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APPENDICES

APPENDIX A Experimental Data of PZC and Zeta Potential

Table A1 Zeta potential of methyl palmitate in deionized water at various pH values

pH	Zeta potential (mV)
1.25	42.69
2.96	-35.43
3.57	-63.3
3.92	-92.29
5.97	-126.33
8.77	-146.643

Table A2 Zeta potential of methyl palmitate in Alfoterra® C145-4(PO) solutions at various concentrations

Alfoterra® C145-4PO Conc. (%w/v)	Zeta potential (-mV)
0 (pure DI water)	131.7272
0.0500	147.1875
0.1000	87.5105
0.2000	77.7818
0.3000	71.4100
0.5000	62.6471

Table A3 Zeta potential of methyl palmitate in 0.1 %w/v Alfoterra® C145-4(PO) solutions at various salinity

Salinity (%w/v)	Zeta potential (-mV)
1.0000	137.9500
3.0000	120.9091
5.0000	77.7385
7.0000	74.5800

APPENDIX B Experimental Data of Detergency Experiment

1. Detergency (%)

The detergency performance can be calculated from the following equation.

$$\text{Detergency (\%)} = [(A-B)/(C_0-B)]x100 \qquad \text{(B.1)}$$

where A = The average reflectance of the soiled swatches after washing

B = The average reflectance of the soiled swatches before washing

C_0= The average reflectance of the unsoiled swatches before washing

2. Semi-Solid Oil Removal (%)

The semi-solid oil removal is determined by the following equation.

$$Semi-solid\ oil\ removal\ (\%) = (C_0 - C_1)/C_0 \qquad \text{(B.2)}$$

where C_0 = The average semi-solid oil concentration of the soiled swatches before washing

C_1 = The average semi-solid oil concentration remains of the soiled swatch after washing

To calculate the oil removal, the calibration curve of colored methyl palmitate was required.

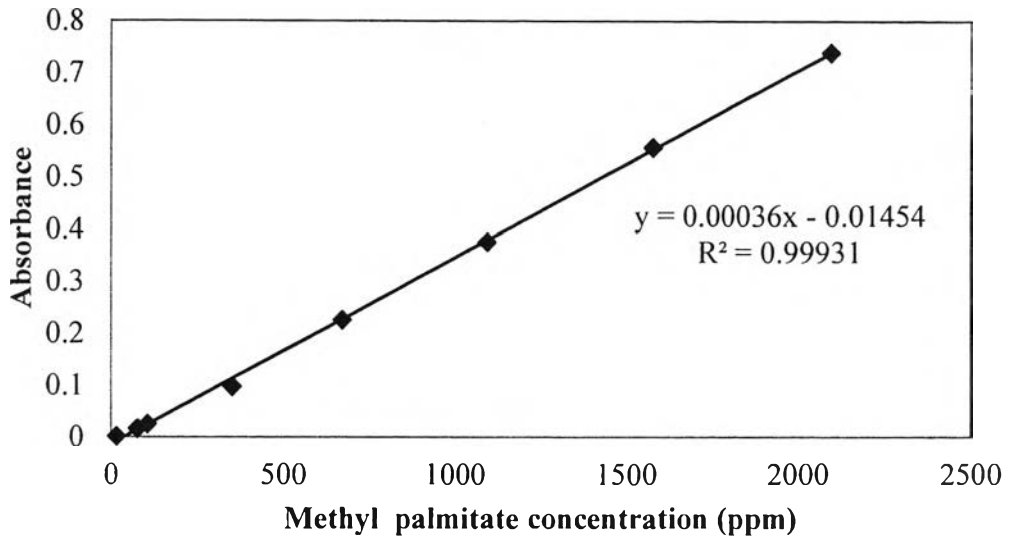

Figure B1 Relationship between colored methyl palmitate concentration and the absorbance measured at 205 nm.

Table B1 Relationship between colored methyl palmitate concentration and the absorbance measured at 205 nm

Methyl palmitate conc. (ppm)	Absorbance
16	0.0008
76	0.0157
104	0.0242
352	0.0965
668	0.2255
1092	0.3755
1576	0.5566
2092	0.7391

3. Experimental Data of Detergency Performance

Table B2 % Detergency of semi-solid oil at different surfactant concentrations

Surfactant concentration (%w/v)	Sample No.	Reflectance of the unsoiled swatches before washing (C_o)	Reflectance of the soiled swatches before washing (B)	Reflectance of the soiled swatches after washing (A)	%Detergency	Average %Detergency
0	1	84.28556	69.64667	69.16667	-3.2789599	-9.555368699
	2	84.28556	71.39	69.19	-17.060135	
	3	84.28556	68.11333	66.76667	-8.3270108	
0.0055	1	84.28556	70.20667	69.1066667	-7.8131396	-7.75470925
	2	84.28556	70.19667	68.9933333	-8.5410324	
	3	84.28556	70.82667	69.8966667	-6.9099557	
0.08	1	84.28556	70.7433	70.94	1.4524902	-3.389730721
	2	84.28556	71.3433	70.58	-5.897733	
	3	84.28556	71.1833	70.43333	-5.723949	
0.154	1	84.28556	69.43333	69.8966667	3.1196438	4.088041954
	2	84.28556	69.32	69.3133333	-0.0445467	
	3	84.28556	69.05	70.45	9.1890288	
0.24	1	84.28556	70.47	73.80667	24.151512	20.00949216
	2	84.28556	70.2733	73.60667	23.78893	
	3	84.28556	70.7733	72.40667	12.088035	
0.286	1	84.28556	68.43333	72.3533333	24.728403	24.77330132
	2	84.28556	69.01	72.73	24.352626	
	3	84.28556	68.82	72.7233333	25.238875	

Table B2 % Detergency of semi-solid oil at different surfactant concentrations **(Cont.)**

Surfactant concentration (%w/v)	Sample No.	Reflectance of the unsoiled swatches before washing (C_o)	Reflectance of the soiled swatches before washing (B)	Reflectance of the soiled swatches after washing (A)	%Detergency	Average %Detergency
0.5	1	84.28556	70.5233	74.34333	27.757311	24.05643262
	2	84.28556	71.2333	74.13333	22.21863	
	3	84.28556	71.1133	74.03667	22.193357	
1	1	84.28556	70.14	73.86333	26.321569	27.42638984
	2	84.28556	70.1633	74.46333	30.44862	
	3	84.28556	70.4733	73.99667	25.50898	
2	1	84.28556	69.4967	74.21667	31.91569	29.93694161
	2	84.28556	70.15	74.47	30.561223	
	3	84.28556	70.42	74.21	27.333912	

Table B3 % Semi-solid oil removal at different surfactant concentrations

Surfactant concentration (%w/v)	Sample No.	Extracted soil before washing (ppm)	Residual soil after washing (ppm)	Average semi-solid oil removal (%)
0	1	5226.259617	4054.59712	34.88034682
	2	5226.259617	2968.88361	
	3	5226.259617	3186.48568	
0.022	1	5226.259617	3299.53092	39.95351603
	2	5226.259617	3036.5909	
	3	5226.259617	3078.43361	
0.08	1	5289.347	3112.9882	45.0208328
	2	5289.347	2931.9353	
	3	5289.347	2679.1933	
0.154	1	5226.259617	2734.60439	44.51076916
	2	5226.259617	3176.19981	
	3	5226.259617	2789.22959	
0.24	1	5289.347	2198.5285	62.5407314
	2	5289.347	1766.7111	
	3	5289.347	1978.8125	
0.286	1	5226.259617	1459.7499	73.21095699
	2	5226.259617	1183.52808	
	3	5226.259617	1556.91683	
0.5	1	5289.347	1861.6374	65.6963742
	2	5289.347	1784.2132	
	3	5289.347	1797.4628	
1	1	5289.347	1627.9795	69.332774
	2	5289.347	949.9462	
	3	5289.347	1616.2125	
2	1	5289.347	1372.1715	71.0467593
	2	5289.347	1556.6852	
	3	5289.347	1665.4554	

Table B4 % Semi-solid oil re-deposition at different surfactant concentrations

Surfactant concentration (%w/v)	% Re-deposition
0	25.60385054
0.022	23.83597682
0.08	19.29510847
0.154	18.44706858
0.24	17.59982891
0.286	19.6600281
0.5	19.4357836
1	17.8039392
2	10.65775875

Table B5 % Semi-solid oil removal of Alfoterra® C145-4PO at different concentrations with 1 %w/v NaCl

Surfactant concentration (%w/v)	Sample No.	Extracted soil before washing (ppm)	Residual soil after washing (ppm)	Average semi-solid oil removal (%)
0	1	5195.376037	3910.86668	28.97472046
	2	5195.376037	3515.93221	
	3	5195.376037	3643.29217	
0.05	1	5195.376037	2456.27137	51.99122472
	2	5195.376037	2369.17317	
	3	5195.376037	2657.26468	
0.1	1	5195.376037	2741.78555	50.95683254
	2	5195.376037	2635.28972	
	3	5195.376037	2266.85564	
0.2	1	5195.376037	2208.61417	53.59983763
	2	5195.376037	2598.01122	
	3	5195.376037	2425.36336	
0.3	1	5195.376037	1950.43338	62.36375347
	2	5195.376037	1991.3705	
	3	5195.376037	1924.22972	

Table B5 % Semi-solid oil removal of Alfoterra® C145-4PO at different concentrations with 1 %w/v NaCl **(Cont.)**

Surfactant concentration (%w/v)	Sample No.	Extracted soil before washing (ppm)	Residual soil after washing (ppm)	Average semi-solid oil removal (%)
0.5	1	5195.376037	1709.85367	63.42260458
	2	5195.376037	2077.00227	
	3	5195.376037	1914.14377	

Table B6 % Semi-solid oil removal of Alfoterra® C145-4PO at different concentrations with 3 %w/v NaCl

Surfactant concentration (%w/v)	Sample No.	Extracted soil before washing (ppm)	Residual soil after washing (ppm)	Average semi-solid oil removal (%)
0	1	5471.75104	4140.27278	28.90151255
	2	5471.75104	3707.76322	
	3	5471.75104	3822.96068	
0.05	1	5471.75104	2215.8325	63.17684329
	2	5471.75104	2003.82966	
	3	5471.75104	1824.95222	
0.1	1	5471.75104	2124.36672	65.4375692
	2	5471.75104	1937.97429	
	3	5471.75104	1611.16949	
0.2	1	5471.75104	1840.77334	66.0032027
	2	5471.75104	1897.23492	
	3	5471.75104	1842.65207	
0.3	1	5471.75104	1943.11614	66.77545134
	2	5471.75104	1730.32223	
	3	5471.75104	1780.45539	
0.5	1	5471.75104	1517.72607	71.05956652
	2	5471.75104	1686.12199	
	3	5471.75104	1546.79735	

Table B7 % Semi-solid oil removal of Alfoterra® C145-4PO at different concentrations with 5 %w/v NaCl

Surfactant concentration (%w/v)	Sample No.	Extracted soil before washing (ppm)	Residual soil after washing (ppm)	Average semi-solid oil removal (%)
0	1	4691.045193	3386.29802	28.923022
	2	4691.045193	3358.41331	
	3	4691.045193	3258.04815	
0.05	1	4691.045193	2721.31699	41.27945635
	2	4691.045193	2894.85476	
	3	4691.045193	2647.64997	
0.1	1	4691.045193	3352.48039	30.66554212
	2	4691.045193	3196.04915	
	3	4691.045193	3209.00272	
0.2	1	4691.045193	3172.02088	32.59425906
	2	4691.045193	3129.89712	
	3	4691.045193	3184.18331	
0.3	1	4691.045193	3061.07536	33.94260335
	2	4691.045193	3205.3441	
	3	4691.045193	3029.92753	
0.5	1	4691.045193	3067.10712	30.26996212
	2	4691.045193	3312.23543	
	3	4691.045193	3433.86022	

Table B8 % Semi-solid oil removal of Alfoterra® C145-4PO at different concentrations with 7 %w/v NaCl

Surfactant concentration (%w/v)	Sample No.	Extracted soil before washing (ppm)	Residual soil after washing (ppm)	Average semi-solid oil removal (%)
0	1	3762.6428	3540.5538	19.10024872
	2	3762.6428	2597.1211	
	3	3762.6428	2994.2311	
0.05	1	3762.6428	2344.181	35.65922335
	2	3762.6428	2672.173	
	3	3762.6428	2246.3868	
0.1	1	3762.6428	2280.6	35.08632106
	2	3762.6428	2447.2161	
	3	3762.6428	2599.5935	
0.2	1	3762.6428	2052.0843	45.22686643
	2	3762.6428	2139.8909	
	3	3762.6428	1990.7769	
0.3	1	3762.6428	2075.6176	45.07444431
	2	3762.6428	2136.7269	
	3	3762.6428	1987.6129	
0.5	1	3762.6428	2238.0813	37.75460429
	2	3762.6428	2195.9574	
	3	3762.6428	2592.177	

Table B9 % Re-deposition of semi-solid oil at different salinities for any given surfactant concentrations

Surfactant concentration (%w/v)	% Re-deposition			
	NaCl 1 %w/v	NaCl 3 %w/v	NaCl 5 %w/v	NaCl 7 %w/v
0	7.030335575	6.005943016	10.10137435	7.107799839
0.05	5.631355805	5.884819736	8.75113603	6.990033294
0.1	6.33529274	5.080428423	7.114419215	6.894203103
0.2	5.717933674	4.676066712	7.34966186	6.957990439
0.3	5.758143799	4.23237929	7.136454359	6.728841395
0.5	5.472299524	4.125841293	6.988801476	6.470750677

Table B10 % Semi-solid oil removal at different washing temperatures for our selected formulation

Washing temperature (°C)	Sample No.	Extracted soil before washing (ppm)	Residual soil after washing (ppm)	Average semi-solid oil removal (%)
10	1	5313.605967	4440.1819	17.62042774
	2	5313.605967	4193.8666	
	3	5313.605967	4497.9291	
20	1	5005.852133	2615.0187	50.60589684
	2	5005.852133	2708.1656	
	3	5005.852133	2094.603	
25	1	4828.622913	2360.0192	50.62954712
	2	4828.622913	2405.89202	
	3	4828.622913	2385.82778	
30	1	5005.852133	1953.9933	65.56109421
	2	5005.852133	1630.8467	
	3	5005.852133	1587.0421	
35	1	4828.622913	2065.43309	61.99733845
	2	4828.622913	1735.36517	
	3	4828.622913	1704.21741	

Table B10 % Semi-solid oil removal at different washing temperatures for our selected formulation **(Cont.)**

Washing temperature (°C)	Sample No.	Extracted soil before washing (ppm)	Residual soil after washing (ppm)	Average semi-solid oil removal (%)
40	1	5005.852133	2141.8691	56.06898536
	2	5005.852133	2431.1973	
	3	5005.852133	2024.2985	
50	1	5313.605967	2806.8502	49.74238116
	2	5313.605967	2520.5866	
	3	5313.605967	2684.0387	

Table B11 % Semi-solid oil removal at different washing temperatures for pure de-ionized water

Washing temperature (°C)	Sample No.	Extracted soil before washing (ppm)	Residual soil after washing (ppm)	Average semi-solid oil removal (%)
10	1	5323.955467	3101.6167	45.89950928
	2	5323.955467	2828.9002	
	3	5323.955467	2710.3412	
20	1	5323.955467	3217.4373	46.0148139
	2	5323.955467	2582.6003	
	3	5323.955467	2822.4042	
25	1	4828.622913	3531.25892	31.67308784
	2	4828.622913	3315.89405	
	3	4828.622913	3050.59384	
30	1	5323.955467	3470.0995	34.7894057
	2	5323.955467	3425.5991	
	3	5323.955467	3519.6504	
35	1	4828.622913	3719.03574	19.60659682
	2	4828.622913	3656.04792	
	3	4828.622913	4270.5992	

Table B11 % Semi-solid oil removal at different washing temperatures for pure de-ionized water **(Cont.)**

Washing temperature (°C)	Sample No.	Extracted soil before washing (ppm)	Residual soil after washing (ppm)	Average semi-solid oil removal (%)
40	1	5313.605967	3845.1308	27.80808882
	2	5313.605967	3765.1663	
	3	5313.605967	3897.684	
50	1	5313.605967	4022.9	17.32950353
	2	5313.605967	4595.822	
	3	5313.605967	4559.6313	

Table B12 % Re-deposition of semi-solid oil at different washing temperatures for our selected formulation

Washing temperature (°C)	% Re-deposition
10	15.94676636
20	5.350171757
25	4.018704065
30	4.510519914
35	3.902975667
40	4.983051751
50	2.897916226

APPENDIX C Experimental Data of Dynamic Interfacial Tension (IFT)

The dynamic interfacial tension of each microemulsion system is calculated from the following equation.

$$IFT = e\,(Vd)^3 n^2 \Delta\rho \qquad (C.1)$$

Where

$e = 3.427 \times 10^{-4}$ (mN cm^3 min^2/m g mm^3)

V = 0.31 (mm/sdv)

d = Measured drop diameter (sdv)

n = Number of revolution (rpm)

$\Delta\rho$ = Density difference of two liquids (g/cm^3)

Table C1 Dynamic interfacial tension as a function of Alfoterra® C145-4PO concentration at 3 %w/v NaCl

Surfactant concentration (%w/v)	drop diameter (d; sdv)	n (rpm)	n^2	vd	$(vd)^3$	$\Delta\rho$	IFT (σ; mN/m)	Average IFT (mN/m)
0	3.47000	1211.00000	1466521.00000	1.07570	1.24473	0.02000	0.0125114	0.0155943
	3.99000	1200.00000	1440000.00000	1.23690	1.89236	0.02000	0.0186771	
0.05	3.98000	914.00000	835396.00000	1.23380	1.87817	0.01400	0.0075278	0.0072437
	3.80000	942.00000	887364.00000	1.17800	1.63469	0.01400	0.0069595	
0.1	1.87000	1374.00000	1887876.00000	0.57970	0.19481	0.01000	0.0012604	0.0011600
	3.23000	555.00000	308025.00000	1.00130	1.00391	0.01000	0.0010597	
0.2	2.84000	761.00000	579121.00000	0.88040	0.68240	0.00400	0.0005417	0.0006756
	2.65000	1032.00000	1065024.00000	0.82150	0.55440	0.00400	0.0008094	
0.3	2.76000	1120.00000	1254400.00000	0.85560	0.62634	0.00200	0.0005385	0.0005780
	3.01000	1053.00000	1108809.00000	0.93310	0.81243	0.00200	0.0006174	
0.5	1.58000	1206.00000	1454436.00000	0.48980	0.11750	0.00800	0.0004685	0.0004387
	1.86000	882.00000	777924.00000	0.57660	0.19170	0.00800	0.0004089	

Table C2 Dynamic interfacial tension as a function of temperature for selected formulation

Temperature (°C)	drop diameter (d; sdv)	n (rpm)	n^2	vd	$(vd)^3$	$\Delta\rho$	IFT (σ; mN/m)	Average IFT (mN/m)
30	1.87000	1374.00000	1887876.00000	0.57970	0.19481	0.01000	0.0012604	0.0011600
	3.23000	555.00000	308025.00000	1.00130	1.00391	0.01000	0.0010597	
35	2.62000	889.00000	790321.00000	0.81220	0.53578	0.01000	0.0014511	0.0025624
	2.83000	1260.00000	1587600.00000	0.87730	0.67522	0.01000	0.0036737	
40	2.43000	1754.00000	3076516.00000	0.75330	0.42747	0.01000	0.0045069	0.0028433
	1.81000	1396.00000	1948816.00000	0.56110	0.17665	0.01000	0.0011798	
50	2.23000	1175.00000	1380625.00000	0.69130	0.33037	0.01000	0.0015631	0.0039511
	4.03000	974.00000	948676.00000	1.24930	1.94985	0.01000	0.0063392	

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