Research Report: Municipal Wastewater Characteristics of Sylhet City in Bangladesh

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An understanding of the nature of wastewater is essential in the design and operation of collection, treatment, and disposal facilities and in the engineering management of environmental quality. Municipal wastewater of Sylhet city, divisional city of the northeastern region of Bangladesh, originates from different types of sources and then falls into the Surma River through different channels. Malni Chara, the largest channel falling into the Surma River originating from a hilly tea garden was selected for the study. In this study, physical parameters (total solids, dissolved solids, suspended solids, pH) and chemical parameters (BOD, alkalinity, DO, chlorides, nitrates, oil and grease) of wastewater were measured. Maximum value of total solids was found in the Stadium area (600mg/l). pH was found to be almost the same at every point (around 6.5). Maximum nitrates and chlorides were found in Subid Bazar (0.2 mg/L) and the Stadium area (42 mg/L) respectively. The findings of the study conclude that the quality of the wastewater of Sylhet city is medium for suspended solids, BOD 5 and chlorides, and strong for alkalinity.

Introduction

Sylhet city has been taken as our study area, which is an important divisional city located in the northeastern part of Bangladesh (Latitude: 24.85º N, Longitude: 91.80º E). Sylhet Municipality was established in 1878.The area of the town is 10.49 sq. km. It has a population of 285,308; density of population is 27,198 per sq km (Banglapedia, 2006). The city is situated beside the Surma River. The wastewater effluent from Sylhet city discharged to the Surma River is polluting the river water, as treatment facilities are not yet established in Sylhet. As the quality of wastewater is not satisfactory, problems like pollution of the Surma River and the streams, deterioration of the environment, and health sanitation have become serious. Obviously it is necessary to evaluate the wastewater discharge and disposal system in order to determine the effects of wastewater discharges on receiving water or the public sewer or on any proposed treatment process and to explore possible treatment process requirements to eliminate such

effects.

Objectives of the Study

This study essentially focuses on the greater importance of analysis and design of an effective and economic rational sewage treatment system for Sylhet city. The present sewerage problems of Sylhet city set the objective of this study to characterize the combined sewage of Sylhet city, assessing the pollution level of wastewater that is discharged into the Surma River and polluting the water.

Study Area

This study was conducted in Sylhet city. The sewerage network of Sylhet city consists of many small drains connected with some natural hilly channels called 'Chara', which fall into the Surma River. Besides these, there are some other big natural channels, which interconnect the 'Charas'. Those natural channels are known as 'Khal'. The main 'Charas' in Sylhet city are Malni Chara, Goali Chara, Jugni Chara, and Mira Chara. Among the Khals, Khal of Mira Bazar, Khal of Niorpool, Khal of Jallar Par, Monipuri-Rajbari Khal, Khal of Taltola, and Khal of Sheikhghat are important (Alam, Nath & Siddique, 2002).

The study route Malni Chara is the largest chara, which originates from Malni Chara Tea Garden and then divides into two branches. The main branch of the chara goes through a housing estate, Darga Moholla, Sylhet Stadium area, and Taltola and falls into the Surma River near Kazir Bazar. This branch of Malni Chara was selected for the study. Another branch goes through Sagar Dighir Par and the Osmani Medical College Hospital area and falls into the Surma River.

Methodology

Laboratory data are essential to design wastewater treatment facilities in urban areas. To obtain such data for Sylhet city, six sampling points on the main branch of Malni Chara have been selected according to their importance. The sampling points are situated at Kazir Bazar, Taltola, Mirja Jungle, the Stadium area, behind the Osmani Medical College Hospital, and Subid Bazar. Wastewater characterization studies were conducted to determine pH, total solids, suspended solids and dissolved solids, dissolved oxygen, alkalinity, nitrate nitrogen, chloride, oil and grease, and BOD 5 by standard method (American Public Health Association, 1985). Although the

five-day BOD has been chosen as the standard value for most wastewater analysis and for regulatory purposes, ultimate BOD is actually a better indicator of total waste strength (Davis & Cornwell, 1998). The Thomas method and the Fujimoto method (Metcalf & Eddy, 1995) were used to determine the ultimate BOD. For the Thomas method, calculation was made for (t/BOD t) (1/3) for each day. A graph was plotted with values of time; t versus (t/ BOD t) (1/3) on arithmetic graph paper and the line of best fit was drawn. Then intercept (a) and slope (b) were found to calculate k & L. For the Fujimoto method, an arithmetic plot was prepared of BOD t versus BOD t+1. The value at the intersection of the plot with a line of slope 1 was found. The intersection points of the two lines represent the ultimate BOD, denoted as BOD L. After getting the value of BOD L, the rate constant was also determined. The sampling points are shown on the map in Figure 1 and in the photographs in Figure 2.

Results and Discussion

Total solids, suspended solids, and dissolved solids vary from 300 mg/l to 600 mg/l, from 100 mg/l to 200 mg/l and from 200 mg/l to 400 mg/l respectively (Figure 3, Graph A). The high amounts of total solids were found in the wastewater of the Stadium area possibly due to high population. The range of pH was found between 6.89 and 6.24 (Figure 3, Graph B) , which is slightly acidic. The highest pH was found in the wastewater of the Stadium area and the lowest at Kazir Bazar. The amount of bicarbonate alkalinity was the highest at the Stadium area and the lowest at Kazir Bazar ranging between 68 mg/l to 262 mg/l (Figure 3, Graph C). The amount of nitrate was the highest at the Medical College and Subid Bazar (0.2 mg/l) (Figure 3, Graph D) due to direct discharge of protein, inorganic and organic chemicals and many other biological compounds from the hospital. The highest amount of chloride was found at the Stadium area (42 mg/l) (Figure 3, Graph E). The main source of chloride is human excreta especially urine and laundry detergent. The range of BOD 5 lies between 108 mg/l to 168 mg/l (Figure 3, Graph F). The average is 135 mg/l, which is very high. BOD of wastewater of different locations with respect to time is shown in Figure 4. The BOD reaction rate constant of the wastewater is found to vary from 0.087 to 0.20187 by the Fujimoto method and from 0.1279 to 0.1918 by the Thomas method (Table 1). The ultimate BOD of the combined sewage is found to vary from 212.84 mg/l to 305.376 mg/l by Fujimoto method and 219.83 mg/l to 276.26 mg/l by Thomas method (Table 1). The graphical presentations for both of the methods are shown in Figure 5. Motor workshops are the major sources of oil and grease at Taltola, which is 80 mg/l (Figure 3, Graph G). Quantity of DO is the highest at Kazir Bazar where wastewater is discharged to Surma River (Figure 3, Graph H). Water is highly polluted by organic matter and more stagnant at Taltola, Mirja

Jungle and Stadium area and the amount of DO were zero at those points.

Conclusion

The quality of wastewater of Sylhet city is not uniform. The average BOD 5 of Sylhet city wastewater is about seven times greater than the effluent standard limit according to the Bangladesh Effluent Quality Standard (Department of Environment, 1997). The values of BOD reaction rate constant and the ultimate BOD may be considered satisfactory for biological treatment of the sewage. According to the Metcalf & Eddy (1995), a standard reference for wastewater treatment technology, average standard weekly concentration of suspended solids should be 45 mg/l and average standard weekly concentration of pH should be 6.0 to 9.0 before discharging into natural stream. But suspended solids were found to be more than 100 mg/l at all the sampling points beyond the standard limit indicating the deteriorating conditions of wastewater while pH of wastewater was under satisfactory condition. According to the *Bangladesh Effluent Quality Standard* (Department of Environment, 1997), o il and grease should be less than 10 mg/l before discharging into natural stream. But oil and grease in the analyzed wastewater was found to be above 10 mg/l in all the sampling spots. The analyses based on the experimental values comparing with the standard values of wastewater quality (Metcalf & Eddy, 1995) concluded that quality of wastewater of Sylhet City is medium for suspended solids, BOD 5 and chlorides, and strong for alkalinity.

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Table 1: The BOD reaction rate constant (k) and ultimate BOD (y) of wastewater of Sylhet city

Location	**Reaction rate constant, K**		**Ultimate BOD (mg/l)**	
	Thomas method	*Fujimoto method*	*Thomas method*	*Fujimoto method*
Kazir Bazar	0.187	0.20187	249.3	237.9
Taltola	0.1918	0.20117	219.83	212.84
Mirja Jungle	0.1648	0.12	276.26	300.0
Stadium area	0.19	0.16	273.03	305.376
Medical College	0.141	0.13	238.0	247.82
Subid Bazar	0.1279	0.087	236.3	305.34

Captions of the Figures

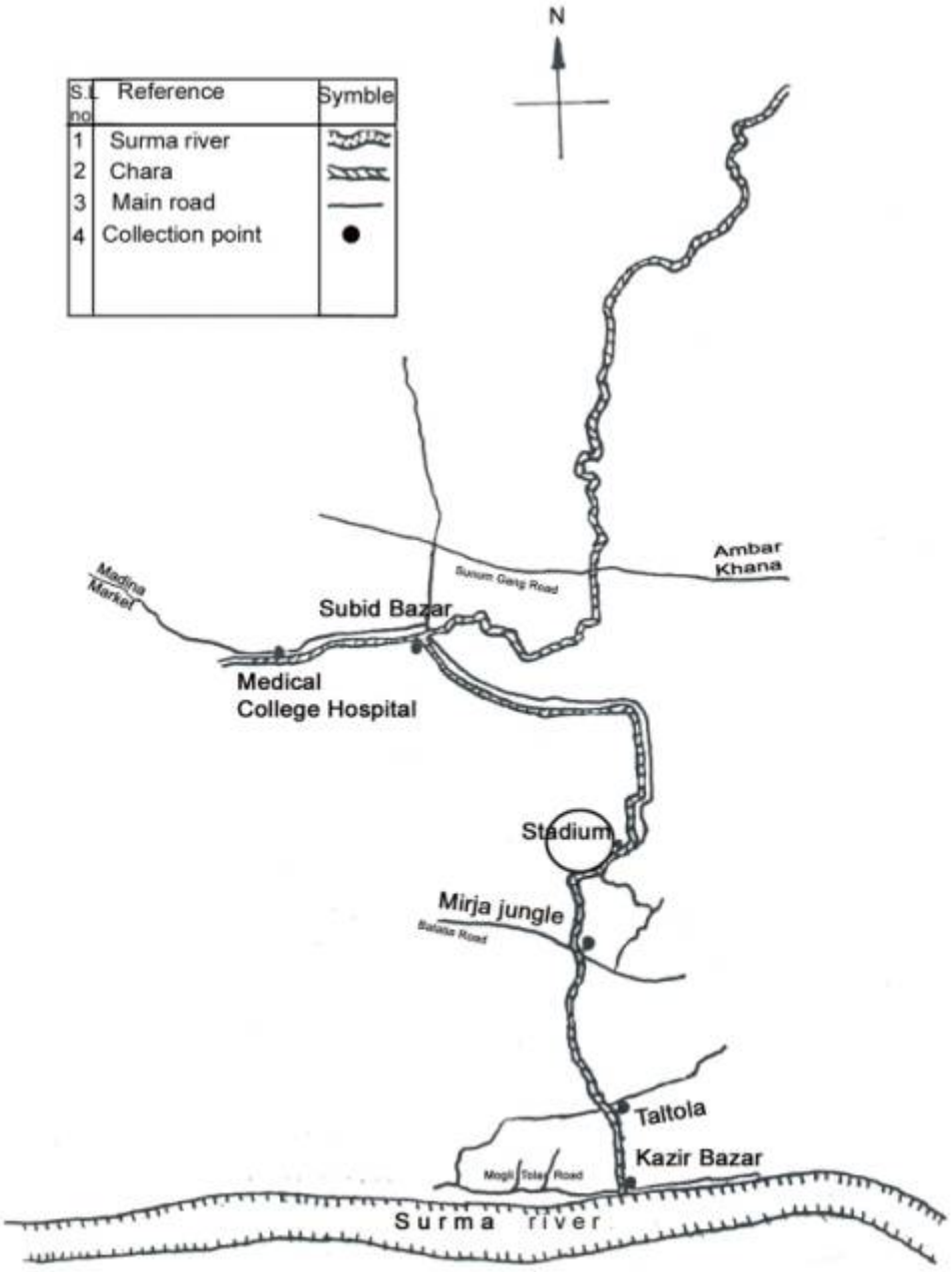
Figure 1: Sampling points on the channel selected for the study.

Figure 2: Some photographs of the sampling points.

Figure 3: Graphical representation of the test results of wastewater analyses

Figure 4: BOD of wastewater of different locations with respect to time.

Figure 5: Graph A to F represent the nature of curve of Thomas method and Graph G to L represent the nature of curve of Fujimoto method to find out the value of ultimate BOD of samples collected from different



places.

Figure 1: Sampling points on the channel selected for the study (Alam, Nath, & Siddique, 2002).

Plate 1: Sampling point in Kazir Bazar (right). Condition of the channel just before collection (left)

Plate 2: Sampling point in Taltola (below) Workshop beside the sampling point (above)

Plate 3: Sampling point in Mirza Jungle

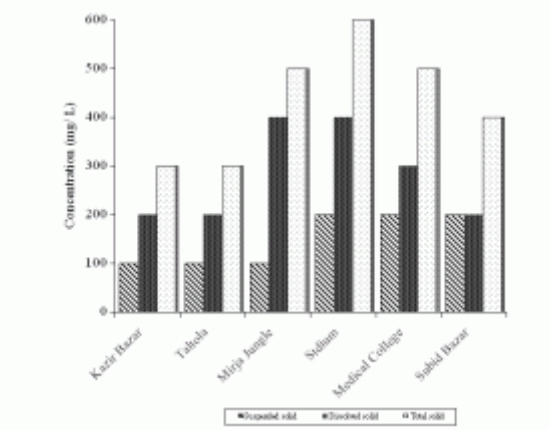
Plate 4: Sampling point in Stadium

Plate 5: Sampling point behind the Medical College (above). Condition of the

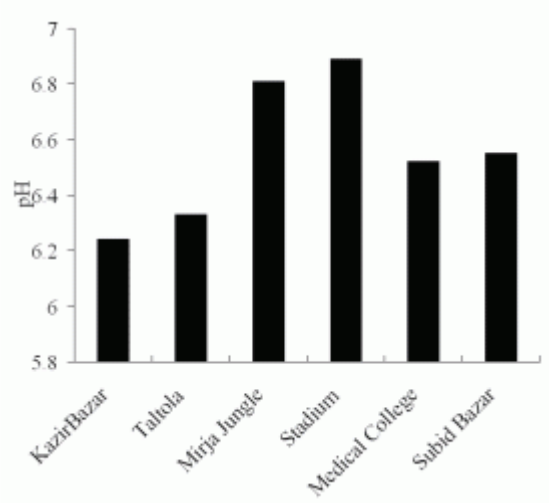
Plate 6: Sampling point in Subid Bazar

channel just before the sampling point (below).

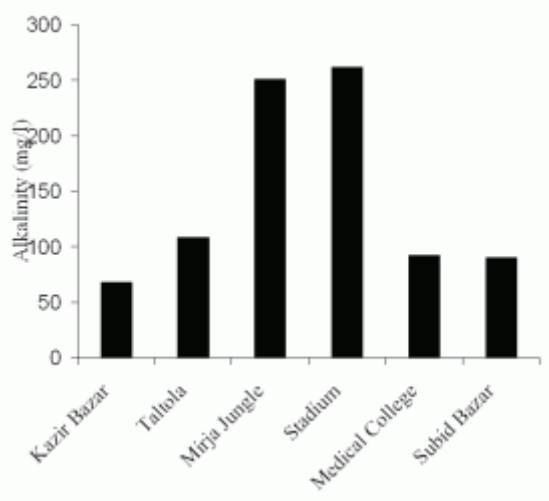
Figure 2: Some photographs of the sampling points.



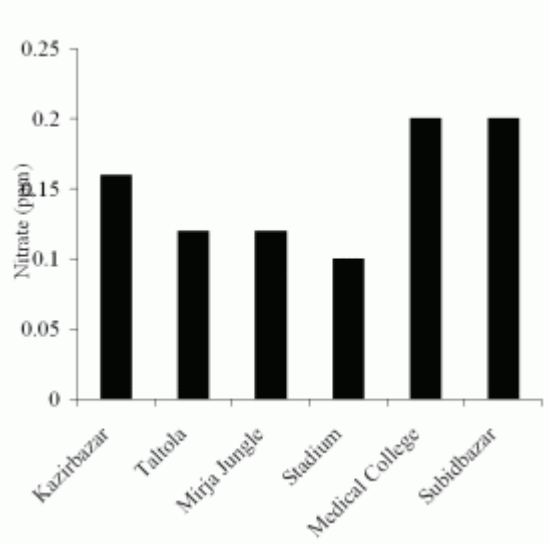
Graph A of Figure 3: Quantity of solids of waste water taken from different places



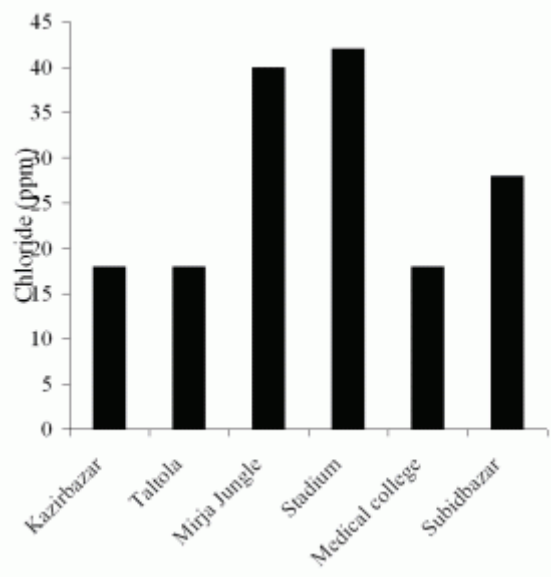
Graph B of Figure 3: pH of wastewater samples taken from different places



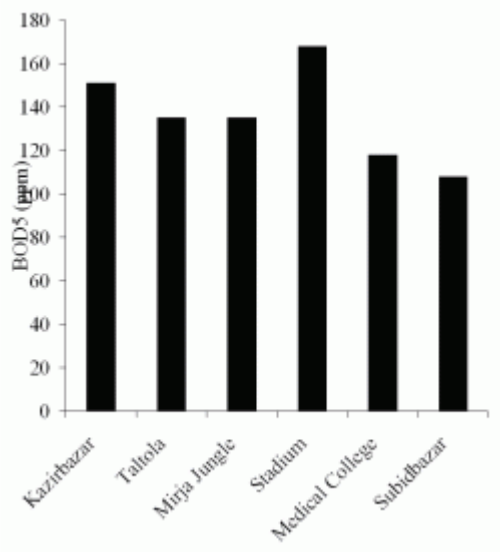
Graph C of Figure 3: Quantity of alkalinities of waste water samples taken from different places



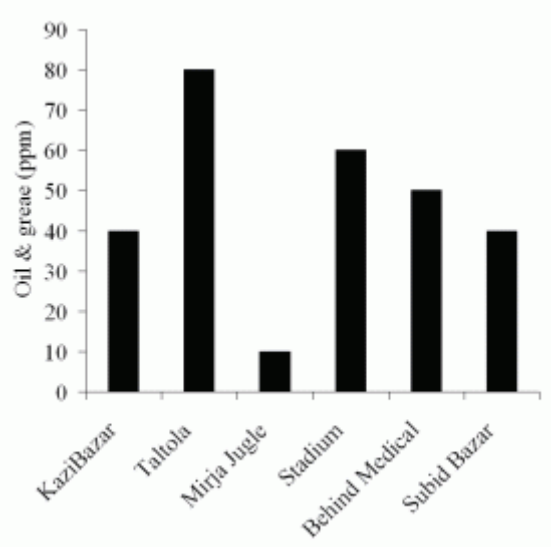
Graph D of Figure 3: Amount of nitrate of waste water samples taken from different places



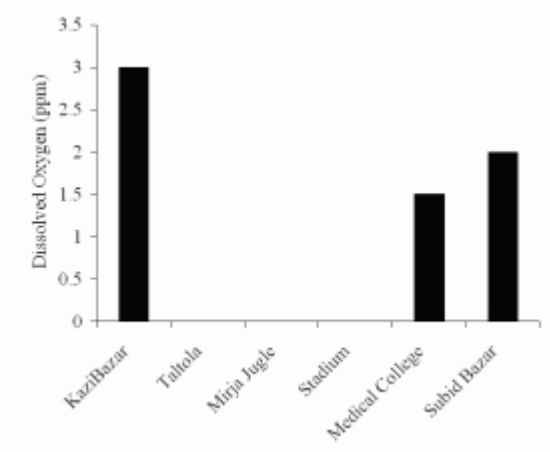
Graph E of Figure 3: Amount of chloride of waste water samples taken from different places



Graph F of Figure 3: Amount of BOD 5 of wastewater samples taken from different places



Graph G of Figure 3: Amount of Oil & Grease of waste water samples taken from different places



Graph H of Figure 3: Amount of DO of waste water samples taken from different places

Figure 3: Graphical representation of the test results of wastewater analyses

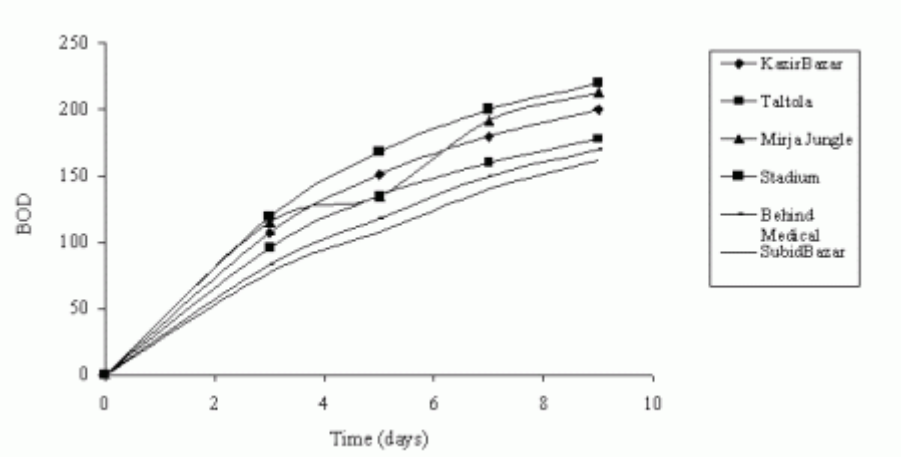
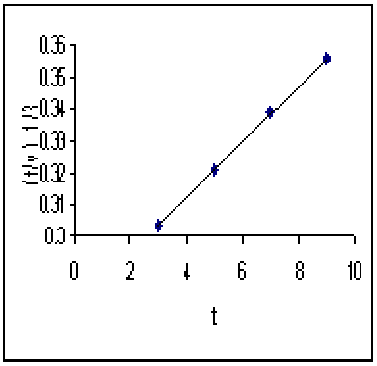
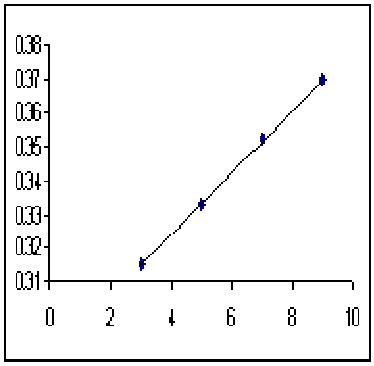


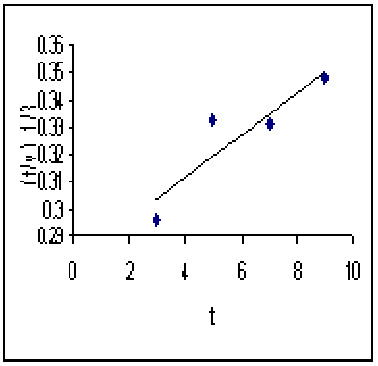
Figure 4: BOD of wastewater of different locations with respect to time.



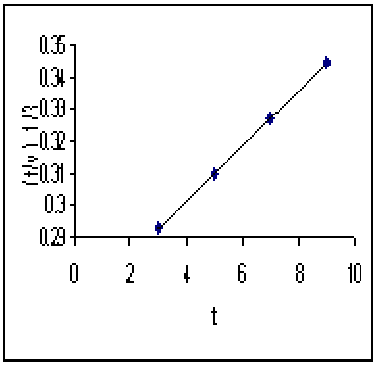
Graph A of Fig. 5: Kazir Bazar



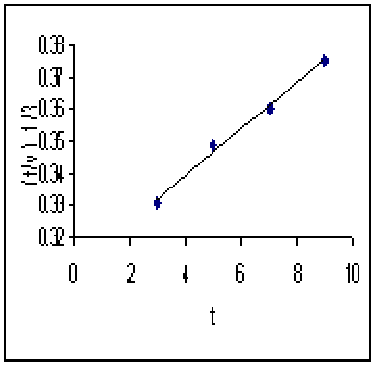
Graph B of Fig. 5: Taltola



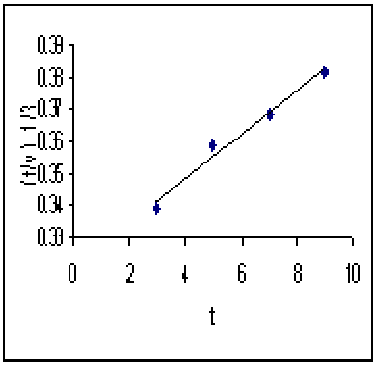
Graph C of Fig. 5: Mirja Jungle



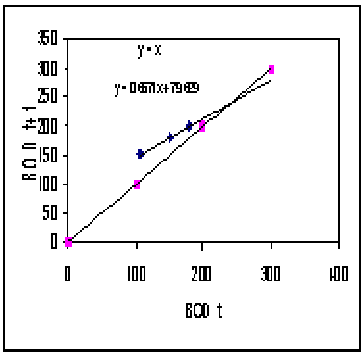
Graph D of Fig. 5: Stadium



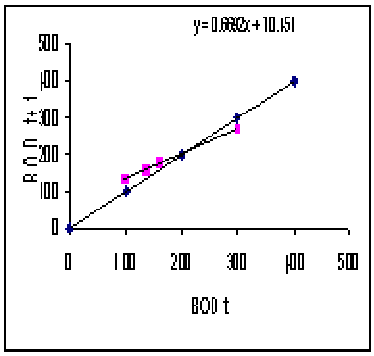
Graph E of Fig. 5: Medical College



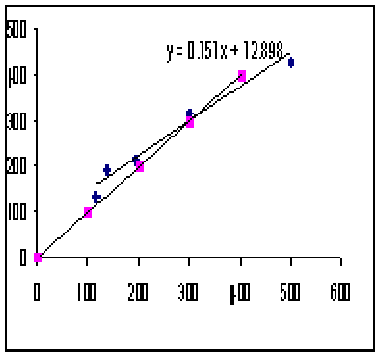
Graph F of Fig. 5: Subid Bazar



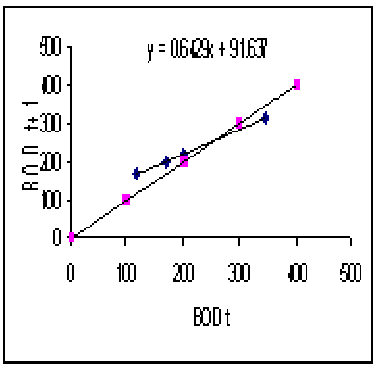
Graph G of Fig. 5: Kazir Bazar



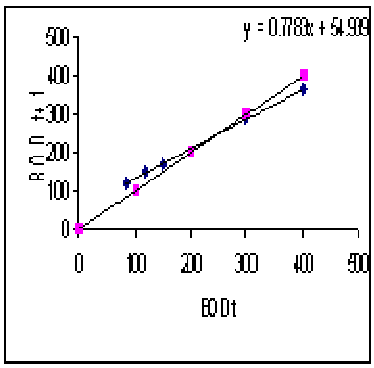
Graph H of Fig. 5: Taltola



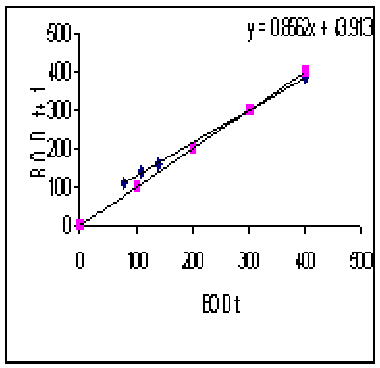
Graph I of Fig. 5: Mirja Jungle



Graph J of Fig. 5: Stadium



Graph K of Fig. 5: Medical College



Graph L of Fig. 5: Subid Bazar

Figure 5: Graphs A to F represent the nature of curve of the Thomas method and Graphs G to L represent the nature of curve of the Fujimoto method to find out the value of ultimate BOD of samples collected from different places.

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