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APPENDICES

Appendix A Experimental Data of Microemulsion Formation

1. Solubilization parameter (SP)

The solubilization parameter of oil (SPo) and water (SPw) are designed as :

$$SPo = \frac{Vo}{Ms} \quad \text{and} \quad SPw = \frac{Vw}{Ms} \qquad (A.1)$$

Where Vo = volume of oil solubilized
Ms = weight of surfactants
Vw = volume of water solubilized

2. Interfacial tension (IFT)

The interfacial tension of each phase of microenulsion is caculated by following formulation :

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

where σ = interfacial tension (mN/m)
n = number of revolution (rpm)
e = 3.427×10^{-4} (mN cm^3 min^2/m g mm^3)
V = 0.31 (mm/sdv)
D = measured drop diameter (sdv)
$\Delta\rho$ = density difference of two liquids (g/cm^3)

3. Experiment data of solubilization parameter

Table A-1 Volume fractions of water, middle, and oil phase and solubilization parameters of oil and water phases in microemulsion formation with 0.5wt% ADPODS, 5wt% AOT and 5wt% Span80 at different NaCl concentrations by using an oil to water ratio of 1:1

Sample number	%NaCl	Phase height (cm)			Relative volume			Ms	Solubilization		Rel. vol. Water+Mid	Rel. vol. Water
		Water	Middle	Oil	Water	Middle	Oil		Spw	Spo		
1	0	3.78	0	3.00	05577	0	0.4429	0.5025	9.9502	1.1486	0.5577	0
2	0.05	4.02	0	2.81	0.5889	0	0.4112	0.5025	9.9502	1.7679	0.5889	0
3	0.07	4.14	0	2.60	0.6144	0	0.3856	0.5025	9.9502	2.2758	0.6144	0
4	0.15	2.52	1.75	2.49	0.3730	0.2587	0.3684	0.5025	2.5280	2.6192	0.6316	0.3730
5	0.2	2.56	1.64	2.60	0.3768	0.2414	0.3818	0.5025	2.4521	2.3525	0.6182	0.3768
6	0.3	2.84	1.46	2.57	0.4134	0.2122	0.3745	0.5025	1.7239	2.4981	0.6256	0.4134
7	0.31	2.89	1.58	2.36	0.4236	0.2316	0.3448	0.5025	1.5205	3.0877	0.6552	0.4236
8	0.32	2.97	1.21	2.63	0.4364	0.1778	0.3858	0.5025	1.2659	2.2733	0.6142	04364
9	0.35	3.05	1.20	2.57	0.4474	0.1756	0.3770	0.5025	1.0466	2.4478	0.6230	0.4474
10	0.43	3.00	1.50	2.29	0.4417	0.2206	0.3377	0.5025	1.1606	3.2300	0.6623	0.4417
11	0.45	2.94	1.77	2.06	0.4345	0.2615	0.3039	0.5025	1.3027	3.9023	0.6961	0.4345
12	0.44	2.99	1.53	2.29	0.4365	0.2245	0.3360	0.5025	1.2041	3.2641	0.6640	0.4395
13	0.47	2.760	2.11	1.99	0.4022	0.3074	0.2904	0.5025	1.9465	4.1716	0.7096	0.4022
14	0.48	2.73	2.21	1.84	0.4028	0.3259	0.2713	0.5025	1.9348	4.5517	0.7287	0.4028
15	0.49	2.82	2.29	1.74	0.4112	0.3345	0.2543	0.5025	1.7670	4.8887	0.7457	0.4112
16	0.5	2.76	2.23	1.87	0.4026	0.3251	0.2723	0.5025	1.9384	4.5307	0.7277	0.4026
17	0.6	2.73	2.54	1.53	0.4018	0.3734	0.2248	0.5025	1.9550	5.4760	0.7752	0.4018
18	0.75	2.80	2.55	1.46	0.4114	0.3746	0.2140	0.5025	1.7628	5.6915	0.7860	0.4114
19	0.8	2.80	2.70	1.29	0.4129	0.3971	0.1900	0.5025	1.7333	6.1700	0.8100	0.4129
20	1.0	2.87	2.60	1.31	0.4233	0.3833	0.1935	0.5025	1.5269	6.1000	0.8065	0.4233

Table A-2 Volume fractions of water, middle, and oil phase and solubilization parameters of oil and water phases in microemulsion formation with 0.75wt% ADPODS, 5wt% AOT and 5wt% Span80 at different NaCl concentrations by using initial oil to water ratio of 1:1

Sample number	%NaCl	Phase height (cm)			Relative volume			Ms	Solubilization		Rel. vol. Water+Mid	Rel. vol. Water
		Water	Middle	Oil	Water	Middle	Oil		Spw	Spo		
1	0	3.75	0	3.20	0.5391	0	0.4609	0.5375	9.3023	0.7283	0.5412	0
2	0.1	3.80	0	3.00	0.5588	0	0.4412	0.5375	9.3023	1.0941	0.5436	0
3	0.2	3.93	0	2.88	0.5775	0	0.4225	0.5375	9.3023	1.4421	0.5467	0
4	0.3	3.86	0	2.93	0.5685	0	0.4315	0.5375	9.3023	1.2742	0.5483	0
5	0.4	2.66	1.79	2.33	0.3930	0.2637	0.3434	0.5375	1.9912	2.9140	0.6566	0.3930
6	0.5	2.82	1.50	2.41	0.4185	0.2230	0.3585	0.5375	1.5168	2.6329	0.6415	0.4185
7	0.6	2.60	2.36	1.85	0.3825	0.3460	0.2715	0.5375	2.1869	4.2570	0.72848	0.3825
8	0.7	2.58	2.59	1.62	0.3801	0.3817	0.2381	0.5375	2.2304	4.8717	0.7619	0.3801
9	0.8	2.66	2.63	1.51	0.3910	0.3866	0.2224	0.5375	2.0275	5.1652	0.7776	0.3910
10	0.9	2.75	2.65	1.43	0.4025	0.3877	0.2099	0.5375	1.8147	5.3979	0.79014	0.4025
11	1.0	3.00	2.34	1.51	0.4384	0.3416	0.2200	0.5375	1.1460	5.2092	0.7800	0.4384

Table A-3 Volume fractions of water, middle, and oil phase and solubilization parameters of oil and water phases in microemulsion formation with 1wt% ADPODS, 5wt% AOT and 5wt% Span80 at different NaCl concentrations by using initial oil to water ratio of 1:1

Sample number	%NaCl	Phase height (cm)			Relative volume			Ms	Solubilization		Rel. vol. Water+Mid	Rel. vol. Water
		Water	Middle	Oil	Water	Middle	Oil		Spw	Spo		
1	0	3.61	0	3.32	0.5216	0	0.4784	0.55	9.0909	0.3934	0.5216	0
2	0.2	3.62	0	3.30	0.5233	0	0.4767	0.55	9.0909	0.4245	0.5233	0
3	0.4	3.60	0	3.24	0.5262	0	0.4738	0.55	9.0909	0.4767	0.5262	0
4	0.6	2.76	1.18	2.90	0.4037	0.1722	0.4240	0.55	1.7502	1.3810	0.5760	0.4037
5	0.7	2.34	2.5.3	1.94	0.3434	03718	0.2848	0.55	2.8470	3.9121	0.7152	0.3434
6	0.72	2.30	2.73	1.81	0.3358	0.3989	0.2653	0.55	2.9851	4.2669	0.7347	0.3358
7	0.75	2.42	2.55	1.86	0.3549	0.3731	0.2720	0.55	2.6381	4.1448	0.7280	0.3549
8	0.77	2.45	2.63	1.75	0.3584	0.3858	0.2558	0.55	2.5746	4.4402	0.7442	0.3584
9	0.8	2.44	2.60	1.77	0.3582	0.3815	0.2604	0.55	2.5791	4.3572	0.7396	0.3582
10	0.83	2.45	2.52	1.86	0.3587	0.3917	0.2725	0.55	2.5687	4.1368	0.7504	0.3587
11	0.85	2.47	2.49	1.92	0.3591	0.3620	0.2788	0.55	2.5611	4.0216	0.7212	0.3591
12	0.87	2.43	2.52	1.81	0.3598	0.3731	0.2671	0.55	2.5492	4.2344	0.7329	0.3598
13	0.89	2.48	2.58	1.72	0.3662	0.3802	0.2536	0.55	2.4327	4.4804	0.7464	0.3662
14	1.0	2.52	2.49	1.74	0.3729	0.3694	0.2577	0.55	2.3118	4.4053	0.7423	0.3729
15	1.2	2.55	2.58	1.65	0.3768	0.3800	0.2432	0.55	2.2405	4.6689	0.7568	0.3768
16	1.4	2.63	2.52	1.66	0.3864	0.3702	0.2434	0.55	2.0647	4.6655	0.7566	0.3864
17	1.5	2.61	2.51	1.66	0.3848	0.3700	0.2451	0.55	2.0942	4.6341	0.7549	0.3848
18	1.6	2.65	2.50	1.69	0.3875	0.3657	0.2469	0.55	2.0457	4.6027	0.7531	0.3875
19	1.8	2.72	2.48	1.60	0.3998	0.3652	0.2351	0.55	1.8225	4.8171	0.7649	0.3998
20	2.0	2.70	2.44	1.92	0.3995	0.3608	0.2397	0.55	1.8268	4.7330	0.7603	0.3995

Table A-4 Volume fractions of water, middle, and oil phase and solubilization parameters of oil and water phases in microemulsion formation with 0.5wt% ADPODS, 3wt% AOT and 5wt% Span80 at different NaCl concentrations by using initial oil to water ratio of 1:1

Sample number	%NaCl	Phase height (cm)			Relative volume			Ms	Solubilization		Rel. vol.	Rel. vol.
		Water	Middle	Oil	Water	Middle	Oil		Spw	Spo	Water	Oil
1	0	3.60	0	3.25	0.5260	0	0.4740	0.4025	12.4224	0.6456	0.5260	0.4740
2	0.1	3.38	0	3.49	0.4924	0	0.5076	0.4025	12.4224	0	0.4924	0.5076
3	0.2	3.44	0	3.43	0.5004	0	0.4996	0.4025	12.4224	0.0090	0.5004	0.4996
4	0.3	3.14	0	3.72	0.4573	0	0.5427	0.4025	1.0608	2.0125	0.4573	0.5427
5	0.4	3.20	0	3.67	0.4656	0	0.5344	0.4025	0.8552	2.0125	0.4656	0.5344
6	0.5	3.04	0	3.86	0.4409	0	0.5591	0.4025	1.4683	2.0125	0.4409	0.5591
7	0.6	3.07	0	3.78	0.4484	0	0.5516	0.4025	1.2811	2.0125	0.4484	0.5516
8	0.7	3.05	0	3.84	0.4430	0	0.5570	0.4025	1.4155	2.0125	0.4430	0.5570
9	0.8	3.09	0	3.81	0.4478	0	0.5522	0.4025	1.2961	2.0125	0.4478	0.5522
10	0.9	3.07	0	3.79	0.4478	0	0.5522	0.4025	1.2973	2.0125	0.4478	0.5522
11	1.0	3.08	0	3.81	0.4469	0	0.5531	0.4025	1.3197	2.0125	0.4469	0.5531
12	1.2	3.04	0	3.82	0.4430	0	0.5570	0.4025	1.4169	2.0125	0.4430	0.5570
13	1.3	2.99	0	3.88	0.4357	0	0.5643	0.4025	1.5985	2.0125	0.4357	0.5643
14	1.4	2.99	0	3.91	0.4337	0	0.5663	0.4025	1.6472	2.0125	0.4337	0.5663
15	1.5	3.20	0	3.66	0.4667	0	0.5333	0.4025	0.8284	2.0125	0.4667	0.5333
16	1.6	3.21	0	3.67	0.4661	0	0.5339	0.4025	0.8412	2.0125	0.4661	0.5339
17	1.7	3.24	0	3.65	0.4704	0	0.5296	0.4025	0.7345	2.0125	0.4704	0.5296
18	1.8	3.24	0	3.60	0.4733	0	0.5267	0.4025	0.6634	2.0125	0.4733	0.5267
19	1.9	3.19	0	3.66	0.4653	0	0.5347	0.4025	0.8610	2.0125	0.4653	0.5347
20	2.0	3.21	0	3.68	0.4652	0	0.5348	0.4025	0.8649	2.0125	0.4652	0.5348

Table A-5 Volume fractions of water, middle, and oil phase and solubilization parameters of oil and water phases in microemulsion formation with 0.5wt% ADPODS, 4wt% AOT and 5wt% Span80 at different NaCl concentrations by using initial oil to water ratio of 1:1

Sample number	%NaCl	Phase height (cm)			Relative volume			Ms	Solubilization		Rel. vol. Water	Rel. vol. Oil
		Water	Middle	Oil	Water	Middle	Oil		Spw	Spo		
1	0	3.08	0	3.77	0.4498	0	0.5502	0.4525	2.2625	0	0.4498	0.5502
2	0.1	4.15	0	2.68	0.6073	0	0.3927	0.4525	2.2625	2.3705	0.6073	0.3927
3	0..3	3.00	0	3.83	0.4395	0	0.5605	0.4525	1.374	11.0497	0.4395	0.5605
4	0.4	3.17	0	3.68	0.4627	0	0.5373	0.4525	0.8252	11.0497	0.4627	0.5373
5	0.5	2.89	0	3.90	0.4260	0	0.5740	0.4525	1.6357	11.0497	0.4260	0.5740
6	0.6	2.95	0	2.88	0.4322	0	0.5678	0.4525	1.4985	11.0497	0.4322	0.5678
7	0.7	2.91	0	3.90	0.4272	0	0.5728	0.4525	1.6082	11.0497	0.4272	0.5728
8	0.75	2.83	0	3.93	0.4189	0	0.5811	0.4525	1.7918	11.0497	0.4189	0.5811
9	0.8	2.91	0	3.90	0.4272	0	0.5728	0.4525	1.6087	11.0497	0.4272	0.5728
10	0.9	2.92	0	3.89	0.4284	0	0.5716	0.4525	1.5822	11.0497	0.4284	0.5716
11	1.0	2.86	0	4.01	0.4161	0	0.5839	0.4525	1.8548	11.0497	0.4161	0.5839
12	1.5	3.12	0	3.59	0.4649	0	0.5351	0.4525	0.7750	11.0497	0.4649	0.5351
13	2.0	3.24	0	3.53	0.4789	0	0.5211	0.4525	0.4669	11.0497	0.4789	0.5211

Table A-6 Volume fractions of water, middle, and oil phase and solubilization parameters of oil and water phases in microemulsion formation with 0.5wt% ADPODS, 5wt% AOT and 1wt% Span80 at different NaCl concentrations by using initial oil to water ratio by 1:1

Sample number	%NaCl	Phase height (cm)			Relative volume			Ms	Solubilization		Rel. vol.	Rel. vol.
		Water	Middle	Oil	Water	Middle	Oil	0.3025	Spw	Spo	Water+Mid	Water
1	0	3.71	0	3.14	0.5414	0	0.4586	0.3025	16.5289	1.3670	0.5414	0
2	0.1	3.62	0	3.24	0.5280	0	0.4720	0.3025	16.5289	0.9247	0.5280	0
3	0.2	3.66	0	3.15	0.5369	0	0.4631	0.3025	16.5289	1.2188	0.5369	0
4	0.3	3.72	0	3.12	0.5434	0	0.4566	0.3025	16.5289	1.4362	0.5434	0
5	0.4	3.65	0	3.17	0.5357	0	0.4643	0.3025	16.5289	1.1786	0.5357	0
6	0.5	3.61	0	3.29	0.5231	0	0.4769	0.3025	16.5289	0.7627	0.5231	0
7	0.6	3.62	0	3.25	0.5269	0	0.4731	0.3025	16.5289	0.8877	0.5269	0
8	0.7	3.69	0	3.19	0.5369	0	0.4631	0.3025	16.5289	1.2186	0.5369	0
9	0.8	3.60	0	3.22	0.5278	0	0.4722	0.3025	16.5289	0.9202	0.5278	0
10	0.9	3.62	0	3.22	0.5292	0	0.4708	0.3025	16.5289	0.9646	0.5292	0
11	1.0	3.63	0	3.27	0.5258	0	0.4742	0.3025	16.5289	0.8535	0.5258	0
12	1.1	3.43	0.17	3.25	0.5006	0.0253	0.4841	0.3025	0.2361	0.8549	0.5259	0.5006
13	1.2	3.45	0.27	3.16	0.5018	0.0392	0.4589	0.3025	0.2352	1.3576	0.5411	0.5018
14	1.3	3.37	0.28	3.18	0.4928	0.0413	0.4659	0.3025	0.2371	1.1274	0.5341	0.4928
15	1.4	3.38	0.17	3.31	0.4931	0.0243	0.4826	0.3025	0.2289	0.5758	0.5174	0.4931
16	1.5	3.41	0.17	3.28	0.4974	0.0248	0.4778	0.3025	0.0868	0.7327	0.5222	0.4974
17	1.6	3.47	0.12	3.27	0.5058	0.0174	0.4759	0.3025	0.0985	0.7644	0.5231	0.5058
18	1.7	3.40	0.14	3.31	0.4966	0.0207	0.4826	0.3025	0.1110	0.5743	0.5174	0.4966
19	1.8	3.47	0.14	3.23	0.5075	0.0203	0.4722	0.3025	0.1259	0.9183	0.5278	0.5075
20	2.0	3.38	0.22	3.26	0.4934	0.0318	0.4748	0.3025	0.2170	0.8341	0.5252	0.4934

Table A-7 Volume fractions of water, middle, and oil phase and solubilization parameters of oil and water phases in microemulsion formation with 0.5wt% ADPODS, 5wt% AOT and 2wt% Span80 at different NaCl concentrations by using initial oil to water ratio of 1:1

Sample number	%NaCl	Phase height (cm)			Relative volume			Ms	Solubilization		Rel. vol. Water+Mid	Rel. vol. Water
		Water	Middle	Oil	Water	Middle	Oil		Spw	Spo		
1	0	3.66	0	3.25	0.5299	0	0.4701	0.3525	14.1844	0.8472	0.5299	0
2	0.1	3.65	0	3.13	0.5383	0	0.4617	0.3525	14.1844	1.0789	0.5383	0
3	0.2	3.63	0	3.16	0.5351	0	0.4649	0.3525	14.1844	0.9944	0.5351	0
4	0.3	3.62	0	3.16	0.5337	0	0.4663	0.3525	14.1844	0.9559	0.5337	0
5	0.4	3.69	0	3.11	0.5426	0	0.4574	0.3525	14.1844	1.2091	0.5426	0
6	0.5	3.66	0	3.13	0.5391	0	0.4609	0.3525	14.1844	1.1078	0.5391	0
7	0.6	3.70	0	3.09	0.5451	0	0.4549	0.3525	14.1844	1.2789	0.5451	0
8	0.7	3.66	0	3.10	0.5417	0	0.4583	0.3525	14.1844	1.1841	0.5417	0
9	0.8	2.79	1.18	2.85	0.4087	0.1732	0.4181	0.3525	2.5890	2.3231	0.5819	0.4087
10	0.9	2.69	1.16	2.71	0.4104	0.1765	0.4131	0.3525	2.5420	2.4642	0.5869	0.4104
11	1.0	2.72	1.52	2.56	0.4004	0.2231	0.3765	0.3525	2.8269	3.5033	0.6235	0.4004
12	1.5	2.88	1.44	2.52	0.4209	0.2104	0.3687	0.3525	2.2440	3.7262	0.6313	0.4209
13	2.0	2.89	1.69	2.22	0.4251	0.2490	0.3259	0.3525	2.1247	4.9382	0.6741	0.4251

Table A-8 Volume fractions of water, middle, and oil phase and solubilization parameters of oil and water phases in microemulsion formation with 0.5wt% ADPODS, 5wt% AOT and 3wt% Span80 at different NaCl concentrations by using initial oil to water ratio of 1:1

Sample number	%NaCl	Phase height (cm)			Relative volume			Ms	Solubilization		Rel. vol. Water+Mid	Rel. vol. Water
		Water	Middle	Oil	Water	Middle	Oil		Spw	Spo		
1	0	3.64	0	3.17	0.5345	0	0.4655	0.4025	12.4224	0.8563	0.5345	0
2	0.1	3.66	0	3.12	0.5403	0	0.4597	0.4025	12.4224	1.0001	0.5403	0
3	0.2	3.70	0	3.07	0.5470	0	0.4530	0.4025	12.4224	1.1673	0.5470	0
4	0.3	2.08	1.87	2.99	0.2996	0.2691	0.4313	0.4025	4.9779	1.7071	0.5687	0.2996
5	0.4	2.36	1.73	2.66	0.3492	0.2566	0.392	0.4025	3.7460	2.6279	0.6058	0.3492
6	0.5	2.57	1.70	2.49	0.3803	0.2512	0.3686	0.4025	2.9749	3.2657	0.6315	0.3803
7	0.6	2.64	2.29	1.82	0.3909	0.3392	0.2699	0.4025	2.7111	5.7164	0.7301	0.3909
8	0.7	2.67	2.11	1.99	0.3950	0.3117	0.2932	0.4025	2.6078	5.1367	0.7067	0.3950
9	0.8	2.68	2.20	1.92	0.3935	0.3240	0.2825	0.4025	2.6452	5.4037	0.7175	0.3935
10	0.9	2.64	2.14	1.95	0.3928	0.3173	0.2899	0.4025	2.6639	5.2189	0.7101	0.3928
11	1.0	2.72	2.13	1.94	0.4008	0.3134	0.2858	0.4025	2.4640	5.3213	0.7142	0.4008
12	1.1	2.89	2.02	1.80	0.4308	0.3005	0.2686	0.4025	1.7185	5.7482	0.7313	0.4308
13	1.2	2.81	2.15	1.83	0.4137	0.3162	0.2701	0.4025	2.1446	5.7121	0.7299	0.4137
14	1.3	2.84	2.12	1.93	0.4153	0.3086	0.2761	0.4025	2.1033	5.5635	0.7239	0.4153
15	1.4	2.88	2.08	1.86	0.4224	0.3049	0.2726	0.4025	1.9268	5.6495	0.7273	0.4224
16	1.5	2.87	2.01	1.98	0.4181	0.2930	0.2888	0.4025	2.0336	5.2468	0.7111	0.4181
17	1.6	2.97	1.84	1.98	0.4374	0.2707	0.2919	0.4025	1.5558	5.1694	0.7081	0.4374
18	1.7	2.92	1.70	2.24	0.4264	0.2474	0.3262	0.4025	1.8295	4.3173	0.6738	0.4264
19	1.8	2.95	1.83	2.03	0.4331	0.2682	0.2988	0.4025	1.6630	5.0000	0.7013	0.4331
20	2.0	3.06	1.64	2.10	0.4503	0.2404	0.3093	0.4025	1.2349	4.7388	0.6907	0.4503

Appendix B Expermental Data of Detergency Experiment

1. %Detergency (%D)

The detergency performance can be determined by %Detergency, it is calculated from the following equation :

$$\% \text{ Detergency} = |(A-B)/(Co-Bo)]\times 100$$

where A = average reflectance of the soiled swatches after washing

B = average reflectance of the soiled swatches before washing

Co = average reflectance of the unsoiled swatches before washing

2. %Oil Removal

The oil removal is calculated from the calibration curve for colored motor oil.

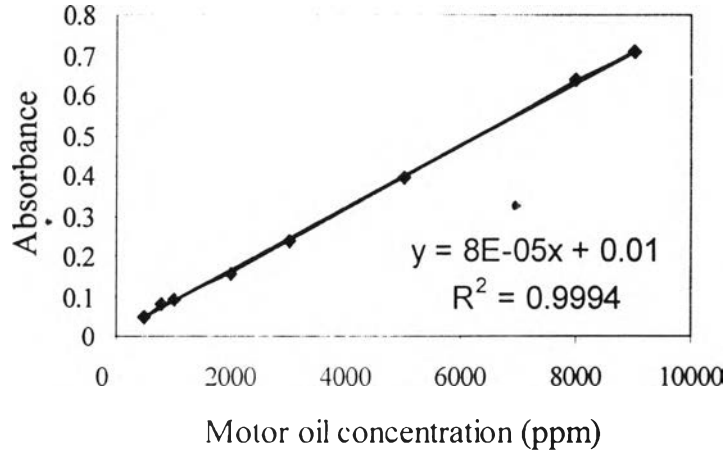

Figure B-1 Relationship between colored motor oil concentration and the absorbance measured at 520 nm.

Table B-1 Relationship between colored motor oil concentration and the absorbance measured at 520 nm

Motor oil concentration (ppm)	Absorbance
500	0.051
800	0.081
1000	0.090
2000	0.157
3000	0.236
5000	0.392
8000	0.637
9000	0.708

3. % ADPODS Concentration

The ADPODS concentration is calculated from the calibration curve for Dowfax8390.

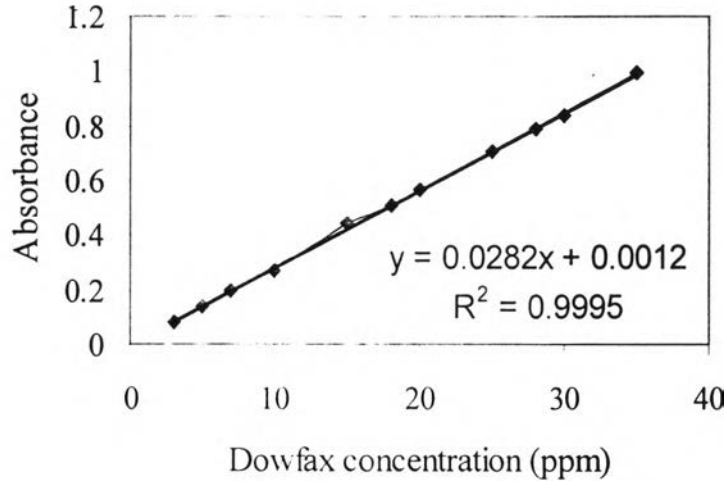

Figure B-2 Relationship between ADPODS concentration and the absorbance measured at 235 nm.

Table B-2 Relationship between ADPODS concentration and the absorbance measured at 235 nm

Motor oil concentration (ppm)	Absorbance
3	0.086
5	0.142
7	0.195
10	0.274
15	0.441
18	0.513
20	0.567
25	0.710
28	0.790
30	0.839
35	0.992

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