

**Water Quality of a Canal Adjacent to Alternative Shrimp-
Paddy Culture Plots in Khulna, Southwest Coastal zone of
Bangladesh**



**Fisheries and Marine Resource Technology Discipline
Khulna University
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January, 2009

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Bangladesh**

BY

Examination Roll No. MS 030621

Registration No. MS 030621

**A Project Thesis Submitted to the Fisheries and Marine Resource
Technology Discipline in Partial Fulfillment of the degree of**

**Master of Science
In
Fisheries and Marine Resource Technology**



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Approved as to style and content by



Professor Dr. Khandaker Anisul Huq

Head

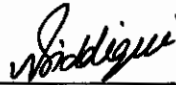
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Khulna**

January, 2009

Declaration

. The results submitted in this project are entirely the candidate's own investigations and no part of the results have been accepted for any degree, nor it is being concurrently submitted for any degree.

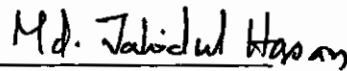
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Acknowledgement

At first, all admiration goes to supreme creator and result of the universe, God, for this great mercy to create and alive us. I am pleased and felt proud to express my deepest sense of gratitude, sincere appreciation, heartfelt indebtedness and profound respect to my honorable supervisor Md. Noman Sddique, Assistant Professor, Fisheries and Marine Resource Technology Discipline, Khulna University, Khulna for his scholastic guidance, constructive criticism and continual effective help to execute this research work successfully.

It pleases me in expressing my gratitude, appreciation and profound with regard due to solemnity to Professor Dr. Khandaker Anisul Huq, Head, Fisheries and Marine Resource Technology Discipline, Khulna University, Khulna for his constant encouragement, valuable suggestions and providences of all necessary facilities.

I wish to express my compliments to Mohammad Abdur Rouf Associate Professor, Dr. Md. Rezaul Haque Professor, Md. Sayadur Rahaman, Assistant Professor, Fisheries & Marine Resource Technology Discipline, Khulna University, Khulna to provide necessary guideline to prepare research methodology and write down the paper.

The author is very grateful to Khulna University Research Cell, Khulna for providing funds to complete the work.

Thanks to all staffs of the Chemistry Laboratory, Fisheries & Marine Resource Technology Discipline, Khulna University, Khulna for their cooperation and all divisional facilities to accomplish the work.

I would like to thank my all friends for their kind cooperation and encouragement of this work.

Author

January, 2009

ABSTRACT

A study was conducted to observe the water quality of Telegati canal, near Kathaltala, Dumuria, Khulna district, which acts as a source of inlet and outlet water for surrounding shrimp farming and agricultural activities. Three stations of the canal were selected to check and compare water parameters both at high and low tide during Shrimp culture (April to July, 2004) and Agriculture period (August to December, 2004). In Shrimp culture period, the average values of Dissolve Oxygen (DO), Biochemical Oxygen Demand (BOD), pH, Alkalinity, and Free CO₂ were 3.867 ± 0.583 mg/l, 1.352 ± 0.469 ppm, 7.5 ± 0.387 , 137.857 ± 27.367 CaCO₃ mg/l, 6.914 ± 2.177 mg/l at low tide and 4.0 ± 0.864 mg/l, 1.295 ± 0.591 ppm, 7.533 ± 0.409 , 128.809 ± 24.393 CaCO₃ mg/l, 7.752 ± 3.818 mg/l at high tide. On the other hand, in Agriculture period, the average values of DO, BOD, pH, Alkalinity and Free CO₂ were 3.867 ± 0.575 mg/l, 1.113 ± 0.464 ppm, 7.393 ± 0.409 , 134 ± 22.038 CaCO₃ mg/l, 6.013 ± 2.120 mg/l at low tide and 3.867 ± 0.609 , 1.087 ± 0.467 ppm, 7.4 ± 0.382 , 141.167 ± 21.083 CaCO₃ mg/l, 5.867 ± 2.074 mg/l at high tide. It is apparent that all the parameters were within the optimum level except DO which found less than standard and indicates a clue for pollution in the study area. Statistical analysis revealed that tidal inundation playing a significant role over the canal water quality instead of shrimp or agriculture activities particularly.



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Chapter – One



1. Introduction

Shrimp farming and agriculture especially paddy cultivation are the major land use activities, through out the southwest coastal region of Bangladesh. Since the same land is used for shrimp culture and agriculture activities in different season. With increasing the population density, demand of intensifying that land use activities are rising. Presently, Shrimp farming has become one of the Asia's fastest growing industries (Chang, 1990), among them Bangladesh is the fifth largest shrimp producer (FAO, 2002). The water bodies that are used for aquaculture are suspected in danger due to pollution. On the other hand more than 20 insecticides, 18 fungicides, 3 herbicides and 2 rodenticides are using in agriculture and public health. These are reported to be adulterated and many bear no levels of Toxaphene, DDT, Aldrin, Dieldrin, Endrin, Heptachlor, Lindane is still being employed. However it is assumed that 25% of the total amount of used pesticides may reach the coastal water and cause pollution of seawater (ESCAP, 1988). Telegati canal is also suspected to receive such fertilizers and chemicals from surrounding shrimp farms, agricultural fields and domestic uses which may pollute the canal water as well as hinder the management and conservation of the dependent aquatic resources for distance future. Rouf, 2006 and Rouf *et al.* 2007 already addressed some soil and water parameters of alternative shrimp-paddy cultivation plot and surrounding river with the focus of nutrient budget but this study, specially, focuses on the canal which acts as a primary source of inlet and outlet water for surrounding shrimp farming and agricultural activities on this area. The rate of respiration of the aquatic organisms depends on the availability of dissolved oxygen (DO), biochemical oxygen demand (BOD), and pH. They are interrelated with one another. Considering the above fact in mind, an initiative had been taken to determine the ranges of water parameters such as dissolved oxygen (DO), biochemical oxygen demand (BOD), pH, alkalinity and free carbon dioxide (CO₂)

of this canal at three locations both at high and low tide during the shrimp culture and the agriculture periods. The study also highlights the role of surrounding shrimp or agricultural activities and tidal inundation over the canal water quality.

1.1 Objectives of the study

The main objectives of the present study were -

- To determine the ranges of water parameter of the canal water through out the study period.
- To determine the role of surrounding shrimp or agricultural activities and tidal inundation over the canal water quality.

1.2 Justification of the Study

It is very often and generally stated that horizontal development of shrimp farming and modernized agricultural activities including the use of pesticides and or other chemicals are deteriorating the water quality of the surrounding rivers and canals in the coastal area of Bangladesh. The Teligati canal still acts as reservoir for different commercially important and some endangered fish species. For the last decay, the Teligati canal has extensively been used for the dumping of domestics, agricultural and mainly shrimp farm wastes. But there is no available information regarding the pollution level and acid-basic character. In this condition, present investigation was designated to work out the present level of pollution and the impact of agriculture and shrimp culture wastes in order to provide baseline information for future conservation and preservation activities in the Teligati canal near Dumuria Thana, Khulna. It is expected that the work will create public awareness regarding the existing pollution problem as well as make valuable strategic approaches in context to the traditional resource management regime.

Chapter – Two



2. Review of Literature

In Bangladesh a very few work has been done on monitoring pollution status of any canal system. There are no significant and comprehensive inventories on the discharge of organic load into the Buriganga River from the Dhaka Urban complex. The total organic wastes load discharge into the Buriganga has been established to be around 200 metric tons/day beside, the other industrial wastes. Dissolved oxygen (DO) and biochemical oxygen demand (BOD) help characterize the health of water systems and can be beneficial as indicators of pollution (Roth and Janet, 2008). The Dissolve Oxygen (DO), Biochemical oxygen demand (BOD), Chemical Oxygen Demand (COD) recorded in 1989 was reported to be 4.2ppm, 2.2ppm and 45ppm respectively (Bashar, 1989).

The total organic wastes discharge from Chittagong to the Karnaphuli river have been estimated at 120 metric tons/day, and approximately 30% of this come from industrial sources and the DO and BOD was 5.1ppm and 30ppm respectively (Khandaker, 1986). The water quality of the river Karnaphuli, Chittagong were total solid 2ppm, total dissolve solid 3ppm, transparency 00 m electrical conductivity 71 micro mhom/se; pH 8.; alkalinity 1.9ppm; hardness 133ppm; DO 4.6ppm; phosphate 0.55ppm; BOD 118ppm and COD 571mg/l (Hossain, 1992).

Balu river as like as drain receive wastes from various portion of Dhaka city and the DO, BOD, COD level of that river were 4.9ppm, 4.2ppm, 10.3ppm respectively (Bashar, 1989). Bhairab river system receive wastes from various industries and urban areas of Khulna city and the water quality parameters of this river were reported as total solid 540ppm, total dissolve solid 450ppm, pH 7.9 electrical conductivity 2150m, DO 7.7ppm and BOD 2.0ppm (Bashar, 1989).

In Bangladesh, there are about 3 thousand industries and about 1176 out of this indicated as extremely polluters, producing about 13 categories of pollutants (DOF, 1999 and IUCN, 1991). Bilgrami studied the physico-chemical parameter of Ganga River in 1983 and found turbidity at 394.5 NTU; DO at 6.60ppm; pH at 6.5; Free CO₂ at 2.34ppm; alkalinity 161.03ppm; hardness 94.82ppm. The physico-chemical quality of waste water in an Indian river of Northern Prodesh was recorded as Alkalinity 170 to 225ppm, total solid 736 to 898ppm and dissolve solid 629 to 790ppm, COD 373 to 375ppm (Das *et al.* 1990).

The water quality parameters of Kulbehar in India were reported to be conductivity 14m mhom/sec; DO 3.0ppm; pH 7.7; alkalinity 300ppm; phosphate 1.6ppm (Namboodiri and Unni, 1992). Diurnal studies were conducted by collecting surface water sample in summer 1988 by Naik and Varghes from Narmadar River. Their funding were, water pH 7.4, alkalinity 168ppm, DO 6.7ppm.

Negative relation between temperature and DO (Agarwal *et al.* 1976 and Hannan *et al.* 1978) phosphate (Singh, 1986) and negative relation with transparency, alkalinity, DO and positive relation with carbon dioxide. Nair *et al.* 1980 reported positive relationship with hardness and negative relationship with phosphate and sulphate with transparency. However, a significant negative relationship between pH and DO (Shastree *et al.* 1991), carbon dioxide, sulphate (Nair *et al.* 1980) hardness (Nair *et al.* 1980, Singh *et al.* 1986, Boyd 1985) has describe the positive correlation of hardness with temperature, transparency, alkalinity and negative correlation with turbidity, conductivity and pH.

The relation between DO and free CO₂ reported to be inversed by many workers (Ganipati, 1943, and Nair *et al.* 1980) and direct by Singh, 1986. However Ganipati, 1943, Zafar, 1964 and Nair *et al.* 1980 reported positive relationship between DO and nitrate. But Shastree *et al.* 1991 describe direct relationship between these two parameters.

River water contains BOD more than 10ppm is considered to be moderately and more than 20ppm as to be highly polluted water (Paul, 1999). The standard value of pH for industrial effluent of Environmental Quality Standards (EQS, 1991) for Bangladesh ranged between 6.0-9.0. After harvesting, heads-on shrimp are brought to depots or shrimp de-heading centers where they are de-headed, cleaned, iced and packaged for onward transportation to the freezing plants in Khulna, Satkhira and Chittagong. The shrimp-tail constitutes about 63 percent of the total body weight. During the year 1984-85, according to MPO estimates, there was a total production of 6,834 metric tons from shrimp farms in Satkhira, Khulna, Bagerhat and Cox'bazar. The total quantity of discards of heads and other wastes thus amounted to 2,528 metric tons. These discards are mostly thrown into the rivers or khals in small quantities throughout the year by de-heading centers located at different bazaars (Chowdhury, 1994 and Islam, 1993).

In Bangladesh, during 1996-1997 the amounts of fertilizer used are 1478,594 metric tons urea, 4,78,928 MT TSP and 2,00328 MT MP AND 306.165 MT others (Zinc, PS, TP). However, it is assumed that 25% of the total amount of pesticides used may reach the coastal water and cause pollution of seawater (ESCAP, 1988).

2.1 Dissolve Oxygen (DO)

The presence of DO is essential to maintain the higher forms of biochemical life in the water. Below 5.0 mg/l, aquatic life is put under stress. (SEED water project)(www.slb.com/seed). DO level in natural water body depends on the physio-chemical and biochemical activities in water body. DO concentrations are greatest at 0°C and decrease with increasing temperature (Claude, E. and Boyd, 1992). Solubility of DO is decreases with increasing salinity, each 9,000mg/l increase in salinity reduce the solubility of DO by roughly 5 of that in pure water (Claude, E. and Boyd, 1992). There exist Negative relation between temperature and DO (Agarwal *et al.* 1976 and Hannan *et al.* 1978).

Ganipati, 1943, Zafar, 1964, Nair *et al.* 1980 reported positive relationship between DO and nitrate. But Shastree *et al.* 1991 describe direct relationship between these two parameters. The relationships of DO with sulphate reported negative by Nair *et al.* 1980.

2. 2 Biochemical Oxygen Demand (BOD)

According to Mishra, 1991 oxygen demand materials are those, which require oxygen for degeneration and therefore steal oxygen, which would be utilized by animals. Generally BOD is high where organic pollution occurred seriously. There exists Positive relationship between BOD and organic pollution. River water contains BOD more than 10ppm is considered to be moderately and more than 20ppm as to be highly polluted water (Paul, 1999).

2.3 pH

pH value depends on the carbon dioxide-carbonate-bicarbonate equilibrium. pH value exceeding 9 indicates presence of sodium carbonate or sodium bicarbonate. A pH range of 6.0 to 9.0 appears to provide protection for the life of freshwater fish and bottom dwelling invertebrates (www.slb.com/seed) (SEED water project). pH and free CO₂ are inversely related. Inverse

relationship exists between pH and alkalinity observed by Zafar, 1964, Shaha and Pandit, 1986 and Nair *et al.* 1980. There are a significant negative relationship between pH and DO (Shastree *et al.* 1991).

2.4 Alkalinity

Alkalinity usually related to total hardness because the anions of alkalinity and the cations of hardness are normally derived from the solutions of carbonate minerals (Claude, E. and Boyd, 1992). Boyd, 1985 demonstrated a high positive co-relation between total alkalinity and total hardness. Total hardness may be considerably greater than total alkalinity. Inverse relationship is found between pH and alkalinity observed by Zafar, 1964, Shaha and Pandit, 1986 and Nair *et al.* 1980.

2.5 CO₂

There is a positive correlation between water temperature and hardness, sulphate (Nair *et al.* 1980). Adverse relationship between alkalinity and CO₂ has been reported Howland, 1931. The relationship between DO and free carbon dioxide reported to be inversed by many workers (Ganipati, 1943 and Nair *et al.* 1980) and directed by Singh, 1986.

Chapter – Three



3. Materials and Method

3.1 Study Area

The investigated site was Telegati canal situated at the southwestern part of Dumuria Upazilla in Khulna. The study was conducted during the shrimp culture period (April-July, 2004) and the Agriculture period (August-December, 2004). Three sampling stations (station I, II and III) were selected that located in the middle of Kulbare village, middle of thousands of shrimp farm and near Putimari bridge respectively (Fig-1) for the present study.

3.2 Experimental Design and Sampling

Water sample was taken from the representative area to analyze water quality parameters such as pH, Alkalinity, free CO₂, Dissolve oxygen (DO) and Biochemical oxygen demand (BOD) to achieve the goal. Sample was collected during in morning (8-10 hrs) and at noon (14-16 hrs) in accordance with the low tide and high tide in every sampling. All parameters were measured at sampling station except BOD, which was brought to the Water Chemistry lab of Fisheries and Marine Resource Technology Discipline of Khulna University for measurement. DO, BOD, alkalinity and free CO₂ were measured according to APHA, 1992 (Appendix-1). pH was measured with a portable pH meter (HI 98106 Hanna instrument, Portugal) (Appendix-1). Buffer solution of pH 4.0 and 7.0 was used for calibrating the pH meter. Data were analyzed by MS Excel software.

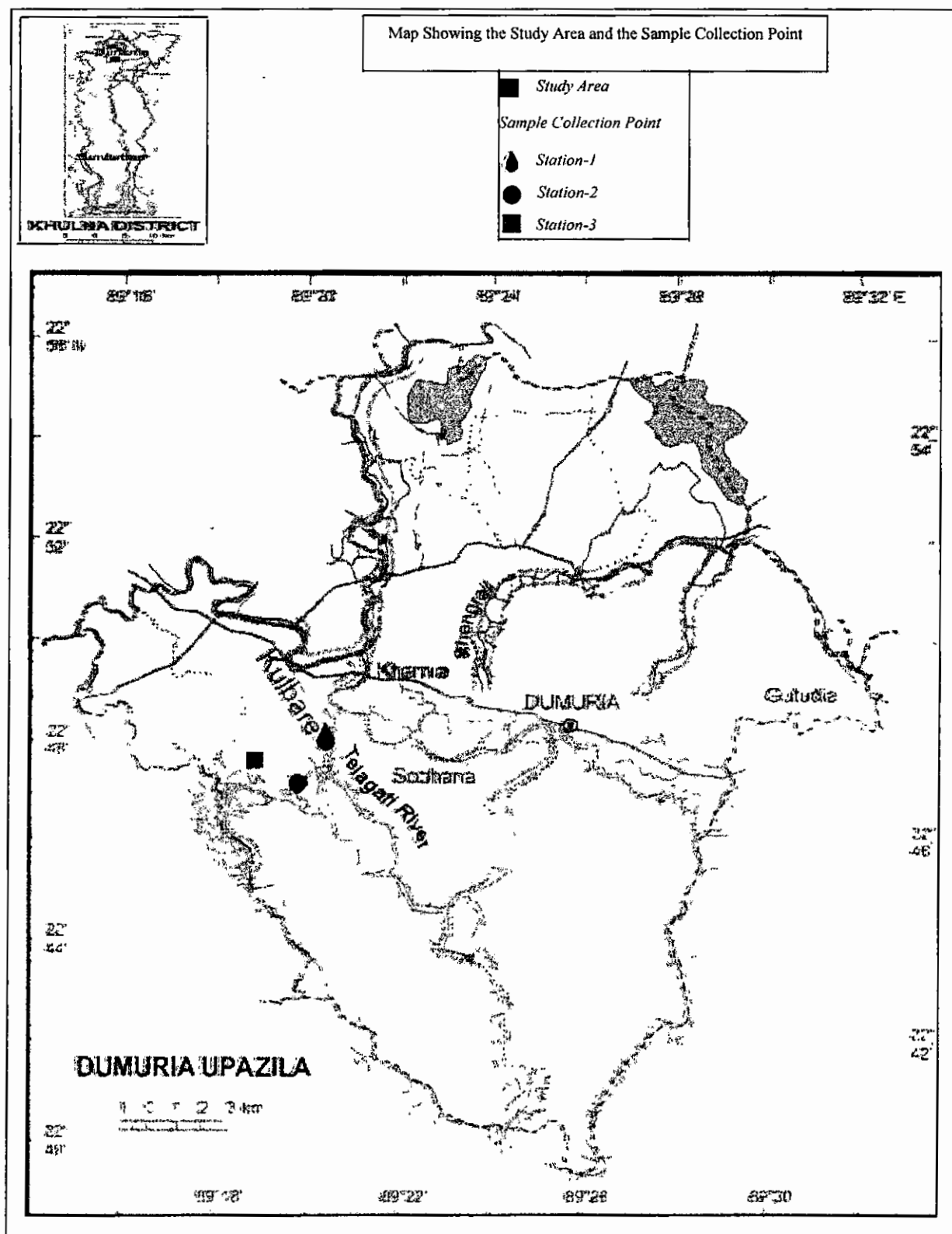


Fig-01 Study area map and the sample collection points

Chapter – Four

4. Results

4.1 Dissolve Oxygen (DO)

The mean values of DO in Shrimp culture period (SCP) and Agriculture period (AP) at high and low tide is shown in Fig.2. DO was less than the optimum range 5-7 mg/l (Wahab *et al.* 2001) both in high and low tide as well as during SCP and AP. Even the sampling stations represents less DO during SCP and AP (Fig. 3).

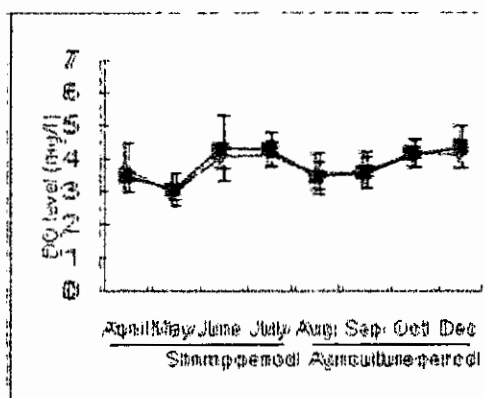


Figure-02 DO at low and high tide during shrimp and agriculture period

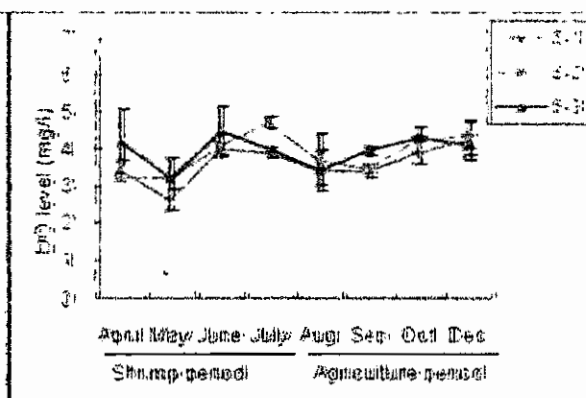


Figure-03 DO at three stations during shrimp and agriculture period

It was observed from Fig.3 that the level of dissolved oxygen was higher in June and lower in May. DO was below optimum level all the study period at all station.

Table -1: Statistical analysis for Dissolve Oxygen (DO)

ANOVA: Single Factor

Source of Variation	SS	df	MS	F	P-value	F crit
Between low and high tide	2.823483	7	0.403355	27.58134	5.42E-05	3.50046
Within low and high tide	0.116994	8	0.014624			
Total	2.940476	15				

ANOVA: Single factor

Source of Variation	SS	df	MS	F	P-value	F crit
Between shrimp and Agriculture period	3.750989	7	0.535856	2.304915	0.07899	2.657195
Within shrimp and Agriculture period	3.719741	16	0.232484			
Total	7.47073	23				

ANOVA: Single factor

Source of Variation	SS	df	MS	F	P-value	F crit
Between station-1, 2, and 3	3.842459	7	0.548923	4.562982	0.005695	2.657195
Within station-1, 2, and 3	1.924786	16	0.120299			
Total	5.767245	23				

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4.2 Biochemical Oxygen Demand (BOD)

The mean values of BOD in SCP and AP at high and low tide are shown in Fig.4. BOD was less than the moderate pollution level in high and low tide as well as during SCP and AP. Even the sampling stations represent less BOD than the moderate pollution level during SCP and AP. BOD ranged from 0.00 ppm to 2.4 ppm in SCP and 0.4 ppm to 2.0 ppm in AP respectively.

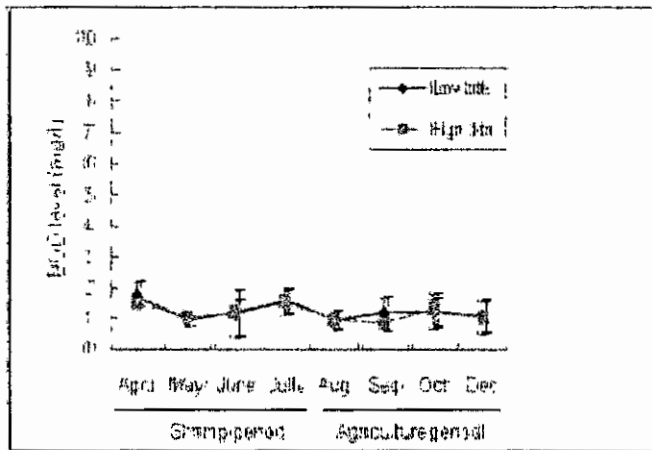


Figure-04 BOD at low and high tide during shrimp and agriculture period

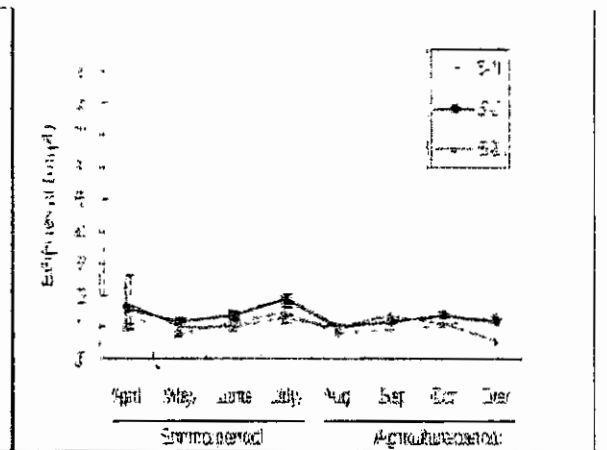


Figure-05 BOD at three stations during shrimp and agriculture period

It was observed from Fig.5 that the level of BOD was higher in July and the lower in December. BOD was below moderate pollution level all the study period at all station.

Table -2: Statistical analysis for Biochemical Oxygen Demand (BOD)

ANOVA: Single Factor

<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Between low and high tide	0.926268	7	0.132324	10.5092	0.001771	3.50046
Within low and high tide	0.10073	8	0.012591			
Total	1.026998	15				

ANOVA: Single factor

<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Between shrimp and Agriculture period	1.685226	7	0.240747	2.229975	0.087248	2.657195
Within shrimp and Agriculture period	1.727349	16	0.107959			
Total	3.412575	23				

ANOVA: Single factor

<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Between station-1, 2, and 3	0.874059	7	0.124866	1.816765	0.152706	2.657195
Within station-1, 2, and 3	1.099675	16	0.06873			
Total	1.973734	23				

4.3 pH

The mean values of pH in SCP and AP at the time of high tide and low tide is shown in Fig.6. pH was between the standard level both in high and low tide as well as during SCP and AP. Even the sampling stations represent standard pH during SCP and AP. The pH ranged from 6.1 to 8.1 in SCP and for AP it ranged from 6.5 to 8.2 (Fig. 6).

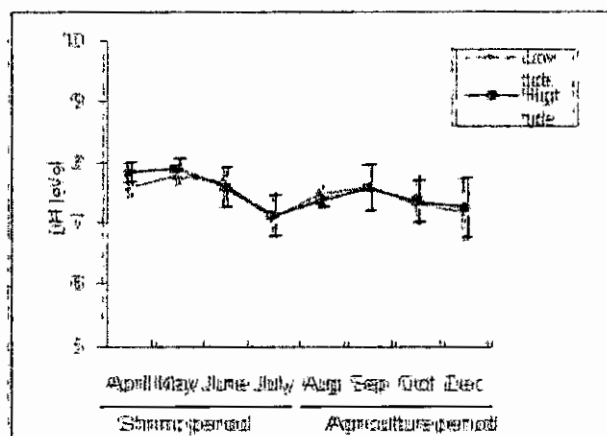


Figure-06 pH at low and high tide during shrimp and agriculture period

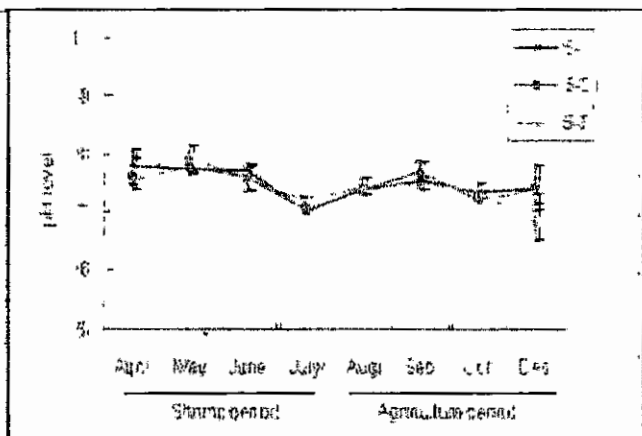


Figure-07 pH at three stations during shrimp and agriculture period

Fig.7 shows that the level of pH was higher in May and the lower in December. pH was at the standard level during all the study period except December when it was below the standard level.

Table -3: Statistical analysis for p^H

ANOVA: Single Factor

Source of Variation	SS	df	MS	F	P-value	F crit
Between low and high tide	0.916885	7	0.130984	17.76801	0.000277	3.50046
Within low and high tide	0.058975	8	0.007372			
Total	0.97586	15				

ANOVA: Single factor e

Source of Variation	SS	df	MS	F	P-value	F crit
Between shrimp and Agriculture period	1.245829	7	0.177976	14.00615	9.56E-06	2.657195
Within shrimp and Agriculture period	0.203311	16	0.012707			
Total	1.44914	23				

ANOVA: Single factor

Source of Variation	SS	df	MS	F	P-value	F crit
Between station-1, 2, and 3	1.609224	7	0.229889	3.836991	0.012297	2.657195
Within station-1, 2, and 3	0.958623	16	0.059914			
Total	2.567847	23				

4.4 Alkalinity

The mean values of alkalinity (CaCO_3) in SCP and AP at the time of high and low tide are shown in Fig.8. Alkalinity was between the standard levels both in high and low tide as well as during SCP and AP. Even the sampling stations represent standard alkalinity during SCP and AP. The Alkalinity ranged from 60 to 160 mg/l in SCP and for AP it was from 80 to 185 mg/l (Fig.8).

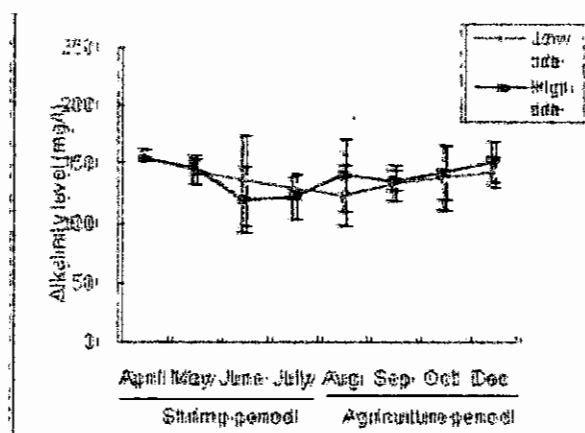


Figure-08 Alkalinity at low and high tide during shrimp and agriculture period

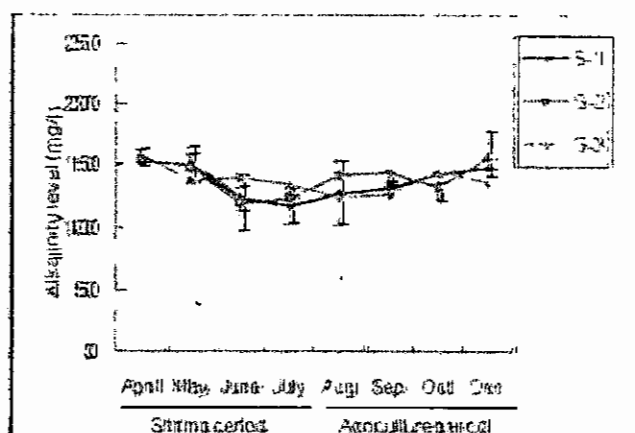


Figure-09 Alkalinity at three stations during shrimp and agriculture period

It was observed from Fig.9 that the level of alkalinity was higher in April and the lower was in July. Alkalinity was between standard levels in all the study period at all stations.

Table -4: Statistical analysis for Alkalinity

ANOVA: Single Factor

Source of Variation	SS	df	MS	F	P-value	F crit
Between low and high tide	1480.148	7	211.4497	4.520543	0.025125	3.50046
Within low and high tide	374.2024	8	46.7753			
Total	1854.351	15				

ANOVA: Single factor

Source of Variation	SS	df	MS	F	P-value	F crit
Between shrimp and Agriculture period	2217.942	7	316.8489	2.260141	0.083817	2.657195
Within shrimp and Agriculture period	2243.038	16	140.1899			
Total	4460.98	23				

ANOVA: Single factor

Source of Variation	SS	df	MS	F	P-value	F crit
Between station-1, 2, and 3	3329.389	7	475.627	3.69884	0.014347	2.657195
Within station-1, 2, and 3	2057.41	16	128.5881			
Total	5386.799	23				



4.5 Free CO₂

The mean values of free CO₂ in SCP and AP at the time of high tide and low tide is shown in Fig.10. Free CO₂ was between the standard levels both in high and low tide as well as during SCP and AP. Even the sampling stations represented standard free CO₂ during SCP and AP.

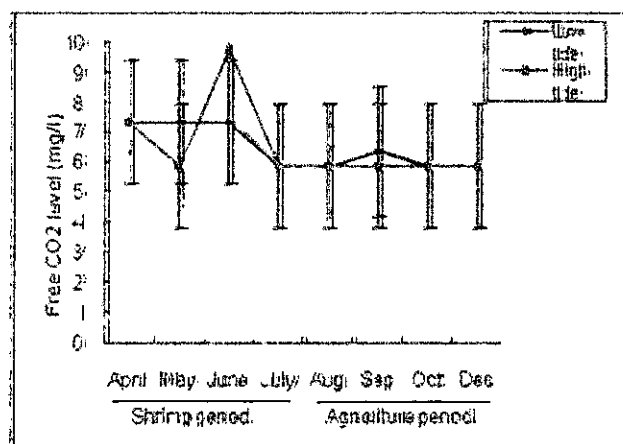


Figure-10 Free co₂ at low and high tide during shrimp and agriculture period

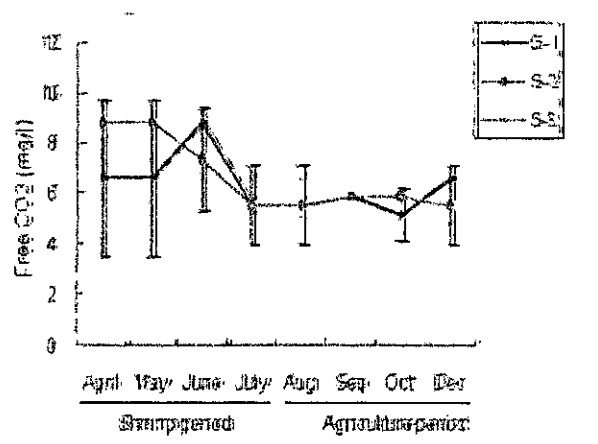


Figure-11 Free co₂ at three stations during shrimp and agriculture period

It was observed from Fig.11 that the level of free CO₂ was higher in April and the lower was in May. Free CO₂ was between standard levels in all the study period at all stations.

Table -5: Statistical analysis for Free CO₂

ANOVA: Single Factor

<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Between low and high tide	13.36416	7	1.909166	3.651153	0.04484	3.50046
Within low and high tide	4.183151	8	0.522894			
Total	17.54731	15				

ANOVA: Single factor

<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Between shrimp and Agriculture period	9.834771	7	1.404967	0.48005	0.835246	2.657195
Within shrimp and Agriculture period	46.82735	16	2.926709			
Total	56.66212	23				

ANOVA: Single factor

<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Between station-1, 2, and 3	41.49905	7	5.928436	2.083773	0.106136	2.657195
Within station-1, 2, and 3	45.52078	16	2.845049			
Total	87.01983	23				

4.6 Statistical Analysis of Observations

One-way analysis of variance (ANOVA) with 5% significance level was conducted following observed data. Two Null hypotheses were considered for each parameter. First, "There is no difference between low tide and high tide observations"; and Second, "There is no difference between agriculture and shrimp period observations". From the analysis, it is remarkable that there is no significant difference between the water quality of SCP and AP except pH, which even shows a very insignificant difference. But there is a difference between the water quality of low and high tide. The above results suggest that, tidal inundation playing a significant role over the water quality instead of shrimp or agriculture activities particularly.

Chapter – Five

5. Discussion

5.1 Dissolve Oxygen (DO)

In present study, the average DO was very less. However, the average DO of SCP (3.93 mg/l) was slightly higher than that of AP (3.87 mg/l). Average DO of high tide (3.92) was slightly higher than that of low tide (3.87) both in SCP and AP. But there was no significant ($p>0.05$) difference observed among the DO level of the AP and SCP. On the other hand there was a difference ($p>0.05$) between low and high tide. Wahab *et al.* 2001 also found less DO than optimum range 5-7 mg/l. In generally, the reason might be the factors like domestic sewages, road runoff, agriculture and shrimp wastes that might dissolve at every station. But major factor noticed during the observation was upland water with high turbidity, which flows over the surrounding river and following similar trend in the canal water with regular water exchange. Rouf, 2006 noticed around 40% of water exchange per 3 days from that canal. In most of the observation the weather was cloudy which may also responsible for that low DO. Statistical analysis of the present study also point out that the tidal inundation has significant role over the DO as there is a significant difference between the DO in high and low tide. But there is no significant difference between the DO in SCP and AP that implied that shrimp or agriculture activities have no special significant controlling over the present DO level in canal water. The highest DO in low tide ranged from 5 to 7 mg/l and high tide ranged from 6 to 8mg/l in the southeast coastal region of Bangladesh (Haque *et al.* 2003). Rahman *et al.* 2003 studied the characteristics of water quality of Sundarban Reserve Forest and found that the DO seasonally varied from 3.9 to 10.6mg/l to 8.4. Younus *et al.* 2003 studied the water quality parameters of the Surma river, Bangladesh and found that the DO seasonally varied from 2 to 4.9mg/l. The present investigation corresponded well with the findings of the above authors. Chakrabarty *et al.* 1959

stated that the lower values of DO during monsoon presumably due to greater consumption of Oxygen by organic matter and relatively lower photosynthetic activity of the phytoplankton and bottom vegetation due to increase in the turbidity and due to reduction of sunlight during the season.

5.2 Biochemical Oxygen Demand (BOD)

BOD level didn't exceed the standard (10 ppm) through out the study period as water was flowing. So there was not sufficient deposition of discharge wastages, sewerage for long time. The decrease and increase in BOD values reflect dilution of standing water with incoming floodwaters followed by worsening of pollution with time (Islam and Harun, 2001). The reason for that might be the presence of charcoal of the near by Brick station and shrimp depots in station-3. 0.00ppm BOD was observed at high tide at station-1 and 3 in June (SCP). Hossain, 1992 stated the higher values of BOD in the disposal zone were due to the consumption of oxygen for the oxidation of large amount of wastages, discharges from the municipal sewerage and surface runoff due to the rainfall. Islam, 1993 also observed the same results during his study on the physio-chemical parameters of the Karnafully River. Islam, 1993 and Uddin, 1993 reported that the BOD values were always high in the discharged area. In present study the average BOD was 1.323ppm (SCP) and 1.1ppm (AP), which indicates low organic pollution according to Paul, 1999. Statistical analysis of the present study showed that culture pattern has no significant effect on BOD as there is no significant difference between the BOD in SCP and AP but tidal action has some effect on BOD as significant difference was observed between low tide and high tide.

5.3 pH

pH level was more or less similar through out the study period following a decreasing trend with time both at low and high tide. But in most of the cases, the average pH that fall in between the optimum range 7-9 (Jung and Co. 1988). Average pH of the study period was 7.5 and 7.4 for SCP and AP. The results of average pH values indicate that the canal water body was basic through out the period except July only. There was a difference between pH observed in AP and SCP but it was very insignificant ($p=0.000009$). On the other hand, there was significant difference ($p<0.05$) between low and high tide. The water pH in Khulna City Corporation ranged between 7.2-8.5 (Nasrin *et al.* 2005) and average 7.6 both in low and high tide in the southeast coastal region of Bangladesh (Hassan, 1990; Haque *et al.* 2003; Rahman *et al.* 2003; Rouf, 2006). The present investigation agrees with the findings of the above works. Most of the cases, variations in pH usually do not occur in that kind of aquatic system due to buffering capacity of brackish water (Chakraborti *et al.* 1985).

5.4 Alkalinity

The Alkalinity level of the three stations both at low and high tides was coincided. The average value of alkalinity was 133.33 mg CaCO_3/l and 137.58 mg CaCO_3/l were found in SCP and AP respectively. The optimum level of alkalinity is 80-250 mg/l (Wahab *et al.* 2001). Through out the study period, the alkalinity level was more or less same and supports the optimum requirements of aquatic organisms. This may be due to addition of lime from shrimp culture area (Muralidhar, 1998) and alkalinity and hardness are usually high in brackish water but for tidal flow it remain more or less same. pH and alkalinity had an inverse relationship (Zafar, 1964; Shah and Pandit, 1986). In present study the pH value was nearly similar all the study period this

may be another cause of optimum alkalinity. No significant difference ($p>0.05$) in Alkalinity between AP and SCP was observed. On the other hand there was significant difference ($p<0.05$) between low and high tide was observed. Considering the average value of alkalinity, it can also be said that the canal water was basic and unpolluted.

5.5 Free CO₂

The Free CO₂ value through out the study period was widespread among the stations of every month but did not cross the optimum level. Average value of Free CO₂ was 7.33 mg/l and 5.94 mg/l for SCP and AP. There was no significance difference ($p>0.05$) of Free CO₂ between AP and SCP. On the other hand, a significant difference ($p<0.05$) was found between low and high tide. The optimum level of Free CO₂ is 5-10mg/l (Wahab *et al.* 2001). The average values of Free CO₂ both at AP and SCP, falls between the optimum ranges. This may occur because of low dissolve oxygen (Ganipati, 1943 and Nair *et al.* 1980). As canal water was turbid so light was not sufficient for photosynthesis that helped to maintain the level of CO₂ at optimum level (Muralidhar, 1998). It indicates that the canal water was basic with few exceptions.

Chapter – Six

6. Conclusion

Observation of water quality parameter is very important for survival, growth and reproduction of aquatic organism as well as for the managing the coastal zone with integrated approach. According to the present study, the values of all considered water parameters were more or less within the optimum range both at low and high tide as well as in shrimp and Agriculture period except DO. Less DO indicates that organic pollution is occurred to some extent. In addition, the present study noticed a clue i.e. river water from upland influenced the canal water instead of surrounding shrimp or agricultural activities particularly. But a more in-depth study is needed for pointing the primary source of the present threat i.e. less DO. At the same time, a collective initiative should immediately start to control the land use activities such as shrimp farming and agriculture activities for having a sustainable eco-friendly coastal zone.

Chapter – Seven

7. REFERENCES

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Chapter – Eight

APPENDIX - 1

1. Analytical Procedure

1.1 Dissolve Oxygen (DO)

Materials: Burette (25 ml), Pipette (10 ml, 25ml), Funnel, Conical flask (250 ml), Measuring flask (100 ml), Beaker (250 ml), Spatula, Burette Stand etc.

Reagents: Manganous sulfate ($\text{MnSO}_4 \cdot 4\text{H}_2\text{O}$)

KOH, KI & NaI, NaOH, NaN_3

Starch

Sodium thiosulfate

Procedure: Laboratory Preparation

- ⇒ 120 gm $\text{MnSO}_4 \cdot 4\text{H}_2\text{O}$ (or 100 g $\text{MnSO}_4 \cdot 2\text{H}_2\text{O}$ or 91 $\text{MnSO}_4 \cdot \text{H}_2\text{O}$) dissolved in distilled water and diluted to 250 ml
- ⇒ Alkali-iodide-acid reagent: For a saturated or less then saturated sample; 700 gm KOH and 150 gm KI dissolved in distilled water and diluted to 1L. Added 10 gm NaN_2 dissolved in 40 ml distilled water.
- ⇒ Starch solution: 2 gm laboratory grade soluble starch and 02 gm salicylic acid dissolved as a preservative, in 100 ml hot distilled water.
- ⇒ Standard sodium thiosulfate titrant: 6.205 gm $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$ dissolved in distilled water and added 0.4 gm NaOH and diluted to 1000 ml.

Field Work:

- ⇒ 1 ml MnSO_4 was added in the solution followed by 1 ml Alkali-iodide-acid reagent to the sample collected in a 250 to 300 ml BOD bottle.
- ⇒ Stopper carefully to exclude air bubbles and mixed by inverting bottle a few times.
- ⇒ When precipitate has settled sufficiently to leave clear supernatant above the manganese hydroxide flow, added 1.0 ml conc. H_2SO_4 .
- ⇒ Restopper and mixed by inverting several times until dissolution is completed.
- ⇒ 50 ml sample was titrated with 0.025 $\text{Na}_2\text{S}_2\text{O}_3$ solutions to pale color. Added a few drops of starch solution and continued to titration to first disappearance of blue color.

Calculation: For titration of 200 ml sample, 1 ml 0.025 M $\text{Na}_2\text{S}_2\text{O}_3 = 1 \text{ mg DO/L}$

$$\text{i.e. DO (in mg/L)} = y \times 200/x$$

Where, y = ml of the titrant

x = ml of the sample.

1.2 Biochemical Oxygen Demand (BOD)

Principle:

For determination of BOD_5 value, an aliquot of the water sample is incubated in dark at 20°C for 5 days and the DO level achieved in this sample is deducted from the initial DO value of water. This gives an estimate of the amount of oxygen required to decompose the OM in the water body during 5-day period under the specified condition.

Requisites:

Apparatus: BOD incubator.

Glassware: Conical flask, BOD bottle, all glassware's for DO estimation.

Reagents: Manganous sulfate ($\text{MnSO}_4 \cdot 4\text{H}_2\text{O}$)

KOH, KI & NaI, NaOH, NaN_3

Starch

Sodium thiosulfate

Procedure:

- ⇒ Two BOD bottles (narrow neck glass stoppered bottle of usually 250 ml volume) was filled with the sample.
- ⇒ One of these bottles was black coloured or wrapped with black paper or polythene sheet to avoid entire of light.
- ⇒ This opaque bottle was incubated in a BOD incubator at 20°C .
- ⇒ The DO of the other bottle was determined by the DO measurement method.
- ⇒ The incubated bottle was brought out from the incubator after 5 days and determined the DO of this water sample (D1).

Calculation:

$$\text{BOD}_5 \text{ (ppm)} = \text{DO (ppm)} - \text{D1 (ppm)}$$

Precaution:

- ⇒ Carefully observed the end point.
- ⇒ We should be careful to take water sample so that no air can enter into BOD bottles.

1.3 pH

Method: Electrometric method.

Principle: The basic principle of Electrometric pH measurement of the acidity of the hydrogen ions by Potentiometric measurement was using a standard hydrogen electrode and a reference electrode.

Equipment:

pH meter (HI 98106 Hanna instrument Portable, Made in Portugal)

Procedure:

pH was measured with a pH meter (HI 98106 Hanna instrument Portable, Made in Portugal) according to the instrumental manual. The calibration was performed at pH 4.0 or pH 7.0 or pH 10.0 according to the different application. Accuracy was ± 0.1 pH was 0.0-14.0.

1.4 Alkalinity

Materials:

Burette (25 ml), Pipette (10 ml, 25ml), Funnel, Conical flask (250 ml), Measuring flask (100 ml), Beaker (250 ml), Spatula, Burette Stand etc.

Reagents:

H₂SO₄, Na₂CO₃, Phenolphthalein, Methyl orange indicator.

Reagent Preparation:

0.1N H₂SO₄ solution: 2.8 ml H₂SO₄ (95-98%, sp.gravity = 1.84) was taken into 1-liter volumetric flask and diluted it to 1000 ml mark of the flask.

0.1N Na₂CO₃ solution: 2.65 gm Na₂CO₃ was taken into 500 ml volumetric flask and diluted it to 500 ml mark of the flask.

Phenolphthalein indicator solution: 2.5 gm Phenolphthalein dissolved into 250 ml 95% ethyl alcohol and added 250 ml of distilled water.

Methyl orange indicator solution: 500 mg methyl orange, free acid powder dissolved in distilled water and diluted to 1 L.

Procedure:

- ⇒ The burette with distilled water rinsed and then rinsed with 0.1N H₂SO₄ by pipette.
- ⇒ The burette was clamped and filled with 0.1N H₂SO₄ solution up to mark.
- ⇒ It was standardized the H₂SO₄ by Na₂CO₃ solution.
- ⇒ The sample (say 100-ml) was taken into 250 ml of conical flask and added 5 drops of the Phenolphthalein indicator solution into it.
- ⇒ If the solution became colored with step (a) if not, go directly on to step (b).
- ⇒ It was titrated with 0.1N H₂SO₄ until the color disappears. Recorded the number of ml of acid used.
- ⇒ 5 drops methyl orange indicator solution was added to the sample and titrated with 0.1N H₂SO₄ to a light pink (pH 4.5) color as required by the sample composition.

Calculation:

Alkalinity, mg CaCO₃/L = $A \times N \times 50,000 / \text{ml sample}$.

A = ml Standard acid used and N = Normality of standard acid.

1. 5 Free CO₂

Method: Titrametric method.

Materials:

Burette (25 ml), Pipette (10 ml, 25ml), Funnel, Conical flask (250 ml), Measuring flask (100 ml), Beaker (250 ml), Spatula, Burette Stand etc.

Reagents:

Phenolphthalein

N/44 (0.022N) NaOH solution or 0.05 or 0.1N NaOH solution.

Reagent Preparation:

N/44(0.022N) NaOH solution: 125 gm particulate NaOH was taken in 1000 ml volumetric flask. Dilution of the particulate by adding water after cooling added water to yet 100 ml volume.

Phenolphthalein: 2.5 gm Phenolphthalein dissolved into 250 ml 95% ethyl alcohol and added 250 ml of distilled water.

Procedure:

- ⇒ It was Taken 10 ml sample water in a conical flask.
- ⇒ 1 drop of phenolphthalein indicator was added and shaking a bit of.
- ⇒ Then it was taken $N/44$ NaOH in burette.
- ⇒ Titration was done until the light pink color appears.

Calculation

$$\text{CO}_2 \text{ mg /L} = A \times N \times 44 \times 1000 / \text{ml sample.}$$

A = Amount of NaOH

N = Normality of NaOH

Precaution:

- ⇒ Water sample should not shake.
- ⇒ The end point observed carefully.