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APPENDICES

APPENDIX A

APPENDIX A

The preliminary results were performed to determine the optimum depth for two propeller sizes in Table A-1. In order to determine the optimum depth in each propeller size, the K_La values were used as an indicator to make a decision for the optimum depth.

Table A-1 The optimum depth for two propeller sizes

K_La values using 10.7 cm propeller diameter	
Depth of propeller	**Average of K_La Values**
3 cm	6.944
4 cm	8.315
5 cm	8.815
6 cm	4.834
K_La values using 15 cm propeller diameter	
Depth of propeller	**Average of K_La Values**
3 cm	5.786
4 cm	9.236
5 cm	11.266
6 cm	8.336

From these results, the optimum depths for each propeller size are at 5 cm. The propellers' depth which is greater than 5 cm was too deep in elevation for propeller to expose the water into the air. Therefore, one did not concern about it.

APPENDIX B

APPENDIX B

To illustrate the experiment clearly, the figure B-1 was the one of the example of the raw data, which were inputted in to the ASCE parameter estimation program.

	Constraints or Units	Values or Texts
No. of Data Points	6-300	25
No. of Probes	1-6	2
Test temperature	°C	30.7
Barometric Pressure	in-Hg	29.92
Test Volume	ft^3	14.12
Gas Flow Rate	ft^3/min	---------
Enter a Title for Your Output		143 26/02/03 depth5cm Di10.7cm 10saa 1005rpm R2

Figure B-1 Environmental Data

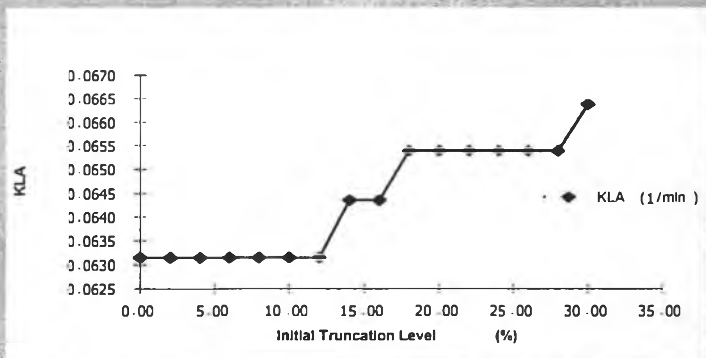
DO concentration in each determination point were inputted into ASCE parameter estimation program as depicted in Table B-1.

Table B-1 Data Input

No	Time (min)	DO Concentration (mg/L) Probe 1	Probe 2
1	0	0.91	0.71
2	4	1.31	1.17
3	8	2.11	1.86
4	12	2.86	2.56
5	16	3.76	3.49
6	20	4.39	4.21
7	24	4.86	4.93
8	28	5.43	5.55
9	32	5.82	6.01
10	36	6.1	6.4
11	40	6.35	6.73
12	44	6.61	6.96
13	48	6.77	7.19
14	52	6.93	7.3
15	56	7.07	7.43
16	60	7.15	7.51
17	64	7.24	7.6
18	71.5	7.35	7.71
19	79	7.43	7.74
20	86.5	7.48	7.77
21	94	7.5	7.8
22	101.5	7.52	7.8
23	109	7.52	7.83
24	116.5	7.52	7.77
25	124	7.52	7.77

After inputting data were done, the initial guess worksheet provided an initial estimation in the parameters at different initial truncation levels. The initial data truncation was preformed as described in chapter 3. Figure B-2 presented the example of data truncation.

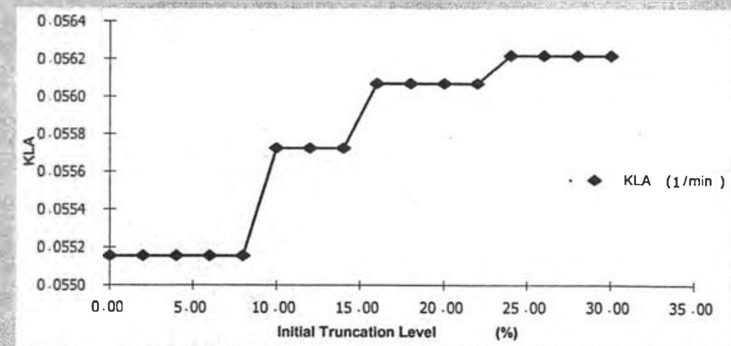
Probe 1			
Initial Truncation Level (%)	Initial Guess of C 0 (mg/L)	CS (mg/L)	KLA (1/min)
0.00	0.91	7.53	0.0632
2.00	0.91	7.53	0.0632
4.00	0.91	7.53	0.0632
6.00	0.91	7.53	0.0632
8.00	0.91	7.53	0.0632
10.00	0.91	7.53	0.0632
12.00	0.91	7.53	0.0632
14.00	1.31	7.53	0.0644
16.00	1.31	7.53	0.0644
18.00	2.11	7.53	0.0654
20.00	2.11	7.53	0.0654
22.00	2.11	7.53	0.0654
24.00	2.11	7.53	0.0654
26.00	2.11	7.53	0.0654
28.00	2.11	7.53	0.0654
30.00	2.86	7.53	0.0664



Choose an initial truncation Level (1-30%) for Final Calculation

12 %

Probe 2			
Initial Truncation Level (%)	Initial Guess of C0 (mg/L)	CS (mg/L)	KLA (1/min)
0.00	0.71	7.84	0.0552
2.00	0.71	7.84	0.0552
4.00	0.71	7.84	0.0552
6.00	0.71	7.84	0.0552
8.00	0.71	7.84	0.0552
10.00	1.17	7.84	0.0557
12.00	1.17	7.84	0.0557
14.00	1.17	7.84	0.0557
16.00	1.86	7.84	0.0561
18.00	1.86	7.84	0.0561
20.00	1.86	7.84	0.0561
22.00	1.86	7.84	0.0561
24.00	2.56	7.84	0.0562
26.00	2.56	7.84	0.0562
28.00	2.56	7.84	0.0562
30.00	2.56	7.84	0.0562



Choose an initial truncation level (1-30%) for Final Calculation

8 %

Figure B-2 Initial data truncation

After choosing a proper initial truncation level, one can proceed by activating the main program from the taskbar. The program was run the data. The table and curve of truncated DO concentration and residual curve were shown in the output worksheet as depicted in Figure B-3.

Probe 1
Nonlinear Estimation

Unsteady State Oxygen Transfer

Iteration Number	C (mg/L)	C_0 (mg/L)	KLA (1/min)	Sum of Squares
1	7.53	2.11	0.0654	3.3923702
2	7.55	2.07	0.0422	0.668622(
3	7.59	2.00	0.0471	0.0546069
4	7.61	2.00	0.0471	0.0522066

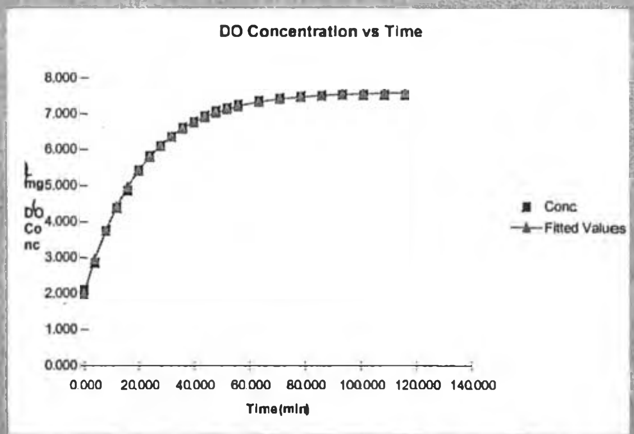
143 26/02/03 depth5cm DI 0.7cm 10saa 1005rpm R2

	Test Conditions	Standard Conditions
[illegible](°C)	30.70	20.00
Pressure(" Hg)	29.92	29.92
C [illegible] mg/L)	7.61	9.26
[illegible] (1/hr)	2.82	2.19
[illegible]_mean_square	0.05	
[illegible] (lb/hr)		0.02
SOTE		1.73
[illegible] (ft)		0.61
Tau		0.82
Omega		1.00
[illegible]	18.00	

Summary Data

No of Data Points 23

No	Time	Conc	Fitted Values	Residuals
1	0.000	2.110	1.998	0.112
2	4.000	2.860	2.960	-0.100
3	8.000	3.760	3.757	0.003
4	12.000	4.390	4.418	-0.028
5	16.000	4.860	4.965	-0.105
6	20.000	5.430	5.418	0.012
7	24.000	5.820	5.793	0.027
8	28.000	6.100	6.104	-0.004
9	32.000	6.350	6.362	-0.012
10	36.000	6.610	6.575	0.035
11	40.000	6.770	6.752	0.018
12	44.000	6.930	6.898	0.032
13	48.000	7.070	7.019	0.051
14	52.000	7.150	7.120	0.030
15	56.000	7.240	7.203	0.037
16	63.500	7.350	7.323	0.027
17	71.000	7.430	7.407	0.023
18	78.500	7.480	7.466	0.014
19	86.000	7.500	7.507	-0.007
20	93.500	7.520	7.536	-0.016
21	101.000	7.520	7.557	-0.037
22	108.500	7.520	7.571	-0.051
23	116.000	7.520	7.581	-0.061



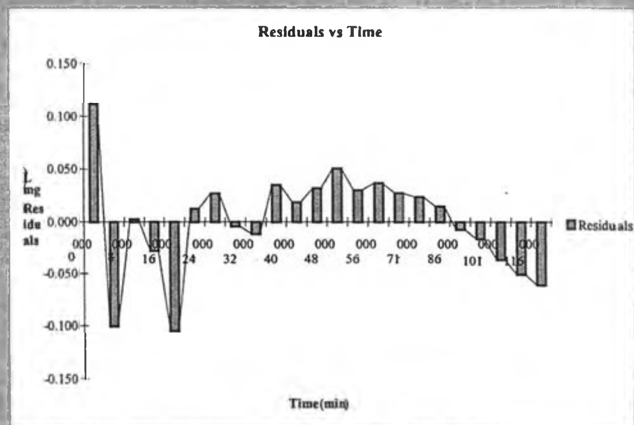


Figure B-3 Raw data

The summary in the program showed the final result which were K_La, C^*_α, and SOTR as presented in Figure B-4.

Summary (for standard conditions, 20°C)							
Probe	KLA (1/hr)	C * (mg/L)	SOTE (%)	SOTR lb/hr	de ft	RMS	Barometric (in hg)
1	2.191	9.259	1.725	0.018	0.609	0.051	29.920
2	2.102	9.727	1.739	0.018	2.318	0.190	29.920
Average	2.147	9.493	1.732	0.018	1.463	0.120	29.920

Figure B-4 Conclusion Table

APPENDIX C

APPENDIX C

The power inputs for each size of propellers were calculated by the following theory as described in chapter 2. The range between RPMs and power input per volume tank for 10.7 cm and 15 cm of propeller diameters used in this experiment were revealed in Figure C-1.

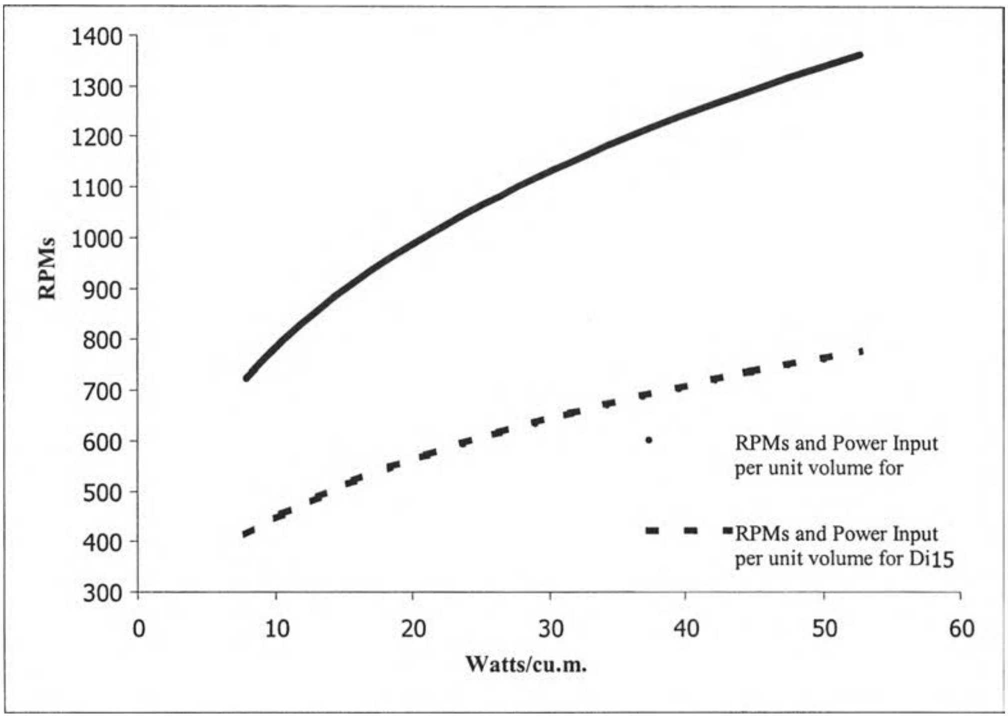


Figure C-1 RPMs as a function of power inputs per unit volume

The turbulent condition used in this research was indicated by using Reynolds number. Figure C-2 showed the range of turbulent condition as a function of Reynolds number and power input per unit volume.

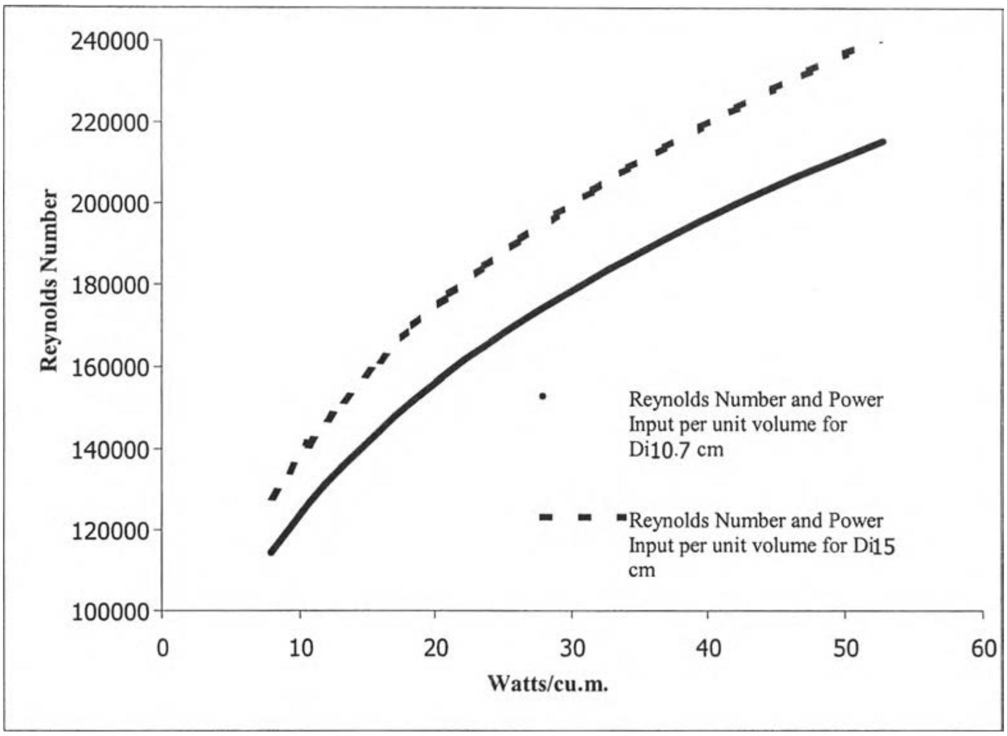


Figure C-2 Reynolds Number as a function of power inputs per unit volume

APPENDIX D

APPENDIX D

Guide for Estimating DO Determination Times

As described in chapter 3, the timing of DO determination is of importance in analyzing unsteady-state test data to ensure precision of the estimate of the oxygen transfer parameter. It is convenient to plan a test based on either 12, 15, 18, 21, or 24 measurements. Table D-1 shows the time intervals estimated to give the distribution of data values required. Use of Table D-1 requires an approximate value of K_La which can be estimated from the expected values of OTR_0 as indicated in the table. However, K_La can more easily be approximated form an inspection of the DO-versus-time plot by nothing the approximate value of the saturation concentration, C^*_∞ approached at infinite time. An approximate value of K_La is then given as the reciprocal of the time interval between dissolved oxygen concentrations of zero and 63% of C^*_∞ (For this method to be applied, the data may have to be extrapolated to zero DO.).

It should be also noted that the table assumes that sampling will begin at time zero, which is assumed to occur at a zero dissolved oxygen concentration. If zero DO is not attained, or if early truncation is to be practiced, the determination interval for zero to 86% saturation should be decreased by roughly 25% so that the required numbers of points are obtained in this region.

TableD-2 presents data value distributions for $0/K_La$ to $2/K_La$ and $2/K_La$ to $3.9/K_La$. This table can be used to check compliance with the timing criteria, where as Table D-1 is used for experimental planning (ASCE, 1993)

Table D-1 Estimate Dissolved Oxygen Determination Intervals (ASCE,1993)

Total Number of Data Values	**Time from 0 to 2/K_La** (0-86.5% Saturation)		**Time from 2/Kla to 3.9/K_La** (86.5-98.0% Saturation)	
	Number of Values	**Determination Interval, hr**	**Number of Values**	**Determination Interval, hr**
12	8	0.285/K_La	4	0.500/K_La
15	10	0.222/K_La	5	0.400/K_La
18	12	0.182/K_La	6	0.333/K_La
21	14	0.153/K_La	7	0.285/K_La
24	16	0.133/K_La	8	0.250/K_La

K_La = Volumetric transfer coefficient,hr^{-1}, and may be approximated by
K_La = $OTR_0/10W$, where:
OTR_0 = expected oxygen transfer rate at zero dissolved oxygen, ld/hr; and
W = weight of water, 10^6 lb

Table D-2 Distribution of DO Data Values (ASCE, 1993)

Total Number of Data Values	**Time from 0 to 2/K_La Number of Values**	**Time from 2/K_La to 3.92/K_La Number of Values**
12	7-9	3-5
13	8-9	4-5
14	9-10	4-5
15	9-11	4-6
16	10-12	4-7
17	10-12	5-7
18	11-13	5-7
19	12-14	5-7
20	12-15	5-8
21	13-15	6-8
24	14-18	6-10

APPENDIX E

APPENDIX E

The average of the experimental results were shown as a function of the surfactant concentrations and the variation of power input in Table E-1. Each experimental result was shown in Table E-2 to E-25.

Table E-1 K_La values as a function of surfactant concentration and power input

Oxygen transfer coefficient using 10.7 cm propeller diameter (hr^{-1})												
Dia 10.7 cm	**13.2 Watts/m^3** (632 RPMs)			**26.3 Watts/m^3** (798 RPMs)			**39.5 Watts/m^3** (914 RPMs)			**52.7 Watts/m^3** (1005 RPMs)		
SAA Conc.	**Run 1**	**Run 2**	**Run 3**	**Run 1**	**Run 2**	**Run 3**	**Run 1**	**Run 2**	**Run 3**	**Run 1**	**Run 2**	**Run 3**
0 mg/L	1.601	1.727	1.945	3.214	3.098	3.294	4.302	4.124	4.079	5.689	5.679	5.674
5 mg/L	1.038	1.045	1.062	2.760	2.749	2.796	3.607	3.546	3.561	5.110	5.144	5.051
10 mg/L	0.584	0.542	0.589	0.880	0.841	0.897	1.286	1.362	1.221	2.149	2.147	2.156

Oxygen transfer coefficient using 15 cm propeller diameter (hr^{-1})												
Dia 15 cm	**13.2 Watts/m^3** (362 RPMs)			**26.3 Watts/m^3** (455 RPMs)			**39.5 Watts/m^3** (519 RPMs)			**52.7 Watts/m^3** (571 RPMs)		
SAA Conc.	**Run 1**	**Run 2**	**Run 3**	**Run 1**	**Run 2**	**Run 3**	**Run 1**	**Run 2**	**Run 3**	**Run 1**	**Run 2**	**Run 3**
0 mg/L	2.481	2.213	2.318	4.409	5.038	5.368	7.451	6.619	7.285	7.506	7.561	7.540
5 mg/L	2.161	2.009	2.162	4.268	4.358	4.251	4.755	4.789	4.638	5.778	5.787	5.745
10 mg/L	0.913	1.040	1.034	3.272	2.934	2.931	4.126	4.181	4.088	4.372	4.473	4.408

Table E-2 Experimental results for 10.7 cm diameter propeller, 13.2 Watts/m^3 in clean water

Probe	KLA (1/hr)	C* (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	1.851	9.131	0.015	0.148	29.920
2	1.351	8.007	0.010	0.145	29.920
Average	1.601	8.569	0.012	0.146	29.920
Probe	KLA (1/hr)	C* (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	2.003	9.516	0.017	0.259	29.920
2	1.450	9.262	0.012	0.165	29.920
Average	1.727	9.389	0.014	0.212	29.920
Probe	KLA (1/hr)	C* (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	2.087	9.357	0.017	0.075	29.920
2	1.804	8.765	0.014	0.416	29.920
Average	1.945	9.061	0.016	0.245	29.920

Table E-3 Experimental results for 10.7 cm diameter propeller, 13.2 Watts/m^3 in water with SAA 5 mg/L

Probe	KLA (1/hr)	C* (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	0.904	10.076	0.008	0.107	29.920
2	1.171	8.384	0.009	0.163	29.920
Average	1.038	9.230	0.008	0.135	29.920
Probe	KLA (1/hr)	C* (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	0.528	11.986	0.006		29.920
2	1.562	9.009	0.012	0.041	29.920
Average	1.045	10.497	0.009	0.020	29.920
Probe	KLA (1/hr)	C* (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	1.212	10.401	0.011	0.084	29.920
2	0.913	8.467	0.007		29.920
Average	1.062	9.434	0.009	0.042	29.920

Table E-4 Experimental results for 10.7 cm diameter propeller, 13.2 Watts/m^3 in water with SAA 10 mg/L

Probe	KLA (1/hr)	C^* (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	0.671	9.837	0.006	0.086	29.920
2	0.496	10.343	0.005	0.175	29.920
Average	0.584	10.090	0.005	0.131	29.920
Probe	KLA (1/hr)	C^* (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	0.643	10.055	0.006	0.095	29.920
2	0.442	10.864	0.004	0.212	29.920
Average	0.542	10.460	0.005	0.154	29.920
Probe	KLA (1/hr)	C^* (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	0.575	10.141	0.005	0.139	29.920
2	0.604	10.134	0.005	0.233	29.920
Average	0.589	10.138	0.005	0.186	29.920

Table E-5 Experimental results for 10.7 cm diameter propeller, 26.3 Watts/m^3 in clean water

Probe	KLA (1/hr)	C^* (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	3.918	10.093	0.035	0.132	29.920
2	2.510	6.850	0.015		29.920
Average	3.214	8.472	0.025	0.066	29.920
Probe	KLA (1/hr)	C^* (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	2.673	9.886	0.023	0.176	29.920
2	3.523	8.598	0.027	0.244	29.920
Average	3.098	9.242	0.025	0.210	29.920
Probe	KLA (1/hr)	C^* (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	3.624	9.533	0.030	0.086	29.920
2	2.963	9.322	0.024	0.072	29.920
Average	3.294	9.427	0.027	0.079	29.920

Table E-6 Experimental results for 10.7 cm diameter propeller,26.3 Watts/m^3 in water with SAA 5 mg/L

Probe	KLA (1/hr)	C^* (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	3.300	9.803	0.029	0.088	29.920
2	2.220	10.619	0.021	0.444	29.920
Average	2.760	10.211	0.025	0.266	29.920
Probe	KLA (1/hr)	C^* (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	3.806	9.481	0.032	0.071	29.920
2	1.693	9.564	0.014	0.249	29.920
Average	2.749	9.522	0.023	0.160	29.920
Probe	KLA (1/hr)	C^* (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	2.823	10.526	0.026	0.210	29.920
2	2.769	9.252	0.023	0.167	29.920
Average	2.796	9.889	0.024	0.189	29.920

Table E-7 Experimental results for 10.7 cm diameter propeller,26.3 Watts/m^3 in water with SAA 10 mg/L

Probe	KLA (1/hr)	C^* (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	0.722	10.535	0.007	0.026	29.920
2	1.038	9.802	0.009	0.064	29.920
Average	0.880	10.169	0.008	0.045	29.920
Probe	KLA (1/hr)	C^* (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	0.755	11.338	0.008	0.071	29.920
2	0.926	10.587	0.009	0.086	29.920
Average	0.841	10.963	0.008	0.078	29.920
Probe	KLA (1/hr)	C^* (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	0.795	11.023	0.008	0.117	29.920
2	1.000	12.044	0.011	0.253	29.920
Average	0.897	11.534	0.009	0.185	29.920

Table E-8 Experimental results for 10.7 cm diameter propeller, 39.5 Watts/m^3 in clean water

Probe	KLA (1/hr)	C* (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	4.028	10.214	0.036	0.183	29.920
2	4.576	8.489	0.034	0.259	29.920
Average	4.302	9.351	0.035	0.221	29.920
Probe	KLA (1/hr)	C* (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	5.316	9.595	0.045	0.085	29.920
2	2.932	9.123	0.024	0.139	29.920
Average	4.124	9.359	0.034	0.112	29.920
Probe	KLA (1/hr)	C* (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	4.764	9.613	0.040	0.134	29.920
2	3.394	9.102	0.027	0.111	29.920
Average	4.079	9.358	0.034	0.123	29.920

Table E-9 Experimental results for 10.7 cm diameter propeller, 39.5 Watts/m^3 in water with SAA 5 mg/L

Probe	KLA (1/hr)	C* (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	4.364	9.008	0.035	0.096	29.920
2	2.850	9.903	0.025	0.097	29.920
Average	3.607	9.456	0.030	0.096	29.920
Probe	KLA (1/hr)	C* (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	4.833	9.554	0.041	0.167	29.920
2	2.259	9.242	0.018		29.920
Average	3.546	9.398	0.030	0.083	29.920
Probe	KLA (1/hr)	C* (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	4.414	9.492	0.037	0.130	29.920
2	2.709	9.961	0.024	0.170	29.920
Average	3.561	9.727	0.030	0.150	29.920

Table E-10 Experimental results for 10.7 cm diameter propeller, 39.5 Watts/m^3 in water with SAA 10 mg/L

Probe	KLA (1/hr)	C* (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	1.174	9.326	0.010	0.021	29.920
2	1.399	9.568	0.012	0.043	29.920
Average	1.286	9.447	0.011	0.032	29.920
Probe	KLA (1/hr)	C* (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	1.267	9.623	0.011	0.096	29.920
2	1.457	9.749	0.013	0.149	29.920
Average	1.362	9.686	0.012	0.122	29.920
Probe	KLA (1/hr)	C* (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	1.101	9.603	0.009	0.015	29.920
2	1.341	9.727	0.011	0.037	29.920
Average	1.221	9.665	0.010	0.026	29.920

Table E-11 Experimental results for 10.7 cm diameter propeller, 52.7 Watts/m^3 in clean water

Probe	KLA (1/hr)	C* (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	4.504	10.133	0.040	0.156	29.920
2	6.873	9.676	0.059	0.404	29.920
Average	5.689	9.905	0.049	0.280	29.920
Probe	KLA (1/hr)	C* (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	6.179	9.243	0.050	0.049	29.920
2	5.178	9.459	0.043	0.105	29.920
Average	5.679	9.351	0.047	0.077	29.920
Probe	KLA (1/hr)	C* (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	5.428	9.328	0.045	0.121	29.920
2	5.919	9.585	0.050	0.273	29.920
Average	5.674	9.456	0.047	0.197	29.920

Table E-12 Experimental results for 10.7 cm diameter propeller, 52.7 Watts/m^3 in water with SAA 5 mg/L

Probe	KLA (1/hr)	C^* (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	3.719	10.059	0.033	0.227	29.920
2	6.501	9.472	0.054	0.216	29.920
Average	5.110	9.766	0.044	0.222	29.920
Probe	KLA (1/hr)	C^* (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	6.201	9.396	0.051	0.058	29.920
2	4.087	10.980	0.040	0.364	29.920
Average	5.144	10.188	0.045	0.211	29.920
Probe	KLA (1/hr)	C^* (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	5.803	9.403	0.048	0.157	29.920
2	4.299	10.473	0.040	0.182	29.920
Average	5.051	9.938	0.044	0.170	29.920

Table E-13 Experimental results for 10.7 cm diameter propeller, 52.7 Watts/m^3 in water with SAA 10 mg/L

Probe	KLA (1/hr)	C^* (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	1.758	9.449	0.015	0.054	29.920
2	2.540	9.777	0.022	0.107	29.920
Average	2.149	9.613	0.018	0.080	29.920
Probe	KLA (1/hr)	C^* (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	2.191	9.259	0.018	0.051	29.920
2	2.102	9.727	0.018	0.190	29.920
Average	2.147	9.493	0.018	0.120	29.920
Probe	KLA (1/hr)	C^* (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	1.766	9.600	0.015	0.053	29.920
2	2.546	9.809	0.022	0.107	29.920
Average	2.156	9.704	0.018	0.080	29.920

Table E-14 Experimental results for 15 cm diameter propeller, 13.2 Watts/m^3 in clean water

Probe	KLA (1/hr)	C (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	2.323	9.591	0.020	0.059	29.920
2	2.638	7.710	0.018	0.110	29.920
Average	2.481	8.650	0.019	0.084	29.920

Probe	KLA (1/hr)	C (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	1.507	10.079	0.013	0.071	29.920
2	2.920	8.901	0.023	0.046	29.920
Average	2.213	9.490	0.018	0.058	29.920

Probe	KLA (1/hr)	C (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	1.474	10.578	0.014	0.074	29.920
2	3.162	8.656	0.024	0.067	29.920
Average	2.318	9.617	0.019	0.070	29.920

Table E-15 Experimental results for 15 cm diameter propeller, 13.2 Watts/m^3 in water with SAA 5 mg/L

Probe	KLA (1/hr)	C (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	1.485	10.321	0.014	0.045	29.920
2	2.838	8.415	0.021	0.131	29.920
Average	2.161	9.368	0.017	0.088	29.920

Probe	KLA (1/hr)	C (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	1.694	9.429	0.014	0.043	29.920
2	2.324	9.375	0.019	0.063	29.920
Average	2.009	9.402	0.017	0.053	29.920

Probe	KLA (1/hr)	C (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	1.450	10.282	0.013	0.155	29.920
2	2.874	8.708	0.022	0.166	29.920
Average	2.162	9.495	0.018	0.160	29.920

Table E-16 Experimental results for 15 cm diameter propeller, 13.2 Watts/m^3 in water with SAA 10 mg/L

Probe	KLA (1/hr)	C (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	0.791	9.903	0.007	0.041	29.920
2	1.035	10.527	0.010	0.103	29.920
Average	0.913	10.215	0.008	0.072	29.920
Probe	KLA (1/hr)	C (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	0.972	9.512	0.008	0.023	29.920
2	1.108	9.446	0.009	0.076	29.920
Average	1.040	9.479	0.009	0.049	29.920
Probe	KLA (1/hr)	C (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	0.949	9.434	0.008	0.054	29.920
2	1.118	9.600	0.009	0.113	29.920
Average	1.034	9.517	0.009	0.083	29.920

Table E-17 Experimental results for 15 cm diameter propeller, 26.3 Watts/m^3 in clean water

Probe	KLA (1/hr)	C (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	4.165	9.194	0.034	0.071	29.920
2	4.653	8.790	0.036	0.126	29.920
Average	4.409	8.992	0.035	0.098	29.920
Probe	KLA (1/hr)	C (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	4.347	10.210	0.039	0.162	29.920
2	5.729	9.061	0.046	0.261	29.920
Average	5.038	9.636	0.042	0.212	29.920
Probe	KLA (1/hr)	C (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	5.207	9.904	0.045	0.083	29.920
2	5.528	8.441	0.041	0.116	29.920
Average	5.368	9.173	0.043	0.100	29.920

Table E-18 Experimental results for 15 cm diameter propeller, 26.3 Watts/m^3 in water with SAA 5 mg/L

Probe	KLA (1/hr)	C^* (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	3.410	9.664	0.029	0.126	29.920
2	5.125	8.758	0.040	0.138	29.920
Average	4.268	9.211	0.034	0.132	29.920
Probe	KLA (1/hr)	C^* (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	4.193	9.920	0.037	0.098	29.920
2	4.523	9.653	0.038	0.153	29.920
Average	4.358	9.787	0.038	0.125	29.920
Probe	KLA (1/hr)	C^* (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	3.027	10.263	0.027	0.234	29.920
2	5.475	9.026	0.044	0.265	29.920
Average	4.251	9.644	0.035	0.249	29.920

Table E-19 Experimental results for 15 cm diameter propeller, 26.3 Watts/m^3 in water with SAA 10 mg/L

Probe	KLA (1/hr)	C^* (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	2.401	10.317	0.022	0.085	29.920
2	4.143	8.780	0.032	0.235	29.920
Average	3.272	9.549	0.027	0.160	29.920
Probe	KLA (1/hr)	C^* (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	2.819	9.302	0.023	0.100	29.920
2	3.048	9.807	0.026	0.294	29.920
Average	2.934	9.554	0.025	0.197	29.920
Probe	KLA (1/hr)	C^* (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	2.580	9.890	0.022	0.069	29.920
2	3.283	9.777	0.028	0.175	29.920
Average	2.931	9.833	0.025	0.122	29.920

Table E-20 Experimental results for 15 cm diameter propeller, 39.5 Watts/m^3 in clean water

Probe	KLA (1/hr)	C * (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	6.993	9.907	0.061	0.121	29.920
2	7.910	9.063	0.063	0.265	29.920
Average	7.451	9.485	0.062	0.193	29.920
Probe	KLA (1/hr)	C * (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	6.848	9.765	0.059	0.176	29.920
2	6.389	8.787	0.049	0.311	29.920
Average	6.619	9.276	0.054	0.243	29.920
Probe	KLA (1/hr)	C * (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	6.313	10.197	0.057	0.162	29.920
2	8.256	8.838	0.064	0.186	29.920
Average	7.285	9.518	0.061	0.174	29.920

Table E-21 Experimental results for 15 cm diameter propeller, 39.5 Watts/m^3 in water with SAA 5 mg/L

Probe	KLA (1/hr)	C * (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	3.557	10.894	0.034	0.050	29.920
2	5.954	9.232	0.048	0.121	29.920
Average	4.755	10.063	0.041	0.086	29.920
Probe	KLA (1/hr)	C * (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	4.665	11.514	0.047	0.163	29.920
2	4.912	9.037	0.039	0.169	29.920
Average	4.789	10.275	0.043	0.166	29.920
Probe	KLA (1/hr)	C * (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	3.677	10.018	0.032	0.043	29.920
2	5.599	9.525	0.047	0.052	29.920
Average	4.638	9.771	0.040	0.048	29.920

Table E-22 Experimental results for 15 cm diameter propeller, 39.5 Watts/m^3 in water with SAA 10 mg/L

Probe	KLA (1/hr)	C (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	2.725	9.975	0.024	0.277	29.920
2	5.526	9.283	0.045	0.106	29.920
Average	4.126	9.629	0.035	0.191	29.920
Probe	KLA (1/hr)	C (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	3.628	10.078	0.032	0.070	29.920
2	4.734	9.486	0.040	0.168	29.920
Average	4.181	9.782	0.036	0.119	29.920
Probe	KLA (1/hr)	C (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	3.777	9.883	0.033	0.038	29.920
2	4.398	9.521	0.037	0.236	29.920
Average	4.088	9.702	0.035	0.137	29.920

Table E-23 Experimental results for 15 cm diameter propeller, 52.7 Watts/m^3 in clean water

Probe	KLA (1/hr)	C (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	5.762	10.176	0.052	0.142	29.920
2	9.249	9.467	0.077	0.176	29.920
Average	7.506	9.822	0.064	0.159	29.920
Probe	KLA (1/hr)	C (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	6.528	9.211	0.053	0.106	29.920
2	8.593	8.895	0.067	0.055	29.920
Average	7.561	9.053	0.060	0.081	29.920
Probe	KLA (1/hr)	C (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	5.811	10.168	0.052	0.135	29.920
2	9.269	9.200	0.075	0.176	29.920
Average	7.540	9.684	0.064	0.156	29.920

Table E-24 Experimental results for 15 cm diameter propeller, 52.7 Watts/m^3 in water with SAA 5 mg/L

Probe	KLA (1/hr)	C^* (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	5.032	9.623	0.043	0.065	29.920
2	6.525	9.668	0.056	0.059	29.920
Average	5.778	9.646	0.049	0.062	29.920
Probe	KLA (1/hr)	C^* (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	4.771	9.813	0.041	0.204	29.920
2	6.803	9.418	0.056	0.117	29.920
Average	5.787	9.615	0.049	0.160	29.920
Probe	KLA (1/hr)	C^* (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	5.269	9.490	0.044	0.092	29.920
2	6.221	9.172	0.050	0.073	29.920
Average	5.745	9.331	0.047	0.083	29.920

Table E-25 Experimental results for 15 cm diameter propeller, 52.7 Watts/m^3 in water with SAA 10 mg/L

Probe	KLA (1/hr)	C^* (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	3.512	10.112	0.031	0.029	29.920
2	5.232	9.910	0.046	0.049	29.920
Average	4.372	10.011	0.038	0.039	29.920
Probe	KLA (1/hr)	C^* (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	3.576	9.914	0.031	0.041	29.920
2	5.370	9.519	0.045	0.033	29.920
Average	4.473	9.717	0.038	0.037	29.920
Probe	KLA (1/hr)	C^* (mg/L)	SOTR lb/hr	RMS	Barometric (in hg)
1	3.500	9.972	0.031	0.024	29.920
2	5.315	9.478	0.044	0.044	29.920
Average	4.408	9.725	0.038	0.034	29.920

BIOGRAPHY

Mr. Sasin Chindanonda was born on May 13, 1980 in Bangkok, Thailand. He attended Assumption College in Bangkok and graduated in 1997. He received his Bachelor's Degree in Environmental Engineering form Faculty of Engineering, Kasetsart University, in 2000. He pursued his Master Degree studies in the International Postgraduate Programs in Environmental Management, Inter-Department of Environmental Management, Chulalongkorn University, Bangkok, Thailand in May 2001. He was awarded Master Degree of Science in Environmental Management in May 2003.