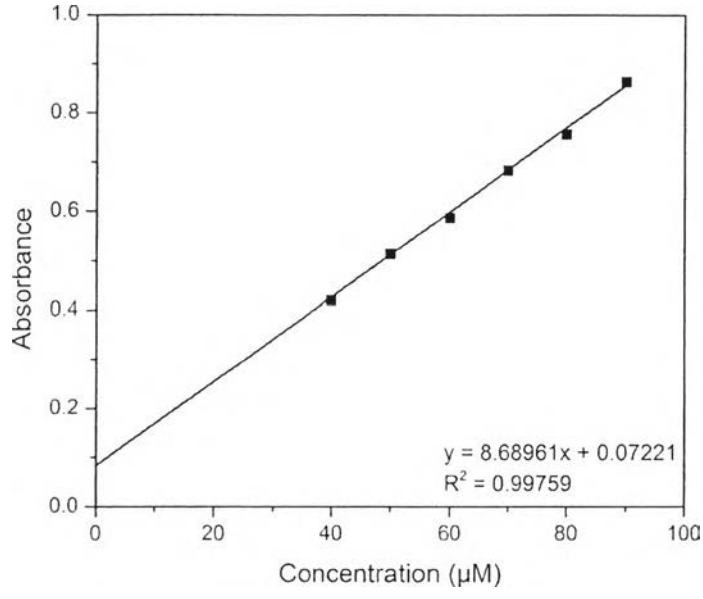

Figure B7 Calibration curve of C7BzO solution at pH 8.

Appendix C Adsorption Isotherms of Surfactant Solution

Table C1 Adsorption isotherm on 5 %w/v of natural rubber latex particles of CPC at pH 8

Initial Surfactant concentration (μM)	Sample No.	Equilibrium Surfactant concentration (μM)	Adsorbed surfactant (μmol/g NR)	Average Equilibrium surfactant concentration (μM)	Average Adsorbed surfactant (μmol/g NR)
100	1	89.70	0.19	88.00	0.23
	2	99.60	0.09		
	3	80.00	0.40		
250	1	206.60	0.82	200.43	0.98
	2	200.10	0.99		
	3	194.30	1.13		
350	1	226.50	2.41	244.47	3.03
	2	232.50	2.36		
	3	214.80	2.63		
550	1	271.10	5.45	285.80	5.01
	2	302.00	4.94		
	3	284.30	4.64		
700	1	310.40	7.68	327.27	7.14
	2	346.80	6.65		
	3	324.60	7.08		
900	1	383.10	9.93	384.77	9.65
	2	384.80	9.75		
	3	386.40	9.25		
2000	1	700.00	23.64	753.13	23.49
	2	694.20	25.36		
	3	865.20	21.48		
3500	1	744.40	47.30	897.87	46.89
	2	877.70	49.64		
	3	1071.50	43.44		
5000	1	817.60	76.43	1854.20	59.29
	2	1445.60	69.88		
	3	3299.40	31.54		
6500	1	2456.40	80.48	2978.70	70.29
	2	2979.80	70.36		
	3	3499.90	60.03		

Table C2 Adsorption isotherm on 10 %w/v of natural rubber latex particles of CPC at pH 8

Initial Surfactant concentration (μM)	Sample No.	Equilibrium Surfactant concentration (μM)	Adsorbed surfactant (μmol/g NR)	Average Equilibrium surfactant concentration (μM)	Average Adsorbed surfactant (μmol/g NR)
100	1	76.60	0.23	79.70	0.20
	2	67.70	0.32		
	3	94.80	005		
300	1	191.40	1.08	187.13	1.13
	2	164.40	1.36		
	3	205.60	0.94		
500	1	250.20	2.45	267.73	2.28
	2	265.50	2.34		
	3	287.50	2.06		
700	1	303.20	3.86	306.57	3.88
	2	301.10	3.93		
	3	315.40	3.84		
900	1	360.60	5.35	359.00	5.32
	2	342.20	5.35		
	3	374.20	5.25		
3000	1	508.20	24.15	571.07	24.06
	2	566.80	24.22		
	3	566.20	23.81		
6000	1	804.90	51.95	739.50	51.54
	2	721.60	51.01		
	3	692.00	51.66		
9000	1	2070.30	68.28	2090.87	68.23
	2	2663.90	62.36		
	3	1538.40	74.09		
12000	1	6064.50	58.68	5629.37	62.30
	2	5487.20	64.82		
	3	5336.40	63.40		
17000	1	6546.20	103.33	6496.03	102.59
	2	6587.60	98.22		
	3	6354.30	106.21		

Table C3 Adsorption isotherm on 20 %w/v of natural rubber latex particles of CPC at pH 8

Initial Surfactant concentration (μM)	Sample No.	Equilibrium Surfactant concentration (μM)	Adsorbed surfactant (μmol/g NR)	Average Equilibrium surfactant concentration (μM)	Average Adsorbed surfactant (μmol/g NR)
1000	1	360.50	3.15	386.17	3.04
	2	402.60	2.94		
	3	395.40	3.02		
4000	1	224.00	18.42	414.60	17.77
	2	509.60	17.47		
	3	510.20	17.41		
7000	1	135.00	34.87	391.13	32.94
	2	513.60	32.27		
	3	524.80	31.68		
10000	1	773.00	46.04	655.30	46.35
	2	589.70	46.03		
	3	603.20	46.97		
13000	1	1251.00	58.45	1210.07	58.76
	2	1236.40	58.66		
	3	1142.80	59.16		
16000	1	2146.00	67.74	2296.32	67.45
	2	2687.00	64.90		
	3	2056.10	69.72		
19000	1	3722.50	73.25	3496.57	75.96
	2	3789.80	74.43		
	3	2977.40	80.20		
22000	1	15715.50	31.16	14875.07	35.44
	2	15008.90	34.92		
	3	13900.80	40.26		
26000	1	9691.50	81.72	14029.57	59.79
	2	19984.60	29.83		
	3	12412.60	67.83		
30000	1	8020.00	107.43	10820.8	94.36
	2	10445.80	97.64		
	3	13996.60	78.02		

Table C4 Adsorption isotherm on 5 %w/v of natural rubber latex particles of DBSA at pH 3

Initial Surfactant concentration (μM)	Sample No.	Equilibrium Surfactant concentration (μM)	Adsorbed surfactant (μmol/g NR)	Average Equilibrium surfactant concentration (μM)	Average Adsorbed surfactant (μmol/g NR)
100	1	17.60	1.52	13.43	1.69
	2	10.20	1.80		
	3	12.50	1.75		
600	1	244.40	6.74	268.20	6.22
	2	261.40	6.22		
	3	298.80	5.70		
900	1	326.20	10.66	312.43	11.23
	2	302.20	11.68		
	3	308.90	11.36		
4000	1	519.80	62.71	516.60	67.38
	2	501.20	69.72		
	3	528.80	69.71		
6000	1	534.40	109.07	564.60	108.58
	2	574.60	108.26		
	3	584.80	108.42		
8000	1	694.40	145.46	693.80	140.43
	2	695.60	143.21		
	3	691.40	132.63		
10000	1	952.40	180.54	931.27	176.53
	2	965.80	180.95		
	3	875.60	168.10		
12000	1	1142.50	206.24	1109.93	209.01
	2	1098.70	203.86		
	3	1088.60	216.93		
15000	1	2862.40	273.74	2429.07	247.82
	2	2056.80	258.63		
	3	2368.00	247.08		
20000	1	6884.50	260.79	6418.97	259.12
	2	6287.80	244.64		
	3	6084.60	271.92		

Table C5 Adsorption isotherm on 10 %w/v of natural rubber latex particles of DBSA at pH 3

Initial Surfactant concentration (μM)	Sample No.	Equilibrium Surfactant concentration (μM)	Adsorbed surfactant (μmol/g NR)	Average Equilibrium surfactant concentration (μM)	Average Adsorbed surfactant (μmol/g NR)
1000	1	82.40	9.17	232.97	7.44
	2	366.50	6.16		
	3	250.00	6.99		
4000	1	242.50	34.17	358.77	34.70
	2	532.60	34.70		
	3	301.20	35.23		
7000	1	466.60	65.27	569.80	64.09
	2	702.30	62.89		
	3	540.50	64.11		
10000	1	634.40	93.40	713.93	92.02
	2	802.10	91.79		
	3	705.30	90.87		
13000	1	794.70	122.14	878.50	117.35
	2	965.30	114.51		
	3	875.50	115.39		
16000	1	985.40	149.96	1077.60	145.91
	2	1122.40	141.39		
	3	1125.00	146.39		
19000	1	1345.80	176.44	1966.23	167.36
	2	2596.60	155.57		
	3	1956.30	170.06		
22000	1	1622.80	203.60	2671.60	189.43
	2	2966.40	186.91		
	3	3425.60	177.79		
26000	1	2268.60	236.13	3072.67	228.85
	2	3401.20	226.02		
	3	354820	224.38		
30000	1	3641.60	260.56	3845.17	256.56
	2	3908.40	253.07		
	3	3985.50	262.04		

Table C6 Adsorption isotherm on 20 %w/v of natural rubber latex particles of DBSA at pH 3

Initial Surfactant concentration (μM)	Sample No.	Equilibrium Surfactant concentration (μM)	Adsorbed surfactant (μmol/g NR)	Average Equilibrium surfactant concentration (μM)	Average Adsorbed surfactant (μmol/g NR)
1000	1	5.40	4.99	8.03	4.92
	2	10.20	4.95		
	3	8.50	4.82		
5000	1	52.20	24.72	30.57	24.85
	2	14.00	24.89		
	3	25.50	24.94		
9000	1	126.50	44.40	105.60	43.96
	2	97.80	43.20		
	3	92.50	44.28		
13000	1	175.60	64.09	273.10	63.95
	2	187.50	62.82		
	3	456.20	62.37		
16000	1	445.4	75.29	532.87	75.91
	2	367.70	76.20		
	3	785.50	75.23		
19000	1	978.90	88.96	1032.87	88.71
	2	854.20	91.94		
	3	1265.50	85.22		
22000	1	1236.50	103.17	1207.57	102.83
	2	1200.80	103.16		
	3	1185.40	102.17		
25000	1	1798.90	111.11	1488.50	114.73
	2	1355.60	117.59		
	3	1311.00	115.51		
28000	1	1595.00	129.71	1808.57	129.88
	2	1898.50	128.71		
	3	1932.20	131.22		
30000	1	1341.60	143.04	1687.43	141.26
	2	1755.70	143.74		
	3	1965.00	137.00		

Table C7 Adsorption isotherm on 5 %w/v of natural rubber latex particles of C7BzO at pH 3

Initial Surfactant concentration (μM)	Sample No.	Equilibrium Surfactant concentration (μM)	Adsorbed surfactant (μmol/g NR)	Average Equilibrium surfactant concentration (μM)	Average Adsorbed surfactant (μmol/g NR)
3000	1	150.00	56.74	200	54.61
	2	150.00	56.89		
	3	300.00	50.20		
7000	1	1000.00	120.82	983.33	116.86
	2	900.00	114.62		
	3	1050.00	115.13		
11000	1	1950.00	181.25	2083.33	180.67
	2	2150.00	180.46		
	3	2150.00	180.28		
15000	1	3000.00	236.78	2900.00	240.59
	2	2850.00	243.58		
	3	2850.00	241.41		
19000	1	3300.00	309.60	3500.00	300.02
	2	3600.00	285.13		
	3	3600.00	305.31		
22000	1	4150.00	347.88	4283.33	343.10
	2	4400.00	325.99		
	3	4300.00	355.42		
25000	1	4500.00	406.42	4383.33	395.34
	2	4250.00	395.69		
	3	4400.00	383.90		
28000	1	4800.00	456.42	5083.33	455.27
	2	4850.00	462.54		
	3	5600.00	446.84		
29000	1	4850.00	477.74	5450.00	457.03
	2	5100.00	478.67		
	3	6400.00	414.68		
30000	1	5400.00	457.06	6300.00	452.61
	2	5650.00	453.53		
	3	7850.00	437.23		

Table C8 Adsorption isotherm on 10 %w/v of natural rubber latex particles of C7BzO at pH 3

Initial Surfactant concentration (μM)	Sample No.	Equilibrium Surfactant concentration (μM)	Adsorbed surfactant (μmol/g NR)	Average Equilibrium surfactant concentration (μM)	Average Adsorbed surfactant (μmol/g NR)
3000	1	0.00	28.42	50.00	27.58
	2	50.00	26.77		
	3	100.00	27.56		
7000	1	1000.00	60.58	766.67	62.24
	2	800.00	58.07		
	3	500.00	68.08		
11000	1	1050.00	84.59	1650.00	90.72
	2	1750.00	90.70		
	3	1250.00	96.87		
15000	1	2650.00	123.12	2333.33	122.02
	2	2500.00	117.42		
	3	1850.00	125.51		
19000	1	3050.00	159.36	2783.33	160.30
	2	2850.00	156.14		
	3	2450.00	165.40		
22000	1	3650.00	182.80	3583.33	181.19
	2	3800.00	179.84		
	3	3300.00	180.92		
25000	1	4650.00	194.64	4400.00	196.58
	2	4250.00	188.84		
	3	4300.00	206.26		
28000	1	5050.00	230.21	4983.33	226.45
	2	5000.00	226.74		
	3	4900.00	222.39		
29000	1	5100.00	249.11	5150.00	238.59
	2	5100.00	231.54		
	3	5250.00	235.10		
30000	1	5600.00	242.71	5283.33	240.15
	2	5050.00	237.71		
	3	5200.00	240.03		

Table C9 Adsorption isotherm on 20 %w/v of natural rubber latex particles of C7BzO at pH 3

Initial Surfactant concentration (μM)	Sample No.	Equilibrium Surfactant concentration (μM)	Adsorbed surfactant (μmol/g NR)	Average Equilibrium surfactant concentration (μM)	Average Adsorbed surfactant (μmol/g NR)
3000	1	150.00	14.97	100.00	14.70
	2	0.00	14.14		
	3	150.00	14.97		
7000	1	650.00	34.07	666.67	34.66
	2	750.00	35.00		
	3	600.00	34.92		
11000	1	1250.00	54.01	1183.33	54.26
	2	1050.00	53.93		
	3	1250.00	54.85		
15000	1	1450.00	72.06	1650.00	72.91
	2	1750.00	72.42		
	3	1750.00	74.25		
19000	1	2550.00	92.32	2583.33	93.42
	2	2900.00	95.35		
	3	2300.00	92.58		
22000	1	2650.00	109.37	2900.00	107.57
	2	3350.00	109.61		
	3	2700.00	103.74		
25000	1	3200.00	115.70	2883.33	121.18
	2	2200.00	124.42		
	3	3250.00	123.43		
28000	1	4400.00	136.73	4100.00	137.00
	2	4150.00	135.32		
	3	3750.00	138.94		
29000	1	4750.00	134.34	4433.33	136.72
	2	4250.00	141.44		
	3	4300.00	134.38		
30000	1	4650.00	146.19	4650.00	148.27
	2	4600.00	149.09		
	3	4700.00	149.53		

Table C10 Adsorption isotherm on 5 %w/v of natural rubber latex particles of C7BzO at pH 8

Initial Surfactant concentration (μM)	Sample No.	Equilibrium Surfactant concentration (μM)	Adsorbed surfactant (μmol/g NR)	Average Equilibrium surfactant concentration (μM)	Average Adsorbed surfactant (μmol/g NR)
3000	1	750.00	44.22	416.67	50.14
	2	250.00	53.45		
	3	250.00	52.74		
5000	1	1750.00	62.48	1083.33	75.69
	2	750.00	79.83		
	3	750.00	84.78		
8000	1	2750.00	105.53	1750.00	117.07
	2	1200.00	126.98		
	3	1300.00	118.68		
11000	1	3450.00	144.30	2600.00	162.85
	2	2150.00	168.76		
	3	2200.00	175.47		
14000	1	3750.00	197.80	2966.67	200.05
	2	2550.00	201.48		
	3	2600.00	200.88		
17000	1	3200.00	273.27	3300.00	265.90
	2	3350.00	265.31		
	3	3350.00	259.11		
20000	1	3900.00	299.59	4100.00	295.67
	2	4200.00	289.70		
	3	4200.00	297.72		
24000	1	4300.00	375.88	4416.67	368.51
	2	4500.00	372.71		
	3	4450.00	356.95		
28000	1	5200.00	409.26	5300.00	409.12
	2	5400.00	415.90		
	3	5300.00	402.20		
30000	1	5800.00	435.64	5950.00	435.99
	2	6050.00	421.95		
	3	6000.00	450.37		

Table C11 Adsorption isotherm on 10 %w/v of natural rubber latex particles of C7BzO at pH 8

Initial Surfactant concentration (μM)	Sample No.	Equilibrium Surfactant concentration (μM)	Adsorbed surfactant (μmol/g NR)	Average Equilibrium surfactant concentration (μM)	Average Adsorbed surfactant (μmol/g NR)
3000	1	0.00	29.80	16.67	28.83
	2	-100.00	30.02		
	3	150.00	26.69		
5000	1	1150.00	36.81	1050.00	37.93
	2	1050.00	37.34		
	3	950.00	39.63		
8000	1	1300.00	67.16	1333.33	66.81
	2	1400.00	65.97		
	3	1300.00	67.30		
11000	1	1800.00	84.36	1966.67	83.48
	2	2000.00	83.42		
	3	2100.00	82.66		
14000	1	2550.00	114.86	2600.00	109.22
	2	2600.00	109.18		
	3	2650.00	103.63		
17000	1	3150.00	142.74	3233.33	137.33
	2	3250.00	136.49		
	3	3300.00	132.75		
20000	1	4050.00	167.33	3950.00	157.72
	2	4000.00	145.72		
	3	3800.00	160.13		
24000	1	4250.00	181.53	4450.00	190.08
	2	4650.00	194.10		
	3	4450.00	194.60		
28000	1	5200.00	217.18	5550.00	218.05
	2	5400.00	218.97		
	3	6050.00	218.00		
30000	1	5800.00	241.47	5933.33	235.88
	2	6050.00	226.95		
	3	5950.00	239.21		

Table C12 Adsorption isotherm on 20 %w/v of natural rubber latex particles of C7BzO at pH 8

Initial Surfactant concentration (μM)	Sample No.	Equilibrium Surfactant concentration (μM)	Adsorbed surfactant (μmol/g NR)	Average Equilibrium surfactant concentration (μM)	Average Adsorbed surfactant (μmol/g NR)
3000	1	0.00	13.11	100.00	14.69
	2	50.00	18.88		
	3	250.00	15.28		
5000	1	750.00	21.26	583.33	23.68
	2	550.00	24.93		
	3	450.00	24.86		
8000	1	1400.00	30.82	1333.33	36.91
	2	1550.00	40.27		
	3	1050.00	39.65		
11000	1	1950.00	45.18	1866.67	51.56
	2	2100.00	54.77		
	3	1550.00	54.71		
14000	1	2100.00	59.40	2316.67	65.59
	2	2600.00	69.47		
	3	2250.00	67.90		
17000	1	3100.00	64.62	3183.33	75.94
	2	3300.00	84.48		
	3	3150.00	78.72		
20000	1	3900.00	80.24	3833.33	91.19
	2	3750.00	96.43		
	3	3850.00	96.91		
24000	1	4200.00	95.88	4466.67	109.86
	2	4600.00	114.42		
	3	4600.00	119.28		
28000	1	5300.00	110.80	5566.67	129.37
	2	5650.00	138.52		
	3	5750.00	138.78		
30000	1	6100.00	119.24	6150.00	135.19
	2	6200.00	148.83		
	3	6150.00	137.50		

Table C13 Adsorption isotherm on 5 %w/v of natural rubber latex particles of NP30 at pH 3

Initial Surfactant concentration (μM)	Sample No.	Equilibrium Surfactant concentration (μM)	Adsorbed surfactant (μmol/g NR)	Average Equilibrium surfactant concentration (μM)	Average Adsorbed surfactant (μmol/g NR)
100	1	273.50	-3.35	97.07	0.10
	2	2.10	1.97		
	3	15.60	1.68		
250	1	241.50	0.16	139.63	2.20
	2	32.00	4.36		
	3	145.40	2.08		
350	1	229.50	2.34	188.73	3.01
	2	112.60	4.50		
	3	224.10	2.28		
450	1	196.00	5.06	238.03	4.00
	2	156.20	5.33		
	3	361.90	1.62		
600	1	244.50	6.98	244.77	6.75
	2	135.60	8.62		
	3	354.20	4.66		
2000	1	377.00	31.66	526.67	29.18
	2	856.40	22.76		
	3	346.60	33.11		
4000	1	601.00	61.08	786.60	61.45
	2	856.20	62.66		
	3	902.60	60.60		
6000	1	857.50	102.64	1038.57	91.92
	2	1123.60	87.86		
	3	1134.60	85.27		
8000	1	1390.00	130.62	1456.67	126.20
	2	1458.40	119.27		
	3	1521.60	128.72		
10000	1	1844.00	162.07	1858.67	161.97
	2	1846.00	161.70		
	3	1886.00	162.15		

Table C14 Adsorption isotherm on 10 %w/v of natural rubber latex particles of NP30 at pH 3

Initial Surfactant concentration (μM)	Sample No.	Equilibrium Surfactant concentration (μM)	Adsorbed surfactant (μmol/g NR)	Average Equilibrium surfactant concentration (μM)	Average Adsorbed surfactant (μmol/g NR)
100	1	82.00	0.18	81.00	0.19
	2	75.60	2.24		
	3	85.40	0.14		
250	1	176.50	0.73	137.73	1.06
	2	126.50	1.15		
	3	110.20	1.31		
400	1	196.50	2.04	204.37	1.94
	2	201.10	1.98		
	3	215.50	1.80		
550	1	218.00	3.31	239.67	3.05
	2	235.60	3.14		
	3	265.40	2.71		
700	1	258.50	4.40	287.57	4.09
	2	305.40	3.95		
	3	298.80	3.90		
850	1	293.00	5.57	298.23	5.43
	2	302.90	5.24		
	3	298.80	5.50		
1000	1	323.50	6.74	358.63	6.35
	2	387.80	6.13		
	3	364.60	6.18		
4000	1	1379.50	26.17	1073.47	28.26
	2	986.30	28.87		
	3	854.60	29.75		
8000	1	3595.00	43.09	3357.33	58.84
	2	2466.80	53.29		
	3	4010.20	80.15		
10000	1	5150.50	46.18	4900.30	48.30
	2	4850.80	48.75		
	3	4699.60	49.95		

Table C15 Adsorption isotherm on 20 %w/v of natural rubber latex particles of NP30 at pH 3

Initial Surfactant concentration (μM)	Sample No.	Equilibrium Surfactant concentration (μM)	Adsorbed surfactant (μmol/g NR)	Average Equilibrium surfactant concentration (μM)	Average Adsorbed surfactant (μmol/g NR)
100	1	49.00	0.26	40.67	0.30
	2	25.00	0.38		
	3	48.00	0.26		
300	1	78.00	1.10	82.03	1.08
	2	72.10	1.11		
	3	96.00	1.01		
500	1	106.00	1.97	108.28	1.90
	2	62.20	2.08		
	3	156.63	1.65		
700	1	176.00	2.53	161.03	2.63
	2	132.60	2.80		
	3	174.49	2.56		
900	1	176.00	3.62	184.97	3.55
	2	186.60	3.54		
	3	192.30	3.49		
2000	1	631.00	6.83	586.59	7.02
	2	563.20	7.06		
	3	565.56	7.16		
4000	1	1428.00	12.58	1149.60	14.14
	2	1032.20	14.79		
	3	988.60	15.05		
6000	1	2227.00	18.31	2092.85	19.33
	2	1855.00	20.71		
	3	2196.56	18.97		
8000	1	3444.50	22.49	3335.08	22.78
	2	3566.00	21.18		
	3	2994.75	24.04		
10000	1	3278.00	33.15	3489.13	32.40
	2	3566.20	32.18		
	3	3489.13	32.40		

Table C16 Adsorption isotherm on 5 %w/v of natural rubber latex particles of NP30 at pH 3.9

Initial Surfactant concentration (μM)	Sample No.	Equilibrium Surfactant concentration (μM)	Adsorbed surfactant (μmol/g NR)	Average Equilibrium surfactant concentration (μM)	Average Adsorbed surfactant (μmol/g NR)
100	1	69.00	0.60	54.00	0.86
	2	51.50	0.97		
	3	41.50	1.01		
250	1	66.50	3.48	54.60	3.71
	2	42.50	3.76		
	3	54.90	3.88		
350	1	70.00	5.60	68.17	5.42
	2	68.00	5.52		
	3	66.50	5.15		
450	1	599.50	7.09	67.47	7.23
	2	64.90	7.15		
	3	78.00	7.49		
600	1	76.50	10.34	82.90	10.21
	2	82.70	10.32		
	3	89.50	9.98		
2000	1	101.00	38.04	113.40	36.53
	2	116.00	37.45		
	3	123.20	34.11		
4000	1	228.50	73.73	192.10	74.53
	2	178.90	76.59		
	3	168.90	73.27		
6000	1	298.50	113.48	234.93	113.51
	2	202.30	114.92		
	3	204.00	112.13		
8000	1	409.50	140.82	489.17	139.44
	2	565.80	135.14		
	3	492.20	142.37		
10000	1	1204.50	176.30	1080.50	176.12
	2	996.50	173.01		
	3	1040.50	179.06		

Table C17 Adsorption isotherm on 10 %w/v of natural rubber latex particles of NP30 at pH 3.9

Initial Surfactant concentration (μM)	Sample No.	Equilibrium Surfactant concentration (μM)	Adsorbed surfactant (μmol/g NR)	Average Equilibrium surfactant concentration (μM)	Average Adsorbed surfactant (μmol/g NR)
100	1	43.50	0.56	47.71	0.52
	2	54.20	0.46		
	3	45.60	0.54		
200	1	66.00	1.34	63.67	1.36
	2	70.00	1.29		
	3	55.00	1.46		
300	1	72.00	2.27	82.47	2.08
	2	96.50	1.82		
	3	78.90	2.16		
400	1	85.00	3.13	89.83	3.05
	2	92.30	2.96		
	3	92.20	3.05		
500	1	101.00	3.99	103.80	3.95
	2	100.20	3.98		
	3	110.20	3.86		
600	1	122.00	4.78	123.07	4.75
	2	104.60	4.94		
	3	142.60	4.52		
3000	1	154.00	28.16	156.67	28.38
	2	156.20	28.28		
	3	159.80	28.71		
5000	1	193.50	47.98	192.80	47.20
	2	189.40	45.77		
	3	195.50	47.84		
7000	1	275.00	67.00	279.17	67.11
	2	256.00	67.23		
	3	306.50	67.12		
10000	1	742.00	90.62	799.40	90.05
	2	879.50	91.76		
	3	776.70	87.77		

Table C18 Adsorption isotherm on 20 %w/v of natural rubber latex particles of NP30 at pH 3.9

Initial Surfactant concentration (μM)	Sample No.	Equilibrium Surfactant concentration (μM)	Adsorbed surfactant (μmol/g NR)	Average Equilibrium surfactant concentration (μM)	Average Adsorbed surfactant (μmol/g NR)
100	1	12.50	0.44	10.17	0.45
	2	9.50	0.45		
	3	8.50	0.45		
300	1	27.50	1.32	25.83	1.33
	2	14.40	1.36		
	3	35.60	1.32		
500	1	61.00	2.09	58.57	2.15
	2	54.50	2.23		
	3	60.20	2.14		
700	1	81.50	3.08	84.93	3.06
	2	78.80	3.09		
	3	94.50	3.02		
900	1	106.00	3.96	106.07	3.96
	2	112.00	3.93		
	3	100.2	3.99		
2000	1	163.00	9.04	153.73	9.10
	2	152.20	9.02		
	3	146.00	9.25		
4000	1	129.50	18.74	170.37	18.85
	2	185.80	19.06		
	3	195.80	18.77		
6000	1	182.00	28.48	230.73	28.60
	2	245.40	28.75		
	3	264.80	28.57		
8000	1	372.00	38.00	357.70	37.66
	2	354.50	38.22		
	3	346.60	36.75		
10000	1	501.00	46.34	473.00	46.53
	2	485.50	47.46		
	3	432.50	45.78		

Table C19 Adsorption isotherm on 5 %w/v of natural rubber latex particles of NP30 at pH 8

Initial Surfactant concentration (μM)	Sample No.	Equilibrium Surfactant concentration (μM)	Adsorbed surfactant (μmol/g NR)	Average Equilibrium surfactant concentration (μM)	Average Adsorbed surfactant (μmol/g NR)
100	1	74.00	0.51	85.47	0.29
	2	85.50	0.29		
	3	96.90	0.06		
300	1	87.50	4.38	77.23	4.23
	2	55.60	4.27		
	3	88.60	4.05		
400	1	136.5	4.86	108.3	5.62
	2	66.30	6.44		
	3	122.30	5.55		
600	1	158.50	8.26	131.73	8.94
	2	100.20	9.78		
	3	136.50	8.78		
700	1	290.00	7.77	218.43	9.26
	2	165.50	10.66		
	3	199.80	9.36		
2000	1	238.00	35.17	266.70	33.38
	2	325.50	33.49		
	3	236.60	31.48		
4000	1	509.00	69.58	640.77	64.87
	2	658.80	65.36		
	3	745.50	59.66		
6000	1	1323.00	93.45	1160.90	94.01
	2	956.50	92.65		
	3	1203.20	95.94		
8000	1	2726.00	95.53	2532.40	101.58
	2	1985.60	107.39		
	3	2885.60	101.84		
10000	1	3524.00	127.98	3435.57	130.14
	2	3446.20	129.91		
	3	3336.50	132.53		

Table C20 Adsorption isotherm on 10 %w/v of natural rubber latex particles of NP30 at pH 8

Initial Surfactant concentration (μM)	Sample No.	Equilibrium Surfactant concentration (μM)	Adsorbed surfactant (μmol/g NR)	Average Equilibrium surfactant concentration (μM)	Average Adsorbed surfactant (μmol/g NR)
100	1	175.00	-0.74	163.20	-0.63
	2	162.30	-0.62		
	3	152.30	-0.53		
200	1	160.00	0.39	164.10	0.35
	2	156.50	0.43		
	3	175.80	0.23		
300	1	176.00	1.21	174.47	1.20
	2	168.90	1.24		
	3	178.50	1.15		
400	1	193.00	1.97	194.80	1.97
	2	194.80	1.91		
	3	196.60	2.03		
600	1	182.00	4.12	183.20	4.11
	2	188.80	3.98		
	3	178.80	4.22		
700	1	194.00	4.81	236.93	4.53
	2	246.90	4.50		
	3	269.90	4.27		
900	1	179.00	7.12	213.47	6.82
	2	225.60	6.72		
	3	235.80	6.64		
2000	1	186.00	18.00	187.80	17.75
	2	178.90	17.26		
	3	198.50	17.98		
4000	1	357.50	36.20	359.17	35.77
	2	354.40	34.73		
	3	365.60	36.37		
6000	1	858.00	51.36	858.43	50.60
	2	868.50	50.10		
	3	848.80	50.33		

Table C21 Adsorption isotherm on 20 %w/v of natural rubber latex particles of NP30 at pH 8

Initial Surfactant concentration (μM)	Sample No.	Equilibrium Surfactant concentration (μM)	Adsorbed surfactant (μmol/g NR)	Average Equilibrium surfactant concentration (μM)	Average Adsorbed surfactant (μmol/g NR)
100	1	16.50	0.40	13.03	0.43
	2	12.70	0.44		
	3	9.90	0.46		
300	1	12.50	1.41	17.43	1.40
	2	19.60	1.39		
	3	20.20	1.40		
500	1	49.00	2.25	44.85	2.25
	2	42.00	2.29		
	3	43.55	2.22		
700	1	58.00	3.21	68.98	3.12
	2	64.45	3.14		
	3	84.40	3.02		
900	1	128.00	3.76	105.51	3.92
	2	94.54	4.02		
	3	94.00	3.98		
2000	1	129.00	9.35	149.97	9.16
	2	165.50	9.07		
	3	155.40	9.07		
4000	1	228.00	18.78	215.37	18.66
	2	253.30	18.18		
	3	164.80	19.02		
6000	1	256.00	28.57	351.97	28.18
	2	544.30	27.26		
	3	255.60	28.72		
8000	1	479.00	36.64	807.70	35.04
	2	1055.40	33.79		
	3	888.70	34.69		
10000	1	1116.00	43.14	1147.93	43.82
	2	1225.60	44.45		
	3	1102.20	43.88		

Appendix D Example of Calibration for Surfactant Adsorption Isotherms

Adsorption for solution of CPC on natural rubber latex particles

$$\Gamma = \frac{(C_o - C_e) \times V}{1000 \times W}$$

Where

Γ = The amount of adsorbed surfactant to the surface particles (μmol/g)

C_o = Initial surfactant solution concentration (μmol/L)

C_e = Equilibrium surfactant solution concentration (μmol/L)

V = The volume of a surfactant solution (mL)

W = The weight of natural rubber (g)

The adsorption isotherm was a plot between adsorption of surfactant on natural rubber particles and concentration of surfactant solution (μmol/L).

C_o = 10,000 μmol/L

Equilibrium concentration of surfactant was converted from

UV-Vis spectrophotometer (wavelength) → mmol/L

The concentration of surfactant solution should be diluted about 50 times before using UV spectrophotometer in order to get the accurate absorbance.

Calibration equation for CPC solution from UV-Vis spectrophotometer,

$$Y = 4.62385X + 0.00152$$

Where $X = C_e$ (mmol/L)

Y = Wavelength

Substituting into calibration equations,

$X = (0.85546 - 0.00152)/4.62385$

Diluted concentration $X = 0.18468$ mmol/L

Real concentration $X = 0.18468 \times 1000 \times 50 = 9{,}234$ µmol/L

Thus, surfactant adsorption for solution of CPC on natural rubber particles at 10,000 µmol/L, initial concentration is

$$\Gamma = \frac{(10{,}000 - 9{,}234)\ \mu\text{mol/L} \times 20\ \text{mL}}{1000 \times 2\ \text{g}} = 7.66\ \mu\text{mol/g}$$

Appendix E Calibration of Percent Weight Polymethacryloxypropyltrimethoxysilane (PMPS) in Admicellar Modified Natural Rubber

$$\text{Weight of PMPS} = \frac{\text{conc. of MPS monomer(mM)} \times 248.35 \times \text{total volume}}{1000 \text{ ml} \times 1000}$$

Ex. Conc. of MPS monomer = 50 mM and total volume = 500 ml.

$$\text{Weight of PMPS} = \frac{50 \text{ mM} \times 248.35 \times 500 \text{ ml}}{1000 \text{ ml} \times 1000}$$

$$= 6.20875 \text{ g}$$

Total weight of admicelled PMPS-NR = 25.15 + 6.20875 = 31.35875 g

$$\% \text{ Wt. of PMPS} = \frac{(6.20875 \times 100)}{31.35875} = 19.79910 \%$$

Table E1 wt% of PMPS in admicelled PMPS-NR with different concentration of MPS monomer using cationic surfactant

Samples	NR used (g)	Calculated PMPS (g)	Admicelled PMPS-NR (g)	Weight of PMPS (%)
50 mM-MPS	25.01	6.20875	31.21875	19.88789
00 mM-MPS	25.40	12.4175	37.8175	32.83533
200 mM-MPS	25.30	24.835	50.135	49.53625

Table E2 wt% of PMPS in admicelled PMPS-NR with different concentration of MPS monomer using anionic surfactant

Samples	NR used (g)	Calculated PMPS (g)	Admicelled PMPS-NR (g)	Weight of PMPS (%)
50 mM-MPS	25.15	6.20875	31.35875	19.79910
100 mM-MPS	25.68	12.4175	38.0975	32.594
200 mM-MPS	25.60	24.835	50.435	49.24160

Appendix F Data of Fourier-Transform Infrared Spectroscopy

Table F1 FT-IR peak assignments for the IR absorption band

Wavenumber (cm^{-1})	Assignment
Rubber	
3035	=C-H stretching
2960	C-H stretching of CH_3
2926	C-H stretching of CH_2
2853	C-H stretching of CH_2 and CH_3
1663	C=C stretching
1448	C-H bending of CH_2
1375	C-H bending of CH_3
1128	C-H bending
834	C=CH wagging
Polymethacryloxypropyltrimethoxysilane	
2921, 2847	C-H stretching of CH_2
1724	C=O stretching
1111	Si-O-Si asymmetric stretching
1087	Si-O-C asymmetric stretching
821	Si-O-C symmetric stretching

Appendix G Data of Thermogravimetric Analysis

Table G1 The degradation temperature of the admicelled rubbers using cationic surfactant

Samples	On Set Temp. (°C)	Peak temp. (°C)	Residual Content (%)
Rubber	358.1	382.3	-
PMPS	368.4	414.7	44.7
PMPS-ad-NR 50 mM MPS	357.4	382.2	4.5
PMPS-ad-NR 100 mM MPS	358.3	383.3	9.8
PMPS-ad-NR 200 mM MPS	354.3	381.0	15.3

Table G2 The degradation temperature of the admicelled rubbers using anionic surfactant

Samples	On Set Temp. (°C)	Peak temp. (°C)	Residual Content (%)
Rubber	358.1	382.3	-
PMPS	368.4	414.7	44.7
PMPS-ad-NR 50 mM MPS	358.3	382.1	3.5
PMPS-ad-NR 100 mM MPS	357.2	383.3	8.1
PMPS-ad-NR 200 mM MPS	355.8	382.6	11.9

Appendix H Appearance of Admicelled PMPS-NR

Figure H1 Appearance of admicelled PMPS-NR with different concentration of MPS monomer using cationic surfactant.

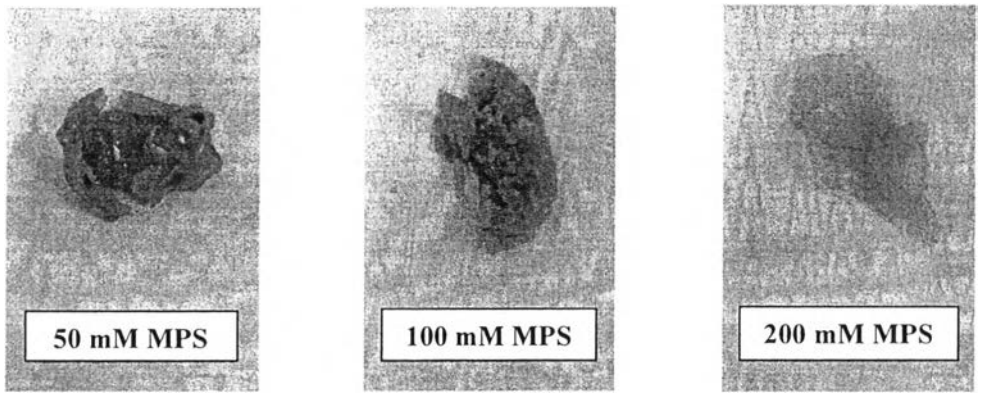

Figure H2 Appearance of admicelled PMPS-NR with different concentration of MPS monomer using anionic surfactant.

Appendix I The surface tension of surfactants

Table I1 The surface tension of CPC solution at various concentrations

Conc. of CPC (μM)	Surface tension (mN/m)			
	1	2	3	AV
200	47.5	48.0	48.5	48.0
400	47.5	47.0	47.0	47.16667
600	45.4	45.4	45.0	45.26667
800	44.0	44.2	43.8	44.0
1000	44.2	44.2	44.0	44.13333
1500	43.4	43.6	43.2	43.4
2000	43.8	43.0	43.5	43.43333
2500	43.6	43.0	43.0	43.2
3000	44.0	43.0	43.2	43.4
3500	43.5	42.0	42.6	42.7

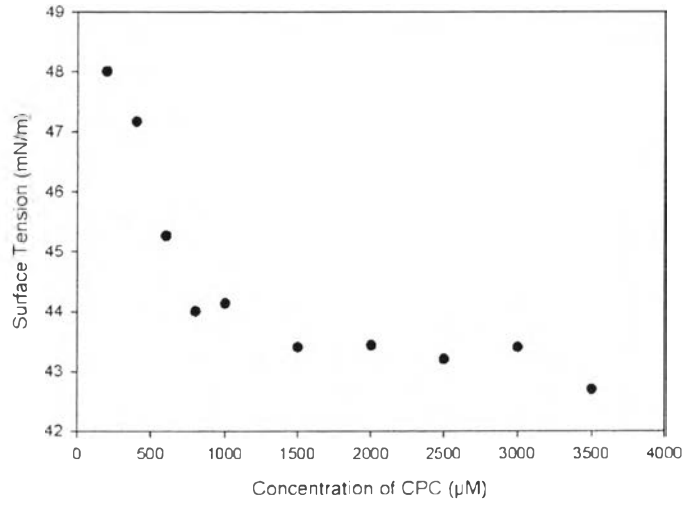

Figure I1 The surface tension of CPC solution at various concentrations.

Table I2 The surface tension of DBSA solution at various concentrations

Conc. of DBSA	Surface tension (mN/m)			
(μM)	1	2	3	AV
200	47.0	47.2	47.0	47.06667
400	44.5	44.6	44.0	44.36667
600	40.1	40.3	40.1	40.16667
800	39.5	39.0	39.3	39.26667
1000	39.1	39.0	39.4	39.16667
1200	36.9	36.0	36.6	36.5
1500	36.0	36.2	36.3	36.16667
2000	35.2	35.0	35.0	35.06667
2500	35.0	35.0	35.2	35.06667
3000	34.8	34.7	34.2	34.56667

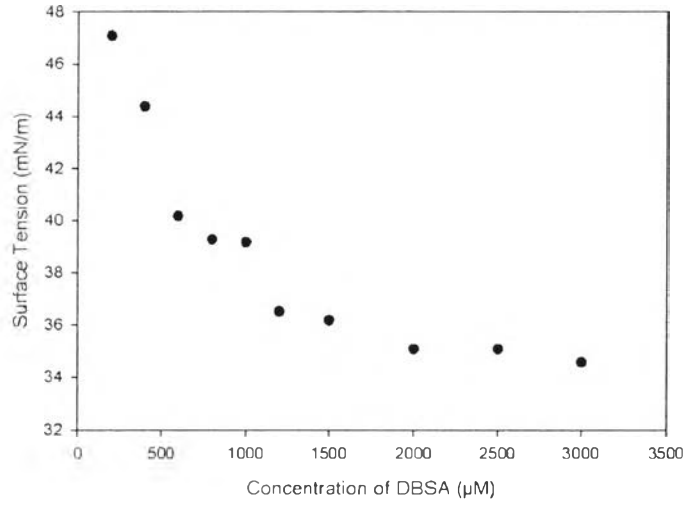

Figure I2 The surface tension of DBSA solution at various concentrations.

Table I3 The surface tension of C7BzO solution at various concentrations

Conc. of C7BzO (μM)	Surface tension (mN/m)			
	1	2	3	AV
200	48.0	48.6	48.4	48.33333
400	42.9	42.7	42.5	42.7
600	38.4	38.0	38.2	38.2
800	36.8	36.7	36.5	36.66667
1000	35.3	35.4	35.2	35.36667
2000	36.6	36.5	36.6	36.56667
3000	36.4	36.0	36.4	36.26667
4000	37.6	37.5	37.2	37.43333
4500	36.6	36.6	36.5	36.56667
5000	36.8	36.4	36.6	36.6
5500	36.4	36.2	36.4	36.33333
6000	36.4	36.3	36.3	36.33333
7000	36.4	36.2	36.2	36.26667

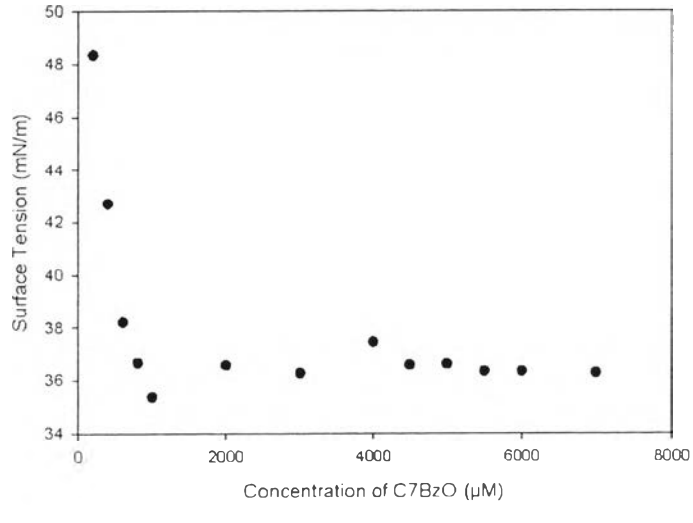

Figure I3 The surface tension of C7BzO solution at various concentrations.

Table I4 The surface tension of NP30 solution at various concentrations

Conc. of NP30 (μM)	Surface tension (mN/m)			
	1	2	3	AV
20	51.5	51.2	51.5	51.4
40	51.8	51.6	51.7	51.7
60	47.8	47.5	47.4	47.56667
80	48.2	48	47.8	48.0
100	49.6	49.2	49.0	49.26667
120	47.7	47.6	47.6	47.63333
140	48.7	48.5	48.3	48.5
160	46.3	46.2	46.0	46.16667
200	46.6	46.6	46.2	46.46667
300	46.2	46.0	46.0	46.06667

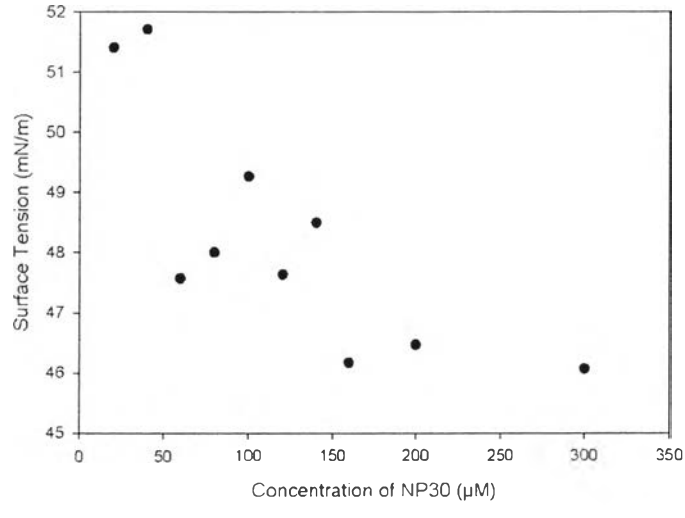

Figure I4 The surface tension of NP30 solution at various concentrations.

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Proceeding:

1. Sriyapai, S.; and Magaraphan, R. (2013, April 23) DBSA adsorption isotherm and MPS admicellar polymerization on natural rubber latex particles at the 4th Research Symposium on Petrochemical and Materials Technology and the 19th PPC Symposium on Petroleum, Petrochemicals, and Polymers, Bangkok, Thailand.

Presentations:

1. Sriyapai, S.; and Magaraphan, R. (2012, December 11-15) Surfactant adsorption and Admicellar polymerization of MPS on natural rubber latex particles at the 28th International Conference of The Polymer Processing Society (PPS-28), Pattaya, Thailand.
2. Sriyapai, S.; and Magaraphan, R. (2013, April 23) DBSA adsorption isotherm and MPS admicellar polymerization on natural rubber latex particles at the 4th Research Symposium on Petrochemical and Materials Technology and the 19th PPC Symposium on Petroleum, Petrochemicals, and Polymers, Bangkok, Thailand.

3. Sriyapai, S.; and Magaraphan, R. (2013, May 21-23) Admicellar polymerization of PMPS on natural rubber latex particles at the 3rd International Symposium Frontiers in Polymer Science, Sitges, Spain.