APPENDIX

First stage screening of the microorganisms isolated.

Isolate No.	Gram stain	Rods	Coccus	Coccobacilli	Filamentous	Pleiomorphic	Spores	Oxygen requirement
A								
1	+	+					+	FA
2	-	+					-	Ae
3	-	+					-	Ae
4	+	+					+	FA
5	-	+					-	FA
6	-	+					-	FA
7	-	+					-	Ae
8	-	+					-	Ae
9	+	-			+	+	-	FA
10	-	+					-	FA
B								
1	-	+	NONE	NONE			-	FA
2	-	+					-	FA
3	-	+					-	FA
4	-	+					-	FA
5	-	+					-	FA
6	+	+					+	FA
7	+	+					+	FA
8	+	+					+	FA
9	+	+					+	FA
10	-	+					-	FA

First stage screening of the microorganisms isolated

Isolate No.	Gram stain	Rods	Coccus	Coccobacilli	Filamentous	Pleiomorphic	Spores	Oxygen requirement
C								
1	-	-					-	FA
2	-	-					-	FA
3	-	+					-	Ae
4	-	+					-	Ae
5	-	+					-	Ae
6	-	+					-	FA
7	-	+					-	Ae
8	-	+					-	FA
9	-	+					-	Ae
10	-	+					-	FA
D								
1	+	-	NONE	NONE	+	+	-	FA
2	+	-			+	+	-	FA
3	+	+					+	FA
4	+	+					+	FA
5	+	+					+	FA
6	-	+					-	Ae
7	+	-					-	Ae
8	-	-					-	FA
9	+	+					+	FA
10	-	+					-	FA

First stage screening of the microorganisms isolated.

Isolate No.	Gram stain	Rods	Coccus	Coccobacilli	Filamentous	Pleiomorphic	Spores	Oxygen requirement
E								
1	-	+					-	FA
2	-	+					-	FA
3	+	+					+	FA
4	-	+					-	FA
5	-	+					-	Ae
6	+	+					+	FA
7	+	+					+	FA
8	-	+					-	Ae
9	-	+					-	Ae
10	+	+					+	FA
F			NONE	NONE	NONE	NONE		
1	+	+					+	FA
2.	+	+					+	FA
3	+	+					+	FA
4	-	+					-	Ae
5	-	+					-	FA
6	-	+					-	FA
7	-	+					-	Ae
8	-	+					-	FA
9	-	+					-	Ae
10	-	+					-	FA

First stage screening of the microorganisms isolated.

Isolate No.	Gram stain	Rods	Coccus	Coccobacilli	Filamentous	Pleiomorphic	Spores	Oxygen requirement
G								
1	-	+					-	Ae
2	-	+					-	FA
3	-	+					-	Ae
4	-	+					-	Ae
5	-	+					-	FA
6	-	+					-	FA
7	-	+					-	Ae
8	-	+					-	Ae
9	-	+					-	FA
10	-	+					-	FA
H			NONE	NONE	NONE	NONE		
1	-	+					-	FA
2.	-	+					-	Ae
3	+	+					+	FA
4	+	+					+	FA
5	-	+					-	Ae
6	-	+					-	Ae
7	-	+					-	Ae
8	-	+					-	Ae
9	-	+					-	Ae
10	+	+					+	FA

First stage screening of the microorganisms isolated.

Isolate No.	Gram stain		Rods	Coccus	Coccobacilli	Filamentous	Pleiomorphic	Spores	Oxygen requirement
I									
1		-	+					-	FA
2		-	+					-	FA
3		-	+					-	FA
4		-	+					-	FA
5		-	+					-	Ae
6		-	+					-	Ae
7		-	+					-	Ae
8	+		-			+		-	Ae
9	+		+				+		FA
10	+		+					+	FA
J				NONE					
1	-		+					-	FA
2	-		+					-	FA
3	-		+					-	FA
4	+		-			+	+	-	Ae
5	+		-			+	+	-	Ae
6	+		+					+	FA
7	+		+					+	FA
8	+		-			+	+	-	Ae
9	+		-					-	Ae
10	+		+					+	FA

First stage screening of the microorganisms isolated.

Isolate No.	Gram stain	Rods	Coccus	Coccobacilli	Filamentous	Pleiomorphic	Spores	Oxygen requirement
K								
1	-	+					-	Ae
2	-	+					-	Ae
3	-	+					-	Ae
4	-	+					-	Ae
5	-	+					-	FA
6	-	+					-	FA
7	-	+					-	Ae
8	-	+					-	FA
9	-	+					-	Ae
10	-	+					-	Ae
L								
1	-	+					-	Ae
2	-	+					-	Ae
3	-	+					-	FA
4	-	+					-	FA
5	-	+					-	FA
6	-	+					-	FA
7	-	+					-	FA
8	-	+					-	FA
9	-	+					-	FA
10	-	+					-	FA

First stage screening of the microorganisms isolated.

Isolate No.	Gram stain	Rods	Coccus	Coccobacilli	Filamentous	Pleiomorphic	Spores	Oxygen requirement
M								
1	-	+					-	FA
2	-	+					-	FA
3	-	+					-	FA
4	-	+					-	FA
5	-	+					-	FA
6	-	+					-	FA
7	+	-			+	+	-	FA
8	+	-			+	+	-	FA
9	-	+					-	FA
10	-	+					-	FA
N			NONE	NONE				
1	+	+					+	FA
2	+	+					+	FA
3	+	+					+	FA
4	-	+					-	FA
5	-	+					-	FA
6	-	+					-	FA
7	-	+					-	FA
8	-	+					-	FA
9	+	+					+	FA
10	-	+					-	FA

First stage screening of the microorganisms isolated.

Isolate No.	Gram stain		Rods	Coccus	Coccobacilli	Filamentous	Pleiomorphic	Spores	Oxygen requirement
0									
1		-	+					-	Ae
2		-	+					-	Ae
3		-	+					-	FA
4		-	+					-	Ae
5		-	+					-	FA
6	+	+	+					+	FA
7	-	+	+					-	FA
8	-	-	+					-	FA
9	-	-	+					-	Ae
10	+		+					+	FA
P				NONE	NONE	NONE	NONE		
1	-	-	+					-	FA
2.	-	-	+					-	Ae
3	-	-	+					-	Ae
4	-	-	+					-	FA
5	-	-	+					-	Ae
6	-	-	+					-	FA
7	-	-	+					-	Ae
8	-	-	+					-	Ae
9	-	+	+					-	FA
10	-	+	+					-	Ae

First stage screening of the microorganisms isolated.

Isolate No.	Gram stain	Rods	Coccus	Coccobacilli	Filamentous	Pleiomorphic	Spores	Oxygen requirement
Q								
1	+	+					+	FA
2	+	+					+	FA
3	-	+					-	FA
4	-	+					-	Ae
5	-	+					-	Ae
6	-	+					-	Ae
7	-	+					-	FA
8	-	+					-	FA
9	-	+					-	FA
10	-	+					-	Ae
R			NONE	NONE	NONE	NONE		
1	-	+					-	Ae
2.	-	+					-	FA
3	-	+					-	FA
4	-	+					-	FA
5	-	+					-	FA
6	-	+					-	Ae
7	-	+					-	Ae
8	-	+					-	Ae
9	-	+					-	Ae
10	-	+					-	Ae

First stage screening of the microorganisms isolated.

S	Isolate No.									
	Gram stain									
1				-	-	-	-	+	+	+
2.				-	-	-	+	+	+	+
3				-	-	-	-	+	+	+
4				-	-	-	-	+	+	+
5				-	-	-	-	+	+	+
6				-	-	-	+	+	+	+
7				-	-	-	+	+	+	+
8				-	-	-	+	+	+	+
9				-	-	-	+	+	+	+
10				-	-	-	+	+	+	+
	Rods									
1				+	-	+				
2.				+	-	+				
3				+	-	+				
4				+	-	+				
5				+	-	+				
6				+	-	+				
7				+	-	+				
8				+	-	+				
9				+	-	+				
10				+	-	+				
	Coccus									
				NONE						
	Coccobacilli									
				NONE						
	Filamentous									
				NONE						
	Pleiomorphic									
				NONE						
	Spores									
	-	-	-	-	-	-	-	-	+	+
	-	-	-	-	-	-	-	-	+	+
	-	-	-	-	-	-	-	-	-	-
	Oxygen requirement									
	FA	FA	FA	FA	FA	FA	Ae	Ae	FA	FA
	FA	Ae	FA	Ae	Ae	FA	FA	Ae	Ae	FA

Second stage screening of the microorganisms isolated

Gram negative facultative anaerobic rods

Isolate No.	Pigment	Catalase	Oxidase	Nitrate red.	O-F(glucose)	Triple Sugar Iron Medium
A						
5	-	+	-	+	F	A/A
6	-	+	-	+	F	A/A
9	-	+	-	+	F	A/A
10	-	+	-	+	F	A/A
B						
1	-	+	-	+	F	A/A
2	R	+	-	+	F	A/A
3	-	+	-	+	F	A/A
4	-	+	-	+	F	A/A, H_2S
5	-	+	-	+	F	A/A
10	-	+	-	+	F	A/A
C						
1	-	+	-	+	F	A/A
2	R	+	-	+	F	A/A
6	-	+	-	+	F	A/A
8	-	+	-	+	F	A/A, H_2S
10	-	+	-	+	F	A/A
D						
1	-	+	-	+	F	A/A, H_2S
2	-	+	-	+	F	A/A
8	-	+	-	+	F	A/A, H_2S
10	-	+	-	+	F	A/A

Second stage screening of the microorganisms isolated

Isolate No.	Pigment	Catalase	Oxidase	Nitrate red.	O-F(glucose)	Triple Sugar Iron Medium
E						
1	-	+	-	+	F	A/A
2	-	+	-	+	F	A/A
4	-	+	-	+	F	A/A
F						
5	-	+	-	+	F	A/A
6	-	+	-	+	F	A/A
8	-	+	-	+	F	A/A
10	-	+	-	+	F	A/A
G						
2	-	+	-	+	F	A/A
5	-	+	-	+	F	A/A
6	-	+	-	+	F	A/A
9	-	+	-	+	F	A/A
10	-	+	-	+	F	A/A
H						
1	-	+	-	+	F	A/A
I						
1	-	+	-	+	F	A/A
2	-	+	-	+	F	A/A, H_2S
3	-	+	-	+	F	A/A
4	-	+	-	+	F	A/A

Second stage screening of the microorganisms isolated

Isolate No.	Pigment	Catalase	Oxidase	Nitrate red.	O-F(glucose)	Triple Sugar Iron Medium
J						
1	-	+	-	+	F	A/A
2	-	+	-	+	F	A/A
3	R	+	-	+	F	A/A
4	-	+	-	+	F	A/A
K						
5	-	+	-	+	F	A/A
6	-	+	-	+	F	A/A, H_2S
8	-	+	-	+	F	A/A, H_2S
L						
3	-	+	-	+	F	A/A
4	-	+	-	+	F	A/A
5	-	+	-	+	F	A/A
6	-	+	-	+	F	A/A
7	-	+	-	+	F	A/A
8	-	+	-	+	F	A/A
9	-	+	-	+	F	A/A, H_2S
10	-	+	-	+	F	A/A, H_2S
M						
1	-	+	-	+	F	A/A
2	R	+	-	+	F	A/A
3	-	+	-	+	F	A/A

Second stage screening of the microorganisms isolated

Isolate No.	Pigment	Catalase	Oxidase	Nitrate red.	O-F(glucose)	Triple Sugar Iron Medium
M						
4	-	+	-	+	F	A/A
5	-	+	-	+	F	A/A
6	-	+	-	+	F	A/A
7	-	+	-	+	F	A/A
8	-	+	-	+	F	A/A
9	-	+	-	+	F	A/A
10	-	+	-	+	F	A/A
N						
4	-	+	-	+	F	A/A
5	-	+	-	+	F	A/A, H_2S
6	-	+	-	+	F	A/A, H_2S
7	-	+	-	+	F	A/A, H_2S
8	-	+	-	+	F	A/A
10	-	+	-	+	F	A/A
0						
3	-	+	-	+	F	A/A
5	-	+	-	+	F	A/A
7	-	+	-	+	F	A/A
8	-	+	-	+	F	A/A, H_2S

Second stage screening of the microorganisms isolated

Isolate No.	Pigment	Catalase	Oxidase	Nitrate red.	O-F(glucose)	Triple Sugar Iron Medium
P						
1	-	+	-	+	F	A/A,H_2S
4	-	+	-	+	F	A/A,H_2S
6	-	+	-	+	F	A/A,H_2S
9	-	+	-	+	F	A/A,H_2S
Q						
3	-	+	-	+	F	A/A
7	-	+	-	+	F	A/A
8	-	+	-	+	F	A/A,H_2S
9	-	+	-	+	F	A/A,H_2S
R						
2	-	+	-	+	F	A/A
3	-	+	-	+	F	A/A
4	-	+	-	+	F	A/A
5	-	+	-	+	F	A/A,H_2S
S						
3	R	+	-	+	F	A/A
4	-	+	-	+	F	A/A
5	-	+	-	+	F	A/A,H_2S
6	-	+	-	+	F	A/A,H_2S
9	-	+	-	+	F	A/A
10	-	+	-	+	F	A/A,H_2S
T						
1	-	+	-	+	F	A/A,H_2S
10	-	+	-	+	F	A/A

Second stage screening of the microorganisms isolated

Gram negative aerobic rods

Isolate No.	Pigment	Catalase	Oxidase	Nitrate red.	O-F(glucose)	Triple Sugar Iron Medium
A						
2	BG	+	+	+	O	Alk/Alk
3	BG	+	+	+	O	Alk/Alk
7	BG	+	+	+	O	Alk/Alk
8	BG	+	+	+	O	Alk/Alk
C						
3	BG	+	+	+	O	Alk/Alk
4	BG	+	+	+	O	Alk/Alk
5	BG	+	+	+	O	Alk/Alk
7	-	+	+	+	-	Alk/Alk
9	BG	+	+	+	O	Alk/Alk
D						
6	BG	+	+	+	O	Alk/Alk
7	-	+	+	+	-	Alk/Alk
E						
5	BG	+	+	+	O	Alk/Alk
8	BG	+	+	+	O	Alk/Alk
9	BG	+	+	+	O	Alk/Alk
10	BG	+	+	+	O	Alk/Alk

Second stage screening of the microorganisms isolated

Isolate No.	Pigment	Catalase	Oxidase	Nitrate red.	O-F(glucose)	Triple Sugar Iron Medium
F						
4	-	+	+	+	-	Alk/Alk
7	BG	+	+	+	O	Alk/Alk
9	BG	+	+	+	O	Alk/Alk
G						
1	BG	+	+	+	O	Alk/Alk
3	BG	+	+	+	O	Alk/Alk
4	BG	+	+	+	O	Alk/Alk
7	BG	+	+	+	O	Alk/Alk
8	BG	+	+	+	O	Alk/Alk
H						
2	BG	+	+	+	O	Alk/Alk
5	BG	+	+	+	O	Alk/Alk
6	BG	+	+	+	O	Alk/Alk
7	BG	+	+	+	O	Alk/Alk
8	BG	+	+	+	O	Alk/Alk
9	BG	+	+	+	O	Alk/Alk
I						
5	BG	+	+	+	O	Alk/Alk
6	BG	+	+	+	O	Alk/Alk
7	BG	+	+	+	O	Alk/Alk
8	BG	+	+	+	O	Alk/Alk

Second stage screening of the microorganisms isolated

Isolate No.	Pigment	Catalase	Oxidase	Nitrate red.	O-F(glucose)	Triple Sugar Iron Medium
J						
5	-	+	+	+	-	Alk/Alk
8	BG	+	+	+	O	Alk/Alk
9	BG	+	+	+	O	Alk/Alk
K						
1	BG	+	+	+	O	Alk/Alk
2	-	+	+	+	-	Alk/Alk
3	-	+	+	+	-	Alk/Alk
4	BG	+	+	+	O	Alk/Alk
7	BG	+	+	+	O	Alk/Alk
9	-	+	+	+	-	Alk/Alk
10	BG	+	+	+	O	Alk/Alk
L						
1	BG	+	+	+	O	Alk/Alk
2	BG	+	+	+	O	Alk/Alk
O						
1	BG	+	+	+	O	Alk/Alk
2	-	+	+	+	-	Alk/Alk
4	BG	+	+	+	O	Alk/Alk
9	BG	+	+	+	O	Alk/Alk

Second stage screening of the microorganisms isolated

Isolate No.	Pigment	Catalase	Oxidase	Nitrate red.	O-F(glucose)	Triple Sugar Iron Medium
P						
2	-	+	+	+	-	Alk/Alk
3	BG	+	+	+	O	Alk/Alk
5	-	+	+	+	-	Alk/Alk
7	BG	+	+	+	O	Alk/Alk
8	BG	+	+	+	O	Alk/Alk
10	BG	+	+	+	O	Alk/Alk
Q						
4	BG	+	+	+	O	Alk/Alk
5	BG	+	+	+	O	Alk/Alk
6	BG	+	+	+	O	Alk/Alk
10	BG	+	+	+	O	Alk/Alk
R						
1	BG	+	+	+	O	Alk/Alk
6	-	+	+	+	-	Alk/Alk
7	BG	+	+	+	O	Alk/Alk
8	BG	+	+	+	O	Alk/Alk
9	BG	+	+	+	O	Alk/Alk
10	BG	+	+	+	O	Alk/Alk
S						
7	-	+	+	+	-	Alk/Alk
8	BG	+	+	+	O	Alk/Alk

Second stage screening of the microorganisms isolated

Isolate No.	Pigment	Catalase	Oxidase	Nitrate red.	O-F(glucose)	Triple Sugar Iron Medium
T						
2	BG	+	+	+	O	Alk/Alk
4	BG	+	+	+	O	Alk/Alk
5	-	+	+	+	-	Alk/Alk
8	BG	+	+	+	O	Alk/Alk
9	BG	+	+	+	O	Alk/Alk

APPENDIX 1.4.

Second stage screening of the microorganisms isolated.

Gram positive facultative anaerobic rods with spores

Isolate No.	Catalase	Nitrate red.	O-F(glucose)	Sporulation medium	Spore stain
A					
1	+	+	O	+	+
4	+	+	O	+	+
B					
6	+	+	O	+	+
7	+	+	O	+	+
8	+	+	O	+	+
9	+	+	O	+	+
D					
3	+	+	O	+	+
4	+	+	O	+	+
5	+	+	O	+	+
9	+	+	O	+	+
E					
3	+	+	O	+	+
6	+	+	O	+	+
7	+	+	O	+	+
10	+	+	O	+	+
F					
1	+	+	O	+	+
2	+	+	O	+	+
3	+	+	O	+	+

Isolate No.	Catalase	Nitrate red.	O-F(glucose)	Sporulation medium	Spore stain
H					
3	+	+	O	+	+
4	+	+	O	+	+
10	+	+	O	+	+
I					
9	+	+	O	+	+
10	+	+	O	+	+
J					
6	+	+	O	+	+
7	+	+	O	+	+
10	+	+	O	+	+
N					
1	+	+	O	+	+
2	+	+	O	+	+
3	+	+	O	+	+
10	+	+	O	+	+
O					
6	+	+	O	+	+
10	+	+	O	+	+

Second stage screening of the microorganisms isolated

Gram positive facultative anaerobic rods with spores

Isolate No.	Catalase	Nitrate red.	O-F(glucose)	Sporulation medium	Spore stain
Q					
1	+	+	0	+	+
2	+	+	0	+	+
S					
1	+	+	0	+	+
2	+	+	0	+	+
T					
1	+	+	0	+	+
3	+	+	0	+	+
6	+	+	0	+	+

APPENDIX 1.5.

Second stage screening of the microorganisms isolated

Gram positive non-spore forming bacteria

Isolate No.	Pigment	Nitrate red.	O-F(glucose)	Acid fast	Branching	Aerial hyphae
A						
9	YG	+	O	+	+	+
D						
1	YG	+	O	+	+	+
2	YG	+	O	+	+	+
I						
8	YG	+	O	+	+	+
J						
4	YG	+	O	+	+	+
5	YG	+	O	+	+	+
8	YG	+	O	+	+	+
9	YG	+	O	+	+	+
M						
7	YG	+	O	+	+	+
8	YG	+	O	+	+	+

APPENDIX 2

Test results for determination of kinetic coefficients.

θ_c Solids retention time(days)	S_o Influent substrate concentration(mg/l)	S Effluent substrate concentration(mg/l)	X MLVSS maintained in the activated sludge tank.(mg/l)
20	426	53	1995
	428	54	1910
	418	62	1860
	421	60	1883
	422	51	1952
Average	423	56	1920
15	411	62	1790
	421	63	1802
	409	60	1758
	415	69	1740
	419	71	1710
Average	415	65	1760

Test results for determination of kinetic coefficients.

θ_c Solids retention time(days)	S_o Influent substrate concentration(mg/l)	S Effluent substrate concentration(mg/l)	X MLVSS maintained in the activated sludge tank.(mg/l)
12	413	81	1380
	459	86	1512
	402	75	1480
	418	72	1441
	398	81	1422
Average	418	79	1447
10	438	87	1221
	436	90	1248
	440	81	1202
	421	82	1250
	415	85	1264
Average	430	85	1237

Test results for determination of kinetic coefficients.

θ_c Solids retention time(days)	S_o Influent substrate concentration(mg/l)	S Effluent substrate concentration(mg/l)	X MLVSS maintained in the activated sludge tank.(mg/l)
9	431	101	1108
	434	90	1156
	426	86	1172
	428	95	1123
	421	88	1136
Average	428	92	1139
8	456	108	1083
	462	121	1091
	438	115	1021
	441	110	1005
	463	101	980
Average	452	111	1036

Test results for determination of kinetic coefficients.

θ_c Solids retention time(days)	S_d Influent substrate concentration(mg/l)	S Effluent substrate concentration(mg/l)	X MLVSS maintained in the activated sludg tank.(mg/l)
7	443	106	908
	468	118	911
	429	120	902
	438	102	925
	452	104	939
Average	446	110	917
6	453	118	734
	462	125	808
	460	130	765
	468	116	773
	437	111	910
Average	456	120	798

Test results for determination of kinetic coefficients.

θ_c Solids retention time(days)	S_o Influent substrate concentration(mg/l)	S Effluent substrate concentration(mg/l)	X MLVSS maintained in the activated sludg tank.(mg/l)
5	440	126	714
	452	134	728
	438	144	736
	531	139	741
	444	147	726
Average	441	138	729

APPENDIX 3

Appendix 3.1. : Oxygen transfer in distilled-deionized water at an air flow rate of 500 ml/min.

Air flow rate(ml/min) 500	Final D.O - Initial D.O C	C_{av}	$\Delta C/\Delta t$
Time(min)			
0	0.8		
		1.25	0.3
3	1.7		
		1.9	0.4
4	2.1		
		2.4	0.3
6	2.7		
		3.2	0.143
13	3.7		
		4.0	0.15
17	4.3		
		4.4	0.05
21	4.5		
		4.65	0.1
24	4.8		
		4.95	0.05
30	5.1		
Overall oxygen transfer coefficient($k_L a$ per min)			0.09
Correlation coefficient			0.91

Appendix 3.2 : Oxygen transfer in distilled-deionized water at an air flow rate of 1000 ml/min.

Air flow rate(ml/min) 1000	Final D.O - Initial D.O C	C_{av}	$\Delta C/\Delta t$
Time(min)			
0	1.1		
		2.15	2.1
1	3.2		
		3.9	1.4
2	4.6		
		5.3	0.7
4	6.0		
		6.3	0.3
6	6.6		
		6.8	0.2
8	7.0		
		7.1	0.1
10	7.2		
		7.3	0.1
12	7.4		
		7.45	0.05
14	7.5		

Overall oxygen transfer coefficient($k_L a$ per min) 0.39

Correlation coefficient 0.99

Appendix 3.3. : Oxygen transfer in distilled-deionized water at an air flow rate of 1500 ml/min.

Air flow rate(ml/min) 1500	Final D.O - Initial D.O C	C_{av}	$\Delta C/\Delta t$
Time(min)			
0	0.9		
		2.15	2.5
1	3.4		
		4.45	2.1
2	5.5		
		5.8	0.6
3	6.1		
		6.35	0.5
4	6.6		
		6.75	0.3
5	6.9		
		7.05	0.3
6	7.2		
		7.3	0.4
6.5	7.4		
		7.5	0.2
7.5	7.6		

Overall oxygen transfer coefficient($k_L a$ per min) 0.47

Correlation coefficient 0.95

Appendix : Oxygen transfer in distilled - deionized water at an 3.4. air flow rate of 2000 ml/min.

Air flow rate(ml/min) 2000	Final D.O - Initial D.O C	Cav	ΔC/Δt
Time (min)			
0.167	3.3	5.2	22.75
0.334	7.1	9.0	22.75
0.501	10.9	12.25	16.17
0.668	13.6	14.95	16.17
0.835	16.3	17.35	12.58
1.002	18.4	19.4	11.98
1.169	20.4		
Overall oxygen transfer coefficient(k_La per min)			0.85
Correlation coefficient			0.96

Appendix : Oxygen transfer in treated detergent water after foaming at an
3.5. air flow rate of 500 ml/min.

Air flow rate(ml/min)	Final D.O - Initial D.O C	C_{av}	$\Delta C/\Delta t$
Time(min)			
0	0		
		0.75	1.5
1	1.5		
		1.65	0.3
2	1.8		
		2.1	0.6
3	2.4		
		2.75	0.7
4	3.1		
		3.4	0.6
5	3.7		
		4.0	0.6
6	4.3		
		4.5	0.4
7	4.7		
		4.85	0.3
8	5.0		
		5.15	0.3
9	5.3		
		5.35	0.1
10	5.4		
		5.65	0.25
12	5.9		
		5.95	0.1
13	6.0		
		6.1	0.2
14	6.2		
Overall oxygen transfer coefficient(k_La per min)			0.17
Correlation coefficient			0.78

Appendix 3.6. : Oxygen transfer in detergent water at an air flow rate of 1000 ml/min.

Air flow rate(ml/min)	Final D.O - Initial D.O C	C_{av}	$\Delta C/\Delta t$
Time(min)			
0	0		
		1.25	5.0
0.5	2.5		
		3.1	2.4
1	3.7		
		4.05	1.4
1.5	4.4		
		4.65	1.0
2	4.9		
		5.05	0.6
2.5	5.2		
		5.5	1.2
3	5.8		
		6.15	0.7
4	6.5		
		6.6	0.2
5	6.7		

Overall oxygen transfer coefficient(k_La per min) 0.83

Correlation coefficient 0.94

Appendix 3.7. : Oxygen transfer at an air flow rate of 1500 ml/min in detergent water after foaming.

Air flow rate(ml/min)	Final D.O - Initial D.O C	C_{av}	$\Delta C/\Delta t$
Time(min)			
0	0		
		1.35	10.8
0.25	2.7		
		3.35	5.2
0.5	4.0		
		4.15	1.2
0.75	4.3		
		4.6	2.4
1	4.9		
		5.1	1.6
1.25	5.3		
		5.5	2.0
1.5	5.7		
		5.75	0.4
1.75	5.8		
		5.9	0.8
2	6.0		
		6.25	1.0
2.5	6.5		
		6.65	0.6
3	6.8		
Overall oxygen transfer coefficient($k_L a$ per min)			1.85
Correlation coefficient			0.92

Appendix 3.8. : Oxygen transfer in treated detergent water after foaming at an air flow rate of 2000 ml/min.

Air flow rate(ml/min) 2000	Final D.O - Initial D.O C	C_{av}	$\Delta C/\Delta t$
Time(min)			
0	0		
		2.45	14
0.35	4.9		
		5.15	1.43
0.68	5.4		
		5.65	1.47
1.03	5.9		
		5.95	0.29
1.37	6.0		
		6.25	1.42
1.72	6.5		
		6.65	0.86
2.07	6.8		
		6.85	0.15
2.73	6.9		
Overall oxygen transfer coefficient($k_L a$ per min)			3.1
Correlation coefficient			0.94

Appendix 3.9. : Oxygen transfer in 10% deterent water at an air flow rate of 500 ml/min.

Air flow rate(ml/min) 500	Final D.O - Initial D.O C	C_{av}	$\Delta C/\Delta t$
Time(min)			
0	0.7		
		1.3	0.6
2	1.9		
		2.45	0.55
4	3.0		
		3.45	0.45
6	3.9		
		4.2	0.3
8	4.5		
		4.95	0.3
11	5.4		
		5.55	0.15
13	5.7		
		6.0	0.15
17	6.3		
		6.55	0.125
21	6.8		
		6.85	0.033
24	6.9		
Overall oxygen transfer coefficient($k_L a$ per min)			0.104
Correlation coefficient			0.99

Appendix 3.10. : Oxygen transfer in 10% detergent wastewater at an air flow rate of 1000 ml/min.

Air flow rate(ml/min) 1000	Final D.O - Initial D.O C	C_{av}	$\Delta C/\Delta t$
Time(min)			
0	0.5		
		1.7	2.4
1	2.9		
		3.65	1.5
2	4.4		
		4.85	0.9
3	5.3		
		5.6	0.6
4	5.9		
		6.1	0.4
5	6.3		
		6.55	0.25
7	6.8		
		7.0	0.1
11	7.2		
Overall oxygen transfer coefficient($k_L a$ per min)			0.44
Correlation coefficient			0.99

Appendix : Oxygen transfer in 10 % detergent wastewater at an air flow rate of 1500 ml/min.

Air flow rate(ml/min) 1500	Final D.O - Initial D.O C	C_{av}	$\Delta C/\Delta t$
Time (min)			
0.25	4.3		
		6.1	14.4
0.5	7.9		
		9.1	9.6
0.75	10.3		
		11.35	8.4
1	12.4		
		13.5	8.8
1.25	14.6		
		15.4	4.8
1.5	16.2		
		17.8	6.4
2	19.4		

Overall oxygen transfer coefficient($k_L a$ per min) 0.69

Correlation coefficient 0.89

Appendix : Oxygen transfer in 10% detergent water at an air flow rate
3.12. of 2000 ml/min.

Air flow rate(ml/min) 2000	Final D.O - Initial D.O C	C_{av}	$\Delta C/\Delta t$
Time(min)			
0	0.4		
		1.8	8.4
0.333	3.2		
		3.7	3.0
0.666	4.2		
		4.55	2.1
1	4.9		
		5.15	1.0
1.5	5.4		
		5.7	1.4
2	6.0		
		6.25	1.0
2.5	6.5		
		6.7	0.8
3	6.9		
		7.0	0.4
3.5	7.1		
		7.15	0.2
4	7.2		
		7.35	0.3
5	7.5		

Overall oxygen transfer coefficient($k_L a$ per min) 1.27

Correlation coefficient 0.92

Appendix 3.13. : Oxygen transfer in 25% detergent wastewater at an air flow rate of 500 ml/min.

Air flow rate(ml/min) 500	Final D.O - Initial D.O C	C_{av}	$\Delta C/\Delta t$
Time(min)			
0	0.8		
3	1.8	1.3	0.333
4	2.0	1.9	0.2
9	3.2	2.6	0.24
12	4.0	3.6	0.27
16	4.8	4.4	0.2
20	5.3	5.05	0.125
28	6.0	5.65	0.088
40	6.5	6.25	0.042

Overall oxygen transfer coefficient($k_L a$ per min) 0.048

Correlation coefficient 0.88

Appendix : Oxygen transfer in 25% detergent water at an air flow rate
3.14. of 1000 ml/min

Air flow rate(ml/min) 1000	Final D.O - Initial D.O C	C_{av}	$\Delta C/\Delta t$
Time(min)			
0	0.6		
		1.0	3.2
0.25	1.4		
		1.85	3.6
0.5	2.3		
		3.0	2.8
1	3.7		
		4.15	1.8
1.5	4.6		
		5.0	1.6
2	5.4		
		5.6	0.8
2.5	5.8		
		5.95	0.6
3	6.1		
		6.35	1.0
3.5	6.6		
		6.95	1.4
4	7.3		
		7.45	0.6
4.5	7.6		
Overall oxygen transfer coefficient($k_L a$ per min)			0.47
Correlation coefficient			0.93

Appendix 3.15. : Oxygen transfer in 25% detergent wastewater at an air flow rate of 1500 ml/min.

Air flow rate(ml/min) 1500	Final D.O - Initial D.O C	C_{av}	$\Delta C/\Delta t$
Time(min)			
0	1.2		
		1.8	7.2
0.166	2.4		
		3.15	4.5
0.5	3.9		
		4.55	2.6
1	5.2		
		5.7	1.0
2	6.2		
		6.5	0.6
3	6.8		
		7.0	0.4
4	7.2		
		7.35	0.3
5	7.5		

Overall oxygen transfer coefficient($k_L a$ per min) 1.23

Correlation coefficient 0.98

Appendix 3.16. : Oxygen transfer in 25% detergent wastewater at an air flow rate of 2000 ml/min.

Air flow rate(ml/min) 2000	Final D.O - Initial D.O C	C_{av}	$\Delta C/\Delta t$
Time(min)			
0	0.9		
		1.85	11.38
0.167	2.8		
		3.95	13.77
0.334	5.1		
		5.75	7.78
0.501	6.4		
		6.85	5.39
0.668	7.3		
		7.45	3.61
0.835	7.6		
Overall oxygen transfer coefficient($k_L a$ per min)			1.57
Correlation coefficient			0.86

Appendix 3.17. : Oxygen transfer in 50% detergent wastewater at an air flow rate if 500 ml/min.

Air flow rate(ml/min) 500	Final D.O - Initial D.O C	C_{av}	$\Delta C/\Delta t$	Cav
Time (min)				
0	2.4			
1	3.9	3.15	1.5	
3	7.5	5.7	1.8	
5	11.0	9.25	1.75	
7	13.6	12.3	1.3	
9	16.1	14.85	1.25	
11	17.9	17.0	0.9	
13	19.8	18.85	0.95	
Overall oxygen transfer coefficient($k_L a$ per min)			0.05	
Correlation coefficient			0.85	

Appendix 3.18. : Oxygen transfer in 50 % detergent water at an air flow rate of 1000 ml/min.

Air flow rate(ml/min) 1000	Final D.O - Initial D.O C	C_{av}	$\Delta C/\Delta t$
Time(min)			
0	0.8		
		1.95	2.3
1	3.1		
		3.85	1.5
2	4.6		
		4.85	0.5
3	5.1		
		5.35	0.5
4	5.6		
		5.7	0.2
5	5.8		
		5.95	0.3
6	6.1		
		6.2	0.2
7	6.3		
		6.35	0.1
8	6.4		
		6.5	0.2
9	6.6		
		6.65	0.1
10	6.7		

Overall oxygen transfer coefficient($k_L a$ per min) 0.49

Correlation coefficient 0.97

Appendix 3.19. : Oxygen transfer in 50% detergent water at an air flow rate of 1500 ml/min.

Air flow rate(ml/min) 1500	Final D.O - Initial D.O C	C_{av}	$\Delta C/\Delta t$
Time(min)			
0	0.9		
		1.95	8.4
0.25	3.0		
		3.85	6.8
0.5	4.7		
		5.45	6.0
0.75	6.2		
		6.5	2.4
1	6.8		
		7.1	1.2
1.5	7.4		
		7.5	0.4
2	7.6		

Overall oxygen transfer coefficient($k_L a$ per min) 1.47

Correlation coefficient 0.95

Appendix 3.20. : Oxygen transfer in 50% detergent water at an air flow rate of 2000 ml/min.

Air flow rate(ml/min) 2000	Final D.O - Initial D.O C	C_{av}	$\Delta C/\Delta t$
Time(min)			
0	1.1		
		1.95	10.18
0.167	2.8		
		3.3	5.99
0.334	3.8		
		4.25	5.39
0.501	4.7		
		5.05	4.19
0.668	5.4		
		5.7	3.59
0.835	6.0		
		6.15	1.8
1.002	6.3		
		6.55	2.99
1.169	6.8		
		6.95	1.8
1.336	7.1		
		7.2	1.2
1.503	7.3		

Overall oxygen transfer coefficient($k_L a$ per min) 1.53

Correlation coefficient 0.97

Appendix 3.21. : Oxygen transfer in 75% detergent wastewater at an air flow rate of 500 ml/min.

Air flow rate(ml/min) 500	Final D.O - Initial D.O C	C_{av}	$\Delta C/\Delta t$
Time (min)			
0	1.1		
		1.85	1.5
1	2.6		
		3.7	2.2
2	4.8		
		6.7	1.9
4	8.6		
		10.15	1.55
6	11.7		
		13.5	1.2
9	15.3		
		15.85	1.1
10	16.4		
		17.25	0.85
12	18.1		
		18.95	0.85
14	19.8		

Overall oxygen transfer coefficient($k_L a$ per min) 0.065

Correlation coefficient 0.86

Appendix 3.22. :Oxygen transfer in 75 % detergent wastewater at an air flow rate of 1000 ml/min.

Air flow rate(ml/min) 1000	Final D.O - Initial D.O C	C_{av}	$\Delta C/\Delta t$
Time(min)			
0	0		
0.5	1.4	0.7	2.8
1	2.7	2.05	2.6
1.5	3.6	3.15	1.8
2	4.2	3.9	1.2
2.5	4.7	4.45	1.0
3	5.1	4.9	0.8
3.5	5.3	5.2	0.4
4	5.4	5.35	0.2
5	5.8	5.6	0.4
6	5.9	5.85	0.1
7	6.0	5.95	0.1
10	6.1	6.05	0.03
11	6.2	6.15	0.1
Overall oxygen transfer coefficient(k_La per min)		0.56	
orrelation coefficient		0.99	

Appendix 3.23. : Oxygen transfer in 75% detergent water at an air flow rate of 1500 ml/min.

Air flow rate(ml/min) 1500	Final D.O - Initial D.O C	C_{av}	$\Delta C/\Delta t$
Time(min)			
0	1.3		
		2.95	6.6
0.5	4.6		
		5.05	1.8
1	5.5		
		5.65	0.6
1.5	5.8		
		6.1	1.2
2	6.4		
		6.45	0.2
2.5	6.5		
		6.65	0.6
3	6.8		
		7.1	0.6
4	7.4		
Overall oxygen transfer coefficient($k_L a$ per min)			1.5
Correlation coefficient			0.93

Appendix 3.24. : Oxygen transfer in 75% detergent water at an air flow rate of 2000 ml/min.

Air flow rate(ml/min) 2000	Final D.O - Initial D.O C	C_{av}	$\Delta C/\Delta t$
Time(min)			
0	0.8		
		2.8	8.0
0.5	4.8		
		5.5	2.8
1	6.2		
		6.5	1.2
1.5	6.8		
		6.85	0.2
2	6.9		
		7.1	0.8
2.5	7.3		
		7.45	0.3
3.5	7.6		
Overall oxygen transfer coefficient($k_L a$ per min)			1.72
Correlation coefficient			0.99

Appendix 3.25. : Oxygen transfer in 100 % detergent wastewater at an air flow rate of 500 ml/min.

Air flow rate(ml/min) 500	Final D.O - Initial D.O C	C_{av}	$\Delta C/\Delta t$
Time(min)			
0	0		
		0.45	0.9
1	0.9		
		1.35	0.9
2	1.8		
		2.35	0.73
3.5	2.9		
		3.15	0.5
4.5	3.4		
		3.5	0.4
5	3.6		
		3.8	0.4
6	4		
		4.2	0.4
7	4.4		
		4.6	0.4
8	4.8		
		4.9	0.2
9	5.0		
		5.25	0.33
10.5	5.5		
		5.6	0.2
11.5	5.7		
		5.8	0.08
14	5.9		
		6.05	0.2
15.5	6.2		
		6.25	0.05
17.5	6.3		
Overall oxygen transfer coefficient($k_L a$ per min)		0.15	
Correlation coefficient		0.97	

Appendix 3.26. : Oxygen transfer in 100% detergent water at an air flow rate of 1000 ml/min.

Air flow rate(ml/min) 1000	Final D.O - Initial D.O C	C_{av}	$\Delta C/\Delta t$
Time(min)			
0	1.3		
		1.9	4.8
0.25	2.5		
		3.0	4.0
0.5	3.5		
		4.25	3.0
1	5.0		
		5.55	1.64
1.67	6.1		
		6.25	0.9
2	6.4		
		6.6	0.4
3	6.8		
		7.15	0.7
4	7.5		
Overall oxygen transfer coefficient($k_L a$ per min)			0.87
Correlation coefficient			0.99

Appendix 3.27. : Oxygen transfer in 100% detergent wastewater at an air flow rate of 1500 ml/min.

Air flow rate(ml/min) 1500	Final D.O - Initial D.O C	C_{av}	$\Delta C/\Delta t$
Time(min)			
0	1.0		
		1.9	7.2
0.25	2.8		
		3.85	8.4
0.75	5.8		
		5.35	3.6
1	5.8		
		6.05	0.4
2	6.3		
		6.5	0.4
3	6.7		
Overall oxygen transfer coefficient($k_L a$ per min)			1.73
Correlation coefficient			0.87

Appendix 3.28. : Oxygen transfer in 100% detergent wastewater at an air flow rate of 2000 ml/min.

Air flow rate(ml/min) 2000	Final D.O - Initial D.O C	C_{av}	$\Delta C/\Delta t$
Time(min)			
0	0.5		
		1.5	11.98
0.167	2.5		
		3.35	20.48
0.25	4.2		
		5.1	7.2
0.5	6.0		
		6.35	2.8
0.75	6.7		
		6.75	0.4
1	6.8		
		7.0	0.8
1.5	7.2		
		7.3	0.4
2	7.4		
Overall oxygen transfer coefficient ($k_L a$ per min)			2.9
Correlation coefficient			0.84

Appendix 3.29. : Oxygen transfer in distilled, deionized water at a pure oxygen flow rate of 500 ml/min.

Oxygen flow rate(ml/min) 500	Final D.O - Initial D.O C	C_{av}	$\Delta C/\Delta t$
Time (min)			
0	0.8		
		3.25	9.8
0.5	5.7		
		6.6	3.6
1	7.5		
		8.4	3.6
1.5	9.3		
		10.1	3.2
2	10.9		
		11.85	3.8
2.5	12.8		
		13.55	3.0
3	14.3		
		15.0	2.8
3.5	15.7		
		16.4	2.8
4	17.1		
		17.8	2.8
4.5	18.5		
		19.4	3.6
5	20.3		
		20.7	1.6
5.5	21.1		
Overall oxygen transfer coefficient($k_L a$ per min)		0.27	
Correlation coefficient		0.71	

Appendix : Oxygen transfer in distilled, deionized water at a pure
3.30. oxygen flow rate of 1000 ml/min.

Oxygen flow rate(ml/min) 1000	Final D.O - Initial D.O C	C_{av}	$\Delta C/\Delta t$
Time (min)			
0	0.8		
		3.8	12.0
0.5	6.8		
		8.5	6.8
1	10.2		
		10.3	0.4
1.5	10.4		
		11.1	2.8
2	11.8		
		12.65	3.4
2.5	13.5		
		14.25	1.0
4	15.0		
		15.75	1.5
5	16.5		
		16.65	0.3
6	16.8		
		17.5	1.4
7	18.2		
		18.35	0.3
8	18.5		
		19.2	1.4
9	19.9		
Overall oxygen transfer coefficient($k_L a$ per min)		0.63	
Correlation coefficient		0.83	

Appendix 3.31. : Oxygen transfer in distilled, deionized water at a pure oxygen flow rate of 1500 ml/min.

Oxygen flow rate(ml/min) 1500	Final D.O - Initial D.O C	C_{av}	$\Delta C/\Delta t$
Time(min)			
0	0		
		1.1	4.4
0.5	2.2		
		3.55	2.7
1.5	4.9		
		5.2	1.2
2	5.5		
		5.75	1.0
2.5	6		
		6.2	0.8
3	6.4		
		6.5	0.2
4	6.6		
		6.65	0.2
4.5	6.7		
		6.75	0.2
5	6.8		
Overall oxygen transfer coefficient(k_La per min)		0.75	
Correlation coefficient		0.99	

Appendix 3.32. : Oxygen transfer in distilled -deionized water at a pure oxygen flow rate of 2000 ml/min.

Oxygen flow rate(ml/min) 2000	Final D.O - Initial D.O C	C_{av}	$\Delta C/\Delta t$
Time(min)			
0	0		
		1.3	5.2
0.5	2.6		
		3.45	3.4
1	4.3		
		4.9	2.4
1.5	5.5		
		5.65	0.6
2	5.8		
		5.95	0.6
2.5	6.1		
		6.2	0.4
3	6.3		
		6.4	0.4
3.5	6.5		
		6.55	0.2
4	6.6		
		6.65	0.2
4.5	6.7		
		6.75	0.2
5	6.8		
Overall oxygen transfer coefficient($k_L a$ per min)			0.98
Correlation coefficient			0.99

Appendix 3.33. : Oxygen transfer in treated detergent water after foaming at a pure oxygen flow rate of 500 ml/min.

Oxygen flow rate(ml/min) 500	Final D.O - Initial D.O C	C_{av}	$\Delta C/\Delta t$
Time (min)			
0	0.9		
		3.4	29.94
0.167	5.9		
		6.85	22.89
0.25	7.8		
		9.15	10.8
0.5	10.5		
		11.0	4.0
0.75	11.5		
		13.05	12.4
1	14.6		
		16.3	6.8
1.5	18.0		
		19.5	6.0
2	21.0		

Overall oxygen transfer coefficient($k_L a$ per min) 1.4

Correlation coefficient 0.82

Appendix 3.34. : Oxygen transfer in treated detergent water after foaming at a pure oxygen flow rate of 1000 ml/min.

Oxygen flow rate(ml/min) 1000	Final D.O - Initial D.O C	C_{av}	$\Delta C/\Delta t$
Time (min)			
0.083	1.3	50.6	3.4
0.167	5.5	50.6	7.6
0.25	9.7	36.14	11.2
0.333	12.7	31.33	14.0
0.417	15.3	42.17	17.05
0.5	18.8	21.69	19.7
0.583	20.6	6.02	20.85
0.67	21.1		
Overall oxygen transfer coefficient($k_L a$ per min)		2.12	
Correlation coefficient		0.84	

Appendix 3.35. : Oxygen transfer in treated detergent water after foaming at a pure oxygen flow rate of 1500 ml/min.

Oxygen flow rate(ml/min) 1500	Final D.O - Initial D.O C	C_{av}	$\Delta C/\Delta t$
Time (min)			
0	1.3		
		4.55	78.3
0.083	7.8		
		9.95	51.8
0.166	12.1		
		13.45	32.5
0.249	14.8		
		15.85	25.3
0.332	16.9		
		17.7	19.28
0.415	18.5		
		19.05	13.25
0.498	19.6		
		20.05	10.84
0.581	20.5		
		20.8	7.23
0.664	21.1		

Overall oxygen transfer coefficient($k_L a$ per min) 4.3

Correlation coefficient 0.99

Appendix 3.36. : Oxygen transfer in treated detergent water after foaming at a pure oxygen flow rate of 2000 ml/min.

Oxygen flow rate(ml/min) 2000	Final D.O - Initial D.O C	C_{av}	$\Delta C/\Delta t$
Time (min)			
0	0.9		
		9.25	100.0
0.167	17.6		
		19.35	42.17
0.167	21.1		

Overall oxygen transfer coefficient(k_La per min) 5.7

Correlation coefficient 1

Appendix 3.37. : Oxygen transfer in 10% treated detergent water after foaming at a pure oxyge flow rate of 500 ml/min.

Oxygen flow rate(ml/min) 500	Final D.O - Initial D.O C	C_{av}	$\Delta C/\Delta t$
Time (min)			
0.5	2.1		
		2.45	1.4
1	2.8		
		3.5	2.8
1.5	4.2		
		4.8	2.4
2	5.4		
		6.05	1.3
3	6.7		
		7.5	1.6
4	8.3		
		8.7	0.8
5	9.1		
		9.55	0.9
6	10.0		
		10.6	1.2
7	11.2		
		12.25	1.05
9	13.3		
		14.4	1.1
11	15.5		
		16.3	0.8
13	17.1		
		17.75	0.65
15	18.4		
Overall oxygen transfer coefficient($k_L a$ per min)			0.1
Correlation coefficient			0.72

Appendix 3.38. : Oxygen transfer in 10% treated detergent water after foaming at a pure oxygen flow rate of 1000 ml/min.

Oxygen flow rate(ml/min) 1000	Final D.O - Initial D.O C	C_{av}	$\Delta C/\Delta t$
Time (min)			
0.167	3.1		
0.333	5.6	4.35	14.97
0.5	7.7	7.15	12.57
0.67	8.6	8.15	5.39
1	10.8	9.7	6.6
1.33	13.3	12.05	7.5
1.67	15.6	14.4	6.6
2.33	18.4	17.0	4.18
2.67	20.0	19.2	4.8

Overall oxygen transfer coeffucient($k_L a$ per min) 0.59

Correlation coefficient 0.78

Appendix 3.40. : Oxygen transfer in 10% treated detergent water after foaming at a pur oxygen flow rate of 2000 ml/min.

Oxygen flow rate(ml/min) 2000	Final D.O - Initial D.O C	C_{av}	$\Delta C/\Delta t$
Time (min)			
0	1.1		
		2.5	33.73
0.083	3.9		
		7.05	75.9
0.167	10.2		
		13	67.47
0.25	15.8		
		17.05	49.4
0.333	19.9		
Overall oxygen transfer coefficient($k_L a$ per min)			2.56
Correlation coefficient			0.95

Appendix : Oxygen transfer in 25% treated detergent water after foaming at a pure oxyge
3.41. flow rate of 500 ml/min.

Oxygen flow rate(ml/min) 500	Final D.O - Initial D.O C	C_{av}	$\Delta C/\Delta t$
Time (min)			
0	0.8		
		1.5	2.8
0.5	2.2		
		2.7	2.0
1	3.2		
		4.35	2.3
2	5.5		
		6.5	2.0
3	7.5		
		8.35	1.7
4	9.2		
		10.85	1.65
6	12.5		
		13.75	1.25
8	15.0		
		15.9	0.9
10	16.8		
		17.75	0.75
12	18.3		
		18.9	0.6
14	19.5		
		20.1	0.6
16	20.7		
Overall oxygen transfer coefficient($k_L a$ per min)			0.11
Correlation coefficient			0.97

Appendix 3.42. : Oxygen transfer in 25% treated detergent water after foaming at a pure oxygen flow rate of 1000 ml/min.

Oxygen flow rate(ml/min) 1000	Final D.O - Initial D.O C	C_{av}	$\Delta C/\Delta t$
Time (min)			
0	1.2		
		3.2	16.0
0.25	5.2		
		6.95	14.0
0.5	8.7		
		9.7	8.0
0.75	10.7		
		11.65	7.6
1	12.6		
		13.45	6.8
1.25	14.3		
		15.05	6.0
1.5	15.8		
		17.0	4.8
2	18.2		
		18.8	4.8
2.25	19.4		
		20.0	4.8
2.5	20.6		
Overall oxygen transfer coefficient($k_L a$ per min)			0.69
Correlation coefficient			0.94

Appendix 3.43. : Oxygen transfer in 25% treated detergent water after foaming at a pure oxygen flow rate of 1500 ml/min.

Oxygen flow rate(ml/min) 1500	Final D.O - Initial D.O C	C_{av}	$\Delta C/\Delta t$
Time (min)			
0	2.4		
		5.25	48.72
0.117	8.1		
		10.45	28.2
0.283	12.8		
		15.25	29.4
0.45	17.7		
		19.25	18.6
0.617	20.8		
		20.95	1.8
0.783	21.1		
Overall oxygen transfer coefficient($k_L a$ per min)			2.59
Correlation coefficient			0.93

Appendix : Oxygen transfer in 25% treated detergent water after foaming at a pure oxyge
3.44. flow rate of 2000 ml/min.

Oxygen flow rate(ml/min) 2000	Final D.O - Initial D.O C	C_{av}	$\Delta C/\Delta t$
Time (min)			
0	0.7		
		1.5	19.28
0.083	2.3		
		5.3	72.29
0.166	8.3		
		10.85	61.45
0.249	13.4		
		16.25	68.67
0.332	19.1		
		20.1	24.1
0.415	21.1		
Overall oxygen transfer coefficient($k_L a$ per min)			3.0
Correlation coefficient			0.85

Appendix 3.45. : Oxygen transfer in 50% treated detergent water after foaming at a pure oxyge rate of 500 ml/min.

Oxygen flow rate(ml/min) 500	Final D.O - Initial D.O C	C_{av}	$\Delta C/\Delta t$
Time(min)			
0	1.0		
		1.5	0.5
2	2.0		
		2.25	0.25
4	2.5		
		2.85	0.23
7	3.2		
		3.4	0.2
9	3.6		
		3.8	0.2
11	4.0		
		4.35	0.175
15	4.7		
		4.85	0.075
19	5.0		
		5.2	0.1
23	5.4		
		5.5	0.05
27	5.6		
		5.85	0.05
39	6.1		
Overall oxygen transfer coefficient($k_L a$ per min)			0.09
Correlation coefficient			0.92

Appendix 3.46. : Oxygen transfer in 50% treated detergent water after foaming at a pure oxygen flow rate of 1000 ml/min.

Oxygen flow rate(ml/min) 1000	Final D.O - Initial D.O C	C_{av}	$\Delta C/\Delta t$
Time (min)			
Time (min)			
0.167	1.6	3.8	26.35
0.334	6.0	8.3	27.54
0.501	10.6	13.15	30.54
0.668	15.7	17.55	22.16
0.835	19.4	19.95	13.25
0.918	20.5		
Overall oxygen transfer coefficient(k_L per min)			0.69
Correlation coefficient			0.7

Appendix 3.47. : Oxygen transfer in 50% treated detergent water after foaming at a pure oxygen flow rate of 1500 ml/min.

Oxygen flow rate(ml/min) 1500	Final D.O - Initial D.O C	C_{av}	$\Delta C/\Delta t$
Time (min)			
0	0.7	2.25	37.34
0.083	3.8	6.3	60.24
0.167	8.8	10.05	30.12
0.25	11.3	12.75	34.94
0.333	14.2	15.05	20.48
0.416	15.9	16.5	14.46
0.499	17.1	17.7	14.46
0.582	18.3	18.75	10.84
0.665	19.2	19.5	7.23
0.748	19.8	20.05	6.02
0.831	20.3		
Overall oxygen transfer coefficient($k_L a$. per min)			2.46
Correlation coefficient			0.87

Appendix 3.48. : Oxygen transfer in 50% treated detergent water after foaming at a pure oxygen flow rate of 2000 ml/min.

Oxygen flow rate(ml/min) 2000	Final D.O - Initial D.O C	C_{av}	$\Delta C/\Delta t$
Time (min)			
0	1.0	3.45	59.04
0.083	5.9	9.4	84.3
0.167	12.9	15.1	53.0
0.25	17.3	18.4	26.5
0.333	19.5	20.2	16.86
0.416	20.9	21.0	2.4
0.499	21.1		
Overall oxygen transfer coefficient(k_La per min)			3.6
Correlation coefficient			0.82

Appendix 3.49. : Oxygen transfer in 75% treated detergent water after foaming at a pure oxyg rate of 500 ml/min.

Oxygen flow rate(ml/min) 500	Final D.O - Initial D.O C	C_{av}	$\Delta C/\Delta t$
Time(min)			
0	0.8		
		1.25	0.9
1	1.7		
		2.0	0.6
2	2.3		
		2.35	0.05
4	2.4		
		3.5	0.16
18	4.6		
		4.7	0.1
20	4.8		
		5.1	0.06
30	5.4		
Overall oxygen transfer coefficient($k_L a$ per min)			0.18
Correlation coefficient			0.77

Appendix 3.50. : Oxygen transfer in 75% treated detergent water after foaming at a pure oxygen flow rate of 1000 ml/min.

Oxygen flow rate(ml/min) 1000	Final D.O - Initial D.O C	C_{av}	$\Delta C/\Delta t$
Time (min)			
0	2.3		
		3.7	33.73
0.083	5.1		
		7.9	33.53
0.25	10.7		
		13.3	31.13
0.417	15.9		
		17.75	22.15
0.584	19.6		
		20.35	8.98
0.751	21.1		
Overall oxygen transfer coefficient($k_L a$ per min)			1.34
Correlation coefficient			0.87

Appendix 3.51 : Oxygen transfer rate at a pure oxygen flow rate of 1500 ml/min in 75% treated detergent wastewater.

Oxygen flow rate(ml/min) 1500	Final D.O - Initial D.O C	C_{av}	$\Delta C/\Delta t$
Time (min)			
0	1.7	5.45	44.9
0.167	9.2	11.75	61.4
0.25	14.3	15.5	28.9
0.33	16.7	17.65	22.89
0.417	18.6	19.1	12.05
0.5	19.6	20.25	15.66
0.583	20.9		
Overall oxygen transfer coefficient(k_La per min)			2.69
Correlation coefficient			0.79

Appendix 3.52 : Oxygen transfer in 75% treated detergent water after foaming at a pur
oxygen flow rate of 2000 ml/min.

Oxygen flow rate(ml/min) 2000	Final D.O - Initial D.O C	C_{av}	$\Delta C/\Delta t$
Time (min)			
0	1.4	3.95	30.54
0.167	6.5	9.15	63.85
0.25	11.8	13.85	49.4
0.33	15.9	16.95	25.3
0.417	18.0	18.7	16.87
0.5	19.4	20.1	16.87
0.583	20.8		
Overall oxygen transfer coefficient($k_L a$ per min)			4.75
Correlation coefficient			0.98

Appendix 3.53. : Oxygen transfer in 100% treated detergent water after foaming at a pure oxygen flow rate of 500ml/min.

Oxygen flow rate(ml/min) 500	Final D.O - Initial D.O C	Cav	Δ C/Δt
Time (min)			
0	1.0		
1	3.3	2.15	2.3
2	5.4	4.35	2.1
3	7.0	6.2	1.6
4	8.7	7.85	1.7
5	10.6	9.65	1.9
6	11.9	11.25	1.3
8	13.9	12.9	1.0
10	15.9	14.9	1.0
12	17.4	16.65	0.75
14	18.6	18.0	0.6
Overall oxygen transfer coefficient($k_L a$ per min)			0.11
Correlation coefficient			0.96

Appendix 3.54. : Oxygen transfer in 100% treated detergent wastewater at a pure oxygen flow rate of 1000 ml/min.

Oxygen flow rate(ml/min) 1000	Final D.O - Initial D.O C	C_{av}	$\Delta C/\Delta t$
Time (min)			
0	0.8	2.4	38.55
0.083	4.0	5.7	40.96
0.166	7.4	8.25	20.48
0.25	9.1	10.35	10.0
0.5	11.6	12.8	4.8
1	14.0	15.2	4.8
1.5	16.4	17.05	2.6
2	17.7	18.45	3.0
2.5	19.2	20	3.2
3	20.8		
Overall oxygen transfer coefficient($k_L a$ per min)			2.33
Correlation coefficient			0.90

Appendix 3.55. : Oxygen transfer rate in 100% treated detergent wastewater at a pure oxygen flow rate of 1500 ml/min and 2000 ml/min.

Oxygen flow rate(ml/min) 1500 2000	Final D.O - Initial D.O C	C_{av}	$\Delta C/\Delta t$
Time (min)			
0	3.1	6.2	74.69
0.083	9.3	12.25	71.08
0.167	15.2	17.0	43.37
0.249	18.8	19.95	27.71
0.332	21.1		
Overall oxygen transfer coefficient(k_La per min)			3.5
Correlation coefficient			0.93
0	0.3	2.45	130.3
0.033	4.6	8.7	97.6
0.117	12.8	15.8	36.1
0.283	18.8	19.9	32.8
0.35	21.0		
Overall oxygen transfer coefficient(k_La per min)			6.1
Correlation coefficient			0.98