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8. Appendices

Appendix I

Prevailing effluent discharge standards for crude palm oil mills 1984
(Environmental Quality Act)

Parameter		Parameter limits for crude palm oil mills (second schedule)	Remarks
Biochemical Oxygen Demand (BOD; 3-day, 30°C)	mg/L	100	
Chemical Oxygen Demand (COD)	mg/L	*	
Total Solids	mg/L	*	
Suspended Solids	mg/L	400	
Oil and Grease	mg/L	50	
Ammoniacal Nitrogen	mg/L	150	Value of filtered sample
Total Nitrogen	mg/L	200	Value of filtered sample
pH	-	5-9	
Temperature	°C	45	

Note: * No discharge standard after 1984

(Source: *Industry Process & The Environment, Handbook 3, Crude Palm Oil Industry, 1999*)

Appendix II

Filter Whatman #1

Characteristics	Discharge Limit	Raw Sample	P/Treated Membrane Feed	Pre-treatment Efficiency %	Membrane Permeate	Membrane Rejection R	Overall Treatment Efficiency %
OD (3 days), mg/L	100	110	88	20.00	14.0	0.8409	87.27
OD, mg/L	-	1336	1306	2.25	193	0.8522	85.55
T & G, mg/L	50	-	80	-	53.0	0.3375	-
N, mg/L	150	24.4	23.6	3.16	19.2	0.1875	21.31
N, mg/L	200	120	97.5	18.75	25.4	0.7395	78.83
S, mg/L	400	657	612	6.85	5.0	0.9918	99.24
Turbidity, FTU	-	1155	1076	6.84	24	0.9777	97.92
Colour, PtCo APHA	-	11500	10600	7.83	230	0.9783	98.00

Centrifugation (Speed 2500 rpm, 10 min.)

Characteristics	Discharge Limit	Raw Sample	P/Treated Membrane Feed	Pre-treatment Efficiency %	Membrane Permeate	Membrane Rejection R	Overall Treatment Efficiency %
OD (3 days), mg/L	100	110	-	-	-	-	-
OD, mg/L	-	1336	931	30.31	591	0.3652	55.76
T & G, mg/L	50	-	-	-	-	-	-
N, mg/L	150	24.4	18.8	22.95	17.2	0.0878	29.71
N, mg/L	200	120	60.0	50.00	39.4	0.3437	67.18
S, mg/L	400	657	90	86.30	40	0.5600	93.91
Turbidity, FTU	-	1155	410	64.50	100	0.7750	91.34
Colour, PtCo APHA	-	11500	3170	72.43	800	0.7476	93.04

Coagulation (Ferrous Sulphate 338 ppm)

Characteristics	Discharge Limit	Raw Sample	P/Treated Membrane Feed	Pre-treatment Efficiency %	Membrane Permeate	Membrane Rejection R	Overall Treatment Efficiency %
OD (3 days), mg/L	100	-	-	-	-	-	-
OD, mg/L	-	1448	806	44.34	407	0.4950	71.89
T & G, mg/L	50	-	-	-	-	-	-
N, mg/L	150	25.3	23.9	5.53	21.3	0.1088	16.81
N, mg/L	200	112.5	39.4	65.00	33.8	0.1417	69.96
S, mg/L	400	700	150	78.57	0.0	1.0000	100.00
Turbidity, FTU	-	1113	395	64.51	90	0.7722	91.91
Colour, PtCo APHA	-	9050	3200	64.64	740	0.7688	91.82

Appendix III

Results of Coagulation Test

	Rapid Mixing 155 rpm, 3 minutes ml	Slow Stir 25 rpm, 30 minutes Cationic Flocculant 10 000 ppm ml	Floc Approx. Vol ml	Colour PtCo, APHA	Turbidity FTU	SS mg/l
Ferrous Sulphate 10 000 ppm 10 g/l (1%)	25 (244 ppm)	10	20	3350	410	200
	27.5 (268 ppm)	10	20	3310	400	190
	35 (338 ppm)	10	20	3200	395	150
Ferrous Sulphate 10 000 ppm 10 g/l (1%)	20 (196 ppm)	10	40	3520	445	250
	25 (244 ppm)	10	40	3400	415	220
	25 (244 ppm)	0	no floc	4320	545	300

Appendix IV

Flocculation Index

Letter Designation	Floc Type	Average floc size
A	Pin point	Extremely fine
B	Fine	1/64" in diameter
C	Small	1/32" in diameter
D	Fair	1/32" to 3/64" in diameter
E	Good	3/64" to 3/32" in diameter
F	Large straggler	1/4" and larger in diameter
	Minutes to settle	Comment
G	Less than 2	Excellent
H	2 – 4	Good
I	4 – 7	Fair
J	More than 10	Poor

(Source: *Applied Water and Spentwater Analysis*, Jackson 1993)

Appendix V

Results of membrane stirred-cell treatment on filtered and centrifuged POME final discharge

Transmembrane pressure: 4.5 bar

Characteristics	Discharge Limit	Raw Sample	Filter Paper						Centrifuge						
			pH 8			pH 2.2			pH 8			pH 2.2			
			Feed	Permeate	Rejection	Feed	Permeate	Rejection	Feed	Permeate	Rejection	Feed	Permeate	Rejection	
BOD (3 days), mg/L	100	110	88	14.0	0.8409	0.5436	739.5	337.5	0.5436	931	591	0.3652	703	313	0.5468
COD, mg/L	-	1336	1306	193	0.8522	0.4733	0.3375	18.3	15.5	0.1503	60.0	39.4	0.3437	54.4	0.4483
O & G, mg/L	50	-	80	53.0	0.3375	0.7395	0.9918	60	11	0.8167	90	40	0.5600	20	0.5000
AN, mg/L	150	24.4	23.6	19.2	0.1875	0.8542	0.9777	240	35	0.8542	410	100	0.7750	200	0.7600
TN, mg/L	200	-	97.5	25.4	0.7395	0.8549	0.9777	1920	279	0.8549	3170	800	0.7476	1600	0.7647
SS, mg/L	400	657	612	5.0	0.9918	0.9783	0.9777	10600	10600	0.9783	10600	10600	0.9783	10600	10600
Turbidity, FTU	-	1155	1076	24	0.9777	0.9783	0.9777	10600	10600	0.9783	10600	10600	0.9783	10600	10600
Colour, PtCo APHA	-	11500	10600	230	0.9783	0.9783	0.9783	10600	10600	0.9783	10600	10600	0.9783	10600	10600

Characteristics	Discharge Limit	Raw Sample	Filter Paper						Centrifuge								
			pH 8			pH 2.2			pH 8			pH 2.2					
			Feed	Permeate	Rejection	Feed	Permeate	Rejection	Feed	Permeate	Rejection	Feed	Permeate	Rejection			
BOD (3 days), mg/l	100	110															
COD, mg/l	-	1336	1277	306.5	0.7600	739.5	348	0.5294	931	613	0.3416	703	479	0.3186			
O & G, mg/l	50	-															
AN, mg/l	150	24.4	19.3	16.8	0.1295	18.6	18.6	0.0000	18.8	18.8	0.0000	20.4	20.4	0.0000			
TN, mg/l	200	-	97.5	30.0	0.8923	31.9	26.3	0.1755	60.0	41.0	0.3167	54.4	38.1	0.2996			
SS, mg/l	400	657	600	92	0.8462	58	12	0.7931	90	60	0.3333	20	20	0.0000			
Turbidity, FTU	-	1155	2300	85	0.8630	220	38	0.8273	408	100	0.7649	200	50	0.7500			
Colour, PtCo APHA	-	11500	19100	680	0.9644	1935	285	0.8527	3170	840	0.7350	1600	430	0.7313			

Appendix VI

Proposed Parameter Limits of Effluent of Standards A and B for year 2005

	<u>Parameter</u>	<u>Unit</u>	<u>Standard</u>	
			<u>A</u>	<u>B</u>
1.	Temperature	° C	40	40
2.	pH value	-	6.0 – 9.0	5.5 – 9.0
3.	BOD ₅ at 20° C	mg/l	20	50
4.	COD	mg/l	80	200
5.	Suspended Solids	mg/l	50	100
6.	Mercury	mg/l	0.005	0.01
7.	Cadmium	mg/l	0.01	0.05
8.	Chromium, Total	mg/l	0.05	0.05
9.	Arsenic	mg/l	0.05	0.10
10.	Cyanide	mg/l	0.05	0.10
11.	Lead	mg/l	0.10	0.2
12.	Copper	mg/l	0.20	1.0
13.	Manganese	mg/l	0.05	1.0
14.	Nickel	mg/l	0.20	1.0
15.	Tin	mg/l	0.20	1.0
16.	Zinc	mg/l	1.0	2.0
17.	Boron	mg/l	1.0	4.0
18.	Iron (Fe)	mg/l	1.0	5.0
19.	Phenol	mg/l	0.05	0.2
20.	Free Chlorine	mg/l	1.0	2.0
21.	Sulphide	mg/l	0.2	0.50
22.	Oil and Grease	mg/l	1.0	10.0
23.	Ammoniacal Nitrogen	mg/l	5.0	5.0
24.	Sulphate	mg/l	100	500
25.	Chloride	mg/l	400	600
26.	Colour	Hazen	10.0	50.0
27.	Detergens, Anionic	mg/l	5.0	10.0
28.	Flouride	mg/l	2.0	5.0
29.	Nitrate-Nitrogen	mg/l	20.0	20.0
30.	Polychlorinated Biphenyls	mg/l	0.04	0.3
31.	Selenium	mg/l	0.01	0.5
32.	Silver	mg/l	0.1	0.1