

ลิขสิทธิ์มหาวิทยาลัยเชียงใหม่

Copyright© by Chiang Mai University
All rights reserved



APPENDIX 1

PICTURES OF MONITORING SITES

ลิขสิทธิ์มหาวิทยาลัยเชียงใหม่

Copyright© by Chiang Mai University

All rights reserved



Figure 1. Site 1 – Water supply pond



Figure 2. Site 2 – 1st Sediment pond



Figure 3. Site 3 – 2nd Sediment pond



Figure 4. Site 4 – Discharged place to small channel



Figure 5. Site 5 – Junction to big channel along the road



Figure 6. Site 6 – 50m far from site 5



Figure 7. Site 7 – 100m far from site 5



Figure 8. Site 8 – 200m far from site 5

APPENDIX 2. Procedure of Dissolved Oxygen analysis (Winkler method)

1. Remove the BOD bottle containing the sample from the dissolved oxygen sampler and insert the matching ground-glass stopper in the neck of the bottle. Be sure that no air bubbles have been trapped under the stopper and maintain a water seal around the stopper until ready for the next step of the procedure.
2. Pour off the water seal and remove the ground glass stopper. Add 1ml of MnSO_4 solution, then 1ml of alkaline-iodide-azide solution. For both additions, hold the tip of the pipette against the inside of the bottle neck to prevent splashing.
3. Replace the ground-glass stopper, being careful to avoid trapping air bubbles under it.
4. Mix the contents by inverting the bottle several times. Keep a finger over the stopper during mixing to make sure that it does not fall out. A brown floc will form in the bottle before and during the mixing. If there was no dissolved oxygen in the sample, the floc will be white. When the bottle is set down the floc will settle, leaving a clear liquid above it.
5. Allow the floc to settle between a half and two-thirds of the way down the bottle, then mix again as in step 4 (above). Allow to settle once more, until all of the floc is in the lower third of the bottle.
6. Remove the stopper, add 1ml of H_2SO_4 without splashing, replace the stopper and mix the contents of the bottle by inverting it several times. The floc will disappear and the liquid in the bottle will be a yellowish-brown colour. If there was no dissolved oxygen in the sample the liquid will be colourless.
7. Transfer a volume, V_t , corresponding to 200ml of the original sample to the flask. A djustment should be made to compensate for the amount by

which the sample was diluted when 1ml of MnSO_4 and 1 ml of the alkaline-iodide-azide solution were added.

8. Titration with sodium thiosulphate solution (0.025 mol l^{-1}), stirring the contents of the flask until the yellow-brown colour fades to a pale straw colour. Add a few drops of starch solution and a blue colour will develop. Continue titrating a drop at a time until the blue colour disappears.

Calculation

For titration of 201.3ml (200ml of sample plus 1.3ml allowance for reagents) with 0.025 mol l^{-1} sodium thiosulphate:

1ml $\text{Na}_2\text{S}_2\text{O}_3$ solution = 1 mg l^{-1} dissolved oxygen

(Batram and Ballance, 1996)

APPENDIX 3. Industrial effluent standards of Thailand (Department of Environmental Quality Promotion – Ministry of Natural Resources and Environment)

Items	Units	Standard Values	Remarks
BOD (5 days, at 20°C)	mg/l	20	Depends on physical geography or under office's consideration but not more than 60 mg/l except 1) Fishery canning Max. 100 2) Starch industry -Centrifugal Max. 60 -Sedimentation Max. 100 3) Noodle industry Max. 100 4) Tanning industry Max. 100 5) Pulp industry Max. 100 6) Frozen Food industry Max. 100 7) Industrial Estate Authorits of Thailand Standard Value :Max 1000 mg/l per day.
Chemical Oxygen Demand	mg/l	Max. 120	Notification of the Ministry of Industry NO.2, B. E.2539(1996). Depend on offfee's consideration but not more than 400 mg/l.
Chloride	mg/l	Max. 2000	Notification of Industrial Estate Authorits of Thailand.
Colour and odour	-	None	
Cyanide as HCN	mg/l	Max. 0.2	
Total Dissolved solids (TDS)	mg/l	see remarks	1) Standard value: Max. 2,000 or under office's consideration but not more than 5,000 2) Notification Of The Ministry Of Industry No2,B.E.2539(1996). Standard value:Max 3,000 or under office's consideration but not more than 5,000. 3) If salinity of receiving water is higher than 2,000 mg/l, TDS in the effluent should not be higher than

			5,000 mg/l of the TDS in the receiving water.
Formaldchye	mg/l	Max. 1.0	Notification Of Industrial Estate Authorits of Thailand. Standard value: Max. 2 mg/l.
Free Chlorine	mg/l	Max. 1.0	Notification of Industrial Estate Authorits of Thailand. Standard value: Max. 5 mg/l.
Free ammonia	mg/l	Max. 5	Only Of Industrial Estate Authorits of Thailand.
Heavy Metals/Copper (Cu)	mg/l	Max. 1.0	Notification of The Ministry of Industry No 2,B.E.2539(1996). Standard Value: Max 2.0 mg/l.
Heavy metals/Arsenic (As)	mg/l	Max. 0.25	Notification of Industrial Estate Authorits of Thailand. Standard value: Max. 1 mg/l.
Heavy metals/Barium (Ba)	mg/l	Max. 1.0	
Heavy metals/Cadmium (Cd)	mg/l	Max. 0.03	1) Zinc industry max. 0.1 2) Notification Of Industrial Estate Authorits of Thailand. Standard value: Max. 1 mg/l.
Heavy metals/Chromium (Cr)	mg/l	Max. 0.5	1) Zinc industry max. 0.22 2) Notification of The Ministry of Industry No 2,B.E.2539(1996). Standard Value: Hexavlent Chromium: Max 0.25 mg/l Trivalent Chromium: Max 0.75 mgA
Heavy metals/Lead (Pb)	mg/l	Max. 0.2	Notification Of Industrial Estate Authorits of Thailand. Standard value Max. 1 mg/l.
Heavy metals/Manganese (Mn)	mg/l	Max. 5.0	1) Zinc industry Max. 0.02 2)Notification of Industrial Estate Authorits of Thailand. Standard value: Max 10 mgA.
Heavy metals/Mercury (Hg)	mg/l	Max. 0.005	Zinc Industry Max. 0.002
Heavy metals/Nickel (NI)	mg/l	Max. 0.2	1) Zinc industry Max. 0.2 2) Notification Of Industrial Estate Authorits of Thailand. Standard value: Max. 1 mg/l.

Heavy metals/Selenium (Se)	mg/l	Max. 0.2	Notification Of Industrial Estate Authorits of Thailand. Standard value: Max. 1 mg/l.
Heavy metals/Silver (Ag)	mg/l	-	Notification of Industrial Estate Authorits of Thailand. Standard value: Max. 1.0 mg/l
Heavy metals/Soluble iron	mg/l	Max. 10	Only Of Industrial Estate Authorits of Thailand.
Heavy metals/Zinc(Zn)	mg/l	Max. 5.0	Zinc industry Max. 3.0
Insecticides	mg/l	none	
Oil & Grease	mg/l	Max. 5.0	1) Refinery & Lubricant oil industry Max 15.0 2) Notification Of Industrial Estate Authorits of Thailand. Standard value: Max. 10 mg/l.
Permanganate Value	-	Max. 60	
Phenol & cresols	mg/l	Max. 1.0	
Radioactivity	Becquire/l	none	
Sulphide as H ₂ S	-	Max. 1.0	Notification Of Industrial Estate Authorits of Thailand. Standard value: Max. 5 mg/l.
Suspended solids (SS)	mg/l	see remark	1) Standard value: depents on dilution ratio of wastewater and receiving water 2) Ratio of wastewater and receiving water 1) 1/8 to 1/150 Max. 30 2) 1/151 to 1/300 Max. 60 3) 1/301 to 1/500 Max. 150 3) Notification of The Ministry Of Industry No 2,B.E.2539(1996). Standard value: Max 50 mg/l or under office's consideration but not more than 150 mg/l. 4)Notification of Industrial Estate Authorits of Thailand Standard value: Max 200 mg/l.
Synthetic detergent	mg/l	Max. 30	Only Of Industrial Estate Authorits of Thailand.
Tar	mg/l	none	Notification of Industrial Estate

			Authorits of Thailand. Standard value: Max. 10 mg/l.
Temperature	°C	Max. 40	Notification of Industrial Estate Authorits of Thailand. Standard value: Max. 45
Total Kjeldahl Nitrogen	mg/l	Max. 100	Notification of The Ministry of Industry No 2,B.E.2539(1996). Depend on office's consideration but not more than 200 mg/l.
Total ammonical Nitrogen as N	mg/l	Max. 50	Only Of Industrial Estate Authorits of Thailand.
pH	-	5-9	1) Notification of The Ministry Of Industry No 2,B.E.2539(1996). Standard value: Max. 5.5-9 2) Notification of Industrial Estate Authorits of Thailand Standard value: Max. 6-9

DOCUMENTATION

(1) Notification of the Ministry of Industry No.12, B.E. 2525 (1982) issued under the Factory Act B.E.2521 (1978), published in the Royal Government Gazette. Vol.95 Part 33, dated March 5, B.E. 2525(1982).

(2) Notification of the Ministry of Industry No. 10,B.E.2521 (1978) issued under the Factory ACT B.E. 2521 (1978), published in the Royal Government Gazette, vol. 95, Part 132, dated November 28, B.E.2521 (1978).

(3) Notification of the Harbour Department No.214/2525(1982)

(4) Notification of the Ministry of Industry No.2 B.E. 2539(1996) issue under the Factory Act B.E. 2535(1992).

(5) Notification of Industry Estate Authorits of Thailand B.E.2530(1987)

http://www.deqp.go.th/english/greendata/env_standard/main_env_std.html

APPENDIX 4. Output from data analysis by SPSS program

Table 1 The t-test result for comparison between two methods

Independent Samples Test

	Levene's Test for Equality of Variances		t-test for Equality of Means		
	F	Sig.	t	df	Sig. (2-tailed)
Equal variances assumed	.054	.817	.069	58	.945
Equal variances not assumed			.069	57.960	.945

Table 2 Correlation of chloride with TDS and conductivity

		CHLORIDE	COND	TDS
CHLORIDE	Pearson Correlation	1.000	.982**	.982**
	Sig. (2-tailed)	.	.000	.000
	N	30	30	30
COND	Pearson Correlation	.982**	1.000	1.000**
	Sig. (2-tailed)	.000	.	.000
	N	30	30	30
TDS	Pearson Correlation	.982**	1.000**	1.000
	Sig. (2-tailed)	.000	.000	.
	N	30	30	30

** Correlation is significant at the 0.01 level (2-tailed).

Table 3 Correlation of chloride with temperature and DO

		CHLORIDE	TEMP	DO
CHLORIDE	Pearson Correlation	1.000	-.514**	.078
	Sig. (2-tailed)	.	.004	.683
	N	30	30	30
TEMP	Pearson Correlation	-.514**	1.000	.010
	Sig. (2-tailed)	.004	.	.959
	N	30	30	30
DO	Pearson Correlation	.078	.010	1.000
	Sig. (2-tailed)	.683	.959	.
	N	30	30	30

** Correlation is significant at the 0.01 level (2-tailed).

Table 4 Repeated measures analyses of variance on sampling sites and times -
Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
TIME	Sphericity	1.698E-02	3	5.661E-03	209.279	.000
	Assumed					
	Greenhous	1.698E-02	2.082	8.157E-03	209.279	.000
	e-Geisser					
	Huynh-Feldt	1.698E-02	3.000	5.661E-03	209.279	.000
	Lower-bound	1.698E-02	1.000	1.698E-02	209.279	.000
TIME * SITE	Sphericity	9.978E-03	18	5.544E-04	20.496	.000
	Assumed					
	Greenhous	9.978E-03	12.491	7.989E-04	20.496	.000
	e-Geisser					

	Huynh-Feldt	9.978E-03	18.000	5.544E-04	20.496	.000
	Lower-bound	9.978E-03	6.000	1.663E-03	20.496	.000
Error (TIME)	Sphericity	5.680E-04	21	2.705E-05		
	Assumed					
	Greenhouse-Geisser	5.680E-04	14.572	3.898E-05		
	Huynh-Feldt	5.680E-04	21.000	2.705E-05		
	Lower-bound	5.680E-04	7.000	8.114E-05		

Table 5 ANOVA analysis result and LSD test

ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2.239E-02	7	3.199E-03	4.710	.002
Within Groups	1.494E-02	22	6.793E-04		
Total	3.734E-02	29			

Multiple Comparisons

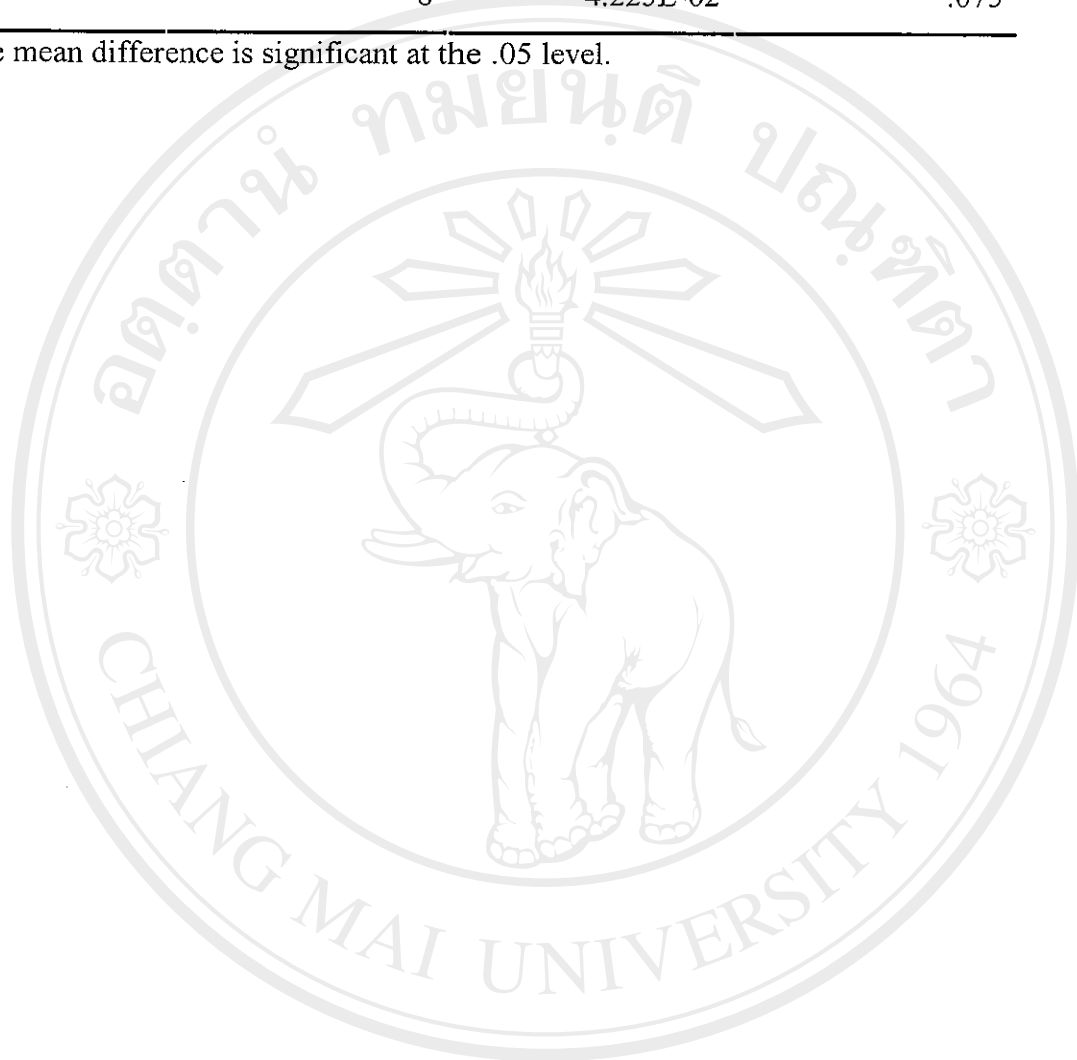
Dependent Variable: CHLORIDE

LSD

(I) SITE	(J) SITE	Mean difference (I-J)	Sig.
1	2	-8.325E-02*	.000
	3	-8.400E-02*	.000
	4	-8.575E-02*	.000
	5	-6.650E-02*	.002

6	-6.550E-02*	.002
7	-6.825E-02*	.001
8	-4.225E-02	.075

* The mean difference is significant at the .05 level.



ลิขสิทธิ์มหาวิทยาลัยเชียงใหม่
 Copyright© by Chiang Mai University
 All rights reserved

CURRICULUM VITAE

Name in full Ms. Ton Thu Giang
Date of Birth 8 May, 1977
Place of Birth Hanoi
Nationality Vietnam
Educational Background Hanoi-Amsterdam High School, (1991 – 1994)
 B.S. in Chemistry:
 Hanoi National University (1994 – 1998)
 M.S. in Environmental Science:
 Chiang Mai University (2002 – 2004)

Employment record and experience

Employer	Designation	Year of joining	Year of leaving	Nature of work
Hanoi University of Technology, Hanoi, Vietnam	Researcher	1998	Continuing	- Environmental Chemistry - Env. monitoring and pollution control
Asian Institute of Technology, Bangkok, Thailand	Research assistant	2000	2001	- Wastewater treatment

Postal address 10/73 Quan Tho I, Ton Duc Thang Street,
 Dongda District, Hanoi, Vietnam

Tel: (84) 4 511 3472/(84) 91 2268 577