References

Lewis, W.K., and Whitman, W.G. "Principles of Gas Absorption", Ind. Engr. Chem., V. 16, p. 1215 (1924)

Danckwerts, P.V. "Significance of Liquid Film Coefficients in Gas Absorption", Ind. Engr. Chem., V. 43, p. 1460 (1951)

Higbee, R. "The Rate of Absorption of a Pure Gas into a Still Liquid during Short Periods of Exposure", Trans. Amer. Inst. Chem. Engr., V. 31, p. 365 (1935)

Eckenfelder, W.W. Jr., and Ford, D.L. "New Concepts in Oxygen Transfer and Aeration", Water Resources Symposium No. I, Gloyna & Eckenfelder (1968)

Eckenfelder, W.W. Jr. "Oxygen Transfer and Aeration", Industrial Water Pollution Control, McGraw-Hill Inc., N.Y. (1966)

Vennard, J.K. "Elementary Fluid Mechanics", John Wiley & Sons Inc., 4th edition, Toppan Co. Ltd., Tokyo, Japan (1961)

Barna, P.S. "Fluid Metering and Manometry", Fluid Mechanics for Engineers (1969)

Eckenfelder, W.W., and Barnhart, E.B., Paper presented Amer. Inst. of Chem. Engr., Atlanta, Georgia (Feb. 1960)

Fair, G.M., and Geyer, J.C. "Water Supply and Waste Water Disposal", John Wiley & Sons Inc., N.Y. (1954)

Downie, N.M., and Heath, R.W. "Correlation the Pearson r", Basic Statical Methods, 3rd edition, Harper & Row, N.Y. (1970)

Ippen, A.T., Campbell, L.G., and Carver, C.E. Jr., "The Determination of Oxygen Absorption in Aeration Processes", Massachusetts Institute of Technology Hydrodynamics Laboratory Technical Report No. 7 (May 1952)

Jones, D., Day, D.L., and Converse, J.C. "Oxygenation Capacities of Oxidation Ditch Rotors for Confinements Livestock Buildings," Proceedings of the 24th Industrial Waste Conference, (May 6,7&8, 1969)

APPENDIX A

BASIC DATA OBTAINED FROM EXPERIMENTS

Table A-1

Time min.	Temp. °C	C_s mg/l	C_1 mg/l	$C_s - C_1$ mg/l
0	29.0	7.58	0.20	7.38
2	29.0	7.58	0.60	6.98
5	29.0	7.58	1.10	6.48
10	29.0	7.58	2.00	5.58
15	29.0	7.58	2.70	4.88
20	29.0	7.58	3.40	4.18
30	29.0	7.58	4.40	3.18
45	29.0	7.58	5.50	2.08
60	29.0	7.58	6.25	1.38

Conditions of experiments

1. Diffuser No. 1
2. Immersion depth (of effluence) 50 cm.
3. Elevation head (of diffuser) 50 cm.
4. Average power consumption 480 watts

Table A-2

Time min.	Temp. °C	C_s mg/l	C_1 mg/l	$C_s - C_1$ mg/l
0	29.0	7.58	0.30	7.28
2	29.0	7.58	0.75	6.83
5	29.0	7.58	1.65	5.93
10	29.0	7.58	2.95	4.63
15	29.0	7.58	3.90	3.68
20	29.0	7.58	4.65	2.93
30	29.0	7.58	5.80	1.78
45	29.0	7.58	6.75	0.83

Conditions of experiments

1. Diffuser No. 1
2. Immersion depth 50 cm.
3. Elevation head 100 cm.
4. Power 480 watts

Table A-3

Time min.	Temp °C	C_s mg/l	C_1 mg/l	$C_s - C_1$ mg/l
0	29.0	7.58	0.25	7.33
2	29.0	7.58	0.65	6.93
5	29.0	7.58	1.20	6.38
10	29.0	7.58	2.15	5.43
15	29.0	7.58	2.85	4.73
20	29.0	7.58	3.50	4.08
30	29.0	7.58	4.55	3.03
45	29.0	7.58	5.60	1.98
60	29.0	7.58	6.30	1.28

Conditions of experiments

1. Diffuser No. 2
2. Immersion depth 50 cm.
3. Elevation head 50 cm.
4. Power 490 watts

Table A-4

Time min.	Temp. °C	C_s mg/l	C_l mg/l	$C_s - C_l$ mg/l
0	30.7	7.34	0.40	6.94
2	30.7	7.34	1.10	6.24
5	30.7	7.34	2.05	5.29
10	30.7	7.34	3.20	4.14
15	30.7	7.34	4.20	3.14
20	30.7	7.34	4.85	2.49
30	30.7	7.34	5.85	1.49
45	30.7	7.34	6.65	0.69

Conditions of experiments

1. Diffuser No. 2
2. Immersion depth 50 cm.
3. Elevation head 100 cm.
4. Power 492 watts

Table A-5

Time min.	Temp. °C	C_s mg/l	C_l mg/l	$C_s - C_l$ mg/l
0	30.8	7.32	0.40	6.92
2	30.8	7.32	1.15	6.17
5	30.8	7.32	2.30	5.02
10	30.8	7.32	3.65	3.67
15	30.8	7.32	4.65	2.67
20	30.8	7.32	5.35	1.97
30	30.8	7.32	6.25	1.07
40	30.8	7.32	6.75	0.57

Conditions of experiments

1. Diffuser No. 2
2. Immersion depth 50 cm.
3. Elevation head 150 cm.
4. Power 480 watts

Table A-6

Time min.	Temp. °C	C_s mg/l	C_1 mg/l	$C_s - C_1$ mg/l
0	30.6	7.35	0.60	6.75
2	30.6	7.35	1.45	5.90
5	30.6	7.35	2.70	4.65
10	30.6	7.35	4.15	3.20
15	30.6	7.35	5.15	2.20
20	30.6	7.35	5.85	1.55
30	30.6	7.35	6.60	0.75

Conditions of experiments

1. Diffuser No. 2
2. Immersion depth 50 cm.
3. Elevation head 200 cm.
4. Power 492 watts

Table A-7

Time min.	Temp. °C	C_s mg/l	C_l mg/l	$C_s - C_l$ mg/l
0	30.2	7.41	0.80	6.61
2	30.2	7.41	1.40	6.01
5	30.2	7.41	2.25	5.16
10	30.2	7.41	3.35	4.06
15	30.2	7.41	4.15	3.26
20	30.2	7.41	4.85	2.56
30	30.2	7.41	5.80	1.61
45	30.2	7.41	6.60	0.81

Conditions of experiments

1. Diffuser No. 2
2. Immersion depth 30 cm.
3. Elevation head 100 cm.
4. Power 492 watts

Table A-8

Time min.	Temp. °C	C_s mg/l	C_l mg/l	$C_s - C_l$ mg/l
0	30.2	7.41	0.70	6.71
2	30.2	7.41	1.30	6.11
5	30.2	7.41	2.05	5.36
10	30.2	7.41	3.05	4.36
15	30.2	7.41	3.90	3.51
20	30.2	7.41	4.55	2.86
30	30.2	7.41	5.55	1.86
45	30.2	7.41	6.40	1.01

Conditions of experiments

1. Diffuser No. 2
2. Immersion depth 10 cm.
3. Elevation head 100 cm.
4. Power 494 watts

Table A-9

Time min.	Temp. °C	C_s mg/l	C_l mg/l	$C_s - C_l$ mg/l
0	29.0	7.58	0.20	7.38
2	29.0	7.58	0.65	6.93
5	29.0	7.58	1.30	6.28
10	29.0	7.58	2.25	5.33
15	29.0	7.58	2.95	4.63
20	29.0	7.58	3.65	3.93
30	29.0	7.58	4.65	2.93
45	29.0	7.58	5.75	1.83
60	29.0	7.58	6.40	1.18

Conditions of experiments

1. Diffuser No. 3
2. Immersion depth 50 cm.
3. Elevation head 50 cm.
4. Power 464 watts

Table A-10

Time min.	Temp. °C	C_s mg/l	C_l mg/l	$C_s - C_l$ mg/l
0	28.6	7.63	0.20	7.43
2	28.6	7.63	0.85	6.78
5	28.6	7.63	1.75	5.88
10	28.6	7.63	3.10	4.53
15	28.6	7.63	4.10	3.43
20	28.6	7.63	4.90	2.73
30	28.6	7.63	6.00	1.63
45	28.6	7.63	6.90	0.73

Conditions of experiments

1. Diffuser No.3
2. Immersion depth 50 cm.
3. Elevation head 100 cm.
4. Power 480 watts

Table A-11

Time min.	Temp. °C	C_s mg/l	C_l mg/l	$C_s - C_l$ mg/l
0	29.0	7.58	0.25	7.33
2	29.0	7.58	0.70	6.88
5	29.0	7.58	1.30	6.28
10	29.0	7.58	2.25	5.33
15	29.0	7.58	3.00	4.58
20	29.0	7.58	3.70	3.88
30	29.0	7.58	4.70	2.88
45	29.0	7.58	5.80	1.78
60	29.0	7.58	6.45	1.13

Conditions of experiments

1. Diffuser No. 4
2. Immersion depth 50 cm.
3. Elevation head 50 cm.
4. Power 474 watts.

Table A-12

Time min.	Temp. °C	C_s mg/l	C_l mg/l	$C_s - C_l$ mg/l
0	29.7	7.48	0.30	7.18
2	29.7	7.48	1.00	6.48
5	29.7	7.48	2.05	5.43
10	29.7	7.48	3.40	4.08
15	29.7	7.48	4.40	3.08
20	29.7	7.48	5.15	2.33
30	29.7	7.48	6.15	1.33
40	29.7	7.48	6.70	0.78
50	29.7	7.48	7.00	0.48

Conditions of experiments

1. Diffuser No. 4
2. Immersion depth 50 cm.
3. Elevation head 100 cm.
4. Power 484 watts.

Table A-13

Time min.	Temp. °C	C_s mg/l	C_l mg/l	$C_s - C_l$ mg/l
0	29.7	7.48	0.50	6.98
2	29.7	7.48	1.40	6.08
5	29.7	7.48	2.60	4.88
10	29.7	7.48	4.05	3.43
15	29.7	7.48	5.00	2.48
20	29.7	7.48	5.75	1.73
30	29.7	7.48	6.55	0.93
40	29.7	7.48	7.00	0.48

Conditions of experiments

1. Diffuser No.4
2. Immersion depth 50 cm.
3. Elevation head 160 cm.
4. Power 480 watts

Table A-14

Time min.	Temp. °C	C_s mg/l	C_1 mg/l	$C_s - C_1$ mg/l
0	29.9	7.45	0.35	7.10
2	29.9	7.45	1.25	6.20
5	29.9	7.45	2.55	4.90
10	29.9	7.45	4.00	3.45
15	29.9	7.45	5.10	2.35
20	29.9	7.45	5.75	1.70
30	29.9	7.45	6.60	0.85
40	29.9	7.45	7.05	0.40

Conditions of experiments

1. Diffuser No. 4
2. Immersion depth 50 cm.
3. Elevation head 200 cm.
4. Power 486 watts

Table A-15

Time min.	Temp. °C	C_s mg/l	C_1 mg/l	$C_s - C_1$ mg/l
0	30.3	7.40	0.20	7.20
2	30.3	7.40	1.10	6.30
5	30.3	7.40	2.40	5.00
10	30.3	7.40	3.80	3.60
15	30.3	7.40	4.85	2.55
20	30.3	7.40	5.55	1.85
30	30.3	7.40	6.45	0.95
40	30.3	7.40	6.90	0.50

Conditions of experiments

1. Diffuser No. 4
2. Immersion depth 50 cm.
3. Elevation head 250 cm.
4. Power 483 watts

Table A-16

Time min.	Temp. °C	C_s mg/l	C_l mg/l	$C_s - C_l$ mg/l
0	29.7	7.48	0.35	7.13
2	29.7	7.48	0.70	6.78
5	29.7	7.48	1.25	6.23
10	29.7	7.48	2.05	5.43
15	29.7	7.48	2.75	4.73
20	29.7	7.48	3.35	4.13
30	29.7	7.48	4.30	3.18
45	29.7	7.48	5.40	2.08
60	29.7	7.48	6.05	1.43
75	29.7	7.48	6.50	0.98

Conditions of experiments

1. Diffuser No. 5
2. Immersion depth 50 cm.
3. Elevation head 50 cm.
4. Power 500 watts

Table A-17

Time min.	Temp. °C	C_s mg/l	C_l mg/l	$C_s - C_l$ mg/l
0	30.7	7.34	0.30	7.04
2	30.7	7.34	1.05	6.29
5	30.7	7.34	2.05	5.29
10	30.7	7.34	3.30	4.04
15	30.7	7.34	4.30	3.04
20	30.7	7.34	5.00	2.34
30	30.7	7.34	6.00	1.34
40	30.7	7.34	6.55	0.79

Conditions of experiments

1. Diffuser No.5
2. Immersion depth 50 cm.
3. Elevation head 100 cm.
4. Power 490 cm.

Table A-18

Time min.	Temp. °C	C_s mg/l	C_l mg/l	$C_s - C_l$ mg/l
0	30.8	7.32	0.35	6.97
2	30.8	7.32	1.20	6.12
5	30.8	7.32	2.25	5.07
10	30.8	7.32	3.65	3.67
15	30.8	7.32	4.65	2.67
20	30.8	7.32	5.40	1.92
30	30.8	7.32	6.30	1.02
40	30.8	7.32	6.80	0.52

Conditions of experiments

1. Diffuser No. 5
2. Immersion depth 50 cm.
3. Elevation head 150 cm.
4. Power 483 watts

Table A-19

Time min.	Temp. °C	C_s mg/l	C_l mg/l	$C_s - C_l$ mg/l
0	30.6	7.35	0.55	6.80
2	30.6	7.35	1.50	5.85
5	30.6	7.35	2.70	4.65
10	30.6	7.35	4.10	3.25
15	30.6	7.35	5.10	2.25
20	30.6	7.35	5.75	1.60
30	30.6	7.35	6.60	0.75

Conditions of experiments

1. Diffuser No. 5
2. Immersion depth 50 cm.
3. Elevation head 200 cm.
4. Power 486 watts

Table A-20

Time min.	Temp. °C	C_s mg/l	C_l mg/l	$C_s - C_l$ mg/l
0	29.0	7.58	0.15	7.43
2	29.0	7.58	0.60	6.98
5	29.0	7.58	1.25	6.33
10	29.0	7.58	2.25	5.33
15	29.0	7.58	3.15	4.43
20	29.0	7.58	3.80	3.78
30	29.0	7.58	4.90	2.68
45	29.0	7.58	6.00	1.58
60	29.0	7.58	6.65	0.93

Conditions of experiments

1. Diffuser No. 6
2. Immersion depth 50 cm.
3. Elevation head 50 cm.
4. Power 483 watts

Table A-21

Time min.	Temp. °C	C_s mg/l	C_l mg/l	$C_s - C_l$ mg/l
0	28.6	7.63	0.30	7.33
2	28.6	7.63	0.85	6.78
5	28.6	7.63	1.75	5.88
10	28.6	7.63	2.95	4.68
15	28.6	7.63	3.85	3.78
20	28.6	7.63	4.70	2.93
30	28.6	7.63	5.70	1.93
45	28.6	7.63	6.65	0.98

Conditions of experiments

1. Diffuser No. 6
2. Immersion depth 50 cm.
3. Elevation head 100 cm.
4. Power 486 watts

Table A-22

Time min.	Temp. °C	C_s mg/l	C_l mg/l	$C_s - C_l$ mg/l
0	29.0	7.58	0.30	7.28
2	29.0	7.58	0.80	6.78
5	29.0	7.58	1.50	6.08
10	29.0	7.58	2.55	5.03
15	29.0	7.58	3.40	4.18
20	29.0	7.58	4.05	3.53
32	29.0	7.58	5.30	2.28
45	29.0	7.58	6.15	1.43
60	29.0	7.58	6.75	0.83

Conditions of experiments

1. Diffuser No. 7
2. Immersion depth 50 cm.
3. Elevation head 50 cm.
4. Power 492 watts

Table A-23

Time min.	Temp. °C	C_s mg/l	C_1 mg/l	$C_s - C_1$ mg/l
0	28.6	7.63	0.40	7.23
2	28.6	7.63	1.10	6.53
5	28.6	7.63	2.00	5.63
10	28.6	7.63	3.30	4.33
15	28.6	7.63	4.30	3.33
20	28.6	7.63	5.05	2.58
30	28.6	7.63	6.10	1.53
45	28.6	7.63	6.85	0.73

Conditions of experiments

1. Diffuser No. 7
2. Immersion depth 50 cm.
3. Elevation head 80 cm.
4. Power 480 watts

Table A-24

Time min.	Temp. °C	C_s mg/l	C_l mg/l	$C_s - C_l$ mg/l
0	29.7	7.48	0.20	7.28
2	29.7	7.48	1.00	6.48
5	29.7	7.48	2.05	5.43
10	29.7	7.48	3.40	4.08
15	29.7	7.48	4.40	3.08
20	29.7	7.48	5.40	2.08
30	29.7	7.48	6.20	1.28
40	29.7	7.48	6.75	0.73
50	29.7	7.48	7.05	0.43

Conditions of experiments

1. Diffuser No. 7
2. Immersion depth 50 cm.
3. Elevation head 100 cm.
4. Power 486 watts

Table A-25

Time min.	Temp. °C	C_s mg/l	C_l mg/l	$C_s - C_l$ mg/l
0	29.7	7.48	0.60	6.88
2	29.7	7.48	1.30	6.18
5	29.7	7.48	2.45	5.03
10	29.7	7.48	3.85	3.63
15	29.7	7.48	4.90	2.58
20	29.7	7.48	5.65	1.83
30	29.7	7.48	6.50	0.98
40	29.7	7.48	6.95	0.53
50	29.7	7.48	7.20	0.28

Conditions of experiments

1. Diffuser No. 7
2. Immersion depth 50 cm.
3. Elevation head 150 cm.
4. Power 480 watts

Table A-26

Time min.	Temp. °C	C_s mg/l	C_l mg/l	$C_s - C_l$ mg/l
0	29.9	7.45	0.40	7.05
2	29.9	7.45	1.30	6.15
5	29.9	7.45	2.60	4.85
10	29.9	7.45	4.10	3.35
15	29.9	7.45	5.20	2.25
20	29.9	7.45	5.85	1.60
30	29.9	7.45	6.65	0.80
40	29.9	7.45	7.05	0.40

Conditions of experiments

1. Diffuser No. 7
2. Immersion depth 50 cm.
3. Elevation head 200 cm.
4. Power 480 watts

Table A-27

Time min.	Temp. °C	C_s mg/l	C_1 mg/l	$C_s - C_1$ mg/l
0	30.3	7.40	0.10	7.30
2	30.3	7.40	1.00	6.40
5	30.3	7.40	2.30	5.10
10	30.3	7.40	3.80	3.60
15	30.3	7.40	4.90	2.50
20	30.3	7.40	5.65	1.75
30	30.3	7.40	6.55	0.85

Conditions of experiments

1. Diffuser No. 7
2. Immersion depth 50 cm.
3. Elevation head 250 cm.
4. Power 480 watts

Table A-28

Time min.	Temp. °C	C_s mg/l	C_1 mg/l	$C_s - C_1$ mg/l
0	29.7	7.48	0.35	7.31
2	29.7	7.48	1.05	6.43
5	29.7	7.48	2.05	5.43
10	29.7	7.48	3.30	4.18
15	29.7	7.48	4.30	3.18
20	29.7	7.48	5.05	2.43
30	29.7	7.48	6.05	1.43
40	29.7	7.48	6.65	0.83

Conditions of experiments

1. Diffuser No. 7
2. Immersion depth 30 cm.
3. Elevation head 100 cm.
4. Power 492 watts

Table A-29

Time min.	Temp. °C	C_s mg/l	C_l mg/l	$C_s - C_l$ mg/l
0	29.5	7.51	0.90	6.61
2	29.5	7.51	1.50	6.01
5	29.5	7.51	2.35	5.16
10	29.5	7.51	3.45	4.06
15	29.5	7.51	4.25	3.26
20	29.5	7.51	4.95	2.56
30	29.5	7.51	5.90	1.61
45	29.5	7.51	6.70	0.80

Conditions of experiments

1. Diffuser No. 7
2. Immersion depth 10 cm.
3. Elevation head 100 cm.
4. Power 486 watts

Table A-30

Time min.	Temp. °C	C_s mg/l	C_l mg/l	$C_s - C_l$ mg/l
0	29.0	7.58	0.45	7.13
2	29.0	7.58	1.30	6.28
4	29.0	7.58	2.15	5.43
10	29.0	7.58	3.75	3.83
15	29.0	7.58	4.90	2.68
20	29.0	7.58	5.65	1.93
30	29.0	7.58	6.50	1.08

Conditions of experiments

1. Diffuser No. 8
2. Immersion depth 50 cm.
3. Elevation head 30 cm.
4. Power 480 watts

Table A-31

Time min.	Temp. °C	C_s mg/l	C_1 mg/l	$C_s - C_1$ mg/l
0	29.0	7.58	0.25	7.33
2	29.0	7.58	1.20	6.38
5	29.0	7.58	2.55	5.03
10	29.0	7.58	4.15	3.43
15	29.0	7.58	5.25	2.33
20	29.0	7.58	5.95	1.63
30	29.0	7.58	6.80	0.78

Conditions of experiments

1. Diffuser No. 8
2. Immersion depth 50 cm.
3. Elevation head 50 cm.
4. Power 480 watts

Table A-32

Time min.	Temp. °C	C_s mg/l	C_l mg/l	$C_s - C_l$ mg/l
0	28.9	7.60	0.50	7.10
2	28.9	7.60	1.50	6.10
5	28.9	7.60	2.75	4.85
10	28.9	7.60	4.45	3.15
15	28.9	7.60	5.45	2.15
20	28.9	7.60	6.10	1.50
30	28.9	7.60	6.90	0.70

Conditions of experiments

1. Diffuser No. 8
2. Immersion depth 50 cm.
3. Elevation head 60 cm.
4. Power 477 watts

Table A-33

Time min.	Temp. °C	C_s mg/l	C_l mg/l	$C_s - C_l$ mg/l
0	28.9	7.60	0.70	6.90
2	28.9	7.60	1.65	5.95
5	28.9	7.60	2.90	4.70
10	28.9	7.60	4.50	3.10
15	28.9	7.60	5.50	2.10
20	28.9	7.60	6.15	1.45
30	28.9	7.60	6.95	0.65

Conditions of experiments

1. Diffuser No. 8
2. Immersion depth 50 cm.
3. Elevation head 70 cm.
4. Power 480 watts

Table A-34

Time min.	Temp. °C	C_s mg/l	C_l mg/l	$C_s - C_l$ mg/l
0	28.6	7.63	0.30	7.33
2	28.6	7.63	1.30	6.33
5	28.6	7.63	2.65	4.98
10	28.6	7.63	4.30	3.33
15	28.6	7.63	5.40	2.23
20	28.6	7.63	6.10	1.53
30	28.6	7.63	6.90	0.73

Conditions of experiments

1. Diffuser No. 8
2. Immersion depth 50 cm.
3. Elevation head 100 cm.
4. Power 472 watts

Table A-35

Time min.	Temp. °C	C_s mg/l	C_l mg/l	$C_s - C_l$ mg/l
0	28.9	7.60	0.60	7.00
2	28.9	7.60	1.70	5.90
4	28.9	7.60	2.60	5.00
10	28.9	7.60	4.40	3.20
15	28.9	7.60	5.40	2.20
20	28.9	7.60	6.00	1.60
30	28.9	7.60	6.85	0.75

Conditions of experiments

1. Diffuser No. 8
2. Immersion depth 50 cm.
3. Elevation head 150 cm.
4. Power 456 watts

Table A-36

Time min.	Temp. °C	C_s mg/l	C_l mg/l	$C_s - C_l$ mg/l
0	29.0	7.58	0.10	7.48
2	29.0	7.58	1.20	6.38
5	29.0	7.58	2.55	5.03
10	29.0	7.58	4.15	3.43
15	29.0	7.58	5.20	2.38
20	29.0	7.58	5.95	1.63
30	29.0	7.58	6.75	0.83

Conditions of experiments

1. Diffuser No. 8
2. Immersion depth 50 cm.
3. Elevation head 200 cm.
4. Power 468 watts

Table A-37

Time min.	Temp. °C	C_s mg/l	C_1 mg/l	$C_s - C_1$ mg/l
0	29.7	7.48	0.75	6.73
2	29.7	7.48	1.65	5.83
5	29.7	7.48	2.75	4.73
11	29.7	7.48	4.35	3.13
15	29.7	7.48	5.10	2.38
20	29.7	7.48	5.75	1.73
30	29.7	7.48	6.65	0.83
40	29.7	7.48	7.00	0.48

Conditions of experiments

1. Diffuser No. 8
2. Immersion depth 50 cm.
3. Elevation head 250 cm.
4. Power 474 watts

Table A-38

Time min.	Temp. °C	C_s mg/l	C_l mg/l	$C_s - C_l$ mg/l
0	29.5	7.51	0.30	7.21
2	29.5	7.51	0.90	6.61
5	29.5	7.51	1.70	5.81
10	29.5	7.51	2.85	4.66
15	29.5	7.51	3.75	3.76
20	29.5	7.51	4.45	3.06
30	29.5	7.51	5.50	2.01
45	29.5	7.51	6.40	1.11

Conditions of experiments

1. Diffuser No. 9
2. Immersion depth 30 cm.
3. Elevation head 200 cm.
4. Power 492 watts

Table A-39

Time min.	Temp. °C	C_s mg/l	C_1 mg/l	$C_s - C_1$ mg/l
0	29.0	7.58	0.35	7.23
2	29.0	7.58	1.00	6.58
5	29.0	7.58	2.05	5.53
10	29.0	7.58	3.50	4.08
15	29.0	7.58	4.55	3.03
20	29.0	7.58	5.30	2.28
30	29.0	7.58	6.35	1.23
40	29.0	7.58	6.90	0.68

Conditions of experiments

1. Diffusor No. 9
2. Immersion depth 50 cm.
3. Elevation head 60 cm.
4. Power 490 watts

Table A-40

Time min.	Temp. °C	C_s mg/l	C_l mg/l	$C_s - C_l$ mg/l
0	30.7	7.34	0.70	6.64
2	30.7	7.34	1.55	5.79
5	30.7	7.34	2.65	4.69
10	30.7	7.34	4.00	3.34
15	30.7	7.34	5.00	2.34
20	30.7	7.34	5.70	1.64
30	30.7	7.34	6.50	0.84

Conditions of experiments

1. Diffuser No. 9
2. Immersion depth 50 cm.
3. Elevation head 100 cm.
4. Power 480 watts

Table A-41

Time min.	Temp. °C.	C_s mg/l	C_1 mg/l	$C_s - C_1$ mg/l
0	30.8	7.32	0.40	6.92
2	30.8	7.32	1.40	5.92
5	30.8	7.32	2.60	4.72
10	30.8	7.32	4.10	3.22
20	30.8	7.32	5.80	1.52
30	30.8	7.32	6.55	0.77

Conditions of experiments

1. Diffuser No. 9
2. Immersion depth 50 cm.
3. Elevation head 150 cm.
4. Power 468 watts

Table A-42

Time min.	Temp. °C	C_s mg/l	C_1 mg/l	$C_s - C_1$ mg/l
0	30.6	7.35	0.50	6.85
2	30.6	7.35	1.55	5.80
5	30.6	7.35	2.85	4.50
10	30.6	7.35	4.40	2.95
15	30.6	7.35	5.40	1.95
20	30.6	7.35	6.05	1.30
30	30.6	7.35	6.75	0.60

Conditions of experiments

1. Diffuser No. 9
2. Immersion depth 50 cm.
3. Elevation head 200 cm.
4. Power 480 watts

Table A-43

Time min.	Temp. °C	C_s mg/l	C_l mg/l	$C_s - C_l$ mg/l
0	30.2	7.41	0.25	7.16
2	30.2	7.41	1.10	6.31
5	30.2	7.41	2.25	5.16
10	30.2	7.41	3.65	3.76
15	30.2	7.41	4.65	2.76
20	30.2	7.41	5.35	2.06
30	30.2	7.41	6.40	1.01
40	30.2	7.41	6.80	0.61

Conditions of experiments

1. Diffuser No. 9
2. Immersion depth 30 cm.
3. Elevation head 100 cm.
4. Power 488 watts

Table A-44

Time min.	Temp. °C	C_s mg/l	C_l mg/l	$C_s - C_l$ mg/l
0	30.2	7.41	0.80	6.61
2	30.2	7.41	1.50	5.91
5	30.2	7.41	2.50	4.91
10	30.2	7.41	3.60	3.81
15	30.2	7.41	4.55	2.86
20	30.2	7.41	5.20	2.21
30	30.2	7.41	6.15	1.26
40	30.2	7.41	6.65	0.76

Conditions of experiments

1. Diffuser No. 9
2. Immersion depth 10 cm.
3. Elevation head 100 cm.
4. Power 484 watts

Table A-45

Time min.	Temp. °C	C_s mg/l	C_l mg/l	$C_s - C_l$ mg/l
0	30.2	7.41	0.20	7.21
2	30.2	7.41	1.10	6.31
5	30.2	7.41	2.55	4.86
10	30.2	7.41	4.20	3.21
15	30.2	7.41	5.25	2.16
20	30.2	7.41	5.90	1.51
30	30.2	7.41	6.70	0.71

Conditions of experiments

1. Diffuser No. 8
2. Immersion depth 40 cm.
3. Elevation head 100 cm.
4. Depth of water 43 cm.
5. Power 466 watts

Table A-46

Time min.	Temp. °C	C_s mg/l	C_1 mg/l	$C_s - C_1$ mg/l
0	30.2	7.41	0.40	7.01
2	30.2	7.41	1.35	6.06
5	30.2	7.41	2.75	4.66
10	30.2	7.41	4.30	3.11
15	30.2	7.41	5.35	2.06
20	30.2	7.41	6.00	1.41
30	30.2	7.41	6.75	0.66

Conditions of experiments

1. Diffuser No. 8
2. Immersion depth 40 cm.
3. Elevation head 100 cm.
4. Depth of water 43 cm.
5. Power 469 watts

Table A-47

Time min.	Temp. °C.	C_s mg/l	C_l mg/l	$C_s - C_l$ mg/l
0	30.0	7.40	0.50	6.90
2	30.3	7.40	1.75	5.65
5	30.3	7.40	3.25	4.15
10	30.3	7.40	4.85	2.55
15	30.3	7.40	5.80	1.60
20	30.3	7.40	6.35	1.05

Conditions of experiments

1. Diffuser No. 8
2. Immersion depth 30 cm.
3. Elevation head 100 cm.
4. Depth of water 33 cm.
5. Power 471 watts

Table A-48

Time min.	Temp. °C	C_s mg/l	C_l mg/l	$C_s - C_l$ mg/l
0	30.4	7.38	0.85	6.53
2	30.4	7.38	2.10	5.28
5	30.4	7.38	3.45	3.93
10	30.4	7.38	5.00	2.38
15	30.4	7.38	5.85	1.53
20	30.4	7.38	6.40	0.98

Conditions of experiments

1. Diffuser No. 8
2. Immersion depth 30 cm.
3. Elevation head 100 cm.
4. Depth of water 33 cm.
5. Power 477 watts

Table A-49

Time min.	Temp. °C	C_s mg/l	C_1 mg/l	$C_s - C_1$ mg/l
0	30.4	7.38	0.80	6.58
3	30.4	7.38	3.10	4.28
5	30.4	7.38	4.10	3.28
10	30.4	7.38	5.65	1.73
15	30.4	7.38	6.40	0.98

Conditions of experiments

1. Diffuser No. 8
2. Immersion depth 20 cm.
3. Elevation head 100 cm.
4. Depth of water 23 cm.
5. Power 479 watts

Table A-50

Time min.	Temp. °C	C_s mg/l	C_l mg/l	$C_s - C_l$ mg/l
0	30.5	7.37	0.70	6.67
2	30.5	7.37	2.45	4.92
5	30.5	7.37	4.20	3.17
10	30.5	7.37	5.70	1.67
15	30.5	7.37	6.45	0.92

Conditions of experiments

1. Diffuser No. 8
2. Immersion depth 20 cm.
3. Elevation head 100 cm.
4. Power 478 watts
5. Depth of water 33 cm.

APPENDIX B

SAMPLE OF CALCULATION

The determination of $K_{La(T)}$, $K_{La(20°C)}$ and Pearson (r) by the method of least squares for Table A-13.

x = time (min.)	$C_s - C_l$ mg/l	$y = \log(C_s - C_l)$
0	6.98	0.8439
2	6.08	0.7839
5	4.88	0.6884
10	3.43	0.5353
15	2.48	0.3945
20	1.73	0.2380
30	0.93	$\bar{1}$.9685

n	=	7	n.Σxy	=	140.6671
Σx	=	82	Σx.Σy	=	283.1050
Σx^2	=	1654	n.Σx^2	=	11578
Σy	=	3.4525	$(\Sigma x)^2$	=	6724
Σy^2	=	2.300373	n.Σy^2	=	16.1026
Σxy	=	20.0953	$(\Sigma y)^2$	=	11.9197

From $n.A + \Sigma x.B = \Sigma y$

$x.A + \Sigma x^2.B = \Sigma xy$

Substitute $7A + 82B = 3.4525$ ..... (1)

$82A + 1654B = 20.0953$ ..... (2)

Solve & Simplify $B = -0.0293$

Therefore $K_{La(T)} = -\frac{0.0293}{0.4343}$

$= -0.0674 \quad min.^{-1}$

From $K_{La(20°C)} = K_{La(T)} \cdot \theta^{(20-T)}$

Where $T\ (average) = 29.7°C$

$\theta = 1.024$

Therefore $K_{La(20°C)} = -0.0674 \times 1.024^{-9.7}$

$= -0.0535 \quad min.^{-1}$

$= -3.210 \quad hr.^{-1}$

From $Pearson\ (r) = \frac{n.\Sigma xy - (\Sigma x)(\Sigma y)}{\sqrt{[n.\Sigma x^2-(\Sigma x)^2][n.\Sigma y^2-(\Sigma y)^2]}}$

Substitute $r = \frac{140.6671 - 283.1053}{\sqrt{(11578-6724)(16.1026-11.9197)}}$

Therefore $= \pm 0.9992$

When $n = 7$ and degree of freedom (df) $= 7 - 2 = 5$ with the level of significance of 0.1 percent, r should be at least equal to 0.9804 therefore for the value of $r = 0.9992$ indicates that a straight line relationship between log $(C_s - C_l)$ and (t) is real or significant.

Sample Calculation (Table A - 13)
by Graphical Method

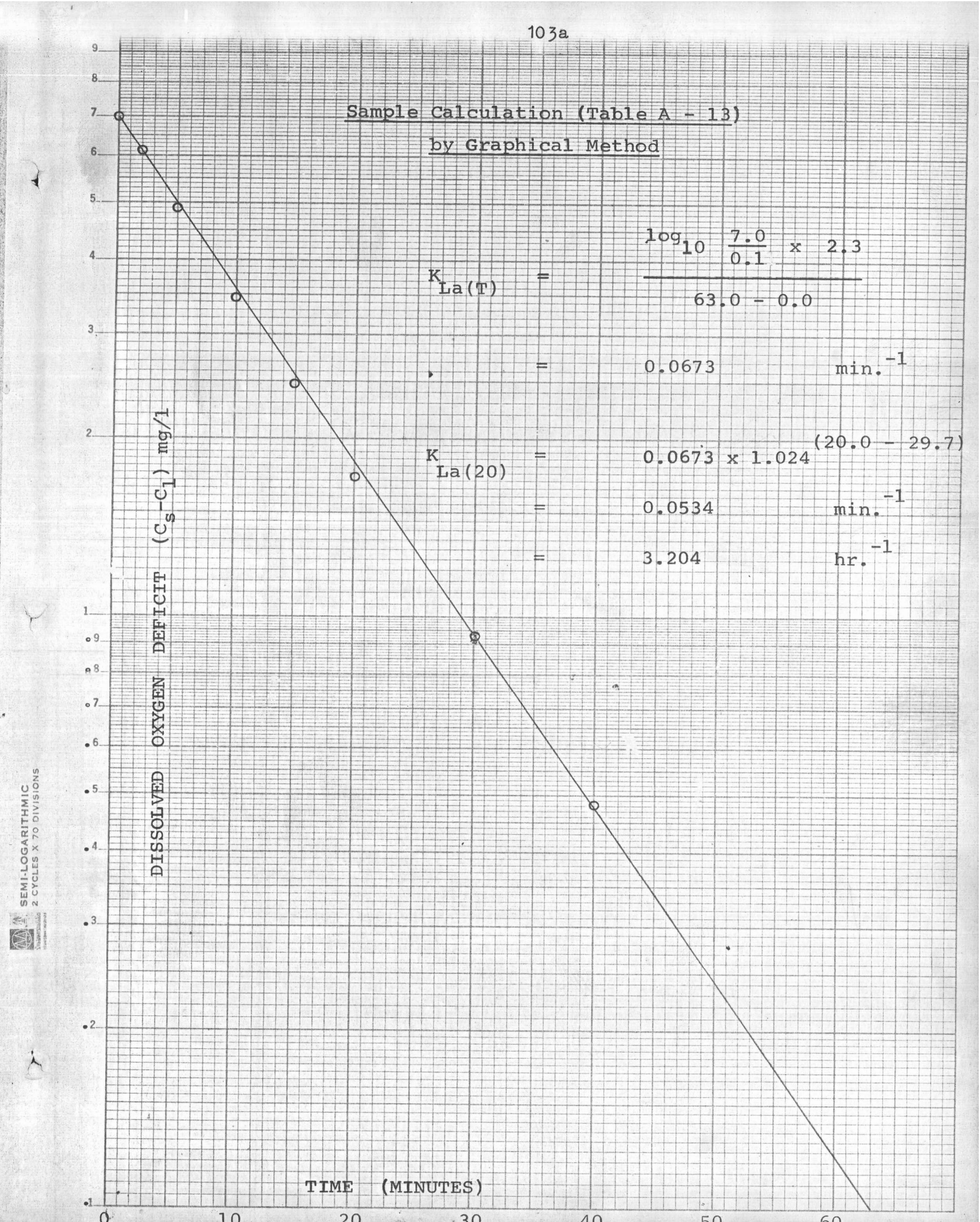
$$K_{La(T)} = \frac{\log_{10} \frac{7.0}{0.1} \times 2.3}{63.0 - 0.0}$$

$$= 0.0673 \text{ min.}^{-1}$$

$$K_{La(20)} = 0.0673 \times 1.024^{(20.0 - 29.7)}$$

$$= 0.0534 \text{ min.}^{-1}$$

$$= 3.204 \text{ hr.}^{-1}$$



APPENDIX C

TABLE OF RESULTS

In order to list all necessary results in one complete table, the following notes have been set up:-

Tn	=	Number of Table A in Appendix A
Dn	=	Diffuser Number
S	=	Immersion depth of effluene or exit (cm.)
H	=	Elevation head of diffuser (cm.)
P	=	Average power consumption (watts)
K_{La}	=	Overall coefficient for oxygen transfer at 20°C (hr^{-1})
r	=	Pearson value

From Table A-1 to Table A-44 (Tn = 1 to 44), the depth of water in the ditch is kept constant at 53 cm.

Table A-45 and Table A-46 (Tn = 45 & 46), water depth is equal to 43 cm.

Table A-47 and Table A-48 (Tn = 47 & 48), water depth 33 cm.

Table A-49 and Table A-50 (Tn = 49 & 50), water depth 23 cm.

The level of significance for all sets of experiment is equal to 99.9%.

Tn	Dn	S	H	P	K_{La}	$K_{La/P}$	r
1	1	50	50	480	1.344	2.800	0.9999
2	1	50	100	480	2.340	4.875	0.9993
3	2	50	50	490	1.404	2.865	0.9999
4	2	50	100	492	2.376	4.829	0.9998
5	2	50	150	480	2.892	6.025	0.9997
6	2	50	200	492	3.420	6.951	0.9997
7	2	30	100	492	2.184	4.439	0.9998
8	2	10	100	494	1.968	3.984	0.9998
9	3	50	50	464	1.464	3.155	0.9998
10	3	50	100	480	2.508	5.225	0.9997
11	4	50	50	474	1.500	3.165	0.9999
12	4	50	100	484	2.652	5.479	0.9998
13	4	50	160	480	3.210	6.688	0.9992
14	4	50	200	486	3.360	6.914	0.9995
15	4	50	250	480	3.156	6.575	0.9997
16	5	50	50	500	1.254	2.508	0.9996
17	5	50	100	490	2.532	5.167	0.9999
18	5	50	150	483	2.970	6.149	0.9999

Tn	Dn	S	H	P	K_{La}	$K_{La/P}$	r
19	5	50	200	486	3.396	6.988	0.9998
20	6	50	50	483	1.668	3.453	0.9998
21	6	50	100	486	2.178	4.481	0.9997
22	7	50	50	492	1.722	3.500	0.9990
23	7	50	80	480	2.496	5.200	0.9999
24	7	50	100	486	2.748	5.654	0.9981
25	7	50	150	480	3.126	6.513	0.9996
26	7	50	200	480	3.456	7.200	0.9992
27	7	50	250	480	3.336	7.013	0.9999
28	7	30	100	492	2.556	5.195	0.9999
29	7	10	100	486	2.226	4.580	0.9998
30	8	50	30	480	3.066	6.388	0.9990
31	8	50	50	480	3.624	7.550	0.9997
32	8	50	60	477	3.750	7.862	0.9994
33	8	50	70	480	3.822	7.963	0.9998
34	8	50	100	472	3.780	8.008	0.9996
35	8	50	150	456	3.570	7.829	0.9993
36	8	50	200	468	3.522	7.526	0.9991

Tn	Dn	S	H	P	K_{La}	$K_{La/P}$	r
37	8	50	250	474	3.288	6.937	0.9996
45	8	40	100	466	3.724	7.996	0.9991
46	8	40	100	469	3.804	8.111	0.9996
47	8	30	100	471	4.446	9.439	0.9989
48	8	30	100	477	4.434	9.296	0.9990
49	8	20	100	479	5.922	12.363	0.9980
50	8	20	100	478	6.144	12.853	0.9977
38	9	50	30	492	1.980	4.024	0.9996
39	9	50	60	490	2.874	5.865	0.9998
40	9	50	100	480	3.210	6.688	0.9998
41	9	50	150	468	3.492	7.462	0.9999
42	9	50	200	480	3.798	7.913	0.9996
43	9	30	100	488	3.030	6.209	0.9984
44	9	10	100	484	2.544	5.256	0.9996

VITA

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