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## **APPENDICES**

# APPENDIX A

## **Appendix A.1** Standard test method for oil and grease (fluorocarbon extractable substances) by gravimetric determination (ASTM D4281-93)

### **Test method – Liquid - liquid extraction**

#### **1. Scope**

1.1. This test method covers the estimation of oil and grease from 4 to 10 mg/l in water and wastewater by a gravimetric determination of fluorocarbon extractable substances from an acidified sample.

1.2. This test method is generally applicable to samples containing extractable substances.

#### **2. Summary of test method**

2.1. In this test method, an acidified water sample is extracted with fluorocarbon solvent in a separatory funnel.

2.2. In the gravimetric portion of the procedure, the fluorocarbon solvent containing the extracted materials is evaporated and the residue is determined gravimetrically.

#### **3. Apparatus**

3.1. Drying Oven, 103°C.

3.2. Evaporating Flask, 250 ml capacity. A flat-bottom boiling flask with standard taper fitting is recommended to facilitate solvent recycling.

3.3. Distillation Apparatus, water-cooled condenser, side arm, and receiver, all of appropriate standard taper fitting.

3.4. Separatory Funnels, 2 l funnels with TFE-fluorocarbon stopcocks.

3.5. Steam Bath.

3.6. Desiccator.

#### 4. Reagents and materials

- 4.1. Acetone ( $(\text{CH}_3)_2\text{CO}$ ), technical grade.
- 4.2. Filter Paper, any high flow, low-retention grade, or optionally phase separating paper.
- 4.3. Fluorocarbon Solvent (Chlorofluorocarbon – 113 or 1, 1, 2 – Trichloro – 1, 2, 2 Trifluoroethane) must be shown to contain no significant residue on evaporation. Redistill if necessary.
- 4.4. Hydrochloric Acid (HCl), sp gr 1.19.
- 4.5. Sodium Bisulfate ( $\text{NaHSO}_4 \cdot \text{H}_2\text{O}$ ).
- 4.6. Sodium Chloride (NaCl).
- 4.7. Sodium Sulfate ( $\text{Na}_2\text{SO}_4$ ), anhydrous.
- 4.8. Sulfuric Acid ( $\text{H}_2\text{SO}_4$ ), sp gr 1.84.

#### 5. Procedure

- 5.1. Tare, to the nearest tenth of a milligram, a boiling flask that has been dried at  $103^\circ\text{C}$  in an oven for 1 h and cooled in a desiccators to room temperature.  
Caution – Always handle the flask with metal tongs or weighing gloves to avoid deposition of body oils.
- 5.2. Mark the sample bottle at the water meniscus for later determination of sample volume. Pour the acidified sample into a separatory funnel.
- 5.3. Add 60 ml of fluorocarbon solvent to the sample bottle, cap, and shake the bottle well. Pour the solvent into the separatory funnel and extract the sample by shaking vigorously for 2 min. Invert the separatory funnel and vent with stopcock to relieve pressure buildup during the extraction. After the layers have separated, drain the solvent layer through filter paper held by a small funnel into the tared boiling flask. If emulsion problems are anticipated, add 1 g  $\text{Na}_2\text{SO}_4$  to the filter paper cone and slowly drain the solvent through the crystals. Add more  $\text{Na}_2\text{SO}_4$  if necessary.
- 5.4. If a clear solvent layer cannot be obtained due to emulsion with water, add up to 100 g of NaCl to separatory funnel. Shake to dissolve the salt. Frequently this will break the emulsion. If the emulsion cannot be broken, this type of sample must be analyzed by the Soxhlet extraction test method.
- 5.5. Repeat the bottle rinse and extraction with two additional 60 ml portions of solvent, combining all solvent in the flask. Rinse the filter with 20 ml of solvent, into the flask.

5.6. Proceed to 6.1.

## 6. Procedure, gravimetric for test method

6.1. Evaporate the solvent from the boiling flask on a hot water bath or steam bath. (Recovering solvent using a condenser system is recommended.)

6.2. When only a few milliliters of solvent remain (under 10 ml of solvent is not recommended), leave the flask on the steam bath and draw air through the flask using vacuum for 5 min to remove the last traces of solvent or residual water. Carefully wipe the exterior of the flask with a lint free cloth and a small amount of acetone to remove any water adhering to the flask. Warning – Wear protective gloves (polyethylene or similar solvent – resistant material) to prevent the acetone from coming in contact with the skin. Use acetone in a fume hood.

6.3. Place in a desiccators for 1 h, remove, and weigh immediately, to the nearest tenth of a milligram.

6.4. Measure the original sample volume by filling the sample bottle to the mark with water at 20°C and measure the volume of water with a graduated cylinder, to the nearest 5 ml.

## 7. Calculation

7.1. Calculate the results of the determination, in milligram per litre as follows:

$$\text{Extractable Residue, mg/l} = \frac{(B - A)}{C} \times 1000$$

where:

A = tare weight of boiling flask, mg,

B = weight of boiling flask after removal of extraction solvent, mg, and

C = volume of sample, L.

## APPENDIX B

**Appendix B.1** Shows the calculation of the percentage of oil content in batch and continuous system.

The percentage of oil content of demulsification by gravity in batch and continuous system can be calculated by equation 4.1.

For 1<sup>st</sup> experiment at 3 min

$$W_s = 10 \text{ g}$$

$$W_o = 0.1854 \text{ g}$$

$$\begin{aligned} \text{Percentage of oil content} &= \frac{W_o}{W_s} \times 100 \\ &= \frac{0.1854}{10} \times 100 \\ &= 1.854 \end{aligned}$$

**Appendix B.2** Shows the calculation of the percentage of demulsification.

The percentage of demulsification can be calculated by equation 4.2.

For 1<sup>st</sup> experiment of concentration 2 %wt at time 20 min.

$$C_0 = 2 \text{ \%wt}$$

$$C_x = 1.666 \text{ \%wt}$$

$$\begin{aligned} \text{Percentage of Demulsification} &= \frac{(C_0 - C_x)}{C_0} \times 100 \\ &= \frac{(2.000 - 1.666)}{2.000} \times 100 \\ &= 16.705 \end{aligned}$$



**Appendix B.3** Shows the calculation the average value.

Three experiments of demulsification by gravity of crude palm oil – in – water emulsions in batch system at 3 min were had results 1.854, 1.881, and 1.956. The average value can calculated by equation 3.1.

$$\begin{aligned}\bar{X} &= \frac{\sum x}{n} \\ &= \frac{(1.854 + 1.881 + 1.956)}{3} \\ &= 1.897\end{aligned}$$

## APPENDIX C

**Appendix C.1** Results of experiments of demulsification of crude palm oil from oil – in – water emulsions by gravity force in batch system.

Time (min)	% Oil Content				Standard Deviation
	1 <sup>st</sup> Exp.	2 <sup>nd</sup> Exp.	3 <sup>rd</sup> Exp.	Average	
0	2.000	2.000	2.000	2.000	0.000
3	1.854	1.881	1.956	1.897	0.053
6	1.949	1.842	1.938	1.910	0.059
9	1.929	1.924	1.927	1.927	0.002
12	1.916	1.903	1.909	1.909	0.006
15	1.925	1.908	1.917	1.917	0.009
18	1.903	1.909	1.906	1.906	0.003
21	1.820	1.826	1.843	1.830	0.012
24	1.664	1.680	1.712	1.685	0.025
27	1.591	1.599	1.605	1.598	0.007
30	1.471	1.493	1.526	1.497	0.028

Time (min)	% Oil Content						Standard Deviation
	1 <sup>st</sup> Exp.	2 <sup>nd</sup> Exp.	3 <sup>rd</sup> Exp.	4 <sup>th</sup> Exp.	5 <sup>th</sup> Exp.	Average	
3.00	1.891	1.938	1.876	1.866	1.949	1.904	0.037
3.45	1.906	1.901	1.910	1.867	1.897	1.896	0.017
5.30	1.906	1.927	1.918	1.857	1.860	1.894	0.033
11.10	1.937	1.816	1.784	1.862	1.740	1.828	0.076
20.00	1.697	1.679	1.828	1.850	1.818	1.774	0.080



**Appendix C.2** Results of experiments of demulsification of crude palm oil from oil – in – water emulsions by gravity force in continuous system.

Flow rate (ml/min)	Retention time (min)	% Oil Content					Standard deviation
		1 <sup>st</sup> Exp.	2 <sup>nd</sup> Exp.	3 <sup>rd</sup> Exp.	4 <sup>th</sup> Exp.	Average	
20.0	3.00	1.837	1.894	1.93	1.815	1.869	0.053
16.0	3.45	1.881	1.857	1.846	1.884	1.867	0.018
11.0	5.30	1.744	1.891	1.928	1.772	1.834	0.089
5.4	11.10	1.682	1.673	1.699	-	1.685	0.013
3.0	20.00	1.287	1.426	1.595	1.587	1.474	0.147

**Appendix C.3** Results of experiments of demulsification of crude palm oil from oil – in – water emulsions by electric field in batch system.

Voltage (V/cm)	Time (min)	% Oil Content				Standard Deviation
		1 <sup>st</sup> Exp.	2 <sup>nd</sup> Exp.	3 <sup>rd</sup> Exp.	Average	
4	3.45	1.184	1.026	1.120	1.110	0.079
	5.30	0.803	1.063	0.892	0.920	0.132
	11.10	0.359	0.364	0.359	0.361	0.003
	20.00	0.230	0.199	0.300	0.243	0.052
6	20.00	0.221	0.232	0.228	0.227	0.006
8	20.00	0.206	0.211	0.203	0.207	0.004
10	3.45	0.345	0.284	0.298	0.309	0.032
	5.30	0.244	0.239	0.316	0.266	0.043
	11.10	0.220	0.208	0.170	0.199	0.026
	20.00	0.189	0.203	0.180	0.191	0.012

**Appendix C.4** Conditions and results of experiments of demulsification by electric fields of crude palm oil – in – water emulsions in continuous system.

Flow rate (ml/min)	Voltage (V/cm)	% Oil Content						Standard deviation
		1 <sup>st</sup> Exp.	2 <sup>nd</sup> Exp.	3 <sup>rd</sup> Exp.	4 <sup>th</sup> Exp.	5 <sup>th</sup> Exp.	Average	
3	2	1.19	1.249	1.45	1.166	1.127	1.236	0.127
	4	0.129	0.125	0.119	0.148	0.144	0.133	0.012
	6	0.245	0.254	0.145	0.256	0.251	0.230	0.048
	8	0.202	0.207	0.222	0.207	0.189	0.205	0.012
	10	0.195	0.217	0.178	0.195	-	0.196	0.016
5.4	4	0.609	0.450	0.544	-	-	0.534	0.080
	10	0.291	0.381	0.392	-	-	0.355	0.055
11	4	1.128	1.292	1.228	-	-	1.216	0.083
	10	0.554	0.674	0.491	-	-	0.573	0.093
16	4	1.568	1.619	1.496	-	-	1.561	0.062
	10	0.806	0.892	0.784	-	-	0.827	0.057

## APPENDIX D

**Appendix D.1** Raw data of the results of experiments of demulsification of crude palm oil from oil – in – water emulsions by gravity force in continuous system at flow rate of 3.0 ml/min.

Time (min)	% Oil Content			
	1 <sup>st</sup> Exp.	2 <sup>nd</sup> Exp.	3 <sup>rd</sup> Exp.	4 <sup>th</sup> Exp.
0	2.262	2.296	2.220	2.215
20	1.903	1.951	1.690	1.906
40	1.703	1.759	1.899	1.752
60	1.560	1.619	1.899	1.727
80	-	1.564	1.675	1.731
100	1.482	1.477	1.931	1.742
120	1.554	1.530	1.820	1.784
140	1.385	1.606	1.860	1.768
160	1.517	1.665	2.014	1.833
180	1.427	1.743	1.815	1.750
200	1.395	1.646	1.874	1.790
220	1.441	1.707	1.731	1.811
240	1.469	1.618	1.782	1.765
260	1.378	1.597	1.705	1.724
280	1.421	1.670	1.733	1.697
300	1.351	1.593	1.679	1.727
320	1.509	1.665	1.506	-
340	1.484	1.725	-	-
Steady State	1.455	1.637	1.770	1.757
% Demulsification	35.667	28.724	20.275	20.668
	1.287	1.426	1.595	1.587

**Appendix D.2** Raw data of the results of experiments of demulsification of crude palm oil from oil – in – water emulsions by gravity force in continuous system at flow rate of 5.4 ml/min.

Time (min)	% Oil Content		
	1 <sup>st</sup> Exp.	2 <sup>nd</sup> Exp.	3 <sup>rd</sup> Exp.
0	2.232	2.232	2.218
10	2.027	2.086	1.804
20	2.083	2.003	1.948
30	2.011	1.916	1.797
40	1.872	1.887	1.907
50	1.638	2.003	1.895
60	1.866	1.831	1.621
70	1.841	1.895	1.846
80	1.924	1.78	1.955
90	1.946	1.866	1.896
100	1.95	1.876	2.015
110	1.927	1.796	1.941
120	1.727	1.768	1.815
130	1.9	1.802	1.893
140	1.888	1.925	1.978
150	1.722	1.851	1.936
160	1.952	2.013	1.944
170	1.928	1.805	1.826
180	1.85	-	-
190	2.025	-	-
200	1.909	-	-
210	1.777	-	-
220	1.911	-	-
230	1.999	-	-
Steady State	1.878	1.868	1.884
% Demulsification	15.878	16.326	15.044
	1.682	1.673	1.699

**Appendix D.3** Raw data of the results of experiments of demulsification of crude palm oil from oil – in – water emulsions by gravity force in continuous system at flow rate of 11.0 ml/min.

Time (min)	% Oil Content			
	1 <sup>st</sup> Exp.	2 <sup>nd</sup> Exp.	3 <sup>rd</sup> Exp.	4 <sup>th</sup> Exp.
0	2.16	2.181	2.078	2.247
7	1.867	2.138	2.078	2.104
14	2.052	2.128	2.158	2.13
21	1.909	2.16	1.992	2.154
28	1.927	2.093	1.987	2.09
35	1.795	2.061	2.009	2.101
42	1.718	2.073	2.018	2.005
49	1.657	2.1	2.102	1.893
56	1.899	2.071	2.05	1.995
63	1.913	2.044	1.906	1.989
70	2.13	2.022	2.039	1.92
77	2.081	1.951	1.719	1.785
84	1.775	2.083	2.034	1.943
91	1.567	2.044	1.966	1.938
98	1.975	2.08	1.927	2.012
105	2.061	2.13	1.96	1.95
112	1.828	-	2.093	2.162
119	1.841	-	2.024	2.047
126	1.866	-	2.163	2.115
133	2.083	-	2.073	1.912
Steady State	1.884	2.063	2.004	1.991
% Demulsification	12.786	5.426	3.578	11.390
	1.744	1.891	1.928	1.772

**Appendix D.4** Raw data of the results of experiments of demulsification of crude palm oil from oil – in – water emulsions by gravity force in continuous system at flow rate of 16.0 ml/min.

Time (min)	% Oil Content			
	1 <sup>st</sup> Exp.	2 <sup>nd</sup> Exp.	3 <sup>rd</sup> Exp.	4 <sup>th</sup> Exp.
0	2.054	2.304	2.255	2.286
5	1.952	2.231	1.921	2.257
10	1.844	2.208	2.181	2.27
15	1.835	2.067	2.167	2.175
20	1.915	2.061	2.013	2.192
25	2.085	1.929	2.008	2.211
30	2.002	2.194	1.976	2.174
35	2.024	2.187	1.871	2.13
40	1.727	2.186	2.171	2.189
45	1.868	2.066	1.955	2.227
50	1.999	2.181	2.162	2.232
55	1.897	1.926	2.213	2.161
60	1.867	2.045	2.111	2.169
65	1.795	2.131	1.952	2.168
70	1.88	2.117	2.05	2.065
75	1.998	2.183	2.038	2.028
80	1.854	2.212	2.046	2.081
85	2.091	2.244	2.146	2.146
90	1.853	2.175	2.249	2.001
95	1.851	2.115	2.177	2.179
100	1.901	2.118	2.201	2.271
105	1.806	2.167	2.072	2.137
Steady state	1.932	2.140	2.081	2.154
% Demulsification	5.927	7.140	7.705	5.793
	1.881	1.857	1.846	1.884



**Appendix D.5** Raw data of the results of experiments of demulsification of crude palm oil from oil – in – water emulsions by gravity force in continuous system at flow rate of 20.0 ml/min.

Time (min)	% Oil Content			
	1 <sup>st</sup> Exp.	2 <sup>nd</sup> Exp.	3 <sup>rd</sup> Exp.	4 <sup>th</sup> Exp.
0	2.301	2.191	2.189	2.375
4	2.149	2.077	2.143	2.297
8	2.007	2.166	2.071	2.241
12	2.086	2.117	2.025	2.112
16	2.145	2.100	2.038	2.191
20	2.149	2.053	2.016	2.088
24	2.115	2.050	2.110	2.116
28	2.055	2.113	2.253	2.049
32	2.072	2.158	2.112	2.188
36	2.126	2.129	2.123	2.235
40	1.996	2.082	2.242	2.178
44	2.091	2.148	2.08	2.174
48	1.956	2.120	2.087	2.160
52	2.131	2.034	2.112	1.938
56	2.210	2.043	2.116	2.075
60	2.182	2.032	2.132	2.035
64	2.151	2.040	2.215	2.172
68	2.067	2.088	2.177	2.259
72	2.117	1.988	2.170	2.146
76	2.071	2.064	1.830	2.278
80	2.097	2.119	2.209	2.243
84	2.162	1.983	2.199	2.194
88	2.222	-	2.047	2.202
92	2.149	-	2.111	2.229
Steady State	2.113	2.075	2.113	2.155
% Demulsification	8.162	5.310	3.495	9.249
	1.837	1.894	1.930	1.815

**Appendix D.6** Raw data of experiments of demulsification by electric fields of crude palm oil – in – water emulsions in continuous system at flow rate 3 ml/min.

Time (min)	% Oil Content at 2V/cm					% Oil Content at 4V/cm				
	1 <sup>st</sup> Exp.	2 <sup>nd</sup> Exp.	3 <sup>rd</sup> Exp.	4 <sup>th</sup> Exp.	5 <sup>th</sup> Exp.	1 <sup>st</sup> Exp.	2 <sup>nd</sup> Exp.	3 <sup>rd</sup> Exp.	4 <sup>th</sup> Exp.	5 <sup>th</sup> Exp.
0	2.051	2.020	1.923	2.000	2.000	2.236	2.257	2.216	2.000	2.000
7	1.919	2.006	1.684	1.986	1.871	2.355	2.593	1.932	2.106	2.298
14	2.224	1.904	1.938	1.885	2.169	1.117	1.771	1.595	0.999	1.569
21	2.027	1.715	1.815	1.698	1.976	0.394	1.021	0.823	0.352	0.905
28	1.812	1.833	1.683	1.716	1.767	0.369	0.661	0.879	0.330	0.586
35	1.766	1.253	1.668	1.240	1.722	0.491	0.398	0.336	0.439	0.353
42	1.455	1.138	1.628	1.127	1.419	0.268	0.238	0.161	0.240	0.211
49	1.318	1.434	1.357	1.222	1.285	0.236	0.266	0.159	0.211	0.236
56	1.103	1.202	1.500	1.190	1.075	0.169	0.207	0.138	0.151	0.183
63	1.177	1.304	1.468	1.192	1.148	0.132	0.197	0.083	0.118	0.174
70	1.174	1.548	1.365	1.146	1.145	0.128	0.120	0.114	0.114	0.106
77	1.100	1.112	1.298	1.101	1.073	0.161	0.106	0.118	0.144	0.094
84	1.389	1.421	1.375	1.164	1.082	0.169	0.086	0.154	0.151	0.076
91	1.155	1.111	-	1.100	1.126	0.131	0.071	0.164	0.117	0.063
98	1.331	1.107	-	1.096	1.103	0.124	0.158	0.141	0.111	0.140
105	1.238	1.236	-	1.247	1.110	0.138	0.182	0.142	0.123	0.161
Steady State	1.221	1.261	1.394	1.166	1.127	0.144	0.141	0.132	0.148	0.144
% Demulsification	40.490	37.559	27.518	41.705	43.628	93.560	93.758	94.055	92.600	92.780
	1.190	1.249	1.450	1.166	1.127	0.129	0.125	0.119	0.148	0.144

Raw data of experiments of demulsification by electric fields of crude palm oil – in – water emulsions in continuous system at flow rate 3 ml/min (Continued).

Time (min)	% Oil Content at 6 V/cm					% Oil Content at 8 V/cm				
	1 <sup>st</sup> Exp.	2 <sup>nd</sup> Exp.	3 <sup>rd</sup> Exp.	4 <sup>th</sup> Exp.	5 <sup>th</sup> Exp.	1 <sup>st</sup> Exp.	2 <sup>nd</sup> Exp.	3 <sup>rd</sup> Exp.	4 <sup>th</sup> Exp.	5 <sup>th</sup> Exp.
0	2.167	2.140	2.280	2.000	2.000	2.261	2.188	2.178	2	2
7	2.052	2.183	2.559	2.040	1.894	2.333	1.949	2.172	1.782	2.064
14	0.460	0.579	0.810	0.541	0.425	0.699	0.427	0.821	0.39	0.618
21	0.390	0.295	0.984	0.276	0.360	0.408	0.672	0.368	0.614	0.361
28	0.324	0.267	0.325	0.250	0.299	0.275	0.31	0.231	0.283	0.243
35	0.252	0.184	0.222	0.172	0.232	0.147	0.244	0.173	0.223	0.13
42	0.272	0.315	0.236	0.295	0.251	0.187	0.18	0.188	0.164	0.165
49	0.213	0.204	0.167	0.191	0.196	0.216	0.225	0.213	0.206	0.191
56	0.266	0.359	0.156	0.336	0.246	0.292	0.187	0.185	0.171	0.258
63	0.261	0.248	0.168	0.232	0.241	0.272	0.181	0.198	0.165	0.241
70	0.298	0.318	0.171	0.297	0.275	0.18	0.289	0.276	0.264	0.159
77	0.294	-	0.162	-	0.271	0.235	0.225	0.296	0.206	0.208
84	-	-	0.201	-	-	0.168	0.267	0.291	0.244	0.149
91	-	-	0.165	-	-	0.175	0.203	0.287	0.186	0.155
98	-	-	0.148	-	-	0.262	0.265	0.295	0.242	0.232
105	-	-	0.149	-	-	0.336	-	0.266	-	-
Steady State	0.265	0.271	0.165	0.256	0.251	0.229	0.227	0.242	0.207	0.189
% Demulsification	87.765	87.321	92.753	87.194	87.431	89.883	89.644	88.908	89.645	90.560
	0.245	0.254	0.145	0.256	0.251	0.202	0.207	0.222	0.207	0.189

Raw data of experiments of demulsification by electric fields of crude palm oil – in – water emulsions in continuous system at flow rate 3 ml/min (Continued).

Time (min)	% Oil Content 10 V/cm			
	1 <sup>st</sup> Exp.	2 <sup>nd</sup> Exp.	3 <sup>rd</sup> Exp.	4 <sup>th</sup> Exp.
0	2.176	2.278	2.269	2.000
7	1.907	1.271	1.785	1.753
14	0.552	0.826	0.410	0.507
21	0.337	0.301	0.208	0.310
28	0.188	0.195	0.149	0.173
35	0.171	0.208	0.206	0.157
42	0.195	0.308	0.221	0.179
49	0.196	0.191	0.218	0.180
56	0.301	0.196	0.304	0.277
63	0.264	0.180	0.159	0.243
70	0.250	0.285	0.129	0.230
77	0.204	0.301	0.161	0.188
84	0.190	0.269	0.198	0.175
91	0.212	0.297	0.177	0.195
98	0.184	0.282	0.234	0.169
105	0.193	0.259	0.267	0.177
Steady State	0.212	0.248	0.202	0.195
% Demulsification	90.242	89.132	91.080	90.238
	0.195	0.217	0.178	0.195

**Appendix D.7** Raw data of experiments of demulsification by electric fields of crude palm oil – in – water emulsions in continuous system at flow rate 5.4 ml/min.

Time (min)	% Oil Content at 4 V/cm			% Oil Content 10 V/cm		
	1 <sup>st</sup> Exp.	2 <sup>nd</sup> Exp.	3 <sup>rd</sup> Exp.	1 <sup>st</sup> Exp.	2 <sup>nd</sup> Exp.	3 <sup>rd</sup> Exp.
0	2.264	2.259	2.059	2.260	2.219	2.138
5	2.513	2.346	2.195	1.969	2.596	2.324
10	2.113	2.428	1.996	0.664	0.640	0.724
15	1.645	1.455	0.875	0.450	0.248	0.272
20	0.787	1.404	0.592	0.333	0.539	0.664
25	0.757	0.654	0.505	0.316	0.249	0.365
30	0.710	0.549	0.600	0.354	0.344	0.282
35	1.029	0.532	0.483	0.239	0.323	0.417
40	0.738	0.565	0.576	0.448	0.362	0.428
45	0.888	0.494	0.533	0.339	0.421	0.420
50	0.512	0.512	0.539	0.278	0.549	0.506
55	0.561	0.459	0.520	0.368	0.426	0.459
60	0.554	0.437	0.523	0.354	0.404	0.484
65	0.423	0.461	0.631	0.308	0.404	0.449
70	0.439	0.565	0.664	0.305	0.582	0.415
75	0.881	-	-	0.189	0.476	0.390
Steady State	0.690	0.508	0.561	0.329	0.423	0.420
% Demulsification	69.527	77.502	72.776	85.429	80.926	80.377
	0.609	0.450	0.544	0.291	0.381	0.392

**Appendix D.8** Raw data of experiments of demulsification by electric fields of crude palm oil – in – water emulsions in continuous system at flow rate 11.0 ml/min.

Time (min)	% Oil Content at 4 V/cm			% Oil Content at 10 V/cm		
	1 <sup>st</sup> Exp.	2 <sup>nd</sup> Exp.	3 <sup>rd</sup> Exp.	1 <sup>st</sup> Exp.	2 <sup>nd</sup> Exp.	3 <sup>rd</sup> Exp.
0	2.233	2.220	2.238	2.239	2.268	2.225
5	2.358	2.374	2.325	2.214	2.251	1.773
10	2.231	2.189	2.202	0.845	0.987	0.532
15	2.126	1.362	1.950	0.617	0.596	0.491
20	1.320	1.415	1.870	0.572	0.628	0.505
25	1.401	1.531	1.137	0.730	0.710	0.441
30	1.439	1.630	1.237	0.559	0.729	0.445
35	1.290	1.604	1.119	0.640	0.844	0.405
40	1.225	1.306	1.230	0.638	0.551	0.489
45	1.020	1.604	1.678	0.512	0.651	0.619
50	1.084	1.538	1.704	0.464	1.096	0.552
55	1.092	1.401	1.398	0.633	0.963	0.626
60	1.343	1.281	1.357	0.652	0.768	0.637
65	1.374	1.060	1.532	0.715	0.627	0.694
70	1.363	1.546	1.353	0.655	0.826	0.622
75	1.543	1.289	-	0.671	0.722	0.586
Steady State	1.259	1.434	1.375	0.620	0.764	0.546
% Demulsification	43.604	35.417	38.584	72.316	66.308	75.461
	1.128	1.292	1.228	0.554	0.674	0.491

**Appendix D.9** Raw data of experiments of demulsification by electric fields of crude palm oil – in – water emulsions in continuous system at flow rate 16.0 ml/min.

Time (min)	% Oil Content at 4 V/cm			% Oil Content at 10 V/cm		
	1 <sup>st</sup> Exp.	2 <sup>nd</sup> Exp.	3 <sup>rd</sup> Exp.	1 <sup>st</sup> Exp.	2 <sup>nd</sup> Exp.	3 <sup>rd</sup> Exp.
0	2.312	2.246	2.110	2.364	2.232	2.222
5	2.474	2.343	2.259	0.919	2.053	1.619
10	1.964	2.297	2.200	1.205	0.859	0.876
15	2.019	1.614	1.366	1.052	0.767	0.708
20	1.991	1.725	1.669	0.717	0.805	0.685
25	1.859	1.815	1.681	0.588	0.918	0.697
30	1.853	1.853	1.608	0.455	1.003	1.204
35	1.796	1.746	1.523	1.144	0.828	0.678
40	1.882	1.877	1.753	1.324	1.011	1.092
45	1.904	1.838	1.582	1.169	1.009	0.933
50	1.754	1.823	1.517	0.750	1.247	0.961
55	1.759	1.834	1.546	1.044	1.183	0.911
60	1.879	1.963	1.453	0.924	1.107	0.854
65	1.836	1.885	1.685	1.050	0.916	0.850
70	1.729	1.848	1.558	0.621	1.125	-
75	1.688	-	-	1.289	1.153	-
Steady State	1.813	1.818	1.578	0.952	0.995	0.871
% Demulsification	21.599	19.038	25.194	59.717	55.418	60.812
	1.568	1.619	1.496	0.806	0.892	0.784

## VITA

Miss Supaporn Nimjaroen was born on October 8, 1983 in Bangkok , Thailand. Education levels are high school in 1998 – 2000 from Triumudomsuksa pattanakarn School, Bangkok, and Bachelor Degree in Chemical Science from Kasetsart University in 2001 – 2004. The last education is studying in Master Degree in Chemical Engineering, Chulalongkorn University that began in 2005.

