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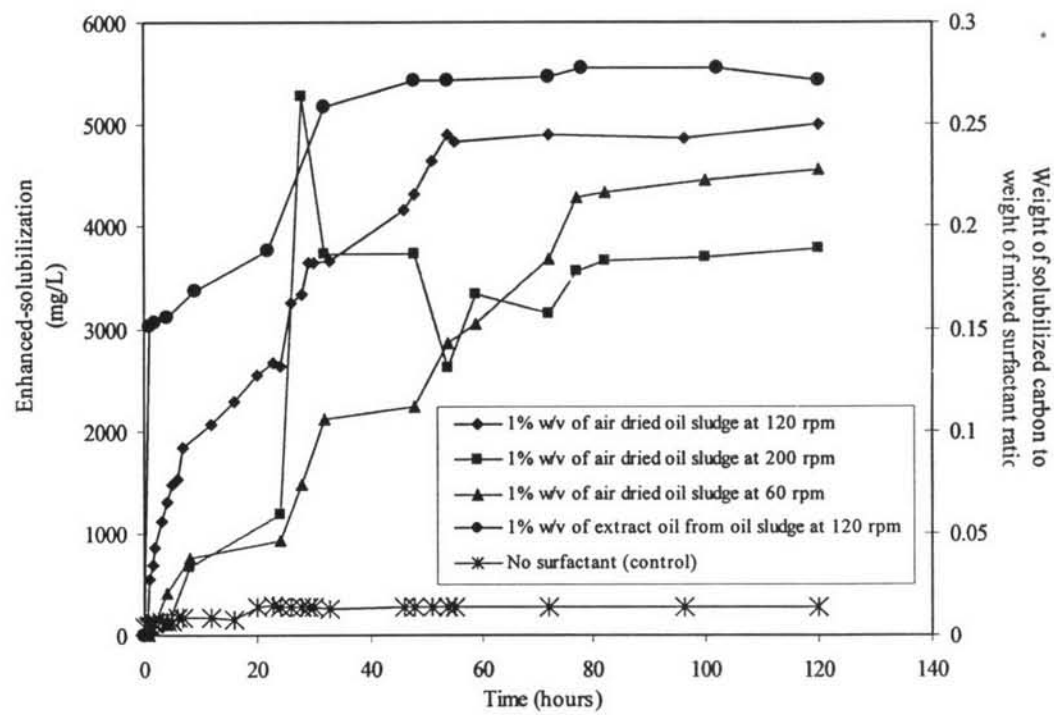
APPENDICES

Appendix A Experimental Data of Enhanced Solubilization of Hydrocarbons In Oil sludge by Mixed Surfactant.

1. Experiment Data of Effect of Contact Time on Solubilization of Air dried Oil Sludge by Mixed Surfactant at Mixing Speed 60,120 and 200 rpm.



Contact time profile of the enhanced solubilization of air-dried oil sludge by mixed-surfactant system by varying the agitation speed using TOC analyzer.

1.1 TOC analyzer

Table A-1 Effect of contact time on solubilization of oil sludge by mixed surfactant (Tween 80 and SDS) at the agitation speed 120 rpm

Time (hr)	C from oil sludge no (control)	S (ppm)	C from surfactant (ppm)	Total Organic Carbon (S+O) (ppm)		Average C from oil sludge (ppm)	
	sample 1	sample 2	(control)	sample 1	sample 2		Ratio
0	88.02	88.25	20480.00	20568.02	20568.25	0.00	0.00
0.5	88.11	88.02	20860.00	21100.00	21090.00	146.93	0.01
1	103.25	100.19	20820.00	21480.00	21474.00	555.28	0.03
1.5	116.68	116.43	20884.00	21680.00	21686.00	682.45	0.03
2	122.71	121.33	20840.00	21820.00	21814.00	854.98	0.04
3	138.68	138.40	20880.00	22140.00	22130.00	1116.46	0.05
4	143.04	141.60	20926.00	22380.00	22360.00	1301.68	0.06
5	144.86	143.36	20940.00	22540.00	22574.00	1472.89	0.07
6	166.68	166.80	20990.00	22700.00	22690.00	1538.26	0.07
7	170.97	171.04	20930.00	22940.00	22936.00	1837.00	0.09
12	164.87	163.60	20880.00	23100.00	23120.00	2065.77	0.10
16	158.07	161.08	20860.00	23300.00	23310.00	2285.42	0.11
20	280.07	277.74	20592.00	23420.00	23400.00	2539.10	0.12
23	293.60	291.31	20460.00	23420.00	23400.00	2656.40	0.13
24	278.66	280.42	20500.00	23400.00	23410.00	2625.46	0.13
26	272.88	281.52	20530.00	24120.00	24000.00	3252.80	0.15
28	274.90	283.06	20800.00	24740.00	24090.00	3336.02	0.16
29	280.16	285.08	20700.00	24640.00	24600.00	3637.38	0.17
30	279.31	284.44	20500.00	24420.00	24440.00	3648.13	0.17
33	265.20	283.72	20460.00	24340.00	24460.00	3665.54	0.17
46	281.16	286.92	20940.00	25360.00	25400.00	4155.96	0.20
48	279.70	284.64	20900.00	25420.00	25560.00	4307.83	0.21
51	282.00	288.44	20940.00	25920.00	25800.00	4634.78	0.22
54	281.96	283.31	20900.00	26120.00	26040.00	4897.36	0.23
55	280.80	287.52	20940.00	26000.00	26100.00	4825.84	0.23
72	283.00	287.12	20940.00	26140.00	26120.00	4904.94	0.23
96	282.40	291.34	20940.00	26020.00	26160.00	4863.13	0.23
120	281.00	286.78	20920.00	26220.00	26180.00	4996.11	0.24

C = Carbon, S = Mixed surfactant, O = Oil sludge

Table A-2 Effect of contact time on solubilization of oil sludge by mixed surfactant (Tween 80 and SDS) at the agitation speed 60 rpm

Time (hr)	C from oil sludge no S (ppm) (control)		C from surfactant (ppm)	Total Organic Carbon (S+O) (ppm)		Average C from oil sludge (ppm)	
	sample 1	sample 2	(control)	sample 1	sample 2		Ratio
0	88.024	88.25	11,612	11,700	11,700	0	0
1	88.1064	88.024	11,612	12,132	12,100	415.9348	0.019806419
4	103.246	100.194	11,612	12,504	12,426	751.28	0.035775238
8	116.682	116.426	11,612	12,672	12,650	932.446	0.04440219
24	122.706	121.33	11,612	12,868	13,560	1479.982	0.070475333
28	138.682	138.4	11,612	13,944	13,800	2121.459	0.101021857
32	143.042	141.6	11,612	13,980	14,000	2235.679	0.106460905
48	144.862	143.36	11,612	14,598	14,620	2852.889	0.135851857
54	166.676	166.8	11,612	14,848	14,806	3048.262	0.145155333
59	170.966	171.04	11,612	15,528	15,400	3680.997	0.175285571
72	164.87	163.6	11,612	16,108	16,020	4287.765	0.204179286
77	158.072	161.08	11,612	16,126	16,086	4334.424	0.206401143
82	280.066	277.74	11,612	16,302	16,402	4461.097	0.21243319
97	293.6	291.308	11,612	16,480	16,440	4555.546	0.216930762
120	291.4	292.4	11,612	16,389	16,435	4508.1	0.214671429

Table A-3 Effect of contact time on solubilization of oil sludge by mixed surfactant (Tween 80 and SDS) at the agitation speed 200 rpm

Time (hr)	C from oil sludge no S (ppm) (control)		C from surfactant (ppm)	Total Organic Carbon (S+O) (ppm)		Average C from oil sludge (ppm)	
	sample 1	sample 2	(control)	sample 1	sample 2		Ratio
0	88.024	88.25	12,482	12,570	12,570	0.00	0.00000
1	88.1064	88.024	12,482	12,662	12,666	93.93	0.00447
4	103.246	100.194	12,482	13,304	13,200	668.28	0.03182
8	116.682	116.426	12,482	13,774	13,800	1188.45	0.05659
24	122.706	121.33	12,482	17,830	17,944	5282.98	0.25157
28	138.682	138.4	12,482	16,266	16,422	3723.46	0.17731
32	143.042	141.6	12,482	16,366	16,352	3734.68	0.17784
48	144.862	143.36	12,482	15,330	15,138	2607.89	0.12419
54	166.676	166.8	12,482	15,954	16,010	3333.26	0.15873
59	170.966	171.04	12,482	15,786	15,800	3142.12	0.14962
72	164.87	163.6	12,482	16,202	16,196	3551.17	0.16910
77	158.072	161.08	12,482	16,306	16,290	3653.56	0.17398
82	280.066	277.74	12,482	16,388	16,400	3688.57	0.17565
97	293.6	291.308	12,482	16,472	16,520	3783.80	0.18018
120	291.4	290.5	12,482	16,468	16,531	3788.40	0.18040

Table A-4 Effect of contact time on solubilization of extract oil from oil sludge by mixed surfactant (Tween 80 and SDS) at the agitation speed 120 rpm

Time (hr)	C from oil sludge no (control) S (ppm)		C from surfactant (ppm)	Total Organic Carbon (S+O) (ppm)		Average C from oil sludge (ppm)	
	sample 1	sample 2	(control)	sample 1	sample 2		Ratio
0	99.20	103.44	10600.00	10699.20	10703.44	0.00	0
1	202.40	207.00	10600.00	13834.00	13840.00	3032.30	0.144395238
2	219.60	220.90	10600.00	13874.00	13884.00	3058.75	0.145654762
4	274.20	269.12	10600.00	13972.00	13986.00	3107.34	0.147968571
9	289.00	286.58	10600.00	14238.00	14240.00	3366.21	0.160295714
22	391.40	397.28	10600.00	14744.00	14760.00	3757.66	0.17893619
32	435.20	430.48	10600.00	16214.00	16190.00	5169.16	0.246150476
48	430.80	429.00	10600.00	16446.00	16462.00	5424.10	0.258290476
54	427.60	426.80	10600.00	16468.00	16440.00	5426.80	0.258419048
72	421.00	424.80	10600.00	16448.00	16520.00	5461.10	0.260052381
78	429.00	427.60	10600.00	16596.00	16580.00	5559.70	0.264747619
102	424.80	428.20	10600.00	16554.00	16480.00	5490.50	0.261452381
120	427.20	430.80	10600.00	16432.00	16600.00	5487.00	0.261285714
148	429.20	427.60	10600.00	16540.00	16580.00	5531.60	0.263409524

2. Enhanced Solubilization of Hydrocarbons in Oil Sludge by Nonionic Surfactant

2.1 Effect of the Enhanced-Solubilization of Hydrocarbons at the Various Concentrations and the Weight of Solubilized Carbon to Weight of Surfactant Ratio.

Table A-5 Enhanced-Solubilization of Hydrocarbons at the Various Concentrations and the Weight of Solubilized Carbon to Weight of Surfactant Ratio

% concentration of surfactant	% oil	C from S	O+S	(mg/L)	Carbon from oil sludge (gram)	W of C per W of S ratio
0	1.0	0	34.56	34.56	0	-
0.05	1.0	529.5	728.6	199.1	0.0106	18.783
0.10	1.0	635.6	1105.0	469.4	0.0218	21.532
0.20	1.0	1528.0	2054.0	526.0	0.0447	11.767
0.30	1.0	2631.0	3278.0	647.0	0.0613	10.555
0.40	1.0	3136.0	3945.0	809.0	0.0828	9.771
0.50	1.0	3507.0	4576.0	1069.0	0.1063	10.056
1.00	1.0	7137.0	8998.0	1861.0	0.2023	9.199
3.00	1.0	14370.0	17650.0	3280.0	0.6025	5.444
5.00	1.0	35240.0	40212.0	4972.0	1.0046	4.949
7.00	1.0	51060.0	56023.0	4963.0	1.4023	3.539

C = Carbon, S = Nonionic surfactant, O = Oil sludge, W = Weight (g or mg)

2.2 Determination of Contact Time Required for Solubilization of Oil Sludge by Nonionic Surfactant System

Table A-6 Contact Time Required for Solubilization of Oil Sludge by Nonionic Surfactant System

Day	C from surfactant (ppm) (control)	Total Organic Carbon (S+O) (ppm)		Average C from oil sludge (ppm)
		sample 1	sample 2	
0	937.6	737.6	737.6	0.0
1	941.7	1341.0	1273.0	365.3
2	936.8	1398.6	1346.5	435.7
3	956.4	1412.0	1401.0	450.1
5	963.4	1414.0	1398.0	442.6
10	960.0	1390.0	1429.0	449.5
15	947.4	1397.0	1405.0	453.6
20	958.0	1421.0	1387.0	446.0
25	951.5	1383.0	1395.0	437.5
30	961.8	1400.0	1389.0	432.7

2.3 Experiment Data of Effect of Contact Time on Solubilization of Extract Oil from Oil Sludge by Nonionic Surfactant at mixing speed 60,120 and 200 rpm

TOC analyzer

Table A-7 Effect of contact time on solubilization of extract oil from oil sludge by nonionic surfactant (Tween 80) at the agitation speed 60 rpm

Time (hr)	C from oil sludge no S (ppm) (control)		C from surfactant (ppm)	Total Organic Carbon (S+O) (ppm)		Average C from oil sludge (ppm)
	sample 1	sample 2	(control)	sample 1	sample 2	
0	6.484	6.224	582	582.0	582.4	0
1	6.728	6.508	582	674.2	675.0	85.782
4	6.248	6.284	582	676.2	677.8	88.534
9	7.75	7.104	582	679.4	679.4	89.773
22	8.306	8.462	582	716.8	717.2	126.416
26	8.47	8.49	582	733.6	732.4	142.320
30	8.904	8.846	582	734.2	733.8	142.925
45	11.306	10.912	582	737.2	736.4	143.491
48	10.83	10.304	582	671.4	670.4	78.133
52	11.092	10.428	582	610.8	613.2	19.040
69	11.306	11.296	582	596.0	599.0	3.999
74	10.45	10.414	582	598.0	597.4	5.068
76	10.906	10.832	582	596.0	599.6	4.731
93	11.128	11.092	582	600.2	602.2	7.910
104	10.45	10.42	582	602.6	607.4	12.365
120	11.128	11.046	582	608.4	604.2	13.013
141	11.242	11.114	582	605.0	606.0	12.122

Table A-8 Effect of contact time on solubilization of extract oil from oil sludge by nonionic surfactant (Tween 80) at the agitation speed 120 rpm

Time (hr)	C from oil sludge no S (ppm) (control)		C from surfactant (ppm)	Total Organic Carbon (S+O) (ppm)		Average C from oil sludge (ppm)
	sample 1	sample 2	(control)	sample 1	sample 2	
0	10.484	10.224	562	0	-	0
1	10.728	10.508	562	575.0	572.4	1.382
4 *	14.248	14.284	562	666.2	669.0	91.634
9	19.75	19.104	562	701.2	700.8	119.873
22	20.306	20.462	562	716.6	717.8	135.116
26	20.47	22.484	562	722.0	722.8	139.223
30	20.904	20.846	562	735.0	733.8	151.825
45	21.306	20.912	562	838.8	841.0	257.091
48	20.83	20.304	562	792.6	802.4	215.233
52	25.092	20.428	562	713.4	694.8	119.640
69	21.306	21.296	562	694.0	696.4	112.199
74	20.45	20.414	562	677.4	600.6	56.868
76	22.906	22.832	562	624.8	626.8	41.231
93	21.128	21.092	562	617.0	615.6	33.490
104	20.45	20.42	562	610.0	613.6	29.665
120	21.128	23.046	562	612.6	611.6	28.013
141	20.43	20.392	562	608.4	609.0	26.289

Table A-9 Effect of contact time on solubilization of extract oil from oil sludge by nonionic surfactant (Tween 80) at the agitation speed 200 rpm

Time (hr)	C from oil sludge no S (ppm) (control)		C from surfactant (ppm)	Total Organic Carbon (S+O) (ppm)		Average C from oil sludge (ppm)
	sample 1	sample 2	(control)	sample 1	sample 2	
0	10.484	10.224	603.0	759.0	753.2	0
1	14.728	14.508	615.0	841.2	757.6	169.782
3	14.248	14.284	600.8	879.2	842.0	245.534
8	19.75	19.104	603.0	880.4	877.4	256.473
20	20.306	20.462	600.0	895.2	882.4	268.416
24	20.47	22.484	613.8	980.8	892.4	301.323
28	20.904	20.846	581.6	991.6	983.0	384.825
43	21.306	20.912	595.0	1,057.4	994.8	409.991
48	20.83	20.304	609.6	1,060.8	1,056.8	428.633
52	25.092	20.428	593.2	956.2	1,060.4	392.340
56	21.306	21.296	598.8	904.6	956.6	310.499
67	20.45	20.414	593.0	712.0	906.8	195.968
72	22.906	22.832	611.2	696.4	710.8	69.531
76	21.128	21.092	598.0	691.8	692.0	72.790
92	20.45	20.42	612.4	699.0	701.8	67.565
102	21.128	23.046	605.0	701.2	697.2	72.113
120	20.43	20.392	607.2	700.4	699.6	72.389
141	23.106	22.904	597.4	694.0	691.2	72.195

2.4 Experiment Data of Effect of Contact Time on Solubilization of Extract Oil from Oil Sludge by Nonionic Surfactant at mixing speed 60,120 and 200 rpm and changing the stirrer.

TOC analyzer

Table A-10 Effect of contact time on solubilization of extract oil from oil sludge by nonionic surfactant (Tween 80) at the agitation speed 60 rpm

Time (hr)	C from oil sludge no S (ppm) (control)		C from surfactant (ppm)	Total Organic Carbon (S+O) (ppm)		Average C from oil sludge (ppm)
	sample 1	sample 2	(control)	sample 1	sample 2	
0	6.484	6.224	582	582.0	582.4	0
1	6.728	6.508	582	620.5	625.6	34.232
4	6.248	6.284	582	648.5	650.1	60.834
9	7.75	7.104	582	679.4	679.4	89.773
22	8.306	8.462	582	720.8	717.2	128.416
26	8.47	8.49	582	733.6	732.4	142.320
30	8.904	8.846	582	754.5	756.6	164.475
45	11.306	10.912	582	763.0	766.4	171.391
48	10.83	10.304	582	789.0	795.4	199.433
52	11.092	10.428	582	802.2	804.7	210.490
69	11.306	11.296	582	815.7	811.1	219.899
74	10.45	10.414	582	835.0	833.4	241.568
76	10.906	10.832	582	842.5	844.6	250.481
93	11.128	11.092	582	867.5	869.8	275.340
104	10.45	10.42	582	879.4	881.7	287.915
120	11.128	11.046	582	891.2	890.0	297.313
141	11.242	11.114	582	901.0	902.2	308.222

Table A-11 Effect of contact time on solubilization of extract oil from oil sludge by nonionic surfactant (Tween 80) at the agitation speed 120 rpm

Time (hr)	C from oil sludge no S (ppm) (control)		C from surfactant (ppm)	Total Organic Carbon (S+O) (ppm)		Average C from oil sludge (ppm)
	sample 1	sample 2	(control)	sample 1	sample 2	
0	10.484	10.224	562	0	-	0
1	10.728	10.508	562	575.0	572.4	1.382
4	14.248	14.284	562	666.2	669.0	91.634
9	19.75	19.104	562	701.2	700.8	119.873
22	20.306	20.462	562	736.6	737.4	154.916
26	20.47	22.484	562	754.6	755.0	171.623
30	20.904	20.846	562	783.0	784.5	201.175
45	21.306	20.912	562	889.0	887.5	305.441
48	20.83	20.304	562	899.0	898.5	316.483
52	25.092	20.428	562	905.2	907.5	321.890
69	21.306	21.296	562	916.5	921.4	335.949
74	20.45	20.414	562	968.4	974.0	389.068
76	22.906	22.832	562	953.0	968.0	375.931
93	21.128	21.092	562	987.0	988.8	405.090
104	20.45	20.42	562	996.4	998.7	415.415
120	21.128	23.046	562	1,012.0	1,008.4	426.113
141	20.43	20.392	562	1,008.0	1,010.4	426.789

Table A-12 Effect of contact time on solubilization of extract oil from oil sludge by nonionic surfactant (Tween 80) at the agitation speed 200 rpm

Time (hr)	C from oil sludge no S (ppm) (control)		C from surfactant (ppm)	Total Organic Carbon (S+O) (ppm)		Average C from oil sludge (ppm)
	sample 1	sample 2	(control)	sample 1	sample 2	
0	10.484	10.224	603.0	613.5	613.2	0
1	14.728	14.508	615.0	759.0	757.6	128.682
3	14.248	14.284	600.8	879.2	842.0	245.534
8	19.75	19.104	603.0	880.4	877.4	256.473
20	20.306	20.462	600.0	895.2	882.4	268.416
24	20.47	22.484	613.8	980.8	892.4	301.323
28	20.904	20.846	581.6	991.6	983.0	384.825
43	21.306	20.912	595.0	1,057.4	994.8	409.991
48	20.83	20.304	609.6	1,080.8	1,076.8	448.633
52	25.092	20.428	593.2	1,090.0	1,086.0	472.040
56	21.306	21.296	598.8	1,080.0	1,082.0	460.899
67	20.45	20.414	593.0	1,084.6	1,082.4	470.068
72	22.906	22.832	611.2	1,085.6	1,084.0	450.731
76	21.128	21.092	598.0	1,079.4	1,087.0	464.090
92	20.45	20.42	612.4	1,076.0	1,088.0	449.165
102	21.128	23.046	605.0	1,080.0	1,082.4	454.113
120	20.43	20.392	607.2	1,086.2	1,080.0	455.489
141	23.106	22.904	597.4	1,077.2	1,077.0	456.695

2.5 The Cost Comparison of Anionic, Nonionic and Mixed Surfactant to the Solubilization of Oil Sludge.

Table below shows the comparisons of pure nonionic (Tween 80), anionic (SDS) and mixed surfactant (Tween 80 and SDS) in the small scale solubilization studied including the prices of each surfactant. When did the comparison of the solubilized-carbon to weight of surfactant ratio, nonionic surfactant provided the highest amount of this ratio. It might because the small amount of nonionic surfactant could enhanced the solubilization of the hydrocarbon from extracted oil from oil sludge much more than the others at the same proportions. From the experiments, the enhanced-solubilization efficiency of nonionic surfactant was 7 times higher than pure anionic surfactant and 5 times higher than the mixed surfactant. The cost of nonionic and anionic surfactant were not different much and that resulted in a price must be depended on the solubilized-carbon to weight of surfactant ratio. If the ratio were high, the cost of surfactant would be low. In contrast, the lower solubilized-carbon to weight of surfactant ratio, the higher cost of surfactant. Using Tween 80 would increase the volume of the medium more than other types of surfactant when compared with SDS and mixed surfactant at the same amount of solubilized hydrocarbon in the aqueous phase. However, Tween 80 was less toxic and less biodegradable than SDS. Using SDS led to the decreasing of pH in the system because of the sulfate group in its. For this reason, Tween 80 was the most suitable to use as a surfactant in this study.

Table A-13 The Comparison of: Pure Anionic Surfactant; Pure Nonionic Surfactant, and Mixed Surfactant

Type of surfactant	Tween-80	SDS	Mixed surfactant
% Weight/Volume	0.1% w/v	2% w/v	T(0.1%)+S(2%) w/v
Prices	2.6 Baths/gram	2.7 Baths/gram	2.7+2.6 Baths/gram
Total volume	50 ml	50 ml	50 ml
Weight of surfactant	50 mg.	1,000 mg.	1,050 mg.
Weight of solubilized carbon	450 mg.	3,300 mg.	5,200 mg.
Solubilized-carbon to weight of surfactant ratio	9.00 (450/50)	3.30 (3,300/1,000)	5.20 (5,200/1,050)
Costs of enhanced-solubilization (Fixed solubilized-carbon= 5,200 mg.)	1.50 Baths	4.25 Baths	4.95 Baths
Volume increased	325 ml	43.75 ml	0 ml
Total volume	375 ml	98.75 ml	50 ml

T = Tween 80
S = Sodium dodecyl sulfate

Appendix B Experimental Data of Enhanced Biodegradation of Hydrocarbons in Extracted oil from Oil Sludge by Nonionic Surfactant.

1. Total Petroleum Hydrocarbon Extraction (TPH)

Table B-1 Oil loading 1 kg/m^{3}d fed into the Bioreactors 50 ml in each day

Oil loading 1 kg/m^{3}d

Day0

Before added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9042	106.9043	106.9042	106.9043	0.000	0.0000	0.0000
After added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9090	106.91	106.9102	106.9102	0.0012	0.0002	0.0467
Remaining oil	TPH before - TPH after (grams/Liter)				mg/L		
Reactor 1	0.00000				0.00		

Day1

Before added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9061	106.9061	106.9061	106.9062	0	0.0001	0.0033
After added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9078	106.9076	106.9088	106.9082	0.001	0.0006	0.0533
Remaining oil	TPH before - TPH after (grams/Liter)				mg/L		
Reactor 1	0.04333				43.33		

Day2

Before added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.907	106.907	106.907	106.9071	0	0.0001	0.0033
After added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9080	106.908	106.9087	106.9087	0.0007	0.0007	0.0467
Remaining oil	TPH before - TPH after (grams/Liter)				mg/L		
Reactor 1	0.05000				50.00		

Day3

Before added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9065	106.9065	106.9065	106.9066	0	0.0001	0.0033
After added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9060	106.906	106.9067	106.9068	0.0007	0.0008	0.0500
Remaining oil	TPH before - TPH after (grams/Liter)				mg/L		
Reactor 1	0.04333				43.33		

Day4

Before added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.907	106.9072	106.907	106.9073	0	0.0001	0.0033
After added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9069	106.9069	106.9076	106.9077	0.0007	0.0008	0.0500
Remaining oil	TPH before - TPH after (grams/Liter)				mg/L		
Reactor 1	0.04667				46.67		

Day5

Before added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9068	106.9068	106.9068	106.9068	0	0.0000	0.0000
After added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9025	106.9025	106.9033	106.9033	0.0008	0.0008	0.0533
Remaining oil	TPH before - TPH after (grams/Liter)				mg/L		
Reactor 1	0.05000				50.00		

Day6

Before added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9075	106.9075	106.9075	106.9076	0	0.0001	0.0033
After added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9020	106.902	106.9028	106.9028	0.0008	0.0008	0.0533
Remaining oil	TPH before - TPH after (grams/Liter)				mg/L		
Reactor 1	0.05000				50.00		

Day7

Before added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.907	106.907	106.907	106.9072	0	0.0002	0.0067
After added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9029	106.9029	106.9037	106.9037	0.0008	0.0008	0.0533
Remaining oil	TPH before - TPH after (grams/Liter)				mg/L		
Reactor 1	0.04667				46.67		

Day8

Before added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9062	106.9062	106.9062	106.9063	0	0.0001	0.0033
After added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9024	106.9024	106.9031	106.9032	0.0007	0.0008	0.0500
Remaining oil	TPH before - TPH after (grams/Liter)				mg/L		
Reactor 1	0.05000				50.00		

Day9

Before added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9065	106.9065	106.9066	106.9065	0.0001	0.0000	0.0033
After added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9020	106.902	106.9028	106.9028	0.0008	0.0008	0.0533
Remaining oil	TPH before - TPH after (grams/Liter)				mg/L		
Reactor 1	0.04667				46.67		

Day10

Before added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.906	106.906	106.906	106.9061	0	0.0001	0.0033
After added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9029	106.9029	106.9036	106.9036	0.0007	0.0007	0.0467
Remaining oil	TPH before - TPH after (grams/Liter)				mg/L		
Reactor 1	0.05000				50.00		

Table B-2 Oil loading 2 kg/m^{3}d (R1) and Oil loading 4 kg/m^{3}d (R) fed into the Bioreactors 50 ml in each day

Day0

R1=Oil loading 2 kg/m^{3}d

R2=Oil loading 4 kg/m^{3}d

Before added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9002	106.9006	106.9003	106.9007	0.0001	0.0001	0.0067
Reactor 2	106.4118	106.4116	106.4134	106.4120	0.0016	0.0004	0.0667
After added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9030	106.9046	106.9036	106.9068	0.0006	0.0022	0.0933
Reactor 2	106.4089	106.4075	106.4117	106.4117	0.0028	0.0042	0.2333

Remaining oil	TPH before - TPH after (grams/Liter)	mg/L
Reactor 1	0.08667	86.67
Reactor 2	0.16667	166.67

Day1

Before added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9065	106.9065	106.9067	106.9067	0.0002	0.0002	0.0133
Reactor 2	106.4087	106.4087	106.4093	106.4093	0.0006	0.0006	0.0400
After added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9025	106.9025	106.9042	106.9042	0.0017	0.0017	0.1133
Reactor 2	106.4065	106.4065	106.4100	106.4100	0.0035	0.0035	0.2333

Remaining oil	TPH before - TPH after (grams/Liter)	mg/L
Reactor 1	0.07333	73.33
Reactor 2	0.19333	193.33

Day2

Before added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9065	106.9065	106.9066	106.9066	0.0001	0.0001	0.0067
Reactor 2	106.4085	106.4085	106.4093	106.4093	0.0008	0.0008	0.0533
After added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9016	106.9016	106.9031	106.9031	0.0015	0.0015	0.1000
Reactor 2	106.4059	106.4059	106.4097	106.4097	0.0038	0.0038	0.2533

Remaining oil	TPH before - TPH after (grams/Liter)	mg/L
Reactor 1	0.10667	106.67
Reactor 2	0.18000	180.00

Day3

Before added oil	Weight of begger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.905	106.905	106.9051	106.9051	0.0001	0.0001	0.0067
Reactor 2	106.4081	106.4081	106.409	106.4090	0.0009	0.0009	0.0600
After added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9035	106.9035	106.9049	106.9049	0.0014	0.0014	0.0933
Reactor 2	106.4045	106.4045	106.4084	106.4084	0.0039	0.0039	0.2600

Remaining oil	TPH before - TPH after (grams/Liter)	mg/L
Reactor 1	0.09333	93.33
Reactor 2	0.19333	193.33

Day4

Before added oil	Weight of begger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9043	106.9043	106.9044	106.9044	1E-04	0.0001	0.0067
Reactor 2	106.4067	106.4067	106.4077	106.4077	0.001	0.0010	0.0667
After added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9028	106.9028	106.9044	106.9044	0.0016	0.0016	0.1067
Reactor 2	106.4049	106.4049	106.4087	106.4087	0.0038	0.0038	0.2549

Remaining oil	TPH before - TPH after (grams/Liter)	mg/L
Reactor 1	0.08667	86.67
Reactor 2	0.19333	193.33

Day5

Before added oil	Weight of begger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9042	106.9042	106.9043	106.9043	1E-04	0.0001	0.0067
Reactor 2	106.406	106.406	106.4071	106.4071	0.0011	0.0011	0.0733
After added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9028	106.9028	106.9044	106.9044	0.0016	0.0016	0.1067
Reactor 2	106.4043	106.4043	106.4080	106.4080	0.0037	0.0037	0.2467

Remaining oil	TPH before - TPH after (grams/Liter)	mg/L
Reactor 1	0.10000	100.00
Reactor 2	0.18157	181.57

Day6

Before added oil	Weight of begger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.903	106.903	106.9031	106.9031	1E-04	0.0001	0.0067
Reactor 2	106.4077	106.4077	106.4086	106.4086	0.0009	0.0009	0.0600
After added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9029	106.9029	106.9046	106.9046	0.0017	0.0017	0.1133
Reactor 2	106.4044	106.4044	106.4081	106.4081	0.0037	0.0037	0.2467

Remaining oil	TPH before - TPH after (grams/Liter)	mg/L
Reactor 1	0.10000	100.00
Reactor 2	0.18667	186.67

Day7

Before added oil	Weight of begger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9026	106.9026	106.9027	106.9027	1E-04	0.0001	0.0067
Reactor 2	106.4061	106.4061	106.4071	106.4071	0.001	0.0010	0.0667
After added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9031	106.9031	106.9047	106.9047	0.0016	0.0016	0.1067
Reactor 2	106.4051	106.4051	106.4090	106.4090	0.0039	0.0039	0.2600

Remaining oil	TPH before - TPH after (grams/Liter)	mg/L
Reactor 1	0.10667	106.67
Reactor 2	0.18000	180.00

Day8

Before added oil	Weight of begger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9049	106.9049	106.9051	106.9051	2E-04	0.0002	0.0133
Reactor 2	106.4074	106.4074	106.4085	106.4085	0.0011	0.0011	0.0733
After added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9029	106.9029	106.9046	106.9046	0.0017	0.0017	0.1133
Reactor 2	106.4042	106.4042	106.4087	106.4087	0.0045	0.0045	0.3000

Remaining oil	TPH before - TPH after (grams/Liter)	mg/L
Reactor 1	0.09333	93.33
Reactor 2	0.18667	186.67

Day9

Before added oil	Weight of begger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.906	106.906	106.9061	106.9061	1E-04	0.0001	0.0067
Reactor 2	106.4054	106.4054	106.4067	106.4067	0.0013	0.0013	0.0867
After added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9030	106.9030	106.9046	106.9046	0.0016	0.0016	0.1067
Reactor 2	106.4041	106.4041	106.4085	106.4085	0.0044	0.0044	0.2933

Remaining oil	TPH before - TPH after (grams/Liter)	mg/L
Reactor 1	0.10667	106.67
Reactor 2	0.21333	213.33

Day10

Before added oil	Weight of begger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9054	106.9054	106.9055	106.9055	1E-04	0.0001	0.0067
Reactor 2	106.406	106.406	106.4072	106.4072	0.0012	0.0012	0.0800
After added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9048	106.9048	106.9064	106.9064	0.0016	0.0016	0.1067
Reactor 2	106.4043	106.4043	106.4088	106.4088	0.0045	0.0045	0.3000

Remaining oil	TPH before - TPH after (grams/Liter)	mg/L
Reactor 1	0.10000	100.00
Reactor 2	0.21333	213.33

Table B-3 Oil loading 6 kg/m^{3}d (R1) and Oil loading 8 kg/m^{3}d (R2) fed into the Bioreactors 50 ml in each day

Day0

Before added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.903	106.903	106.903	106.9030	0	0.0000	0.0000
Reactor 2	106.4075	106.4075	106.408	106.4080	0.0005	0.0005	0.0333
After added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9042	106.9042	106.9086	106.9086	0.0044	0.0044	0.2933
Reactor 2	106.4095	106.4095	106.4155	106.4155	0.006	0.0060	0.4000

Remaining oil	TPH before - TPH after (grams/Liter)	mg/L
Reactor 1	0.29333	293.33
Reactor 2	0.36667	366.67

Day1

Before added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9031	106.9031	106.9045	106.9045	0.0014	0.0014	0.0933
Reactor 2	106.4044	106.4044	106.4068	106.4068	0.0024	0.0024	0.1600
After added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9010	106.901	106.9059	106.9059	0.0049	0.0049	0.3267
Reactor 2	106.4047	106.4047	106.4110	106.4110	0.0063	0.0063	0.4200

Remaining oil	TPH before - TPH after (grams/Liter)	mg/L
Reactor 1	0.20000	200.00
Reactor 2	0.24000	240.00

Day2

Before added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9065	106.9065	106.908	106.9080	0.0015	0.0015	0.1000
Reactor 2	106.4085	106.4085	106.411	106.4110	0.0025	0.0025	0.1667
After added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9016	106.9016	106.9075	106.9076	0.0059	0.0060	0.3967
Reactor 2	106.4034	106.4034	106.4112	106.4112	0.0078	0.0078	0.5200

Remaining oil	TPH before - TPH after (grams/Liter)	mg/L
Reactor 1	0.22667	226.67
Reactor 2	0.25333	253.33

Day3

Before added oil	Weight of begger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9017	106.9017	106.9036	106.9036	0.0019	0.0019	0.1267
Reactor 2	106.4053	106.4053	106.4085	106.4085	0.0032	0.0032	0.2133
After added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9036	106.9036	106.9098	106.9098	0.0062	0.0062	0.4133
Reactor 2	106.4075	106.4075	106.4151	106.4151	0.0076	0.0076	0.5067

Remaining oil	TPH before - TPH after (grams/Liter)	mg/L
Reactor 1	0.27000	270.00
Reactor 2	0.30667	306.67

Day4

Before added oil	Weight of begger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9043	106.9043	106.9064	106.9064	2E-03	0.0021	0.1400
Reactor 2	106.4067	106.4067	106.4098	106.4098	0.0031	0.0031	0.2067
After added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9028	106.9028	106.9096	106.9096	0.0068	0.0068	0.4533
Reactor 2	106.4049	106.4049	106.4133	106.4123	0.0084	0.0074	0.5282

Remaining oil	TPH before - TPH after (grams/Liter)	mg/L
Reactor 1	0.27333	273.33
Reactor 2	0.30000	300.00

Day5

Before added oil	Weight of begger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9016	106.9016	106.9042	106.9042	3E-03	0.0026	0.1733
Reactor 2	106.406	106.406	106.4095	106.4095	0.0035	0.0035	0.2333
After added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9028	106.9028	106.9093	106.9093	0.0065	0.0065	0.4333
Reactor 2	106.4043	106.4043	106.4123	106.4123	0.008	0.0080	0.5333

Remaining oil	TPH before - TPH after (grams/Liter)	mg/L
Reactor 1	0.28000	280.00
Reactor 2	0.29490	294.90

Day6

Before added oil	Weight of begger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9024	106.9024	106.9048	106.9048	2E-03	0.0024	0.1600
Reactor 2	106.4077	106.4077	106.411	106.4110	0.0033	0.0033	0.2200
After added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9029	106.9029	106.9096	106.9096	0.0067	0.0067	0.4467
Reactor 2	106.4044	106.4044	106.4120	106.4120	0.0076	0.0076	0.5067

Remaining oil	TPH before - TPH after (grams/Liter)	mg/L
Reactor 1	0.27333	273.33
Reactor 2	0.31333	313.33

Day7

Before added oil	Weight of begger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9015	106.9015	106.9042	106.9042	3E-03	0.0027	0.1800
Reactor 2	106.4044	106.4044	106.4076	106.4076	0.0032	0.0032	0.2133
After added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9031	106.9031	106.9102	106.9102	0.0071	0.0071	0.4733
Reactor 2	106.4032	106.4032	106.4110	106.4120	0.00776	0.0088	0.5520

Remaining oil	TPH before - TPH after (grams/Liter)	mg/L
Reactor 1	0.26667	266.67
Reactor 2	0.29333	293.33

Day8

Before added oil	Weight of begger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9049	106.9049	106.9078	106.9078	3E-03	0.0029	0.1933
Reactor 2	106.406	106.406	106.4098	106.4098	0.0038	0.0038	0.2533
After added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9029	106.9029	106.9102	106.9102	0.0073	0.0073	0.4867
Reactor 2	106.4042	106.4042	106.4115	106.4115	0.0073	0.0073	0.4867

Remaining oil	TPH before - TPH after (grams/Liter)	mg/L
Reactor 1	0.28000	280.00
Reactor 2	0.29867	298.67

Day9

Before added oil	Weight of begger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.906	106.906	106.9092	106.9092	3E-03	0.0032	0.2133
Reactor 2	106.4054	106.4054	106.4084	106.4084	0.003	0.0030	0.2000
After added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9030	106.9030	106.91	106.91	0.007	0.0070	0.4667
Reactor 2	106.4021	106.4021	106.4097	106.4097	0.0076	0.0076	0.5067

Remaining oil	TPH before - TPH after (grams/Liter)	mg/L
Reactor 1	0.27333	273.33
Reactor 2	0.28667	286.67

Day10

Before added oil	Weight of begger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9054	106.9054	106.9082	106.9082	3E-03	0.0028	0.1867
Reactor 2	106.406	106.406	106.4092	106.4092	0.0032	0.0032	0.2133
After added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9048	106.9048	106.9064	106.9064	0.0016	0.0016	0.1067
Reactor 2	106.4043	106.4043	106.4088	106.4088	0.0045	0.0045	0.3000

Remaining oil	TPH before - TPH after (grams/Liter)	mg/L
Reactor 1	0.28000	280.00
Reactor 2	0.29333	293.33

Table B-4 Oil loading 10 kg/m^{3}d fed into the Bioreactors 50 ml in each day

Day0

Before added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.907	106.907	106.907	106.9070	0	0.0000	0.0000
After added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9029	106.9029	106.9096	106.9096	0.0067	0.0067	0.4467
Remaining oil	TPH before - TPH after (grams/Liter)				mg/L		
Reactor 1	0.00000				0.00		

Day1

Before added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9071	106.9071	106.9097	106.9097	0.0026	0.0026	0.1733
After added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9020	106.902	106.9106	106.9106	0.0086	0.0086	0.5733
Remaining oil	TPH before - TPH after (grams/Liter)				mg/L		
Reactor 1	0.27333				273.33		

Day2

Before added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.907	106.907	106.91113	106.9111	0.00413	0.0041	0.2753
After added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9020	106.902	106.9108	106.9108	0.0088	0.0088	0.5867
Remaining oil	TPH before - TPH after (grams/Liter)				mg/L		
Reactor 1	0.29800				298.00		

Day3

Before added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9065	106.9065	106.9105	106.9105	0.004	0.0040	0.2667
After added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9019	106.9019	106.9114	106.9114	0.0095	0.0095	0.6333
Remaining oil	TPH before - TPH after (grams/Liter)				mg/L		
Reactor 1	0.32000				320.00		

Day4

Before added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.907	106.9072	106.912	106.9120	0.005	0.0048	0.3267
After added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9029	106.9029	106.912	106.912	0.0091	0.0091	0.6067
Remaining oil					mg/L		
Reactor 1	0.30667				306.67		

Day5

Before added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9068	106.9068	106.9112	106.9112	0.0044	0.0044	0.2933
After added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9025	106.9025	106.9114	106.9114	0.0089	0.0089	0.5933
Remaining oil	TPH before - TPH after (grams/Liter)				mg/L		
Reactor 1	0.31333				313.33		

Day6

Before added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9075	106.9075	106.9115	106.9115	0.004	0.0040	0.2667
After added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9020	106.902	106.9114	106.9114	0.0094	0.0094	0.6267
Remaining oil	TPH before - TPH after (grams/Liter)				mg/L		
Reactor 1	0.32667				326.67		

Day7

Before added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.907	106.907	106.9117	106.9117	0.0047	0.0047	0.3133
After added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9029	106.9029	106.9121	106.9121	0.0092	0.0092	0.6133
Remaining oil	TPH before - TPH after (grams/Liter)				mg/L		
Reactor 1	0.31333				313.33		

Day8

Before added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9062	106.9062	106.9105	106.9105	0.0043	0.0043	0.2867
After added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9024	106.9024	106.9114	106.9114	0.009	0.0090	0.6000

Remaining oil	TPH before - TPH after (grams/Liter)	mg/L
Reactor 1	0.32667	326.67

Day9

Before added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9065	106.9065	106.911	106.9110	0.0045	0.0045	0.3000
After added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9020	106.902	106.9115	106.9115	0.0095	0.0095	0.6333

Remaining oil	TPH before - TPH after (grams/Liter)	mg/L
Reactor 1	0.30000	300.00

Day10

Before added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.906	106.906	106.9109	106.9109	0.0049	0.0049	0.3267
After added oil	Weight of beeger		Weight of begger+oil		TPH extracted (g/15 ml)		Avg. TPH extracted (grams/Liter)
Reactor 1	106.9029	106.9029	106.9096	106.9096	0.0067	0.0067	0.4467

Remaining oil	TPH before - TPH after (grams/Liter)	mg/L
Reactor 1	0.30667	306.67

Table B-5 The Percent TPH Removal of Oil loading 1 kg/m^3d

Day	% TPH removal in 1 g/L.d
0	0.00
1	86.66
2	100.00
3	86.66
4	93.34
5	100.00
6	100.00
7	93.34
8	100.00
9	93.34
10	100.00

Table B-6 The Percent TPH Removal of Oil loading 2 and 4 kg/m^3d

Day	% TPH removal in 2 g/L.d	% TPH removal in 4 g/L.d
0	0	0
1	84.615	76.000
2	94.118	77.143
3	93.333	76.316
4	92.857	74.359
5	93.750	71.231
6	93.750	75.676
7	93.750	72.973
8	87.500	71.795
9	94.118	71.111
10	93.750	72.727

Table B-7 The Percent TPH Removal of Oil loading 6 and 8 kg/m^3d

Day	% TPH removal in 6 g/L.d	% TPH removal in 8 g/L.d
0	0	0
1	68.182	60.000
2	69.388	60.317
3	68.067	58.974
4	66.129	59.211
5	61.765	55.828
6	63.077	58.750
7	59.701	57.895
8	59.155	54.106
9	56.164	58.904
10	60.000	57.895

Table B-6 The Percent TPH Removal of Oil loading 10 kg/m^3d

Day	% TPH removal in 10 g/L.d
0	0.00
1	61.19
2	51.98
3	54.55
4	48.42
5	51.65
6	55.06
7	50.00
8	53.26
9	50.00
10	48.42

2. Dry Weight Cells method

Table B-7 Growth of Indigenous Bacteria without the Addition of Surfactant

Day	Dry weight cells (mg/L)
0	0.00
1	0.00
2	1.50
3	1.20
4	1.00
5	1.00
6	1.30
7	1.25
8	1.70
9	1.34
10	1.00

Table B-8 Growth of the Indigenous Bacteria at oil 1 kg/m^3d

Day	Dry weight cells (mg/L)
0	0.00
1	23.30
2	24.70
3	26.00
4	25.20
5	26.80
6	25.50
7	24.90
8	25.40
9	24.90
10	25.30

Table B-9 Growth of the Indigenous Bacteria at oil 2 kg/m^3d

Day	Dry weight cells (mg/L)
0	0.00
1	30.30
2	32.80
3	30.40
4	33.10
5	34.40
6	33.50
7	34.80
8	33.20
9	32.40
10	34.40

Table B-10 Growth of the Indigenous Bacteria at oil 4 kg/m^3d

Day	Dry weight cells (mg/L)
0	0.00
1	29.80
2	38.80
3	43.40
4	40.20
5	42.80
6	44.70
7	43.80
8	44.80
9	42.80
10	43.80

Table B-11 Growth of the Indigenous Bacteria at 6 kg/m^3d

Day	Dry weight cells (mg/L)
0	0.00
1	42.00
2	45.00
3	45.40
4	49.20
5	46.80
6	49.40
7	44.60
8	47.80
9	47.20
10	45.80

Table B-12 Growth of the Indigenous Bacteria at 8 kg/m^3d

Day	Dry weight cells (mg/L)
0	0.00
1	52.50
2	50.80
3	50.50
4	52.80
5	51.00
6	52.70
7	50.50
8	51.20
9	51.00
10	52.40

Table B-13 Growth of the Indigenous Bacteria at 10 kg/m^3d

Day	Dry weight cells (mg/L)
0	0.00
1	52.00
2	52.60
3	54.50
4	53.00
5	54.40
6	52.40
7	53.00
8	54.00
9	52.80
10	53.80

3. Specific TPH Removal

Table B-14 Specific TPH Removal in each Organic Loading

Control	0.00014
1 kg/m^{3}d	0.018584
2 kg/m^{3}d	0.037583
4 kg/m^{3}d	0.071635
6 kg/m^{3}d	0.100296
8 kg/m^{3}d	0.110957
10 kg/m^{3}d	0.119053

Table B-15 The Capability of Removing Extracted Oil from Oil Sludge at the Various Organic Loading

Oil (g/day)	% Oil removal	Amount of TPH removal
Control	7.32	21.95
1	95.33	47.67
2	92.15	96.02
4	73.93	184.84
6	63.16	260.55
8	58.19	287.36
10	52.45	308.47

4. COD Method

Table B-16 The Amount of Influent COD at various oil loading

Influent COD at various oil loading

Day	1 g/L.d	2 g/L.d	4 g/L.d	6 g/L.d	8 g/L.d	10 g/L.d	Control
0	2815	3186	3759	4191	4661	5120	2218
1	2822	3159	3732	4215	4652	5123	2232
2	2813	3208	3789	4226	4653	5130	2210
3	2835	3185	3705	4195	4648	5126	2221
4	2826	3212	3776	4228	4652	5120	2223
5	2823	3196	3720	4190	4650	5126	2215
6	2827	3223	3780	4200	4651	5119	2230
7	2818	3180	3769	4205	4658	5124	2121
8	2830	3175	3723	4197	4650	5123	2215
9	2831	3223	3706	4189	4653	5120	2210
10	2835	3206	3785	4215	4652	5125	2220

Table B-17 The Amount of Effluent COD at various oil loading

Effluent COD at various oil loading

Day	1 g/L.d	2 g/L.d	4 g/L.d	6 g/L.d	8 g/L.d	10 g/L.d	Control
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.0	186.3	156.1	616.7	1006.1	1316.7	1863.6	1869.6
2.0	149.5	228.6	620.0	1128.6	1350.0	1836.5	1858.1
3.0	156.5	256.0	637.1	967.5	1337.0	2018.9	1842.3
4.0	183.1	164.1	702.3	1164.0	1462.0	1870.4	1875.6
5.0	135.5	290.9	760.3	1190.0	1482.4	1898.2	1852.5
6.0	145.1	188.2	665.4	1088.2	1365.4	1845.0	1856.4
7.0	157.8	355.6	690.5	1155.6	1587.3	1750.0	1875.6
8.0	162.2	213.3	699.2	955.2	1483.1	1863.0	1868.1
9.0	150.0	246.2	559.2	1046.2	1542.6	1959.0	1846.7
10.0	148.6	235.0	567.0	1034.5	1359.2	1869.4	1870.5

Table B-18 COD Removal of oil 1 kg/m^{3}d

Day	The amount of COD removal in Reactor1	% removal in R1
0	0	0
1	2635.70	0.9330
2	2663.50	0.9428
3	2678.50	0.9481
4	2642.90	0.9355
5	2687.50	0.9513
6	2681.90	0.9493
7	2660.20	0.9417
8	2667.80	0.9444
9	2681.00	0.9490
10	2686.40	0.9509

Table B-19 COD Removal of oil 2 and 4 kg/m^{3}d

Day	The amount of COD removal in Reactor1	The amount of COD removal in Reactor2	% removal in R1	% removal in R2
0	0	0	0	0
1	3043.90	3333.33	95.12	88.89
2	2971.43	3200.00	92.86	85.33
3	2944.00	3312.93	92.00	88.34
4	3035.90	3011.03	94.87	80.29
5	2909.09	3089.66	90.91	82.39
6	3011.76	3284.62	94.12	87.59
7	2844.44	3024.31	88.89	80.65
8	2986.67	3166.91	93.33	84.45
9	2953.85	3017.86	92.31	80.48
10	2953.85	3290.77	92.31	87.75

R1 = Oil 2 kg/m^{3}d.

R2 = Oil 4 kg/m^{3}d.

Table B-20 The Amount of COD Removal of Oil 6 and 8 kg/m^3d

Day	The amount of COD removal in Reactor1	The amount of COD removal in Reactor2	% removal in R1	% removal in R2
0	0	0	0	0
1	3319.15	3184.93	79.03	68.49
2	3333.33	3248.63	79.37	69.86
3	3276.00	3079.87	78.00	66.23
4	3277.78	3135.23	78.04	67.42
5	3261.54	3040.38	77.66	65.38
6	3250.00	2984.33	77.38	64.18
7	3301.59	3176.41	78.61	68.31
8	3245.28	3131.63	77.27	67.35
9	3320.75	3119.62	79.07	67.09
10	3272.73	2935.11	77.92	63.12

R1 = Oil 6 kg/m^3d

R2 = Oil 8 kg/m^3d

Table B-21 The Amount of COD Removal of Oil 10 kg/m^3d

Day	The amount of COD removal in Reactor1	% removal in R1
0	0	0
1	3337.21	65.12
2	3261.36	63.64
3	3288.54	64.17
4	3106.06	60.61
5	3254.56	63.50
6	3226.85	62.96
7	3280.00	64.00
8	3375.00	65.85
9	3261.36	63.64
10	3165.44	61.76

R1 = Oil 10 kg/m^3d

5. TOC method

Table B-22 Influent TOC of various oil loading

Influent TOC of various oil loading

Day	1 g/L.d	2 g/L.d	4 g/L.d	6 g/L.d	8 g/L.d	10 g/L.d	Control
0.0	155.0	297.4	497.1	698.3	878.3	1061.2	41.9
1.0	154.5	296.7	498.0	698.0	876.5	1063.5	58.9
2.0	155.3	298.4	497.3	697.1	877.3	1060.5	57.0
3.0	153.4	297.0	496.7	698.2	878.0	1060.0	79.0
4.0	154.3	298.0	498.2	698.0	876.3	1062.3	81.2
5.0	152.3	297.5	497.5	697.0	876.5	1061.3	81.9
6.0	155.5	297.3	498.0	696.4	878.0	1060.2	83.6
7.0	154.4	298.0	498.1	698.0	876.5	1060.0	85.2
8.0	154.5	296.5	498.3	697.3	878.0	1061.4	83.3
9.0	155.3	297.3	496.3	698.0	878.3	1060.5	75.3
10.0	153.4	298.0	498.4	697.4	878.0	1060.5	85.2

Table B-23 Effluent TOC of various oil loading

Efluent TOC of various oil loading

Day	1 g/L.d	2 g/L.d	4 g/L.d	6 g/L.d	8 g/L.d	10 g/L.d	Control
0.0	155.00	297.40	497.10	698.30	878.3	1061.20	0.0
1.0	17.50	21.8	99.50	181.09	373.14	528.13	56.0
2.0	8.50	18.55	118.13	192.54	332.41	504.27	54.1
3.0	17.70	33.75	114.24	141.43	346.02	494.70	73.3
4.0	5.60	14.96	98.30	190.80	342.76	496.31	77.8
5.0	7.90	32.25	105.03	158.74	319.67	516.53	77.3
6.0	16.80	18.46	73.10	186.34	358.22	459.38	78.9
7.0	12.70	26.82	97.31	192.61	321.69	466.40	80.1
8.0	16.90	33.54	116.28	173.43	348.04	513.61	77.5
9.0	20.30	34.02	119.92	163.36	319.93	558.04	70.8
10.0	9.40	38.29	129.42	196.17	338.91	539.26	78.4

Table B-24 The Amount of TOC Removal of Oil 1 kg/m^{3}d

Day	The amount of TOC removal in Reactor1	The amount of TOC removal in Reactor2
0	0.00	0
1	137.00	88.39
2	146.80	95.02
3	135.70	87.38
*4	148.70	96.94
5	144.40	93.58
6	138.70	91.07
7	141.70	91.13
8	137.60	89.12
9	135.00	87.38
10	144.00	92.72

Table B-25 The Amount of TOC Removal of Oil 2 and 4 kg/m^{3}d

Day	The amount of TOC removal in Reactor1	The amount of TOC removal in Reactor2	% removal in R1	% removal in R2
0	0.00	0.00	0.00	0.00
1	274.90	398.50	92.43	80.02
2	279.85	379.17	94.32	76.25
3	263.25	382.46	88.22	77.00
4	283.04	399.90	95.30	80.27
5	265.25	392.47	89.01	78.89
6	278.84	424.90	93.73	85.32
7	271.18	400.79	91.21	80.46
8	262.96	382.02	88.24	76.66
9	263.28	376.38	88.80	75.84
10	259.71	368.98	87.36	74.03

R1 = Oil 2 kg/m^{3}d

R2 = Oil 4 kg/m^{3}d

Table B-26 The Amount of TOC Removal of Oil 6 and 8 kg/m^3d

Day	The amount of TOC removal in Reactor1	The amount of TOC removal in Reactor2	% removal in R1	% removal in R2
0	0.00	0.0	0.00	0.00
1	516.91	503.4	74.06	57.43
2	504.56	544.9	72.38	62.11
3	556.77	532.0	79.74	60.59
4	507.20	533.5	72.66	60.89
5	538.26	556.8	77.23	63.53
6	510.06	519.8	73.24	59.20
7	505.39	554.8	72.41	63.30
8	523.87	530.0	75.13	60.36
9	534.64	558.4	76.60	63.57
10	501.23	539.1	71.87	61.40

R1 = Oil 6 kg/m^3d

R2 = Oil 8 kg/m^3d

Table B-27 The Amount of TOC Removal of Oil 10 kg/m^3d

Day	The amount of TOC removal in Reactor1	% removal in R1
0	0.00	0.00
1	535.37	50.34
2	556.23	52.45
3	565.30	53.33
4	565.99	53.28
5	544.77	51.33
6	600.82	56.67
7	593.60	56.00
8	547.79	51.61
9	502.46	47.38
10	521.24	49.15

R1 = Oil 10 kg/m^3d

6. F/M (Food per Mass) Ratio

Table B-28 F/M Ratio in each Condition of Oil Loading

Oil loading (kg/m^3d)	F/M ratio	% oil removal
Control	0.0087	7.32
1	0.0225	95.33
2	0.0291	92.15
4	0.0321	73.93
6	0.0351	63.16
8	0.0367	58.19
10	0.0366	52.45

$$F/M = \frac{(COD_{in}-COD_{out})/2 \times Flowrate}{Amount\ of\ bacteria \times Volume\ of\ aeration\ tank}$$

Flowrate = 0.05 Liter/Day
Amount of bacteria = 1,000 mg/L
Volume of aeration tank = 1 Liter

7. Surfactant Degradation

Table B-29 Surfactant 0.1 kg/m^{3}d

0.1 g/L.d : TOC surf= 63 mg/L

Day	After degrade	Before degrade	C from S	% degrade	C loss
0	41.50	42.53	63	0	0
1	41.72	42.78	63	79.10	49.832
2	41.92	42.97	63	81.38	51.267
3	42.15	43.19	63	78.20	49.265
4	42.36	43.39	63	79.77	50.253
5	42.55	43.57	63	81.68	51.456
6	42.78	43.79	63	77.23	48.652
7	42.99	43.99	63	79.69	50.202
8	43.20	44.19	63	78.78	49.633
9	43.40	44.38	63	79.56	50.123
10	43.60	44.57	63	79.72	50.226
11	43.80	44.76	63	79.11	49.842
12	44.00	44.95	63	78.71	49.586
13	44.23	45.17	63	79.77	50.255
14	44.46	45.39	63	81.33	51.236
15	44.72	45.63	63	81.03	51.052

Table B-30 Surfactant 0.2 kg/m^{3}d

Day	After degrade	Before degrade	C from S	% degrade	C loss
0	36.49	41.15	133	0	0
1	39.20	43.92	133	41.85	55.654
2	41.93	46.49	133	42.00	55.854
3	44.52	48.94	133	41.87	55.691
4	47.17	51.47	133	39.80	52.935
5	49.65	53.81	133	40.19	53.451
6	51.86	55.91	133	41.60	55.323
7	54.05	58.00	133	41.23	54.842
8	55.26	59.14	133	39.59	52.654
9	57.66	61.43	133	37.95	50.475
10	59.58	63.25	133	40.12	53.365
11	61.29	64.88	133	41.70	55.456
12	63.00	66.50	133	40.69	54.124
13	64.53	67.96	133	41.64	55.385
14	66.46	69.79	133	43.79	58.245
15	68.43	71.66	133	40.78	54.235

Table B-31 Surfactant 0.4 kg/m^{3}d

Day	After degrade	Before degrade	C from S	% degrade	C loss
0	45.60	55.97	253	0.00	0
1	53.53	63.51	253	23.45	59.322
2	61.20	70.79	253	23.14	58.533
3	68.72	77.94	253	21.53	54.481
4	75.98	84.83	253	21.18	53.591
5	83.00	91.50	253	20.56	52.021
6	89.78	97.95	253	20.16	51.013
7	96.25	104.09	253	20.71	52.389
8	102.56	110.09	253	19.45	49.201
9	106.48	115.70	253	21.36	54.045
10	113.84	120.80	253	20.13	50.933
11	119.39	126.07	253	20.17	51.025
12	124.66	131.07	253	21.17	53.564
13	129.77	135.94	253	20.18	51.055
14	134.65	140.57	253	20.87	52.813
15	139.26	144.95	253	22.05	55.795

Table B-32 Surfactant 0.6 kg/m^{3}d

Day	After degrade	Before degrade	C from S	% degrade	C loss
0	35.64	52.61	375.00	0.00	0.00
1	50.24	66.48	375.00	14.79	55.46
2	64.02	79.57	375.00	15.16	56.85
3	77.46	92.34	375.00	13.52	50.69
4	89.99	104.24	375.00	15.72	58.94
5	102.13	115.78	375.00	14.79	55.45
6	113.61	126.68	375.00	15.82	59.32
7	124.62	137.14	375.00	15.69	58.84
8	135.28	147.27	375.00	14.84	55.65
9	145.37	156.85	375.00	15.86	59.48
10	154.93	165.93	375.00	16.63	62.37
11	164.16	174.70	375.00	16.12	60.46
12	173.03	183.13	375.00	15.77	59.12
13	181.50	191.18	375.00	16.10	60.39
14	189.67	198.94	375.00	15.53	58.25
15	197.42	206.30	375.00	16.33	61.24

Table B-33 Surfactant 0.8 kg/m^{3}d

Day	After degrade	Before degrade	C from S	% degrade	C loss
0.00	42.36	64.89	463.00	0.00	0.00
1.00	62.13	83.67	463.00	12.26	60.46
2.00	80.75	101.36	463.00	13.56	66.85
3.00	98.62	118.33	463.00	13.32	65.69
4.00	115.65	134.52	463.00	13.58	66.94
5.00	132.17	150.21	463.00	12.46	61.45
6.00	147.82	165.08	463.00	13.25	65.32
7.00	162.80	179.31	463.00	13.15	64.84
8.00	177.27	193.06	463.00	12.30	60.65
9.00	191.15	206.24	463.00	12.06	59.48
10.00	204.34	218.77	463.00	12.65	62.37
11.00	216.85	230.66	463.00	13.28	65.46
12.00	228.80	242.01	463.00	13.41	66.12
13.00	240.28	252.92	463.00	13.06	64.39
14.00	251.16	263.25	463.00	13.84	68.25
15.00	261.62	273.19	463.00	13.44	66.24

Table B-34 Surfactant 1.0 kg/m^{3}d

Day	After degrade	Before degrade	C from S	% degrade	C loss
0.00	44.56	72.83	610.00	0.00	0.00
1.00	69.58	96.60	610.00	11.51	70.23
2.00	93.44	119.27	610.00	11.70	71.34
3.00	116.17	140.86	610.00	11.97	73.05
4.00	197.99	218.59	610.00	11.65	71.05
5.00	216.22	235.91	610.00	11.50	70.12
6.00	233.69	252.51	610.00	11.53	70.31
7.00	250.35	268.33	610.00	11.46	69.92
8.00	266.23	283.42	610.00	11.66	71.10
9.00	281.52	297.94	610.00	11.04	67.35
10.00	296.04	311.74	610.00	11.57	70.57
11.00	309.88	324.88	610.00	11.86	72.35
12.00	323.12	337.47	610.00	11.71	71.46
13.00	335.82	349.52	610.00	11.52	70.25
14.00	347.88	360.98	610.00	12.01	73.26
15.00	359.43	371.96	610.00	11.86	72.33

Appendix C Analytical Method.

1. Enhanced Solubilization

$= (Solubilization_{oil+surf.} - Solubilization_{surf}) - Solubilization_{control}$

where Surf = Surfactant

2. % Enhanced Solubilization

$=$ (Enhanced solubilization x 100) / $Solubilization_{control}$

3. TPH Degradation

$= TPH_{control} - TPH_d$

where TPH = Total Petroleum Hydrocarbon

d = Day 1 to Day7

4. % TPH Degradation

= (TPH degradation x 100) / $TPH_{control}$

5. Yield of Bacteria

= Dry weight cell / TPH degradation

6. Rate of TPH Degradation

= TPH degradation / 7 days

= TPH degradation / (7 days x dry weight cell)

7. F/M Ratio

$= \frac{(COD_{in}-COD_{out})/2 \times Flowrate}{\text{Amount of bacteria} \times \text{Volume of aeration tank}}$

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