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APPENDICES

Appendix A Experimental Data of Phase Behavior Study.

Table A-1 Phase behavior study results for different surfactant system with salinity scan.

No	Surfactant system	wt% NaCl	Type of Oils		Results	Note
			Diesel oil	Motor oil		
1	0.1 wt% Alfoterra, 0.5 wt% Span 80	0-15	✓	✓	Negative	
2	0.1 wt% Alfoterra, 1% wt Span 80	0-15	✓	✓	Negative	
3	0.1 wt% Alfoterra, 2 wt% Span 80	0-15	✓	✓	Negative	
4	0.1 wt% Alfoterra, 2 wt% Span 20	0-15	✓	✓	Negative	
5	0.1 wt% Alfoterra, 4 wt% Span 20	0-15	✓	✓	Negative	
6	0.1 wt% Alfoterra, 2 wt% Tween 60	0-15	✓	✓	Negative	
7	0.1 wt% Alfoterra, 4 wt% Tween 60	0-15	✓	✓	Negative	
8	0.1 wt% Alfoterra, 2 wt% Tween 80	0-15	✓	✓	Negative	
9	0.1wt% Alfoterra, 4 wt% Tween 80	0-15	✓	✓	Negative	
10	0.1 wt% Alfoterra, 2 wt% Span 80, 3 wt% AOT	0-20	✓		Winsor type II	

Table A-1 (continue).

No	Surfactant system	wt% NaCl	Type of Oils		Results	Note
			Diesel oil	Motor oil		
11	0.1 wt% Alfoterra, 1 wt% Span 80, 3 wt% AOT	0-20	✓		Winsor type II	
12	0.1 wt% Alfoterra, 2 wt% Span 80, 3 wt% AOT	0-20	✓		Winsor type II	
13	0.1 wt% Alfoterra, 0.5 wt% Span 80, 3 wt % AOT	0-20	✓		Winsor type II	
14	0.1 wt% Alfoterra, 2 wt% Span 80, 0.5 wt% AOT	0-20	✓		Winsor type II	
15	0.1 wt% Alfoterra, 2 wt% Span 80, 1 wt % AOT	0-20	✓		Winsor type II	
16	0.1% wt Alfoterra, 1% wt AOT	0-5	✓	✓	Winsor type II	
17	0.1% wt Alfoterra, 2% wt AOT	0-5	✓	✓	Winsor type II	
18	0.1 wt% Alfoterra, 0.25 wt% AOT	0-20	✓	✓	Winsor type III for diesel, Negative for motor oil	Middle phase at 1 wt% NaCl for diesel
19	0.1 wt% Alfoterra, 0.5 wt% AOT	0-20	✓	✓	Winsor type III for diesel, Negative for motor oil	Middle phase at 1 wt% NaCl for diesel
20	0.2 wt% Alfoterra, 0.5 wt% AOT	0-20	✓	✓	Winsor type III	Middle phase at 1 wt% NaCl for diesel and 4-10 wt% NaCl for motor oil

Table A-1 (continue).

No	Surfactant system	wt% NaCl	Type of Oils		Results	Note
			Diesel oil	Motor oil		
21	0.2 wt% Alfoterra, 1 wt% AOT	0-20	✓	✓	Winsor type III	Middle phase at 1 wt% NaCl for diesel and 4-10 wt% NaCl for motor oil
22	0.3 wt% Alfoterra, 0.5% wt AOT	1	✓		Winsor type III	Middle phase at 1 wt% NaCl
23	0.3 wt% Alfoterra, 1 wt% AOT	1	✓		Winsor type III	Middle phase at 1 wt% NaCl
24	0.4 wt% Alfoterra, 0.5 wt% AOT	1	✓		Negative	
25	0.4 wt% Alfoterra, 1 wt% AOT	1	✓		Winsor type III	Middle phase at 1 wt% NaCl
26	0.5 wt% Alfoterra, 0.5 wt% AOT	1	✓		Negative	
27	0.5 wt% Alfoterra, 1 wt% AOT	1	✓		Winsor type III	Middle phase at 1 wt% NaCl
28	0.6 wt% Alfoterra, 0.5 wt % AOT	1	✓		Negative	
29	0.6 wt% Alfoterra, 1 wt% AOT	0-15	✓	✓	Winsor type III	Middle phase at 1 wt% NaCl and 6 wt% NaCl for motor oil
30	0.7 wt% Alfoterra, 0.5 wt% AOT	1	✓		Negative	
31	0.7% wt Alfoterra, 1% wt AOT	1	✓		Negative	

Table A-1 (continue).

No	Surfactant system	wt% NaCl	Type of Oils		Results	Note
			Diesel oil	Motor oil		
32	0.8 wt% Alfoterra, 0.5 wt %AOT	1	✓		Negative	
33	0.8 wt% Alfoterra, 1 wt %AOT	1	✓		Negative	
34	1 wt% Alfoterra, 0.5 wt% AOT	1	✓		Negative	
35	1 wt% Alfoterra, 1 wt% AOT	1	✓		Negative	

Note: Alfoterra 145-4PO



Table A-2 Summary of surfactant system that shown the Winsor type III microemulsion.

No	Surfactant system	wt% NaCl	Type of Oils		Results	Note
			Diesel	Motor oil		
1	0.1 wt% Alfoterra, 0.25 wt% AOT	0-20	✓	✓	Winsor type III for diesel, Negative for motor oil	Middle phase at 1 wt% NaCl for diesel
2	0.1 wt% Alfoterra, 0.5 wt% AOT	0-20	✓	✓	Winsor type III for diesel, Negative for motor oil	Middle phase at 1 wt% NaCl for diesel
3	0.2 wt% Alfoterra, 0.5 wt% AOT	0-2	✓	✓	Winsor type III	Middle phase at 1 wt% NaCl for diesel and 4- 10 wt% NaCl for motor oil
4	0.2 wt% Alfoterra, 1 wt% AOT	0-2	✓	✓	Winsor type III	Middle phase at 1 wt% NaCl for diesel and 4-6 wt% NaCl for motor oil
5	0.3 wt% Alfoterra, 0.5% wt AOT	1	✓		Winsor type III	Middle phase at 1 wt% NaCl
6	0.3 wt% Alfoterra, 1 wt% AOT	1	✓		Winsor type III	Middle phase at 1 wt% NaCl
7	0.4 wt% Alfoterra, 1 wt% AOT	1	✓		Winsor type III	Middle phase at 1 wt% NaCl
8	0.5 wt% Alfoterra, 1 wt% AOT	1	✓		Winsor type III	Middle phase at 1 wt% NaCl

Table A-2 (Continue).

No	Surfactant system	wt% NaCl	Type of Oils		Results	Note
			Diesel	Motor oil		
9	0.6 wt% Alfoterra, 1 wt% AOT	0-15	✓	✓	Winsor type III	Middle phase at 1 wt% NaCl and 6 wt% NaCl for motor oil

Table A-3 Density of water and oil phases in microemulsion formation with 0.2 wt% Alforterra, 0.5 % wt AOT and diesel at different NaCl.

No.	wt% NaCl	Phase	Volume (L)				Mass (g)					Density (g/cm ³)
			no. 1	no. 2	no. 3	average	no. 1	no. 2	no. 3	average	SD	
1	0	Upper	50	50	50	50	0.0391	0.0393	0.0392	0.0392	0.0001	0.7840
2		Lower	50	50	50	50	0.0488	0.0493	0.0491	0.0491	0.0003	0.9813
3	0.5	Upper	50	50	50	50	0.0395	0.0393	0.0394	0.0394	0.0001	0.7880
4		Lower	50	50	50	50	0.0492	0.0491	0.0492	0.0492	0.0001	0.9833
5	1	Upper	50	50	50	50	0.0395	0.0398	0.0397	0.0397	0.0002	0.7933
6		Lower	50	50	50	50	0.0484	0.0496	0.0481	0.0487	0.0008	0.9740
7	1.5	Upper	50	50	50	50	0.0387	0.0396	0.0392	0.0392	0.0005	0.7833
8		Lower	50	50	50	50	0.0483	0.089	0.0492	0.0488	0.0232	0.9760
9	2	Upper	50	50	50	50	0.0393	0.0399	0.0396	0.0396	0.0003	0.7920
10		Lower	50	50	50	50	0.0487	0.0493	0.0498	0.0493	0.0006	0.9853
11	3	Upper	50	50	50	50	0.0388	0.0395	0.0392	0.0392	0.0004	0.7833
12		Lower	50	50	50	50	0.0493	0.0487	0.0482	0.0487	0.0006	0.9747
13	4	Upper	50	50	50	50	0.039	0.0393	0.0392	0.0392	0.0002	0.7833
14		Lower	50	50	50	50	0.0482	0.0495	0.0493	0.0490	0.0007	0.9800

Table A-3 (Continue).

No.	wt% NaCl	Phase	Volume (L)				Mass (g)					Density (g/cm ³)
			no. 1	no. 2	no. 3	average	no. 1	no. 2	no. 3	average	SD	
15	5	Upper	50	50	50	50	0.0395	0.0391	0.0393	0.0393	0.0002	0.7860
16		Lower	50	50	50	50	0.0496	0.0486	0.0491	0.0491	0.0005	0.9820
17	6	Upper	50	50	50	50	0.0385	0.0396	0.0391	0.0391	0.0006	0.7813
18		Lower	50	50	50	50	0.0492	0.0496	0.0494	0.0494	0.0002	0.9880
19	7	Upper	50	50	50	50	0.0396	0.039	0.0393	0.0393	0.0003	0.7860
20		Lower	50	50	50	50	0.0491	0.0495	0.0493	0.0493	0.0002	0.9860
21	8	Upper	50	50	50	50	0.0389	0.0395	0.0398	0.0394	0.0005	0.7880
22		Lower	50	50	50	50	0.0486	0.0494	0.0497	0.0492	0.0006	0.9847
23	9	Upper	50	50	50	50	0.0392	0.0399	0.0388	0.0393	0.0006	0.7860
24		Lower	50	50	50	50	0.0488	0.0491	0.0486	0.0488	0.0003	0.9767
25	10	Upper	50	50	50	50	0.0395	0.0398	0.0392	0.0395	0.0003	0.7900
26		Lower	50	50	50	50	0.0486	0.0494	0.0497	0.0492	0.0006	0.9847
27	20	Upper	50	50	50	50	0.0385	0.0391	0.0396	0.0391	0.0006	0.7813
28		Lower	50	50	50	50	0.0487	0.0495	0.0498	0.0493	0.0006	0.9867

Table A-4 Density of water and oil phases in microemulsion formation with 0.2 wt% Alfoterra, 0.5 % wt AOT and motor oil at different NaCl.

No.	wt% NaCl	Phase	Volume (L)				Mass (g)					Density (g/cm ³)
			no. 1	no. 2	no. 3	average	no. 1	no. 2	no. 3	average	SD	
1	0	Upper	50	50	50	50	0.0417	0.0425	0.0414	0.0419	0.0006	0.8373
2		Lower	50	50	50	50	0.0484	0.0487	0.049	0.0487	0.0003	0.9740
3	0.5	Upper	50	50	50	50	0.0419	0.0417	0.0411	0.0416	0.0004	0.8313
4		Lower	50	50	50	50	0.0488	0.0489	0.0485	0.0487	0.0002	0.9747
5	1	Upper	50	50	50	50	0.0418	0.0423	0.0416	0.0419	0.0004	0.8380
6		Lower	50	50	50	50	0.0485	0.0491	0.0488	0.0488	0.0003	0.9760
7	2	Upper	50	50	50	50	0.0418	0.0420	0.0413	0.0417	0.0004	0.8340
8		Lower	50	50	50	50	0.0488	0.0495	0.0487	0.0490	0.0004	0.9800
9	3	Upper	50	50	50	50	0.0426	0.0417	0.0422	0.0422	0.0005	0.8433
10		Lower	50	50	50	50	0.0491	0.0495	0.0490	0.0492	0.0003	0.9840
11	4	Upper	50	50	50	50	0.0414	0.0408	0.0416	0.0413	0.0004	0.8253
12		Lower	50	50	50	50	0.0489	0.0498	0.0487	0.0491	0.0006	0.9827
13	5	Upper	50	50	50	50	0.0412	0.0426	0.0419	0.0419	0.0007	0.8380
14		Lower	50	50	50	50	0.0487	0.0492	0.0495	0.0491	0.0004	0.9827

Table A-4 (Continue).

No.	wt% NaCl	Phase	Volume (L)				Mass (g)					Density (g/cm ³)
			no. 1	no. 2	no. 3	average	no. 1	no. 2	no. 3	average	SD	
15	6	Upper	50	50	50	50	0.0413	0.0418	0.0422	0.0418	0.0005	0.8353
16		Lower	50	50	50	50	0.0481	0.0489	0.0493	0.0488	0.0006	0.9753
17	7	Upper	50	50	50	50	0.0417	0.0415	0.0418	0.0417	0.0002	0.8333
18		Lower	50	50	50	50	0.0487	0.0482	0.0490	0.0486	0.0004	0.9727
19	8	Upper	50	50	50	50	0.0419	0.0413	0.0408	0.0413	0.0006	0.8267
20		Lower	50	50	50	50	0.0484	0.0493	0.0495	0.0491	0.0006	0.9813
21	9	Upper	50	50	50	50	0.0422	0.0419	0.0415	0.0419	0.0004	0.8373
22		Lower	50	50	50	50	0.0483	0.0487	0.0485	0.0485	0.0002	0.9700
23	10	Upper	50	50	50	50	0.0417	0.0418	0.0414	0.0416	0.0002	0.8327
24		Lower	50	50	50	50	0.0485	0.0488	0.0491	0.0488	0.0003	0.9760
25	11	Upper	50	50	50	50	0.0415	0.0413	0.0418	0.0415	0.0003	0.8307
26		Lower	50	50	50	50	0.0486	0.0488	0.0492	0.0489	0.0003	0.9773
27	12	Upper	50	50	50	50	0.0414	0.0417	0.0412	0.0414	0.0003	0.8287
28		Lower	50	50	50	50	0.0487	0.0489	0.0486	0.0487	0.0002	0.9747

Table A-4 (Continue).

No.	wt% NaCl	Phase	Volume (L)				Mass (g)					Density (g/cm ³)
			no. 1	no. 2	no. 3	average	no. 1	no. 2	no. 3	average	SD	
29	13	Upper	50	50	50	50	0.0417	0.0415	0.0419	0.0417	0.0002	0.8340
30		Lower	50	50	50	50	0.0483	0.0488	0.0485	0.0485	0.0003	0.9707
31	14	Upper	50	50	50	50	0.0415	0.0416	0.0417	0.0416	0.0001	0.8320
32		Lower	50	50	50	50	0.0487	0.0483	0.0492	0.0487	0.0005	0.9747
33	15	Upper	50	50	50	50	0.0418	0.0423	0.0419	0.0420	0.0003	0.8400
34		Lower	50	50	50	50	0.0491	0.0493	0.0495	0.0493	0.0002	0.9860
35	20	Upper	50	50	50	50	0.0415	0.0417	0.0413	0.0415	0.0002	0.8300
36		Lower	50	50	50	50	0.0486	0.0488	0.0492	0.0489	0.0003	0.9773

Table A-5 Interfacial tension of microemulsion system with 0.2 wt% Alfoterra 145-4PO, 0.5 wt% AOT and diesel at different NaCl concentration.

No.	wt% NaCl	Winsor type	IFT (mN/m)				
			1	2	3	average	SD
1	0.0	I	0.233	0.232	0.233	0.233	0.001
2	0.5	I	0.009	0.009	0.009	0.009	0.000
3	1.0	III	0.007	0.007	0.007	0.007	0.000
4	1.5	II	0.045	0.046	0.045	0.045	0.001
5	2.0	II	0.099	0.099	0.098	0.099	0.001
6	3.0	II	0.122	0.121	0.122	0.122	0.001
7	4.0	II	0.231	0.231	0.233	0.232	0.001
8	5.0	II	0.263	0.261	0.263	0.262	0.001
9	6.0	II	0.315	0.314	0.314	0.314	0.001
10	7.0	II	0.553	0.553	0.551	0.552	0.001
11	8.0	II	0.648	0.647	0.648	0.648	0.001
12	9.0	II	0.684	0.683	0.685	0.684	0.001
13	10.0	II	0.827	0.825	0.824	0.825	0.002
14	20.0	II	1.659	1.658	1.659	1.659	0.001

Table A-6 Interfacial tension of microemulsion system with 0.2 wt% Alfoterra 145-4PO, 0.5 wt% AOT and motor oil at different NaCl concentration.

No.	wt% NaCl	Winsor type	IFT (mN/m)				
			1	2	3	average	SD
1	0.0	I	4.621	4.625	4.621	4.622	0.002
2	0.5	I	0.466	0.465	0.465	0.465	0.001
3	1.0	I	0.186	0.185	0.186	0.186	0.001
4	2.0	I	N/A*	N/A*	N/A*	N/A*	x
5	3.0	I	0.177	0.174	0.176	0.176	0.002
6	4.0	III	0.148	0.148	0.148	0.148	0.000
7	5.0	III	0.087	0.090	0.087	0.088	0.002
8	6.0	III	0.225	0.225	0.223	0.224	0.001
9	7.0	III	0.250	0.248	0.247	0.248	0.002
10	8.0	III	0.350	0.351	0.350	0.350	0.001
11	9.0	III	0.365	0.365	0.365	0.365	0.000
12	10.0	III	0.208	0.209	0.208	0.208	0.001
13	15.0	II	0.632	0.633	0.631	0.632	0.001
14	20.0	II	0.878	0.877	0.878	0.878	0.001

Note: N/A* indicates value cannot measured

Appendix B Experimental Data of Column Study.

Table B-1 Relationship between diesel concentration and height at time 18 minutes measured by gas chromatography with flame ionization detector.

Diesel concentration (ppm)	Time (min)		Height (pA)		Average	SD	%RSD
	1	2	1	2			
2500	18.149	18.123	93.27	92.67	92.97	0.42	0.46
5000	18.152	18.128	184.82	180.84	182.83	2.81	1.54
10000	18.159	18.138	365.15	363.70	364.43	1.03	0.28
20000	18.177	18.155	655.95	657.69	656.82	1.23	0.19

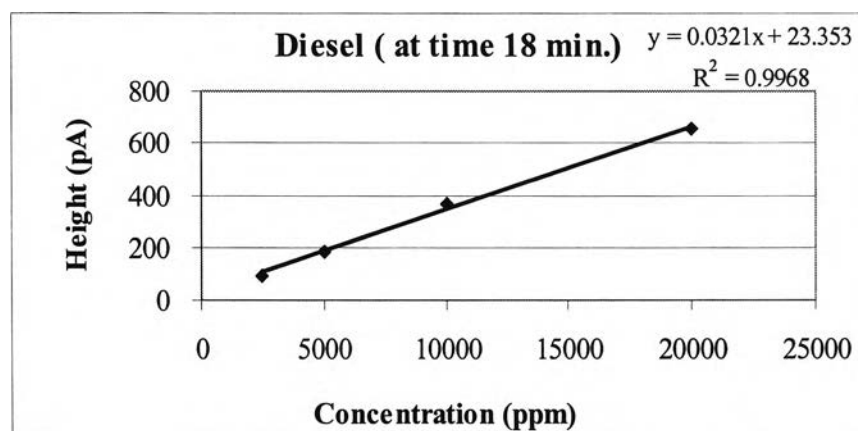


Figure B-1 Relationship between diesel concentration and height at time 18 minutes measured by gas chromatography with flame ionization detector.

Table B-2 Relationship between diesel concentration and height at time 20 minutes measured by gas chromatography with flame ionization detector.

Diesel concentration (ppm)	Time (min)		Height (pA)		Average	SD	%RSD
	1	2	1	2			
2500	20.161	20.136	95.30	96.45	96.38	0.11	0.11
5000	20.165	20.140	191.87	191.18	191.53	0.49	0.25
10000	20.172	20.153	363.54	367.41	365.48	2.74	0.75
20000	20.195	20.173	661.43	675.89	668.66	10.22	1.53

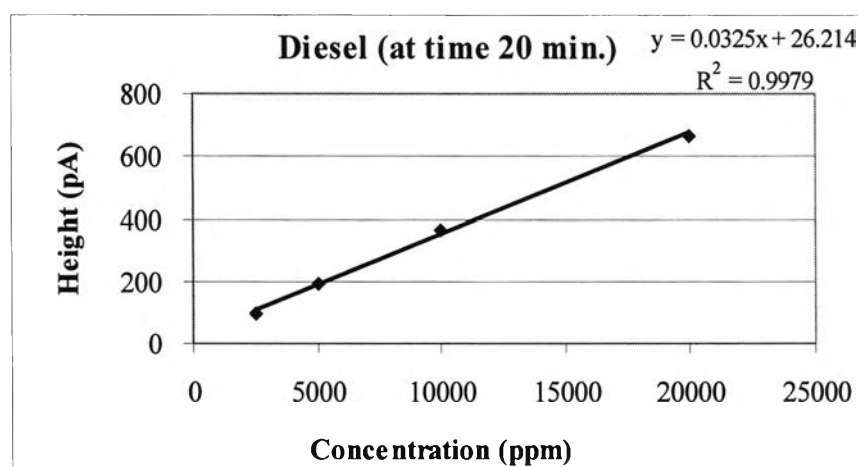


Figure B-2 Relationship between diesel concentration and height at time 20 minutes measured by gas chromatography with flame ionization detector.

Table B-3 Relationship between diesel concentration and height at time 22 minutes measured by gas chromatography with flame ionization detector.

Diesel concentration (ppm)	Time (min)		Height (pA)		Average	SD	%RSD
	1	2	1	2			
2500	22.071	22.043	96.23	98.75	97.49	1.78	1.83
5000	22.074	22.050	195.91	194.61	195.26	0.92	0.47
10000	22.083	22.063	365.23	368.25	366.74	2.14	0.58
20000	22.107	22.085	671.71	677.87	674.79	4.36	0.65

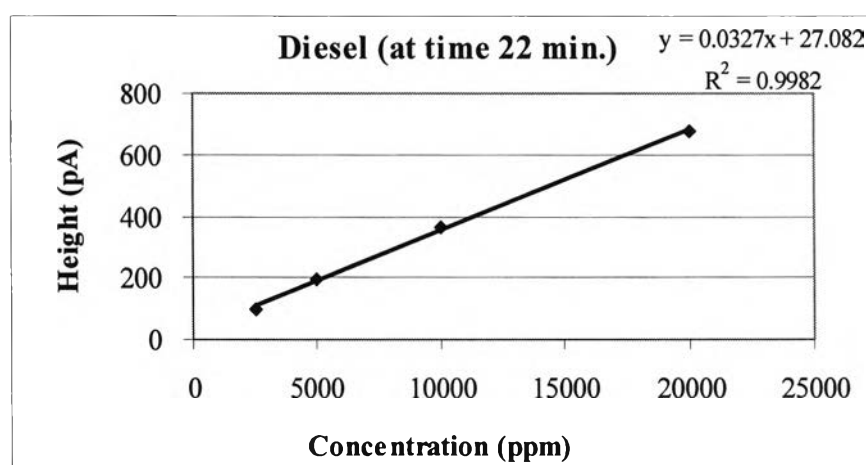


Figure B-3 Relationship between diesel concentration and height at time 22 minutes measured by gas chromatography with flame ionization detector.

Table B-4 Relationship between motor oil concentration and height at time 37 minutes measured by gas chromatography with flame ionization detector.

Motor oil concentration (ppm)	Time (min)		Height (pA)		Average	SD	%RSD
	1	2	1	2			
2500	37.507	37.468	23.92	23.89	23.91	0.02	0.09
5000	37.506	37.477	48.08	47.71	47.90	0.26	0.55
10000	37.527	37.507	86.60	81.82	84.21	3.38	4.01
20000	37.577	37.552	154.24	152.15	153.20	1.48	0.96

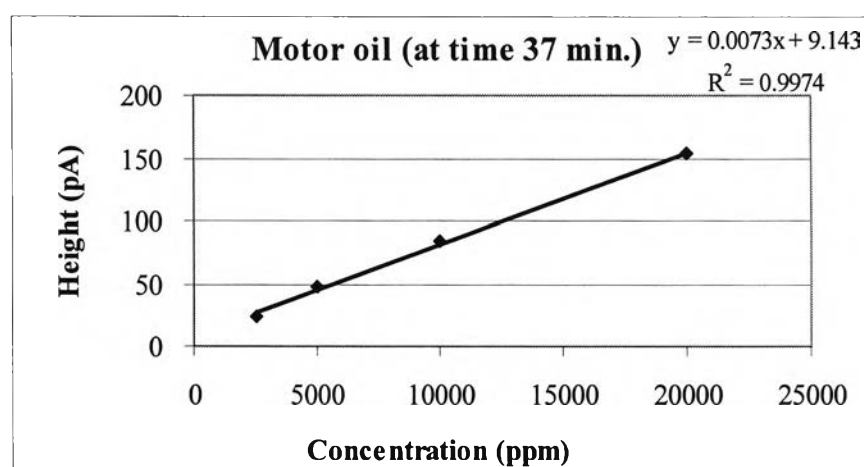


Figure B-4 Relationship between motor oil concentration and height at time 37 minutes measured by gas chromatography with flame ionization detector.



Table B-5 Relationship between motor oil concentration and height at time 38 minutes measured by gas chromatography with flame ionization detector.

Motor oil concentration (ppm)	Time (min)		Height (pA)		Average	SD	%RSD
	1	2	1	2			
2500	38.323	38.648	28.05	26.37	27.21	1.19	4.37
5000	38.683	38.658	54.02	53.26	53.64	0.54	1.00
10000	38.708	38.686	93.46	92.88	93.17	0.41	0.44
20000	38.762	38.734	169.95	163.80	166.88	4.35	2.61

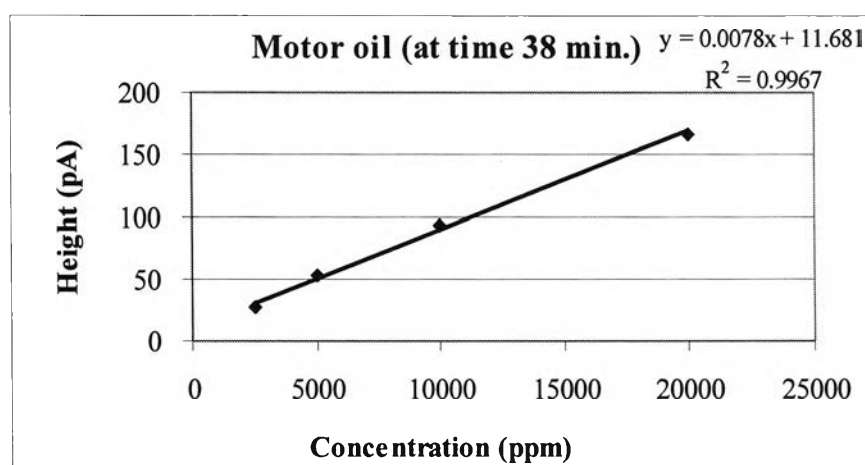


Figure B-5 Relationship between motor oil concentration and height at time 38 minutes measured by gas chromatography with flame ionization detector.

Table B-6 Relationship between motor oil concentration and height at time 39 minutes measured by gas chromatography with flame ionization detector.

Motor oil concentration (ppm)	Time (min)		Height (pA)		Average	SD	%RSD
	1	2	1	2			
2500	39.820	39.782	25.86	24.88	25.39	0.71	2.81
5000	39.821	39.79	51.67	48.41	50.04	2.31	4.61
10000	39.845	39.822	90.14	87.95	89.05	1.55	1.74
20000	39.900	39.872	163.37	159.62	161.50	2.65	1.64

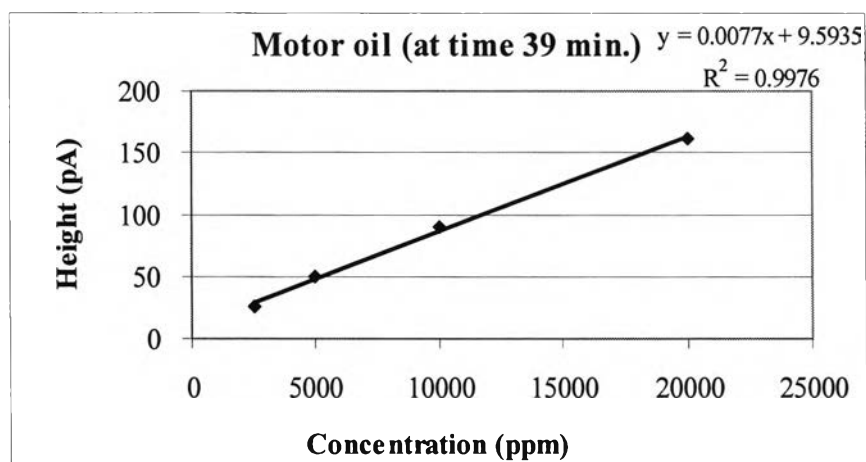


Figure B-6 Relationship between motor oil concentration and height at time 39 minutes measured by gas chromatography with flame ionization detector.

Table B-7 Extraction of diesel with 0.2 wt% Alfoterra, 0.5 wt% AOT by hexane at concentration 2500 ppm measured by gas chromatography.

Time (min)		Height (pA)		Concentration (ppm)		Average	SD	%RSD
1	2	1	2	1	2			
18.152	18.161	109.03	106.70	2669.07	2596.48	2632.78	83.88	3.28
20.166	20.172	111.82	107.25	2634.03	2493.42	2563.73		
22.075	22.082	110.19	105.24	2541.53	2390.15	2465.84		

Table B-8 Extraction of motor oil with 0.2 wt% Alfoterra, 0.5 wt% AOT by hexane at concentration 2500 ppm measured by gas chromatography.

Time (min)		Height (pA)		Concentration (ppm)		Average	SD	%RSD
1	2	1	2	1	2			
37.511	37.504	28.05	27.48	2590.00	2511.92	2550.96	121.49	4.77
38.688	38.681	33.51	32.48	2670.38	2666.54	2668.46		
39.825	39.819	28.11	28.43	2404.74	2446.30	2425.52		

Table B-9 Extraction of diesel and motor oil mixture with 0.2 wt% Alfoterra, 0.5 wt% AOT by hexane at concentration 5000 ppm measured by gas chromatography.

Time (min)		Height (pA)		Concentration (ppm)		Average	SD	%RSD
1	2	1	2	1	2			
18.148	18.142	106.21	109.66	2581.21	2688.69	2634.95	68.07	2.63
20.160	20.152	112.73	110.38	2662.03	2589.72	2625.88		
22.071	22.065	113.20	107.61	2633.58	2462.63	2548.11		
37.509	37.498	28.52	28.68	2654.38	2676.30	2665.34		
38.686	38.677	29.09	32.78	2488.33	2576.79	2532.56		
39.821	39.810	28.75	28.83	2487.86	2498.25	2493.06		

Table B-10 Extraction of diesel with 0.2 wt% Alfoterra, 0.5 wt% AOT by hexane at concentration 5000 ppm measured by gas chromatography.

Time (min)		Height (pA)		Concentration (ppm)		Average	SD	%RSD
1	2	1	2	1	2			
18.116	18.129	187.23	186.95	5105.20	5096.48	5100.84	35.11	0.69
20.132	20.142	189.66	193.49	5029.11	5146.95	5088.03		
22.043	22.053	195.70	195.55	5156.51	5151.93	5154.22		

Table B-11 Extraction of motor oil with 0.2 wt% Alfoterra, 0.5 wt% AOT by hexane at concentration 5000 ppm measured by gas chromatography.

Time (min)		Height (pA)		Concentration (ppm)		Average	SD	%RSD
1	2	1	2	1	2			
37.475	37.478	46.53	45.96	5121.51	5043.42	5082.47	76.51	1.51
38.681	38.656	51.43	52.21	5096.03	5196.03	5146.03		
39.790	39.787	48.06	48.03	4995.65	4991.75	4993.70		

Table B-12 Extraction of diesel and motor oil mixture with 0.2 wt% Alfoterra, 0.5 wt% AOT by hexane at total concentration 10000 ppm measured by gas chromatography.

Time (min)		Height (pA)		Concentration (ppm)		Average	SD	%RSD
1	2	1	2	1	2			
18.128	18.124	183.54	182.98	4990.35	4972.8	4981.58	47.06	0.93
20.142	20.138	191.73	191.88	5092.8	5097.42	5095.11		
22.052	22.050	192.54	191.78	5059.88	5036.64	5048.26		
37.474	37.478	46.19	46.25	5074.93	5082.15	5078.54		
38.651	38.655	52.10	51.02	5181.92	5043.46	5112.69		
39.785	39.792	48.27	48.52	5022.92	5055.39	5039.16		

Table B-13 Extraction of diesel with 0.2 wt% Alfoterra, 0.5 wt% AOT by hexane at concentration 10000 ppm measured by gas chromatography.

Time (min)		Height (pA)		Concentration (ppm)		Average	SD	%RSD
1	2	1	2	1	2			
18.140	18.138	360.56	345.59	10504.89	10038.54	10271.72	5.32	0.05
20.155	20.153	363.02	357.76	10363.30	10201.42	10282.34		
22.067	22.063	371.95	354.29	10546.40	10006.36	10276.39		

Table B-14 Extraction of motor oil with 0.2 wt% Alfoterra, 0.5 wt% AOT by hexane at concentration 10000 ppm measured by gas chromatography.

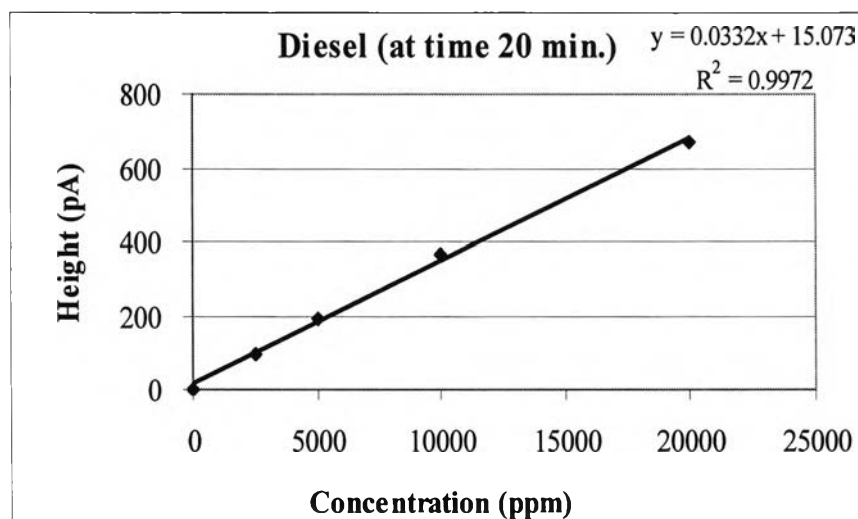
Time (min)		Height (pA)		Concentration (ppm)		Average	SD	%RSD
1	2	1	2	1	2			
37.503	37.504	83.81	85.98	10228.36	10525.62	10376.99	125.63	1.50
38.684	38.686	89.12	91.78	9928.08	10269.10	10098.59		
39.820	39.823	87.59	87.59	10129.40	10129.42	10129.42		

Table B-15 Extraction of diesel and motor oil mixture with 0.2 wt% Alfoterra, 0.5 wt% AOT by hexane at total concentration 20000 ppm measured by gas chromatography.

Time (min)		Height (pA)		Concentration (ppm)		Average	SD	%RSD
1	2	1	2	1	2			
18.139	18.142	362.60	379.63	10568.44	11098.97	10833.71	291.66	2.78
20.154	20.160	365.93	383.47	10452.80	10992.49	10722.65		
22.068	22.071	367.30	381.26	10404.22	10831.13	10617.68		
37.492	37.491	86.89	82.58	10650.27	10059.86	10355.07		
38.671	38.673	93.37	91.86	10473.10	10279.36	10376.23		
39.805	39.808	86.00	87.75	9922.92	10150.19	10036.56		

Table B-16 Relationship between diesel concentration and height at time 20 minutes measured by gas chromatography with flame ionization detector.

Diesel concentration (ppm)	Time (min)		Height (pA)		Average	SD	%RSD
	1	2	1	2			
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2500	20.161	20.136	95.30	96.45	96.38	0.11	0.11
5000	20.165	20.140	191.87	191.18	191.53	0.49	0.25
10000	20.172	20.153	363.54	367.41	365.48	2.74	0.75
20000	20.195	20.173	661.43	675.89	668.66	10.22	1.53





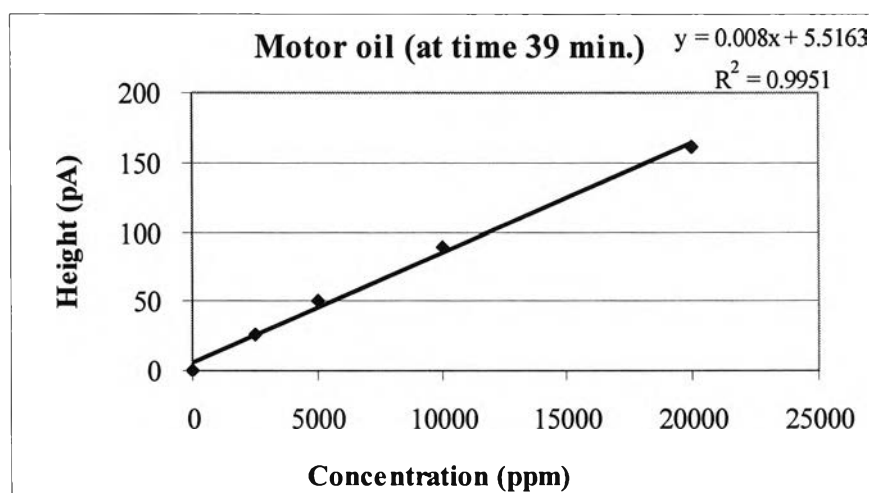
Note:  Diesel peak height
 Linear (Diesel peak height)

Figure B-7 Relationship between diesel concentration and height at time 20 minutes measured by gas chromatography with flame ionization detector.

Table B-17 Relationship between motor oil concentration and height at time 39 minutes measured by gas chromatography with flame ionization detector.

Motor oil concentration (ppm)	Time (min)		Height (pA)		Average	SD	%RSD
	1	2	1	2			
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2500	39.820	39.782	25.86	24.88	25.39	0.71	2.81
5000	39.821	39.79	51.67	48.41	50.04	2.31	4.61
10000	39.845	39.822	90.14	87.95	89.05	1.55	1.74
20000	39.900	39.872	163.37	159.62	161.50	2.65	1.64



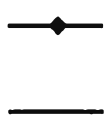

Note:  Motor oil peak height
 Linear (Motor oil peak height)

Figure B-8 Relationship between motor oil concentration and height at time 39 minutes measured by gas chromatography with flame ionization detector.

Table B-18 Diesel and motor oil concentration and weight at different pore volumes of column study flushing with surfactant mixture of 0.2 wt% Alfoterra 145-4PO, 0.5 wt% AOT, and 1 wt% NaCl.

No.	PV	Diesel Concentration (ppm)					Motor oil Concentration (ppm)					Weight of Diesel (mg)	Weight of Motor oil (mg)	Total weight of diesel and motor oil (mg)	
		1	2	Avg	SD	%RSD	1	2	Avg	SD	%RSD				
1	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	1.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	1.2	783.48	786.41	784.94	2.08	1.44	149.03	147.00	148.02	1.44	0.97	6.28	1.18	7.46	
8	1.4	1683.59	1671.84	1677.71	8.31	0.50	1225.60	1217.47	1221.53	5.75	0.47	13.42	9.77	23.19	
9	1.6	1731.07	1796.16	1763.61	46.03	2.61	1237.78	1256.06	1246.92	12.93	1.04	14.11	9.98	24.08	
10	1.8	1696.80	1730.09	1713.45	23.53	1.37	1215.44	1268.25	1241.85	37.34	3.01	13.71	9.93	23.64	
11	2.0	1474.59	1531.37	1502.98	40.15	2.67	1262.16	1351.53	1306.85	63.20	4.84	12.02	10.45	22.48	
12	2.2	1465.78	1524.51	1495.15	41.53	2.78	1227.63	1302.78	1265.20	53.14	4.20	11.96	10.12	22.08	
13	2.4	1851.47	1931.74	1891.61	56.76	3.00	1672.47	1737.47	1704.97	45.96	2.70	15.13	13.64	28.77	
14	2.6	1379.63	1382.08	1380.86	1.73	0.13	1016.38	1010.28	1013.33	4.31	0.43	11.05	8.11	19.15	
15	2.8	1758.96	1824.56	1791.76	46.38	2.59	1284.50	1274.35	1279.42	7.18	0.56	14.33	10.24	24.57	
16	3.0	1799.10	1870.56	1834.83	50.53	2.75	1369.81	1323.10	1346.45	33.04	2.45	14.68	10.77	25.45	
17	3.2	1051.70	1024.78	1038.24	19.04	1.83	541.06	512.63	526.85	20.11	3.82	8.31	4.21	12.52	
18	3.4	8221.77	8364.20	8292.98	100.71	1.21	8332.94	8473.10	8403.02	99.11	1.18	66.34	67.22	133.57	

Table B-18 (Continue).

No.	PV	Diesel Concentration (ppm)					Motor oil Concentration (ppm)					Weight of Diesel (mg)	Weight of Motor oil (mg)	Total weight of diesel and motor oil (mg)
		1	2	Avg	SD	%RSD	1	2	Avg	SD	%RSD			
19	3.6	20614.84	20505.20	20560.02	77.53	0.38	22027.63	22352.63	22190.13	229.81	1.04	164.48	177.52	342.00
20	3.8	13954.30	14151.55	14052.92	139.48	0.99	14792.31	15192.47	14992.39	282.95	1.89	112.42	119.94	232.36
21	4.0	12118.83	12271.54	12195.18	107.98	0.89	11211.22	11426.53	11318.88	152.25	1.35	97.56	90.55	188.11
22	4.2	11621.54	11503.09	11562.32	83.76	0.72	10169.19	10018.88	10094.03	106.29	1.05	92.50	80.75	173.25
23	4.4	3776.02	3933.14	3854.58	111.10	2.88	3510.75	3673.25	3592.00	114.90	3.20	30.84	28.74	59.57
24	4.6	4758.36	4883.17	4820.77	88.26	1.83	4658.41	4792.47	4725.44	94.80	2.01	38.57	37.80	76.37
25	4.8	6315.33	6329.03	6322.18	9.69	0.15	6084.35	6263.10	6173.72	126.40	2.05	50.58	49.39	99.97
26	5.0	5730.43	5785.24	5757.84	38.76	0.67	4961.06	5042.31	5001.69	57.45	1.15	46.06	40.01	86.08
27	5.2	11735.09	11711.11	11723.10	16.96	0.14	12484.81	12356.85	12420.83	90.49	0.73	93.78	99.37	193.15
28	5.4	15298.35	15433.93	15366.14	95.87	0.62	13260.75	13236.38	13248.56	17.24	0.13	122.93	105.99	228.92
29	5.6	832.42	845.64	839.03	9.34	1.11	400.91	415.13	408.02	10.05	2.46	6.71	3.26	9.98
30	5.8	1806.93	1771.20	1789.07	25.27	1.41	1065.13	1022.47	1043.80	30.16	2.89	14.31	8.35	22.66
31	6.0	7433.25	7595.75	7514.50	114.90	1.53	7158.88	7542.78	7350.83	271.46	3.69	60.12	58.81	118.92
32	6.2	8638.29	8679.41	8658.85	29.07	0.34	9088.56	9121.06	9104.81	22.98	0.25	69.27	72.84	142.11
33	6.4	5034.91	5227.75	5131.33	136.36	2.66	4820.91	5066.69	4943.80	173.79	3.52	41.05	39.55	80.60
34	6.6	4106.40	4038.37	4072.39	48.11	1.18	3579.81	3382.78	3481.30	139.32	4.00	32.58	27.85	60.43
35	6.8	2748.65	2905.27	2826.96	110.75	3.92	1853.25	1936.53	1894.89	58.89	3.11	22.62	15.16	37.77
36	7.0	2092.29	2017.89	2055.09	52.61	2.56	2543.88	2641.38	2592.63	68.94	2.66	16.44	20.74	37.18
37	7.2	1654.22	1580.31	1617.27	52.26	3.23	1241.85	1217.47	1229.66	17.24	1.40	12.94	9.84	22.78

Table B-18 (Continue).

No.	PV	Diesel Concentration (ppm)					Motor oil Concentration (ppm)					Weight of Diesel (mg)	Weight of Motor oil (mg)	Total weight of diesel and motor oil (mg)
		1	2	Avg	SD	%RSD	1	2	Avg	SD	%RSD			
38	7.4	1084.00	1076.66	1080.33	5.19	0.48	620.28	587.78	604.03	22.98	3.80	8.64	4.83	13.47
39	7.6	1019.88	1057.08	1038.48	26.30	2.53	628.41	624.35	626.38	2.87	0.46	8.31	5.01	13.32
40	7.8	986.60	985.62	986.11	0.69	0.07	612.16	610.13	611.14	1.44	0.24	7.89	4.89	12.78
41	8.0	1560.73	1641.98	1601.36	57.45	3.59	1087.47	1075.28	1081.38	8.62	0.80	12.81	8.65	21.46
42	8.2	1154.48	1085.47	1119.98	48.80	4.36	551.22	541.06	546.14	7.18	1.31	8.96	4.37	13.33
43	8.4	959.19	975.83	967.51	11.77	1.22	400.91	409.03	404.97	5.75	1.42	7.74	3.24	10.98
44	8.6	1032.12	1048.76	1040.44	11.77	1.13	610.13	630.44	620.28	14.36	2.32	8.32	4.96	13.29
45	8.8	787.88	787.88	787.88	0.00	0.00	185.60	191.69	188.64	4.31	2.28	6.30	1.51	7.81
46	9.0	1024.78	1031.63	1028.20	4.85	0.47	553.25	559.35	556.30	4.31	0.77	8.23	4.45	12.68
47	9.2	2487.77	2373.72	2430.75	80.64	3.32	1554.66	1528.25	1541.45	18.67	1.21	19.45	12.33	31.78
48	9.4	4160.24	4135.77	4148.01	17.30	0.42	3858.10	3620.44	3739.27	168.05	4.49	33.18	29.91	63.10
49	9.6	13812.84	13963.60	13888.22	106.60	0.77	12393.41	12499.03	12446.22	74.69	0.60	111.11	99.57	210.68
50	9.8	40887.69	41074.18	40980.93	131.86	0.32	35060.13	35980.28	35520.20	650.65	1.83	327.85	284.16	612.01
51	10.0	41065.37	41316.95	41191.16	177.89	0.43	38429.97	39147.00	38788.49	507.02	1.31	329.53	310.31	639.84
52	10.2	32071.09	32284.00	32177.55	150.55	0.47	27495.75	27776.06	27635.91	198.21	0.72	257.42	221.09	478.51
53	10.4	6030.46	6237.99	6134.23	146.75	2.39	4975.28	5247.47	5111.38	192.47	3.77	49.07	40.89	89.96
54	10.6	5206.22	5310.47	5258.34	73.72	1.40	4225.75	4170.91	4198.33	38.78	0.92	42.07	33.59	75.65
55	10.8	1432.50	1421.73	1427.11	7.61	0.53	429.35	423.25	426.30	4.31	1.01	11.42	3.41	14.83
56	11.0	2069.77	2137.80	2103.79	48.11	2.29	1591.22	1672.47	1631.85	57.45	3.52	16.83	13.05	29.89

Table B-18 (Continue).

No.	PV	Diesel Concentration (ppm)					Motor oil Concentration (ppm)					Weight of Diesel (mg)	Weight of Motor oil (mg)	Total weight of diesel and motor oil (mg)
		1	2	Avg	SD	%RSD	1	2	Avg	SD	%RSD			
57	11.2	999.82	1012.54	1006.18	9.00	0.89	352.16	350.13	351.14	1.44	0.41	8.05	2.81	10.86
58	11.4	1118.26	1110.92	1114.59	5.19	0.47	575.60	561.38	568.49	10.05	1.77	8.92	4.55	13.46
59	11.6	1598.42	1590.59	1594.51	5.54	0.35	1347.47	1339.35	1343.41	5.75	0.43	12.76	10.75	23.50
60	11.8	1131.48	1125.61	1128.54	4.15	0.37	634.50	636.53	635.52	1.44	0.23	9.03	5.08	14.11
61	12.0	1237.20	1224.48	1230.84	9.00	0.73	721.85	711.69	716.77	7.18	1.00	9.85	5.73	15.58
62	12.2	1186.30	1163.29	1174.80	16.27	1.38	662.94	638.56	650.75	17.24	2.65	9.40	5.21	14.60
63	12.4	734.53	736.49	735.51	1.38	0.19	142.94	140.91	141.92	1.44	1.01	5.88	1.14	7.02
64	12.6	851.51	847.10	849.31	3.11	0.37	181.53	177.47	179.50	2.87	1.60	6.79	1.44	8.23
65	12.8	850.53	898.99	874.76	34.26	3.92	199.81	207.94	203.88	5.75	2.82	7.00	1.63	8.63
66	13.0	1473.61	1527.45	1500.53	38.07	2.54	1018.41	1040.75	1029.58	15.80	1.53	12.00	8.24	20.24
67	13.2	934.23	945.98	940.10	8.31	0.88	366.38	374.50	370.44	5.75	1.55	7.52	2.96	10.48
68	13.4	1099.66	1045.82	1072.74	38.07	3.55	463.88	453.72	458.80	7.18	1.57	8.58	3.67	12.25
69	13.6	1128.05	1154.97	1141.51	19.04	1.67	591.85	602.00	596.92	7.18	1.20	9.13	4.78	13.91
70	13.8	898.99	905.35	902.17	4.50	0.50	224.19	222.16	223.17	1.44	0.64	7.22	1.79	9.00
71	14.0	1552.90	1599.89	1576.40	33.23	2.11	1099.66	1097.63	1098.64	1.44	0.13	12.61	8.79	21.40
72	14.2	1108.96	1100.15	1104.56	6.23	0.56	522.78	526.85	524.81	2.87	0.55	8.84	4.20	13.03
73	14.4	1605.27	1550.95	1578.11	38.42	2.43	1377.94	1473.41	1425.67	67.51	4.74	12.62	11.41	24.03
74	14.6	660.13	686.07	673.10	18.34	2.73	59.66	57.63	58.64	1.44	2.45	5.38	0.47	5.85
75	14.8	730.12	734.53	732.33	3.11	0.43	179.50	185.60	182.55	4.31	2.36	5.86	1.46	7.32

Table B-18 (Continue).

No.	PV	Diesel Concentration (ppm)					Motor oil Concentration (ppm)					Weight of Diesel (mg)	Weight of Motor oil (mg)	Total weight of diesel and motor oil (mg)
		1	2	Avg	SD	%RSD	1	2	Avg	SD	%RSD			
76	15.0	652.30	696.84	674.57	31.50	4.67	114.50	120.60	117.55	4.31	3.67	5.40	0.94	6.34
77	15.2	1179.94	1187.28	1183.61	5.19	0.44	797.00	792.94	794.97	2.87	0.36	9.47	6.36	15.83
78	15.4	993.45	1001.28	997.37	5.54	0.56	388.72	396.85	392.78	5.75	1.46	7.98	3.14	11.12
79	15.6	622.93	626.85	624.89	2.77	0.44	106.38	110.44	108.41	2.87	2.65	5.00	0.87	5.87
80	15.8	672.86	693.90	683.38	14.88	2.18	173.41	183.56	178.49	7.18	4.02	5.47	1.43	6.89
81	16.0	692.44	738.93	715.69	32.88	4.59	199.81	205.91	202.86	4.31	2.12	5.73	1.62	7.35
82	16.2	966.04	964.57	965.31	1.04	0.11	421.22	427.31	424.27	4.31	1.02	7.72	3.39	11.12
83	16.4	748.72	765.37	757.04	11.77	1.55	173.41	177.47	175.44	2.87	1.64	6.06	1.40	7.46
84	16.6	516.72	522.10	519.41	3.81	0.73	21.06	23.10	22.08	1.44	6.51	4.16	0.18	4.33
85	16.8	480.99	487.35	484.17	4.50	0.93	10.91	10.91	10.91	0.00	0.00	3.87	0.09	3.96
86	17.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
87	17.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
88	17.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
89	17.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
90	17.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
91	18.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
92	18.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
93	18.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
94	18.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table B-18 (Continue).

No.	PV	Diesel Concentration (ppm)					Motor oil Concentration (ppm)					Weight of Diesel (mg)	Weight of Motor oil (mg)	Total weight of diesel and motor oil (mg)	
		1	2	Avg	SD	%RSD	1	2	Avg	SD	%RSD				
95	18.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
96	19.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
97	19.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
98	19.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
99	19.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
100	19.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
101	20.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table B-19 Diesel and motor oil accumulative removal, mobilization, and solubilization at different pore volumes of column study flushing with surfactant mixture of 0.2 wt% Alforterra 145-4PO, 0.5 wt% AOT, and 1 wt% NaCl.

No.	PV	Diesel Accumulative Removal (mg)	Motor oil Accumulative Removal (mg)	Total of diesel and motor oil Accumulative Removal (mg)	Mixed diesel and motor oil mobilization (mg)	Mixed diesel and motor oil accumulative mobilization (mg)	Mixed diesel and motor oil solubilization (mg)	Mixed diesel and motor oil accumulative solubilization (mg)
1	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	1.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	1.2	6.28	1.18	7.46	0.00	0.00	7.46	7.46
8	1.4	19.70	10.96	30.66	0.00	0.00	23.19	30.66
9	1.6	33.81	20.93	54.74	0.00	0.00	24.08	54.74
10	1.8	47.52	30.87	78.38	0.00	0.00	23.64	78.38
11	2.0	59.54	41.32	100.86	0.00	0.00	22.48	100.86
12	2.2	71.50	51.44	122.95	0.00	0.00	22.08	122.95
13	2.4	86.64	65.08	151.72	0.00	0.00	28.77	151.72
14	2.6	97.68	73.19	170.87	0.00	0.00	19.15	170.87
15	2.8	112.02	83.42	195.44	0.00	0.00	24.57	195.44
16	3.0	126.70	94.20	220.89	0.00	0.00	25.45	220.89
17	3.2	135.00	98.41	233.41	0.00	0.00	12.52	233.41
18	3.4	201.34	165.64	366.98	85.63	85.63	47.94	281.35

Table B-19 (Continue).

No.	PV	Diesel Accumulative Removal (mg)	Motor oil Accumulative Removal (mg)	Total of diesel and motor oil Accumulative Removal (mg)	Mixed diesel and motor oil mobilization (mg)	Mixed diesel and motor oil accumulative mobilization (mg)	Mixed diesel and motor oil solubilization (mg)	Mixed diesel and motor oil accumulative solubilization (mg)
19	3.6	365.83	343.16	708.98	85.63	171.25	256.38	537.73
20	3.8	478.25	463.10	941.34	85.63	256.88	146.74	684.47
21	4.0	575.81	553.65	1129.46	85.63	342.50	102.49	786.95
22	4.2	668.31	634.40	1302.71	85.63	428.13	87.62	874.58
23	4.4	699.15	663.13	1362.28	0.00	428.13	59.57	934.15
24	4.6	737.71	700.94	1438.65	0.00	428.13	76.37	1010.52
25	4.8	788.29	750.33	1538.62	85.63	513.76	14.34	1024.86
26	5.0	834.35	790.34	1624.69	85.63	599.38	0.45	1025.31
27	5.2	928.14	889.71	1817.84	85.63	685.01	107.53	1132.84
28	5.4	1051.07	995.70	2046.76	85.63	770.63	143.29	1276.13
29	5.6	1057.78	998.96	2056.74	0.00	770.63	9.98	1286.10
30	5.8	1072.09	1007.31	2079.40	0.00	770.63	22.66	1308.77
31	6.0	1132.21	1066.12	2198.32	85.63	856.26	33.30	1342.06
32	6.2	1201.48	1138.96	2340.43	85.63	941.89	56.48	1398.55
33	6.4	1242.53	1178.51	2421.03	0.00	941.89	80.60	1479.15
34	6.6	1275.11	1206.36	2481.46	0.00	941.89	60.43	1539.58
35	6.8	1297.72	1221.52	2519.24	0.00	941.89	37.77	1577.35
36	7.0	1314.16	1242.26	2556.42	0.00	941.89	37.18	1614.53
37	7.2	1327.10	1252.09	2579.20	0.00	941.89	22.78	1637.31
38	7.4	1335.74	1256.93	2592.67	0.00	941.89	13.47	1650.78

Table B-19 (Continue).

No.	PV	Diesel Accumulative Removal (mg)	Motor oil Accumulative Removal (mg)	Total of diesel and motor oil Accumulative Removal (mg)	Mixed diesel and motor oil mobilization (mg)	Mixed diesel and motor oil accumulative mobilization (mg)	Mixed diesel and motor oil solubilization (mg)	Mixed diesel and motor oil accumulative solubilization (mg)
39	7.6	1344.05	1261.94	2605.99	0.00	941.89	13.32	1664.10
40	7.8	1351.94	1266.83	2618.77	0.00	941.89	12.78	1676.88
41	8.0	1364.75	1275.48	2640.23	0.00	941.89	21.46	1698.34
42	8.2	1373.71	1279.85	2653.56	0.00	941.89	13.33	1711.67
43	8.4	1381.45	1283.09	2664.54	0.00	941.89	10.98	1722.65
44	8.6	1389.77	1288.05	2677.82	0.00	941.89	13.29	1735.94
45	8.8	1396.08	1289.56	2685.64	0.00	941.89	7.81	1743.75
46	9.0	1404.30	1294.01	2698.31	0.00	941.89	12.68	1756.43
47	9.2	1423.75	1306.34	2730.09	0.00	941.89	31.78	1788.20
48	9.4	1456.93	1336.25	2793.19	0.00	941.89	63.10	1851.30
49	9.6	1568.04	1435.82	3003.86	85.63	1027.51	125.05	1976.35
50	9.8	1895.89	1719.99	3615.87	342.50	1370.02	269.51	2245.86
51	10.0	2225.42	2030.29	4255.71	342.50	1712.52	297.33	2543.19
52	10.2	2482.84	2251.38	4734.22	256.88	1969.40	221.63	2764.82
53	10.4	2531.91	2292.27	4824.18	85.63	2055.02	4.34	2769.16
54	10.6	2573.98	2325.86	4899.84	85.63	2140.65	-9.97	2759.19
55	10.8	2585.39	2329.27	4914.66	0.00	2140.65	14.83	2774.01
56	11.0	2602.22	2342.32	4944.55	0.00	2140.65	29.89	2803.90
57	11.2	2610.27	2345.13	4955.41	0.00	2140.65	10.86	2814.76

Table B-19 (Continue).

No.	PV	Diesel Accumulative Removal (mg)	Motor oil Accumulative Removal (mg)	Total of diesel and motor oil Accumulative Removal (mg)	Mixed diesel and motor oil mobilization (mg)	Mixed diesel and motor oil accumulative mobilization (mg)	Mixed diesel and motor oil solubilization (mg)	Mixed diesel and motor oil accumulative solubilization (mg)
58	11.4	2619.19	2349.68	4968.87	0.00	2140.65	13.46	2828.22
59	11.6	2631.95	2360.43	4992.37	0.00	2140.65	23.50	2851.72
60	11.8	2640.97	2365.51	5006.49	0.00	2140.65	14.11	2865.84
61	12.0	2650.82	2371.25	5022.07	0.00	2140.65	15.58	2881.42
62	12.2	2660.22	2376.45	5036.67	0.00	2140.65	14.60	2896.02
63	12.4	2666.10	2377.59	5043.69	0.00	2140.65	7.02	2903.04
64	12.6	2672.90	2379.02	5051.92	0.00	2140.65	8.23	2911.27
65	12.8	2679.90	2380.65	5060.55	0.00	2140.65	8.63	2919.90
66	13.0	2691.90	2388.89	5080.79	0.00	2140.65	20.24	2940.14
67	13.2	2699.42	2391.85	5091.28	0.00	2140.65	10.48	2950.63
68	13.4	2708.00	2395.53	5103.53	0.00	2140.65	12.25	2962.88
69	13.6	2717.14	2400.30	5117.44	0.00	2140.65	13.91	2976.79
70	13.8	2724.35	2402.09	5126.44	0.00	2140.65	9.00	2985.79
71	14.0	2736.96	2410.88	5147.84	0.00	2140.65	21.40	3007.19
72	14.2	2745.80	2415.07	5160.87	0.00	2140.65	13.03	3020.22
73	14.4	2758.43	2426.48	5184.90	0.00	2140.65	24.03	3044.25
74	14.6	2763.81	2426.95	5190.76	0.00	2140.65	5.85	3050.11
75	14.8	2769.67	2428.41	5198.08	0.00	2140.65	7.32	3057.43
76	15.0	2775.07	2429.35	5204.41	0.00	2140.65	6.34	3063.76

Table B-19 (Continue).

No.	PV	Diesel Accumulative Removal (mg)	Motor oil Accumulative Removal (mg)	Total of diesel and motor oil Accumulative Removal (mg)	Mixed diesel and motor oil mobilization (mg)	Mixed diesel and motor oil accumulative mobilization (mg)	Mixed diesel and motor oil solubilization (mg)	Mixed diesel and motor oil accumulative solubilization (mg)
77	15.2	2784.53	2435.71	5220.24	0.00	2140.65	15.83	3079.59
78	15.4	2792.51	2438.85	5231.36	0.00	2140.65	11.12	3090.71
79	15.6	2797.51	2439.72	5237.23	0.00	2140.65	5.87	3096.58
80	15.8	2802.98	2441.15	5244.13	0.00	2140.65	6.89	3103.48
81	16.0	2808.70	2442.77	5251.47	0.00	2140.65	7.35	3110.82
82	16.2	2816.43	2446.16	5262.59	0.00	2140.65	11.12	3121.94
83	16.4	2822.48	2447.57	5270.05	0.00	2140.65	7.46	3129.40
84	16.6	2826.64	2447.74	5274.38	0.00	2140.65	4.33	3133.73
85	16.8	2830.51	2447.83	5278.34	0.00	2140.65	3.96	3137.69
86	17.0	2830.51	2447.83	5278.34	0.00	2140.65	0.00	3137.69
87	17.2	2830.51	2447.83	5278.34	0.00	2140.65	0.00	3137.69
88	17.4	2830.51	2447.83	5278.34	0.00	2140.65	0.00	3137.69
89	17.6	2830.51	2447.83	5278.34	0.00	2140.65	0.00	3137.69
90	17.8	2830.51	2447.83	5278.34	0.00	2140.65	0.00	3137.69
91	18.0	2830.51	2447.83	5278.34	0.00	2140.65	0.00	3137.69
92	18.2	2830.51	2447.83	5278.34	0.00	2140.65	0.00	3137.69
93	18.4	2830.51	2447.83	5278.34	0.00	2140.65	0.00	3137.69
94	18.6	2830.51	2447.83	5278.34	0.00	2140.65	0.00	3137.69
95	18.8	2830.51	2447.83	5278.34	0.00	2140.65	0.00	3137.69

Table B-19 (Continue).

No.	PV	Diesel Accumulative Removal (mg)	Motor oil Accumulative Removal (mg)	Total of diesel and motor oil Accumulative Removal (mg)	Mixed diesel and motor oil mobilization (mg)	Mixed diesel and motor oil accumulative mobilization (mg)	Mixed diesel and motor oil solubilization (mg)	Mixed diesel and motor oil accumulative solubilization (mg)
96	19.0	2830.51	2447.83	5278.34	0.00	2140.65	0.00	3137.69
97	19.2	2830.51	2447.83	5278.34	0.00	2140.65	0.00	3137.69
98	19.4	2830.51	2447.83	5278.34	0.00	2140.65	0.00	3137.69
99	19.6	2830.51	2447.83	5278.34	0.00	2140.65	0.00	3137.69
100	19.8	2830.51	2447.83	5278.34	0.00	2140.65	0.00	3137.69
101	20.0	2830.51	2447.83	5278.34	0.00	2140.65	0.00	3137.69

Table B-20 Diesel and motor oil concentration and weight at different pore volumes of column study flushing with surfactant mixture of 0.2 wt% Alfoterra 145-4PO, 0.5 wt% AOT, and 5 wt% NaCl.

No.	PV	Diesel Concentration (ppm)					Motor oil Concentration (ppm)					Weight of Diesel (mg)	Weight of Motor oil (mg)	Total weight of diesel and motor oil (mg)
		1	2	Avg	SD	%RSD	1	2	Avg	SD	%RSD			
1	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	1.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	1.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	1.4	431.07	426.17	428.62	3.46	0.81	230.28	240.44	235.36	7.18	3.05	3.43	1.88	5.31
9	1.6	535.32	549.02	542.17	9.69	1.79	319.66	331.85	325.75	8.62	2.65	4.34	2.61	6.94
10	1.8	860.32	822.14	841.23	27.00	3.21	855.91	900.60	878.25	31.60	3.60	6.73	7.03	13.76
11	2.0	3472.07	3436.83	3454.45	24.92	0.72	3569.66	3358.41	3464.03	149.38	4.31	27.64	27.71	55.35
12	2.2	4942.89	4785.28	4864.09	111.44	2.29	4902.16	5135.75	5018.95	165.18	3.29	38.91	40.15	79.06
13	2.4	5634.98	5626.17	5630.58	6.23	0.11	6265.13	6575.91	6420.52	219.76	3.42	45.04	51.36	96.41
14	2.6	5595.34	5584.08	5589.71	7.96	0.14	5641.53	5867.00	5754.27	159.43	2.77	44.72	46.03	90.75
15	2.8	3578.77	3685.96	3632.36	75.80	2.09	3835.75	4083.56	3959.66	175.23	4.43	29.06	31.68	60.74
16	3.0	1107.01	1090.85	1098.93	11.42	1.04	859.97	841.69	850.83	12.93	1.52	8.79	6.81	15.60
17	3.2	2161.30	2177.94	2169.62	11.77	0.54	1902.00	1839.03	1870.52	44.53	2.38	17.36	14.96	32.32
18	3.4	383.10	384.08	383.59	0.69	0.18	39.35	41.38	40.36	1.44	3.56	3.07	0.32	3.39

Table B-20 (Continue).

No.	PV	Diesel Concentration (ppm)					Motor oil Concentration (ppm)					Weight of Diesel (mg)	Weight of Motor oil (mg)	Total weight of diesel and motor oil (mg)
		1	2	Avg	SD	%RSD	1	2	Avg	SD	%RSD			
19	3.6	2084.94	2082.99	2083.96	1.38	0.07	1879.66	1841.06	1860.36	27.29	1.47	16.67	14.88	31.55
20	3.8	7177.26	7137.13	7157.20	28.38	0.40	8944.35	8865.13	8904.74	56.02	0.63	57.26	71.24	128.50
21	4.0	1207.35	1202.94	1205.14	3.11	0.26	884.35	894.50	889.42	7.18	0.81	9.64	7.12	16.76
22	4.2	2948.35	2957.65	2953.00	6.58	0.22	3165.44	3220.28	3192.86	38.78	1.21	23.62	25.54	49.17
23	4.4	1326.77	1250.42	1288.60	53.99	4.19	1105.75	1059.03	1082.39	33.04	3.05	10.31	8.66	18.97
24	4.6	1107.99	1107.50	1107.74	0.35	0.03	756.38	744.19	750.28	8.62	1.15	8.86	6.00	14.86
25	4.8	582.80	558.32	570.56	17.30	3.03	350.13	339.97	345.05	7.18	2.08	4.56	2.76	7.32
26	5.0	1126.10	1077.15	1101.62	34.61	3.14	918.88	943.25	931.06	17.24	1.85	8.81	7.45	16.26
27	5.2	1107.99	1116.80	1112.39	6.23	0.56	756.38	746.22	751.30	7.18	0.96	8.90	6.01	14.91
28	5.4	2390.85	2387.92	2389.39	2.08	0.09	2271.69	2121.38	2196.53	106.29	4.84	19.12	17.57	36.69
29	5.6	1761.41	1778.05	1769.73	11.77	0.66	1296.69	1266.22	1281.45	21.54	1.68	14.16	10.25	24.41
30	5.8	2051.17	2053.13	2052.15	1.38	0.07	1830.91	1912.16	1871.53	57.45	3.07	16.42	14.97	31.39
31	6.0	1247.97	1203.43	1225.70	31.50	2.57	992.00	1024.50	1008.25	22.98	2.28	9.81	8.07	17.87
32	6.2	2830.39	2845.07	2837.73	10.38	0.37	3143.10	3090.28	3116.69	37.34	1.20	22.70	24.93	47.64
33	6.4	704.18	662.58	683.38	29.42	4.30	632.47	669.03	650.75	25.85	3.97	5.47	5.21	10.67
34	6.6	2401.13	2414.84	2407.99	9.69	0.40	1969.03	1997.47	1983.25	20.11	1.01	19.26	15.87	35.13
35	6.8	5217.47	5256.63	5237.05	27.69	0.53	5755.28	6114.81	5935.05	254.23	4.28	41.90	47.48	89.38
36	7.0	3324.74	3236.64	3280.69	62.30	1.90	3669.19	3882.47	3775.83	150.81	3.99	26.25	30.21	56.45
37	7.2	1711.00	1720.79	1715.89	6.92	0.40	1189.03	1274.35	1231.69	60.33	4.90	13.73	9.85	23.58

Table B-20 (Continue).

No.	PV	Diesel Concentration (ppm)					Motor oil Concentration (ppm)					Weight of Diesel (mg)	Weight of Motor oil (mg)	Total weight of diesel and motor oil (mg)
		1	2	Avg	SD	%RSD	1	2	Avg	SD	%RSD			
38	7.4	3657.08	3681.55	3669.32	17.30	0.47	3169.50	3394.97	3282.24	159.43	4.86	29.35	26.26	55.61
39	7.6	1449.63	1459.42	1454.52	6.92	0.48	1424.66	1475.44	1450.05	35.91	2.48	11.64	11.60	23.24
40	7.8	1104.56	1103.58	1104.07	0.69	0.06	920.91	939.19	930.05	12.93	1.39	8.83	7.44	16.27
41	8.0	557.35	550.00	553.67	5.19	0.94	313.56	323.72	318.64	7.18	2.25	4.43	2.55	6.98
42	8.2	918.57	914.16	916.36	3.11	0.34	857.94	837.63	847.78	14.36	1.69	7.33	6.78	14.11
43	8.4	503.02	512.80	507.91	6.92	1.36	209.97	222.16	216.06	8.62	3.99	4.06	1.73	5.79
44	8.6	1215.67	1220.56	1218.11	3.46	0.28	902.63	888.41	895.52	10.05	1.12	9.74	7.16	16.91
45	8.8	2697.74	2723.69	2710.72	18.34	0.68	3134.97	3344.19	3239.58	147.94	4.57	21.69	25.92	47.60
46	9.0	1129.52	1126.59	1128.05	2.08	0.18	1044.81	1117.94	1081.38	51.71	4.78	9.02	8.65	17.68
47	9.2	1658.14	1664.99	1661.56	4.85	0.29	1540.44	1524.19	1532.31	11.49	0.75	13.29	12.26	25.55
48	9.4	4151.43	4149.97	4150.70	1.04	0.03	5338.88	5485.13	5412.00	103.41	1.91	33.21	43.30	76.50
49	9.6	6639.84	6630.05	6634.94	6.92	0.10	8960.60	8481.22	8720.91	338.97	3.89	53.08	69.77	122.85
50	9.8	9309.34	9462.54	9385.94	108.33	1.15	10703.41	11345.28	11024.35	453.87	4.12	75.09	88.19	163.28
51	10.0	17006.07	16917.47	16961.77	62.64	0.37	23067.63	22190.13	22628.88	620.49	2.74	135.69	181.03	316.73
52	10.2	9660.77	9568.75	9614.76	65.07	0.68	11798.25	11355.44	11576.85	313.12	2.70	76.92	92.61	169.53
53	10.4	8679.90	8601.59	8640.74	55.38	0.64	10526.69	9880.75	10203.72	456.75	4.48	69.13	81.63	150.76
54	10.6	4562.58	4419.17	4490.87	101.41	2.26	4737.63	4623.88	4680.75	80.43	1.72	35.93	37.45	73.37
55	10.8	2258.21	2284.64	2271.43	18.69	0.82	2568.25	2582.47	2575.36	10.05	0.39	18.17	20.60	38.77
56	11.0	7482.20	7350.53	7416.36	93.10	1.26	8269.97	8363.41	8316.69	66.07	0.79	59.33	66.53	125.86

Table B-20 (Continue).

No.	PV	Diesel Concentration (ppm)					Motor oil Concentration (ppm)					Weight of Diesel (mg)	Weight of Motor oil (mg)	Total weight of diesel and motor oil (mg)
		1	2	Avg	SD	%RSD	1	2	Avg	SD	%RSD			
57	11.2	13758.51	13676.77	13717.64	57.80	0.42	17095.75	17010.44	17053.10	60.33	0.35	109.74	136.42	246.17
58	11.4	6892.89	6826.81	6859.85	46.72	0.68	6978.10	6862.31	6920.20	81.87	1.18	54.88	55.36	110.24
59	11.6	5062.32	5018.75	5040.53	30.80	0.61	6179.81	6196.06	6187.94	11.49	0.19	40.32	49.50	89.83
60	11.8	6623.69	6554.67	6589.18	48.80	0.74	7394.50	7863.72	7629.11	331.79	4.35	52.71	61.03	113.75
61	12.0	6574.74	6491.04	6532.89	59.18	0.91	8446.69	8290.28	8368.49	110.60	1.32	52.26	66.95	119.21
62	12.2	6021.65	5902.71	5962.18	84.10	1.41	7735.75	7496.06	7615.91	169.48	2.23	47.70	60.93	108.62
63	12.4	8958.89	8816.46	8887.67	100.71	1.13	9685.75	9612.63	9649.19	51.71	0.54	71.10	77.19	148.29
64	12.6	3594.43	3591.01	3592.72	2.42	0.07	3405.13	3271.06	3338.10	94.80	2.84	28.74	26.70	55.45
65	12.8	1470.67	1490.74	1480.71	14.19	0.96	1363.72	1359.66	1361.69	2.87	0.21	11.85	10.89	22.74
66	13.0	6235.55	6136.19	6185.87	70.26	1.14	7014.66	6805.44	6910.05	147.94	2.14	49.49	55.28	104.77
67	13.2	7742.59	7605.54	7674.06	96.91	1.26	9771.06	9314.03	9542.55	323.17	3.39	61.39	76.34	137.73
68	13.4	12521.16	12618.08	12569.62	68.53	0.55	15141.69	15887.16	15514.42	527.13	3.40	100.56	124.12	224.67
69	13.6	27280.76	27209.30	27245.03	50.53	0.19	31237.31	30650.28	30943.80	415.09	1.34	217.96	247.55	465.51
70	13.8	9429.26	9319.13	9374.19	77.87	0.83	11203.10	10701.38	10952.24	354.77	3.24	74.99	87.62	162.61
71	14.0	8322.59	7837.54	8080.07	342.98	4.24	10701.38	10425.13	10563.25	195.34	1.85	64.64	84.51	149.15
72	14.2	3447.59	3591.01	3519.30	101.41	2.88	4420.75	4692.94	4556.85	192.47	4.22	28.15	36.45	64.61
73	14.4	1780.50	1829.94	1805.22	34.96	1.94	1839.03	1906.06	1872.55	47.40	2.53	14.44	14.98	29.42
74	14.6	2858.29	2954.71	2906.50	68.18	2.35	2647.47	2742.94	2695.20	67.51	2.50	23.25	21.56	44.81
75	14.8	1778.05	1792.25	1785.15	10.04	0.56	1540.44	1587.16	1563.80	33.04	2.11	14.28	12.51	26.79

Table B-20 (Continue).

No.	PV	Diesel Concentration (ppm)					Motor oil Concentration (ppm)					Weight of Diesel (mg)	Weight of Motor oil (mg)	Total weight of diesel and motor oil (mg)
		1	2	Avg	SD	%RSD	1	2	Avg	SD	%RSD			
76	15.0	1537.24	1588.14	1562.69	35.99	2.30	1593.25	1629.81	1611.53	25.85	1.60	12.50	12.89	25.39
77	15.2	1187.77	1188.26	1188.01	0.35	0.03	902.63	961.53	932.08	41.65	4.47	9.50	7.46	16.96
78	15.4	990.52	989.54	990.03	0.69	0.07	1266.22	1337.31	1301.77	50.27	3.86	7.92	10.41	18.33
79	15.6	1470.67	1490.74	1480.71	14.19	0.96	1363.72	1359.66	1361.69	2.87	0.21	11.85	10.89	22.74
80	15.8	1010.58	1006.67	1008.63	2.77	0.27	833.56	859.97	846.77	18.67	2.21	8.07	6.77	14.84
81	16.0	1266.08	1260.70	1263.39	3.81	0.30	1205.28	1225.60	1215.44	14.36	1.18	10.11	9.72	19.83
82	16.2	491.76	491.27	491.51	0.35	0.07	321.69	325.75	323.72	2.87	0.89	3.93	2.59	6.52
83	16.4	1112.88	1102.11	1107.50	7.61	0.69	1132.16	1156.53	1144.35	17.24	1.51	8.86	9.15	18.01
84	16.6	1011.56	1004.71	1008.14	4.85	0.48	839.66	878.25	858.95	27.29	3.18	8.07	6.87	14.94
85	16.8	515.25	514.27	514.76	0.69	0.13	325.75	339.97	332.86	10.05	3.02	4.12	2.66	6.78
86	17.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
87	17.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
88	17.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
89	17.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
90	17.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
91	18.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
92	18.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
93	18.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
94	18.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table B-20 (Continue).

No.	PV	Diesel Concentration (ppm)					Motor oil Concentration (ppm)					Weight of Diesel (mg)	Weight of Motor oil (mg)	Total weight of diesel and motor oil (mg)	
		1	2	Avg	SD	%RSD	1	2	Avg	SD	%RSD				
95	18.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
96	19.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
97	19.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
98	19.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
99	19.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
100	19.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
101	20.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00



Table B-21 Diesel and motor oil accumulative removal, mobilization, and solubilization at different pore volumes of column study flushing with surfactant mixture of 0.2 wt% Alfoterra 145-4PO, 0.5 wt% AOT, and 5 wt% NaCl.

No.	PV	Diesel Accumulative Removal (mg)	Motor oil Accumulative Removal (mg)	Total of diesel and motor oil Accumulative Removal (mg)	Mixed diesel and motor oil mobilization (mg)	Mixed diesel and motor oil accumulative mobilization (mg)	Mixed diesel and motor oil solubilization (mg)	Mixed diesel and motor oil accumulative solubilization (mg)
1	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	1.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	1.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	1.4	3.43	1.88	5.31	0.00	0.00	5.31	5.31
9	1.6	7.77	4.49	12.26	0.00	0.00	6.94	12.26
10	1.8	14.50	11.51	26.01	0.00	0.00	13.76	26.01
11	2.0	42.13	39.23	81.36	0.00	0.00	55.35	81.36
12	2.2	81.04	79.38	160.42	0.00	0.00	79.06	160.42
13	2.4	126.09	130.74	256.83	0.00	0.00	96.41	256.83
14	2.6	170.81	176.78	347.58	0.00	0.00	90.75	347.58
15	2.8	199.87	208.45	408.32	0.00	0.00	60.74	408.32
16	3.0	208.66	215.26	423.92	0.00	0.00	15.60	423.92
17	3.2	226.01	230.23	456.24	0.00	0.00	32.32	456.24
18	3.4	229.08	230.55	459.63	0.00	0.00	3.39	459.63

Table B-21 (Continue).

No.	PV	Diesel Accumulative Removal (mg)	Motor oil Accumulative Removal (mg)	Total of diesel and motor oil Accumulative Removal (mg)	Mixed diesel and motor oil mobilization (mg)	Mixed diesel and motor oil accumulative mobilization (mg)	Mixed diesel and motor oil solubilization (mg)	Mixed diesel and motor oil accumulative solubilization (mg)
19	3.6	245.75	245.43	491.19	0.00	0.00	31.55	491.19
20	3.8	303.01	316.67	619.68	85.63	85.63	42.87	534.05
21	4.0	312.65	323.78	636.44	0.00	85.63	16.76	550.81
22	4.2	336.28	349.33	685.60	0.00	85.63	49.17	599.98
23	4.4	346.59	357.99	704.57	0.00	85.63	18.97	618.95
24	4.6	355.45	363.99	719.44	0.00	85.63	14.86	633.81
25	4.8	360.01	366.75	726.76	0.00	85.63	7.32	641.14
26	5.0	368.83	374.20	743.02	0.00	85.63	16.26	657.40
27	5.2	377.72	380.21	757.93	0.00	85.63	14.91	672.31
28	5.4	396.84	397.78	794.62	0.00	85.63	36.69	708.99
29	5.6	411.00	408.03	819.03	0.00	85.63	24.41	733.40
30	5.8	427.41	423.00	850.42	0.00	85.63	31.39	764.79
31	6.0	437.22	431.07	868.29	0.00	85.63	17.87	782.66
32	6.2	459.92	456.00	915.93	0.00	85.63	47.64	830.30
33	6.4	465.39	461.21	926.60	0.00	85.63	10.67	840.97
34	6.6	484.65	477.08	961.73	0.00	85.63	35.13	876.10
35	6.8	526.55	524.56	1051.11	0.00	85.63	89.38	965.48
36	7.0	552.79	554.76	1107.56	0.00	85.63	56.45	1021.93
37	7.2	566.52	564.62	1131.14	0.00	85.63	23.58	1045.51

Table B-21 (Continue).

No.	PV	Diesel Accumulative Removal (mg)	Motor oil Accumulative Removal (mg)	Total of diesel and motor oil Accumulative Removal (mg)	Mixed diesel and motor oil mobilization (mg)	Mixed diesel and motor oil accumulative mobilization (mg)	Mixed diesel and motor oil solubilization (mg)	Mixed diesel and motor oil accumulative solubilization (mg)
38	7.4	595.88	590.87	1186.75	0.00	85.63	55.61	1101.12
39	7.6	607.51	602.47	1209.99	0.00	85.63	23.24	1124.36
40	7.8	616.35	609.91	1226.26	0.00	85.63	16.27	1140.63
41	8.0	620.77	612.46	1233.24	0.00	85.63	6.98	1147.61
42	8.2	628.11	619.25	1247.35	0.00	85.63	14.11	1161.73
43	8.4	632.17	620.97	1253.14	0.00	85.63	5.79	1167.52
44	8.6	641.91	628.14	1270.05	0.00	85.63	16.91	1184.43
45	8.8	663.60	654.06	1317.65	0.00	85.63	47.60	1232.03
46	9.0	672.62	662.71	1335.33	0.00	85.63	17.68	1249.70
47	9.2	685.92	674.96	1360.88	0.00	85.63	25.55	1275.26
48	9.4	719.12	718.26	1437.38	0.00	85.63	76.50	1351.76
49	9.6	772.20	788.03	1560.23	85.63	171.25	37.22	1388.98
50	9.8	847.29	876.22	1723.51	85.63	256.88	77.66	1466.63
51	10.0	982.98	1057.25	2040.24	171.25	428.13	145.47	1612.11
52	10.2	1059.90	1149.87	2209.77	85.63	513.76	83.91	1696.01
53	10.4	1129.03	1231.50	2360.53	85.63	599.38	65.13	1761.14
54	10.6	1164.95	1268.94	2433.90	0.00	599.38	73.37	1834.52
55	10.8	1183.13	1289.55	2472.67	0.00	599.38	38.77	1873.29
56	11.0	1242.46	1356.08	2598.54	85.63	685.01	40.24	1913.53

Table B-21 (Continue).

No.	PV	Diesel Accumulative Removal (mg)	Motor oil Accumulative Removal (mg)	Total of diesel and motor oil Accumulative Removal (mg)	Mixed diesel and motor oil mobilization (mg)	Mixed diesel and motor oil accumulative mobilization (mg)	Mixed diesel and motor oil solubilization (mg)	Mixed diesel and motor oil accumulative solubilization (mg)
57	11.2	1352.20	1492.51	2844.70	85.63	770.63	160.54	2074.07
58	11.4	1407.08	1547.87	2954.94	85.63	856.26	24.61	2098.68
59	11.6	1447.40	1597.37	3044.77	85.63	941.89	4.20	2102.89
60	11.8	1500.11	1658.40	3158.52	85.63	1027.51	28.12	2131.01
61	12.0	1552.38	1725.35	3277.73	85.63	1113.14	33.59	2164.59
62	12.2	1600.07	1786.28	3386.35	85.63	1198.76	23.00	2187.59
63	12.4	1671.18	1863.47	3534.65	85.63	1284.39	62.67	2250.26
64	12.6	1699.92	1890.18	3590.10	0.00	1284.39	55.45	2305.71
65	12.8	1711.76	1901.07	3612.83	0.00	1284.39	22.74	2328.44
66	13.0	1761.25	1956.35	3717.60	85.63	1370.02	19.14	2347.59
67	13.2	1822.64	2032.69	3855.33	85.63	1455.64	52.11	2399.69
68	13.4	1923.20	2156.81	4080.01	85.63	1541.27	139.05	2538.74
69	13.6	2141.16	2404.36	4545.52	171.25	1712.52	294.26	2833.00
70	13.8	2216.15	2491.98	4708.13	85.63	1798.15	76.99	2909.98
71	14.0	2280.79	2576.48	4857.28	85.63	1883.77	63.52	2973.50
72	14.2	2308.95	2612.94	4921.88	0.00	1883.77	64.61	3038.11
73	14.4	2323.39	2627.92	4951.31	0.00	1883.77	29.42	3067.53
74	14.6	2346.64	2649.48	4996.12	0.00	1883.77	44.81	3112.35
75	14.8	2360.92	2661.99	5022.91	0.00	1883.77	26.79	3139.14

Table B-21 (Continue).

No.	PV	Diesel Accumulative Removal (mg)	Motor oil Accumulative Removal (mg)	Total of diesel and motor oil Accumulative Removal (mg)	Mixed diesel and motor oil mobilization (mg)	Mixed diesel and motor oil accumulative mobilization (mg)	Mixed diesel and motor oil solubilization (mg)	Mixed diesel and motor oil accumulative solubilization (mg)
76	15.0	2373.43	2674.88	5048.31	0.00	1883.77	25.39	3164.53
77	15.2	2382.93	2682.34	5065.27	0.00	1883.77	16.96	3181.49
78	15.4	2390.85	2692.75	5083.60	0.00	1883.77	18.33	3199.83
79	15.6	2402.70	2703.64	5106.34	0.00	1883.77	22.74	3222.57
80	15.8	2410.76	2710.42	5121.18	0.00	1883.77	14.84	3237.41
81	16.0	2420.87	2720.14	5141.01	0.00	1883.77	19.83	3257.24
82	16.2	2424.80	2722.73	5147.54	0.00	1883.77	6.52	3263.76
83	16.4	2433.66	2731.89	5165.55	0.00	1883.77	18.01	3281.78
84	16.6	2441.73	2738.76	5180.49	0.00	1883.77	14.94	3296.72
85	16.8	2445.85	2741.42	5187.27	0.00	1883.77	6.78	3303.50
86	17.0	2445.85	2741.42	5187.27	0.00	1883.77	0.00	3303.50
87	17.2	2445.85	2741.42	5187.27	0.00	1883.77	0.00	3303.50
88	17.4	2445.85	2741.42	5187.27	0.00	1883.77	0.00	3303.50
89	17.6	2445.85	2741.42	5187.27	0.00	1883.77	0.00	3303.50
90	17.8	2445.85	2741.42	5187.27	0.00	1883.77	0.00	3303.50
91	18.0	2445.85	2741.42	5187.27	0.00	1883.77	0.00	3303.50
92	18.2	2445.85	2741.42	5187.27	0.00	1883.77	0.00	3303.50
93	18.4	2445.85	2741.42	5187.27	0.00	1883.77	0.00	3303.50
94	18.6	2445.85	2741.42	5187.27	0.00	1883.77	0.00	3303.50

Table B-21 (Continue).

No.	PV	Diesel Accumulative Removal (mg)	Motor oil Accumulative Removal (mg)	Total of diesel and motor oil Accumulative Removal (mg)	Mixed diesel and motor oil mobilization (mg)	Mixed diesel and motor oil accumulative mobilization (mg)	Mixed diesel and motor oil solubilization (mg)	Mixed diesel and motor oil accumulative solubilization (mg)
95	18.8	2445.85	2741.42	5187.27	0.00	1883.77	0.00	3303.50
96	19.0	2445.85	2741.42	5187.27	0.00	1883.77	0.00	3303.50
97	19.2	2445.85	2741.42	5187.27	0.00	1883.77	0.00	3303.50
98	19.4	2445.85	2741.42	5187.27	0.00	1883.77	0.00	3303.50
99	19.6	2445.85	2741.42	5187.27	0.00	1883.77	0.00	3303.50
100	19.8	2445.85	2741.42	5187.27	0.00	1883.77	0.00	3303.50
101	20.0	2445.85	2741.42	5187.27	0.00	1883.77	0.00	3303.50

Table B-22 Diesel and motor oil concentration and weight at different pore volumes of column study flushing with surfactant gradient system.

No.	PV	Diesel Concentration (ppm)					Motor oil Concentration (ppm)					Weight of Diesel (mg)	Weight of Motor oil (mg)	Total weight of diesel and motor oil (mg)
		1	2	Avg	SD	%RSD	1	2	Avg	SD	%RSD			
1	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	1.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	1.2	668.45	650.83	659.64	12.46	1.89	270.91	279.03	274.97	5.75	2.09	5.28	2.20	7.48
8	1.4	451.13	458.48	454.80	5.19	1.14	226.22	236.38	231.30	7.18	3.10	3.64	1.85	5.49
9	1.6	848.08	838.29	843.19	6.92	0.82	587.78	620.28	604.03	22.98	3.80	6.75	4.83	11.58
10	1.8	1039.46	1115.33	1077.39	53.65	4.98	1085.44	1142.31	1113.88	40.22	3.61	8.62	8.91	17.53
11	2.0	2059.49	2019.85	2039.67	28.03	1.37	1977.16	2099.03	2038.10	86.18	4.23	16.32	16.30	32.62
12	2.2	2422.18	2527.41	2474.80	74.41	3.01	2436.22	2643.41	2539.81	146.50	5.77	19.80	20.32	40.12
13	2.4	713.97	725.72	719.85	8.31	1.15	677.16	699.50	688.33	15.80	2.30	5.76	5.51	11.27
14	2.6	2774.59	2692.36	2733.48	58.14	2.13	2777.47	2834.35	2805.91	40.22	1.43	21.87	22.45	44.32
15	2.8	3846.50	3751.06	3798.78	67.49	1.78	4367.94	4055.13	4211.53	221.19	5.25	30.39	33.69	64.08
16	3.0	4330.09	4412.80	4371.45	58.49	1.34	4112.00	4207.47	4159.74	67.51	1.62	34.97	33.28	68.25
17	3.2	5201.81	5351.10	5276.45	105.56	2.00	5783.72	6102.63	5943.17	225.50	3.79	42.21	47.55	89.76
18	3.4	9893.26	10140.44	10016.85	174.78	1.74	10524.66	10900.44	10712.55	265.72	2.48	80.13	85.70	165.84

Table B-22 (Continue).

No.	PV	Diesel Concentration (ppm)					Motor oil Concentration (ppm)					Weight of Diesel (mg)	Weight of Motor oil (mg)	Total weight of diesel and motor oil (mg)
		1	2	Avg	SD	%RSD	1	2	Avg	SD	%RSD			
19	3.6	22252.07	22032.80	22142.44	155.05	0.70	23211.85	23910.60	23561.22	494.09	2.10	177.14	188.49	365.63
20	3.8	15521.05	15729.07	15625.06	147.09	0.94	17319.19	17049.03	17184.11	191.03	1.11	125.00	137.47	262.47
21	4.0	12423.27	12533.40	12478.34	77.87	0.62	13476.06	13975.75	13725.91	353.33	2.57	99.83	109.81	209.63
22	4.2	7836.07	7946.20	7891.14	77.87	0.99	9259.19	8948.41	9103.80	219.76	2.41	63.13	72.83	135.96
23	4.4	4908.63	4870.45	4889.54	27.00	0.55	5982.78	5578.56	5780.67	285.83	4.94	39.12	46.25	85.36
24	4.6	3616.46	3551.36	3583.91	46.03	1.28	3762.63	3689.50	3726.06	51.71	1.39	28.67	29.81	58.48
25	4.8	1585.21	1696.31	1640.76	78.56	4.79	1503.88	1471.38	1487.63	22.98	1.54	13.13	11.90	25.03
26	5.0	1842.17	1718.34	1780.26	87.56	4.92	2056.38	1914.19	1985.28	100.54	5.06	14.24	15.88	30.12
27	5.2	1931.74	2082.50	2007.12	106.60	5.31	2109.19	2131.53	2120.36	15.80	0.75	16.06	16.96	33.02
28	5.4	1166.72	1223.50	1195.11	40.15	3.36	1075.28	1148.41	1111.85	51.71	4.65	9.56	8.89	18.46
29	5.6	1689.46	1698.27	1693.87	6.23	0.37	1603.41	1550.60	1577.00	37.34	2.37	13.55	12.62	26.17
30	5.8	1047.78	1062.96	1055.37	10.73	1.02	530.91	555.28	543.10	17.24	3.17	8.44	4.34	12.79
31	6.0	688.03	697.82	692.93	6.92	1.00	557.31	541.06	549.19	11.49	2.09	5.54	4.39	9.94
32	6.2	1513.75	1576.40	1545.07	44.30	2.87	1331.22	1351.53	1341.38	14.36	1.07	12.36	10.73	23.09
33	6.4	1475.08	1483.40	1479.24	5.88	0.40	1337.31	1239.81	1288.56	68.94	5.35	11.83	10.31	22.14
34	6.6	4052.07	3957.12	4004.60	67.14	1.68	3732.16	3872.31	3802.24	99.11	2.61	32.04	30.42	62.45
35	6.8	5266.91	5316.83	5291.87	35.30	0.67	5576.53	5769.50	5673.02	136.45	2.41	42.33	45.38	87.72
36	7.0	6608.51	6567.89	6588.20	28.73	0.44	7010.60	6811.53	6911.06	140.76	2.04	52.71	55.29	107.99
37	7.2	2560.70	2519.09	2539.89	29.42	1.16	2682.00	2771.38	2726.69	63.20	2.32	20.32	21.81	42.13

Table B-22 (Continue).

No.	PV	Diesel Concentration (ppm)					Motor oil Concentration (ppm)					Weight of Diesel (mg)	Weight of Motor oil (mg)	Total weight of diesel and motor oil (mg)
		1	2	Avg	SD	%RSD	1	2	Avg	SD	%RSD			
38	7.4	10931.40	11064.05	10997.73	93.79	0.85	12364.97	12111.06	12238.02	179.54	1.47	87.98	97.90	185.89
39	7.6	19748.99	19372.59	19560.79	266.15	1.36	22620.75	22202.31	22411.53	295.88	1.32	156.49	179.29	335.78
40	7.8	6412.73	6421.05	6416.89	5.88	0.09	7010.60	7420.91	7215.75	290.13	4.02	51.34	57.73	109.06
41	8.0	3141.19	3070.71	3105.95	49.84	1.60	3384.81	3232.47	3308.64	107.72	3.26	24.85	26.47	51.32
42	8.2	1352.71	1426.13	1389.42	51.91	3.74	1085.44	1010.28	1047.86	53.14	5.07	11.12	8.38	19.50
43	8.4	2034.04	1992.44	2013.24	29.42	1.46	1954.81	2025.91	1990.36	50.27	2.53	16.11	15.92	32.03
44	8.6	788.86	820.18	804.52	22.15	2.75	618.25	583.72	600.99	24.42	4.06	6.44	4.81	11.24
45	8.8	4071.65	4257.65	4164.65	131.52	3.16	4274.50	4047.00	4160.75	160.87	3.87	33.32	33.29	66.60
46	9.0	5525.83	5373.61	5449.72	107.64	1.98	6194.03	5889.35	6041.69	215.45	3.57	43.60	48.33	91.93
47	9.2	7680.91	7885.51	7783.21	144.67	1.86	7439.19	7814.97	7627.08	265.72	3.48	62.27	61.02	123.28
48	9.4	6512.09	6371.13	6441.61	99.68	1.55	6401.22	6053.88	6227.55	245.61	3.94	51.53	49.82	101.35
49	9.6	1638.07	1617.51	1627.79	14.54	0.89	1438.88	1503.88	1471.38	45.96	3.12	13.02	11.77	24.79
50	9.8	311.64	318.49	315.06	4.85	1.54	114.50	108.41	111.45	4.31	3.87	2.52	0.89	3.41
51	10.0	904.37	815.29	859.83	62.99	7.33	776.69	740.13	758.41	25.85	3.41	6.88	6.07	12.95
52	10.2	1441.80	1375.72	1408.76	46.72	3.32	985.91	1069.19	1027.55	58.89	5.73	11.27	8.22	19.49
53	10.4	1838.26	1873.50	1855.88	24.92	1.34	1390.13	1406.38	1398.25	11.49	0.82	14.85	11.19	26.03
54	10.6	1184.34	1223.99	1204.16	28.03	2.33	983.88	937.16	960.52	33.04	3.44	9.63	7.68	17.32
55	10.8	5885.09	5778.88	5831.99	75.10	1.29	4562.94	4723.41	4643.17	113.47	2.44	46.66	37.15	83.80
56	11.0	9573.16	9722.93	9648.05	105.91	1.10	10333.72	10096.06	10214.89	168.05	1.65	77.18	81.72	158.90

Table B-22 (Continue).

No.	PV	Diesel Concentration (ppm)					Motor oil Concentration (ppm)					Weight of Diesel (mg)	Weight of Motor oil (mg)	Total weight of diesel and motor oil (mg)
		1	2	Avg	SD	%RSD	1	2	Avg	SD	%RSD			
57	11.2	6904.15	6835.13	6869.64	48.80	0.71	7449.35	7171.06	7310.20	196.77	2.69	54.96	58.48	113.44
58	11.4	3653.66	3727.07	3690.37	51.91	1.41	3669.19	3506.69	3587.94	114.90	3.20	29.52	28.70	58.23
59	11.6	2409.94	2499.51	2454.73	63.34	2.58	2507.31	2582.47	2544.89	53.14	2.09	19.64	20.36	40.00
60	11.8	791.31	849.06	820.18	40.84	4.98	329.81	354.19	342.00	17.24	5.04	6.56	2.74	9.30
61	12.0	1590.10	1618.98	1604.54	20.42	1.27	1359.66	1424.66	1392.16	45.96	3.30	12.84	11.14	23.97
62	12.2	828.02	841.23	834.62	9.34	1.12	748.25	750.28	749.27	1.44	0.19	6.68	5.99	12.67
63	12.4	1901.89	1914.61	1908.25	9.00	0.47	1698.88	1745.60	1722.24	33.04	1.92	15.27	13.78	29.04
64	12.6	2417.77	2431.97	2424.87	10.04	0.41	2562.16	2554.03	2558.10	5.75	0.22	19.40	20.46	39.86
65	12.8	2117.74	2037.96	2077.85	56.41	2.72	2235.13	2399.66	2317.39	116.34	5.02	16.62	18.54	35.16
66	13.0	3973.27	4034.94	4004.11	43.61	1.09	4514.19	4197.31	4355.75	224.06	5.14	32.03	34.85	66.88
67	13.2	5618.83	5685.40	5652.11	47.07	0.83	6082.31	6443.88	6263.10	255.66	4.08	45.22	50.10	95.32
68	13.4	8691.16	8575.15	8633.16	82.03	0.95	9844.19	9437.94	9641.06	287.26	2.98	69.07	77.13	146.19
69	13.6	9663.22	9740.55	9701.89	54.68	0.56	11298.56	11751.53	11525.05	320.30	2.78	77.62	92.20	169.82
70	13.8	16566.53	16410.40	16488.46	110.41	0.67	19139.19	18812.16	18975.67	231.25	1.22	131.91	151.81	283.71
71	14.0	24973.95	25300.42	25137.18	230.85	0.92	27400.28	26776.69	27088.49	440.95	1.63	201.10	216.71	417.81
72	14.2	14493.19	14695.82	14594.51	143.28	0.98	16234.50	15765.28	15999.89	331.79	2.07	116.76	128.00	244.76
73	14.4	8544.32	8575.15	8559.74	21.80	0.25	9186.06	9437.94	9312.00	178.10	1.91	68.48	74.50	142.97
74	14.6	8226.17	8305.46	8265.82	56.07	0.68	11062.94	10748.10	10905.52	222.63	2.04	66.13	87.24	153.37
75	14.8	5738.75	5906.14	5822.44	118.37	2.03	6143.25	6628.72	6385.99	343.28	5.38	46.58	51.09	97.67

Table B-22 (Continue).

No.	PV	Diesel Concentration (ppm)					Motor oil Concentration (ppm)					Weight of Diesel (mg)	Weight of Motor oil (mg)	Total weight of diesel and motor oil (mg)
		1	2	Avg	SD	%RSD	1	2	Avg	SD	%RSD			
76	15.0	1143.72	1159.87	1151.79	11.42	0.99	1209.35	1164.66	1187.00	31.60	2.66	9.21	9.50	18.71
77	15.2	3307.12	3324.74	3315.93	12.46	0.38	3693.56	3898.72	3796.14	145.07	3.82	26.53	30.37	56.90
78	15.4	1052.19	1050.72	1051.45	1.04	0.10	1038.72	989.97	1014.35	34.47	3.40	8.41	8.11	16.53
79	15.6	886.75	898.01	892.38	7.96	0.89	721.85	762.47	742.16	28.73	3.87	7.14	5.94	13.08
80	15.8	792.77	739.42	766.10	37.72	4.92	845.75	792.94	819.35	37.34	4.56	6.13	6.55	12.68
81	16.0	729.15	739.42	734.28	7.27	0.99	845.75	792.94	819.35	37.34	4.56	5.87	6.55	12.43
82	16.2	497.14	503.51	500.32	4.50	0.90	374.50	362.31	368.41	8.62	2.34	4.00	2.95	6.95
83	16.4	355.20	362.54	358.87	5.19	1.45	193.72	205.91	199.81	8.62	4.31	2.87	1.60	4.47
84	16.6	374.78	362.54	368.66	8.65	2.35	222.16	226.22	224.19	2.87	1.28	2.95	1.79	4.74
85	16.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
86	17.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
87	17.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
88	17.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
89	17.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
90	17.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
91	18.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
92	18.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
93	18.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
94	18.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table B-22 (Continue).

No.	PV	Diesel Concentration (ppm)					Motor oil Concentration (ppm)					Weight of Diesel (mg)	Weight of Motor oil (mg)	Total weight of diesel and motor oil (mg)	
		1	2	Avg	SD	%RSD	1	2	Avg	SD	%RSD				
95	18.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
96	19.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
97	19.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
98	19.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
99	19.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
100	19.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
101	20.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table B-23 Diesel and motor oil accumulative removal, mobilization, and solubilization at different pore volumes of column study flushing with surfactant gradient system.

No.	PV	Diesel Accumulative Removal (mg)	Motor oil Accumulative Removal (mg)	Total of diesel and motor oil Accumulative Removal (mg)	Mixed diesel and motor oil mobilization (mg)	Mixed diesel and motor oil accumulative mobilization (mg)	Mixed diesel and motor oil solubilization (mg)	Mixed diesel and motor oil accumulative solubilization (mg)
1	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	1.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	1.2	5.28	2.20	7.48	0.00	0.00	7.48	7.48
8	1.4	8.92	4.05	12.97	0.00	0.00	5.49	12.97
9	1.6	15.66	8.88	24.54	0.00	0.00	11.58	24.54
10	1.8	24.28	17.79	42.07	0.00	0.00	17.53	42.07
11	2.0	40.60	34.10	74.70	0.00	0.00	32.62	74.70
12	2.2	60.40	54.42	114.81	0.00	0.00	40.12	114.81
13	2.4	66.15	59.92	126.08	0.00	0.00	11.27	126.08
14	2.6	88.02	82.37	170.39	0.00	0.00	44.32	170.39
15	2.8	118.41	116.06	234.48	0.00	0.00	64.08	234.48
16	3.0	153.38	149.34	302.73	0.00	0.00	68.25	302.73
17	3.2	195.60	196.89	392.48	0.00	0.00	89.76	392.48
18	3.4	275.73	282.59	558.32	0.00	0.00	165.84	558.32

Table B-23 (Continue).

No.	PV	Diesel Accumulative Removal (mg)	Motor oil Accumulative Removal (mg)	Total of diesel and motor oil Accumulative Removal (mg)	Mixed diesel and motor oil mobilization (mg)	Mixed diesel and motor oil accumulative mobilization (mg)	Mixed diesel and motor oil solubilization (mg)	Mixed diesel and motor oil accumulative solubilization (mg)
19	3.6	452.87	471.08	923.95	0.00	0.00	365.63	923.95
20	3.8	577.87	608.55	1186.42	0.00	0.00	262.47	1186.42
21	4.0	677.70	718.36	1396.05	0.00	0.00	209.63	1396.05
22	4.2	740.83	791.19	1532.01	0.00	0.00	135.96	1532.01
23	4.4	779.94	837.43	1617.38	0.00	0.00	85.36	1617.38
24	4.6	808.61	867.24	1675.85	0.00	0.00	58.48	1675.85
25	4.8	821.74	879.14	1700.88	0.00	0.00	25.03	1700.88
26	5.0	835.98	895.02	1731.01	0.00	0.00	30.12	1731.01
27	5.2	852.04	911.99	1764.03	0.00	0.00	33.02	1764.03
28	5.4	861.60	920.88	1782.48	0.00	0.00	18.46	1782.48
29	5.6	875.15	933.50	1808.65	0.00	0.00	26.17	1808.65
30	5.8	883.59	937.84	1821.44	0.00	0.00	12.79	1821.44
31	6.0	889.14	942.24	1831.37	0.00	0.00	9.94	1831.37
32	6.2	901.50	952.97	1854.46	0.00	0.00	23.09	1854.46
33	6.4	913.33	963.28	1876.61	0.00	0.00	22.14	1876.61
34	6.6	945.37	993.69	1939.06	0.00	0.00	62.45	1939.06
35	6.8	987.70	1039.08	2026.78	0.00	0.00	87.72	2026.78
36	7.0	1040.41	1094.37	2134.78	0.00	0.00	107.99	2134.78
37	7.2	1060.73	1116.18	2176.91	0.00	0.00	42.13	2176.91

Table B-23 (Continue)

No.	PV	Diesel Accumulative Removal (mg)	Motor oil Accumulative Removal (mg)	Total of diesel and motor oil Accumulative Removal (mg)	Mixed diesel and motor oil mobilization (mg)	Mixed diesel and motor oil accumulative mobilization (mg)	Mixed diesel and motor oil solubilization (mg)	Mixed diesel and motor oil accumulative solubilization (mg)
38	7.4	1148.71	1214.08	2362.79	0.00	0.00	185.89	2362.79
39	7.6	1305.20	1393.38	2698.57	0.00	0.00	335.78	2698.57
40	7.8	1356.53	1451.10	2807.63	0.00	0.00	109.06	2807.63
41	8.0	1381.38	1477.57	2858.95	0.00	0.00	51.32	2858.95
42	8.2	1392.49	1485.95	2878.45	0.00	0.00	19.50	2878.45
43	8.4	1408.60	1501.88	2910.48	0.00	0.00	32.03	2910.48
44	8.6	1415.04	1506.68	2921.72	0.00	0.00	11.24	2921.72
45	8.8	1448.35	1539.97	2988.32	0.00	0.00	66.60	2988.32
46	9.0	1491.95	1588.30	3080.26	0.00	0.00	91.93	3080.26
47	9.2	1554.22	1649.32	3203.54	0.00	0.00	123.28	3203.54
48	9.4	1605.75	1699.14	3304.89	0.00	0.00	101.35	3304.89
49	9.6	1618.77	1710.91	3329.68	0.00	0.00	24.79	3329.68
50	9.8	1621.29	1711.80	3333.10	0.00	0.00	3.41	3333.10
51	10.0	1628.17	1717.87	3346.04	0.00	0.00	12.95	3346.04
52	10.2	1639.44	1726.09	3365.53	0.00	0.00	19.49	3365.53
53	10.4	1654.29	1737.28	3391.57	0.00	0.00	26.03	3391.57
54	10.6	1663.92	1744.96	3408.88	0.00	0.00	17.32	3408.88
55	10.8	1710.58	1782.11	3492.69	0.00	0.00	83.80	3492.69
56	11.0	1787.76	1863.83	3651.59	0.00	0.00	158.90	3651.59

Table B-23 (Continue).

No.	PV	Diesel Accumulative Removal (mg)	Motor oil Accumulative Removal (mg)	Total of diesel and motor oil Accumulative Removal (mg)	Mixed diesel and motor oil mobilization (mg)	Mixed diesel and motor oil accumulative mobilization (mg)	Mixed diesel and motor oil solubilization (mg)	Mixed diesel and motor oil accumulative solubilization (mg)
57	11.2	1842.72	1922.31	3765.03	0.00	0.00	113.44	3765.03
58	11.4	1872.24	1951.01	3823.25	0.00	0.00	58.23	3823.25
59	11.6	1891.88	1971.37	3863.25	0.00	0.00	40.00	3863.25
60	11.8	1898.44	1974.11	3872.55	0.00	0.00	9.30	3872.55
61	12.0	1911.28	1985.24	3896.52	0.00	0.00	23.97	3896.52
62	12.2	1917.96	1991.24	3909.19	0.00	0.00	12.67	3909.19
63	12.4	1933.22	2005.02	3938.24	0.00	0.00	29.04	3938.24
64	12.6	1952.62	2025.48	3978.10	0.00	0.00	39.86	3978.10
65	12.8	1969.24	2044.02	4013.26	0.00	0.00	35.16	4013.26
66	13.0	2001.28	2078.87	4080.14	0.00	0.00	66.88	4080.14
67	13.2	2046.49	2128.97	4175.46	0.00	0.00	95.32	4175.46
68	13.4	2115.56	2206.10	4321.66	0.00	0.00	146.19	4321.66
69	13.6	2193.17	2298.30	4491.47	0.00	0.00	169.82	4491.47
70	13.8	2325.08	2450.10	4775.19	0.00	0.00	283.71	4775.19
71	14.0	2526.18	2666.81	5192.99	0.00	0.00	417.81	5192.99
72	14.2	2642.93	2794.81	5437.75	0.00	0.00	244.76	5437.75
73	14.4	2711.41	2869.31	5580.72	0.00	0.00	142.97	5580.72
74	14.6	2777.54	2956.55	5734.09	0.00	0.00	153.37	5734.09
75	14.8	2824.12	3007.64	5831.76	0.00	0.00	97.67	5831.76

Table B-23 (Continue).

No.	PV	Diesel Accumulative Removal (mg)	Motor oil Accumulative Removal (mg)	Total of diesel and motor oil Accumulative Removal (mg)	Mixed diesel and motor oil mobilization (mg)	Mixed diesel and motor oil accumulative mobilization (mg)	Mixed diesel and motor oil solubilization (mg)	Mixed diesel and motor oil accumulative solubilization (mg)
76	15.0	2833.33	3017.14	5850.47	0.00	0.00	18.71	5850.47
77	15.2	2859.86	3047.51	5907.36	0.00	0.00	56.90	5907.36
78	15.4	2868.27	3055.62	5923.89	0.00	0.00	16.53	5923.89
79	15.6	2875.41	3061.56	5936.97	0.00	0.00	13.08	5936.97
80	15.8	2881.54	3068.11	5949.65	0.00	0.00	12.68	5949.65
81	16.0	2887.41	3074.67	5962.08	0.00	0.00	12.43	5962.08
82	16.2	2891.42	3077.61	5969.03	0.00	0.00	6.95	5969.03
83	16.4	2894.29	3079.21	5973.50	0.00	0.00	4.47	5973.50
84	16.6	2897.24	3081.01	5978.24	0.00	0.00	4.74	5978.24
85	16.8	2897.24	3081.01	5978.24	0.00	0.00	0.00	5978.24
86	17.0	2897.24	3081.01	5978.24	0.00	0.00	0.00	5978.24
87	17.2	2897.24	3081.01	5978.24	0.00	0.00	0.00	5978.24
88	17.4	2897.24	3081.01	5978.24	0.00	0.00	0.00	5978.24
89	17.6	2897.24	3081.01	5978.24	0.00	0.00	0.00	5978.24
90	17.8	2897.24	3081.01	5978.24	0.00	0.00	0.00	5978.24
91	18.0	2897.24	3081.01	5978.24	0.00	0.00	0.00	5978.24
92	18.2	2897.24	3081.01	5978.24	0.00	0.00	0.00	5978.24
93	18.4	2897.24	3081.01	5978.24	0.00	0.00	0.00	5978.24
94	18.6	2897.24	3081.01	5978.24	0.00	0.00	0.00	5978.24

Table B-23 (Continue).

No.	PV	Diesel Accumulative Removal (mg)	Motor oil Accumulative Removal (mg)	Total of diesel and motor oil Accumulative Removal (mg)	Mixed diesel and motor oil mobilization (mg)	Mixed diesel and motor oil accumulative mobilization (mg)	Mixed diesel and motor oil solubilization (mg)	Mixed diesel and motor oil accumulative solubilization (mg)
95	18.8	2897.24	3081.01	5978.24	0.00	0.00	0.00	5978.24
96	19.0	2897.24	3081.01	5978.24	0.00	0.00	0.00	5978.24
97	19.2	2897.24	3081.01	5978.24	0.00	0.00	0.00	5978.24
98	19.4	2897.24	3081.01	5978.24	0.00	0.00	0.00	5978.24
99	19.6	2897.24	3081.01	5978.24	0.00	0.00	0.00	5978.24
100	19.8	2897.24	3081.01	5978.24	0.00	0.00	0.00	5978.24
101	20.0	2897.24	3081.01	5978.24	0.00	0.00	0.00	5978.24

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