Assessment Of Level Of Water Pollution Discharged From Hazaribagh: A Critical study

Chandan Chakraborty*, Sobur Ahmed, Md Mazaharul Huq, Fatema-Tuj-Zohra, Taslima Tabassum, Ashraf Ali Siddiqui
.

Abstract: The study was carried out on the environment pollution level of the Hazaribag discharged point. For this study water samples were collected from three different pollutant discharge sources namely Rayerbazar (near of Hazaribagh), Sicksion (near of Hazaribagh) and Kamrangirchar (near of Hazaribagh). The water quality parameters studied were temperature, dissolved oxygen, P^H, chloride, biological oxygen demand, Chemical oxygen demand etc. Air temperature in four sampling stations ranged from 18°C to 30.5°C and that of water from 19°C to 32°C. The dissolved oxygen contents in water samples fluctuated from 1.2 to 2.3 mg/1 with an average of 1.7 mg/1. The lowest value of dissolved oxygen was observed in Ryerbazararea and the second lowest value in Kamrangirchar during the lean flow period (Month of April). The P^H value in two sampling stations ranged from 7.35 ± 0.02 to 8.10+ 0.03. The BOD value fluctuated from 600 to 800= mg/1, with an average 690 mg/1 during the study period. The above parameters showed strong seasonal variations being higher during lean flow period (March and April). The canal also showed spatial fluctuations among the sampling stations. Except P^H and dissolved oxygen, concentrations of other parameters were higher, in Rayerbazr stations, particularly during lean flow period (March and April). The water quality of canal deteriorates during lean period and improves during monsoon with flow of increased flush water. Some of the water parameters clearly indicate that the river is polluted and this is much pronounced in station A, B and C. The changes in water quality, particularly during lean season, may pose threat to bio diversity. In addition, the Water quality index (WQI) for Water level sources nearly 44 representing bad water which is not acceptable for irrigation and livestock. Other parameters also found to be in satisfactory limit in most of the samples. Finally, the findings of the study may be useful to predict the surface water contamination vulnerability for various sources and take appropriate step to minimize the problem by the concern authority.

Index Terms— Tannery, Wastewater, Water quality Parameters, Dhaka, Hazaribagh, Environment, Pollution, Human Helath,

1 INTRODUCTION

The leather industry in Bangladesh is one of the industries, which causes horrendous environmental pollution. Of the 270 tanneries in the whole country 90 percent are located in Hazaribagh, a densely populated residential area of Dhaka (world bank, 1993) however by 1997 the number reached to 249 (karim, 1997) of course five are fully mechanized tanneries and are capable of processing finished leather, 33 are capable of producing crust leather, 45 are semi-mechanized and 166 are small and cottage tanneries. Forty tannery units are located in Chittagong, jessore, dhamrai and savar. The pollution caused by the tannery industry which ranks the fourth in earning foreign exchange ,cause phenomenal environmental pollution to the soil, ecology and the human body. [1]

1.1 HISTORY OF DEVELOPMENT OF HAZARIBAGH AS A TANNERY AREA

At present,the tannery industrial units in Hazaribagh spread over about 25 hectares of land .the first tannery industry was established in 1947 which was susequent followed by other industry.

- At that time, leather production with vegetable tanning (leather processed with vegetable substances) started for the local market."The first founders of the tannery factories in Hazaribagh came from India Noor bhai tannery ltd, a small size tannery in Hazaribagh which has worked with the society for environment and human development to experiment less polluting ways and means in processing leather.
- At the end of the 1960s the number of tannery factories began to shoot up in Hazaribagh .according to the ministry of industry, there were 30 tanneries in Hazaribagh in 1965,most of which were owned by the west Pakistan businessmen. After liberation in 1971, all these tanneries were nationalized under the nationalization decree of 1972. According to Bangladesh chamber of industries, the government formed Bangladesh Tanneries Corporation (BTC) with 24 tanneries in 1972. In the fact of management crisis the tanneries were brought under Bangladesh Chemical Industries Corporation (BCIC). Falling to make profit, the government returned the units to the private owners. [1]

1.3 REASONS OF POLLUTION IN HAZARIBAGH (SUBCANAL AND CANAL)

The reasons for high pollution load and oxygen sag for most length of the canal and river may be attributed to the following key point sources :

1 *Chandan Chakraborty is currently pursuing in Leather engineering in Institute of leather Engineering & Technology,University of Dhaka, Bangladesh, PH-+8801686886978. E-mail: chandanle27@gmail.com*
2 *Sobur Ahmed is currently pursuing in Assstant Professor of Leather Engineering in Institute of leather Engineering & Technology,University of Dhaka,PH-+8801714241847 E-mail: soburahmed2001@yahoo.com*
3 *Md Mazaharul Huq is currently pursuing in Leather engineering in Institute of leather Engineering & Technology,University of Dhaka, Bangladesh, PH-+8801732799579. E-mail: jewelhuq@gmail.com*
4 Fatema-Tuj-Zohra *is currently pursuing in Lecturer of Leather products Engineering in Institute of leather Engineering & Technology,University of Dhaka,Ph-+8801915226317,E-mail:fatemalpt@gmail.com*
5 *Taslima Tabassum is currently pursuing in Leather engineering in Institute of leather Engineering & Technology,University of Dhaka, Bangladesh, PH-+8801924859194. E-mail: ttabassumle@gmail.com.*
6 *Ashraf Ali Siddiqui is currently pursuing in Lecturer of Civil Engineering in World University of Bangladesh, PH- +8801682136642 E-mail: ashrafcee@ymail.com .*

1. Sources of pollution load from industries including Hazaribagh Tanneries,. (Institute of Flood Control and Drainage research, 1994)Discharge from Hazaribagh.

TABLE 1
Waste produced at different stages of leather processing

Stages	waste prduced
Soaking	blood, flesh and unused sodium chloride
Liming	hair, flesh and lime liquor
De-liming	flesh and fat
Bating	unused sodium Meta bi-sulfite, unused salts of ammonia
Pickling	unused sulfuric acid, formic acid and sodium chloride
Chrome tanning	unused chromium sulfate, sodium bi-carbonate, sodium carbonate and Sodium formate
Retaining	shaving dust
Rechroming	unused organic acid, fat, resin
Dyeing	unused dye, fixing agent, formaldehyde
Fat-liquoring	unused liquid fat and oil
Finishing	unused pigment, dye, emulsifying agent

2. Discharge through different canals passing through different Densel populated areas
3. Hanging latrines along the banks of the canal

TABLE 2
Solid waste generation in tannery

Raw trimming	8-10%
Salt	5%
Hair	0.5-3%
Liming and unhairing sludge	6%
fleshing	9%
Spilt and trimming	2-5%

[1]

1.4 POTENTIAL THREATS TO ENVIRONMENTS

Tannery industry in Hazaribagh in Dhaka is a perfect example of how industrial wastes in some instances can be dangerous and disastrous..Hazaribagh is a densely populated area in Dhaka city. Of the 249 tannery units, 90% are located on 20 hectares of land in Hazaribagh.The physical look and smell of the area is intolerable. Trimmed leather ,fleshes from cow and buffalo hides ,hair ,liquid and solid wastes generated at different stages of production are spread and piled all over Hazaribagh in large quantity of waste solid and liquid –accumulated in the low land on the west side of Hazaribagh is unthinkable. Liquid waste is pumped out on the other side of the embankment round the clock.

This liquid ultimately goes into water of the canal of the Buriganga River and causes immense harm to the fishes and other species in the water. During the monsoon people are seen taking baths and using the water from where the tannery waste being pumped into.

A huge slum has developed along the Dhaka protection embankment. The households are seen burning the dried leather waste for cooking their meals. The toxic materials in liquid wastes sip into the surrounding crop land and underground water. Eventually the tannery waste is poisoning the soil, water and air round the clock .Tannery wastes also cause harm to the health, houses and utensils of those situated around. [1]

2 LITERATURE REVIEW

- **JICA (1987)** reported the data on water quality analysis for Hazaribagh (1983-85), Chandnighat (1983-85), and Farashgonj (1985) on the Buriganga River. The BOD variation was 1-90 mg/1 However the most frequent range of BOD variation was 3-5 mg/1 to DO variation was between 0-9 mg/1.
- **Ahmed (1988**) conducted an investigation to assess the effects of effluents discharges on single parameter that represents the pollutional status of river receiving organic waste.
- **Hussain (1988)** worked on monitoring and analysis of waste sludge of urea fertilizer factory Ghorashal. He worked on the effects of the waste on the receiving river water and degree of pollution by them.
- **Mohammed (1988)** reported a comparison of sampling data of the Buriganga river water near chandnighat during the 1968-80. While average DO during 1968 was 6.7 mg/1, it came down

to 3.3 mg/1 during 1980. The average BOD value increased almost fourfoid during that period No. of coliforms also increased considerably during the some period.

- **Rashid (1998)** studied about the newsprint effluent and environmental pollution in Bangladesh palp and paper industries are regarding as one of the most polluting industries.
- **Safiullah and Mofizuddin (1988)** studied biogeochemical parameters in river wastes in the industrial belts of Bangladesh. He found gradual deterioration of the river waters due to these wastes and a result physico-chemical and biological damage is being done to the rivers.
- **SEATEC (1989)** mentioned that the PH in the range of 5-9 can be serious if the buffering capacity of their habitat is disrupted.
- **DOE (1992)** analyzed cumulative data for three parameters namely total solid, dissolved oxygen (DO) Biochemical oxygen demand (BOD) from 1984 to 1992 for the Burigangariver.

The Daily Ittefaq (1996) published a report about the pollution in Hazaribagh area mainly by the Hazaribagh tanneries. The report gave emphasis on the status of pollution caused by the tannery industries at that area severe pollution condition was observed to both air and water of that area. Noxious gases caused various respiratory troubles and lung diseases and water caused different intestinal and skin diseases. A strongfulodour prevails throughout the year at that locus. Gradual deterioration of the condition was observed.

- **The Daily Janakantha (1999)** published a report on the pollution of the Buriganga River the report gave emphasis on the status of pollution caused by the wastage of tannery industries at that area. Sever pollution condition was observed to both air and water It gave information that in some selected areas the amount of Oxygen is nearly zero. The amount of oxygen is lower than 2 ug at least 7 points at Buriganga River. The points are Mirpur bridge, Hazaribagh, Kamrangirchar, Chandnighat, Sadarghat, Farashgonj, and Dholaikhal the most severe condition was observed in chandnighat, Dholaikhal, and Pagalarea .[

- **2.1 OBJECTIVES OF THE STUDY**

The present investigation has been carried out with the following objectives:

1. To study present important water quality parameters like dissolved oxygen, P^H, free carbon dioxide, Suspended solid, chloride, chemical oxygen demand(COD), total dissolve solid, NO_3^{2-},PO_4^{3-} biological oxygen demand(BOD) etc.
2. To find out Water Quality Index (WQI).
3. To gather information on the extent of pollution of the selected zone.
4. To predict the possible impact of pollution on the biodiversity of the zone

3 THE METHODOLOGY

3.1 STUDY AREA AND PERIOD

The present study was conducted at the River Buriganga(canal) which encompasses the Southwestern periphery of the Dhaka city during the month of April.

3.2 SELECTION OF SAMPLING SITES

In order to get the representative value for the water quality parameters and to document the spatial variation in relation to pollutant discharge point, it was necessary to sample the river at various points between the Rayerbazar, Sicksion and kamrangirchar. Three sampling sites were selected

Station-A = Rayerbazar (Hazaribagh Tanneries Discharge Point Area)

Station-B = sicksion (Tanneries and Sewerage Discharge Area)

Station-C = Kamrangirchar (Hazaribagh Tanneries and sewerage Discharge Point Area)

3.3 COLLECTIONS OF WATER SAMPLES

The water samples were collected in plastic vials a form approximately 10 cm below the surface water. Caution was taken not to keep any air bubble inside the bottle. The samples were processed for immediate analysis at the sampling sites.

Station-A=Rayerbazar (Hazaribagh Tanneries Discharge Point Area

Station-B =sicksion (Tanneries and Sewerage Discharge Area)

Station-C= Kamrangirchar (Hazaribagh Tanneries and sewerage Dicharge Point Area)

3.4 SAMPLING SCHEDULE AND FREQUENCY

The canal was sampled monthly, generally during the middle of each month. All four locations were monitored on the same day within a three hours time in order to get a sanap-shot of the canal. Collection of samples were done from the selected marked areas between 9.00 AM to 12.00 PM on the sampling days, samples were collected in triplicate.

3.5 METHODS

Physical variables

The temperature of water was determined directly from the water body by dipping a centigrade thermometer into the water body. At the same time air temperature was also measured.

Chemical Variables

Chemicals used:

For Analytical Work

1. Potassium Di-chromate
2. Sulphuric Acid (Cone.)
3. Standard Potassium Permanganate
4. Ammonium Oxalate
5. ManganousSulphate Solution
6. Alkaline Potassium loaded Solution
7. 0.025 N Sodium thiosulphate
8. Starch Solution (Indicator)
9. Potassium Iodide (Solution 10)
10. Phenolpthalein (Indicator)
    a) N Silver Nitrate
11. Nitric Acid - (Concentrated)
    a) N Potassium thiocyanate
12. Ferric alum Indicator
13. Nitrobenzene
14. Pure concentrate nitric acid
15. A mixture of 230 ml Perchloric acid 60% and 70 ml pure concentrated Sulphuric acid
    a) N Sodium thiosulphate Solution
16. 0.1N ferrous ammonium sulphate solution
    a) N Solution of N- Phenylanthranilic acid (sodium Salt) in
17. Water.
    a) N Potassium ferricyanide.
18. Barium chloride solution
19. 10 ml 0.6 % $FeS0_4$ (Indicator) V
20. 20.50 ml 1% dimethyl glyoxime in ethanol (indicator)
21. Buffer 200 gm NH_4CL
22. 200 ml ammonia per litter (Sp. go. 880)

[4]

4 WATER QUALITY INDEX

The concept of water quality index is fundamental to the study of environmental engineering and water resources because they explore the relation between water requirement and the form and extend of permissible departure from purity. Nine water quality parameters were selected to include in the index. These are DO, FC, PH, BOD5, Temperature Change (∆T), PO4, NO_3^{2-}, TS and Turbidity. Based on WQI the classification of water is shown in Table 3.

TABLE 3
Classes of water in respect to WQI

WQI	Water class
0-25	Very bad
25-50	Bad
50-70	Medium
70-90	Good
90-100	Excellent

The WQI of individual parameter was calculated from WQI calculator. According to NSF water quality index equation used for the calculation-

$$WQI=0.17I_{DO}+0.16\ I_{FC}+0.11(I_{pH}+I_{BOD})+0.10(I_{\triangle T}+I_{PO4}+I_{NO3})+0.08I_T+0.07\ I_{TS}\text{-------(1)}$$

Where I is the water quality index for individual parameters from WQI calculator. [2]

5 RESULTS OBTAINED FROM THE TESTS

Results obtained from lab tests for water quality parameters are discussed briefly. Total solids, dissolved solids, and suspended solids vary from 3200 mg/l to 3900 mg/l, from 2000 mg/l to 2200mg/l and from 1200 mg/l to 1700 mg/l respectively. The highest amounts of total solids were found in location A(3900 mg/l) possibly due to Tannery industries and high population.

The range of pH was 7.4-8.6. The highest pH was found at location A and the lowest at B. Value of pH should be 6.5-8.5 for agricultural use (Ag). The study result shows that pH of almost all the samples are in nearly that range. Value of pH found in various samples is represented in Figure 1.

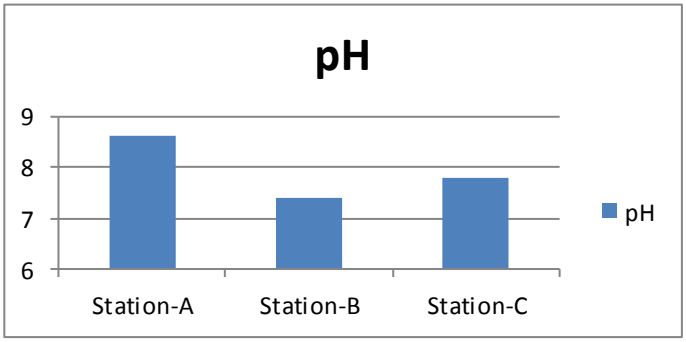

Fig: 1. Value of pH

The lowest BOD_5 was 630 mg/l and highest was 750 mg/l. The average is 690 mg/l in canal, which is very high. Highest BOD_5 limit for sewer discharging is 40 mg/l and for irrigation is 10 mg/l and for fishing is 6 mg/l or less. Quantity of DO is highest (2.2 mg/l) at B and lowest at A. Minimum DO requirement is 5 mg/l for both irrigation and fisheries. Water is not suitable for agricultural and fisheries use on the basis of DO and BOD_5. [3]

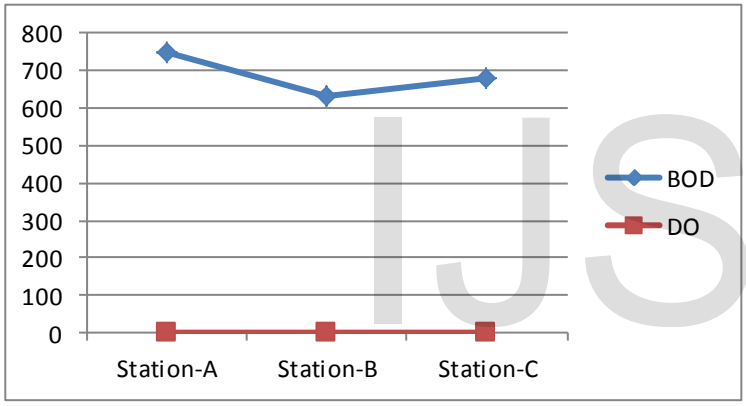

Fig 2: BOD_5 and DO of different sample.

FC should be less than 1000 N/100 ml for irrigation, fisheries and sewer discharge use. In this study average FC was found to be 1565 N/100 ml for Station-A, 1134 N/100 ml for Station-B and 1285 N/100 ml for Station-C canal respectively. Figure3: shows FC found in various sample. [3]

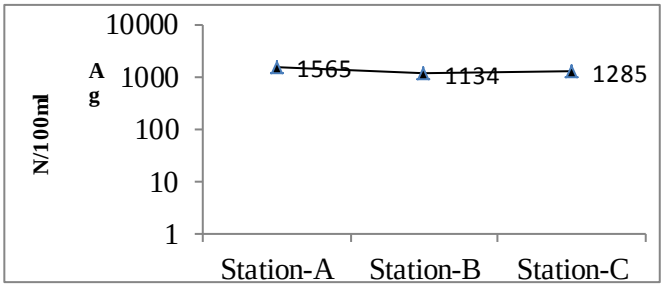

Fig 3: FC found in various sample

TABLE 4
The result of lab tests in wastewater collected from different Locations of canal

Parameters	unit	Station-A	Station-B	Station-C	Average
BOD_5	mg/l	750	630	680	690
COD	mg/l	3470	2680	3190	*3200*
Chloride	mg/l	800	600	630	680
TS	mg/l	3900	3200	3700	3600
p^H		8.6	7.4	7.8	7.9
DS	mg/l	2200	2000	2100	2100
SS	mg/l	1700	1200	1600	1500
Total chromium	mg/l	8.34	6.12	7.22	7.2
DO	mg/l	1.4	2.1	1.7	1.7
No_4^{3-}	mg/l	15	8	10	11
Po_4^{3-}	mg/l	2.01	1.79	1.82	1.88
Turbidity	NTU	26	17	21	22
Faecal coliform	mg/l	1565	1134	1285	1328
Alkalinity	mg/l	550	430	450	480

A comparison between Bangladesh water quality standard and average
value of pollutants and nutrients found in this study of some other parameters like temperature change, TS, and turbidity for use in drinking, recreational, irrigational and fisheries purposes is represented in Table 5.

TABLE 5
Concentration of water quality and Bangladesh water quality standards.

Parameter	Bangladesh water quality standard				Values of water quality		
	Drinking	Recreation	Fisheries	Irrigation	ST-A	ST-B	ST-C
DO (mg/l)	6	5 or more	5 or more	5 or more	1.4	2.1	1.7
FC (N/100ml)	0	200 or less	-	1000 or less	65	50	55
BOD_5 (mg/l)	0.2	3 or less	6or less	10 or less	750	630	680
ΔT ^0C	-	-	-	-	1.5	0.5	1
PO_4^{3-} (mg/l)	6	-	-	-	2.01	1.79	1.82
NO_3^{2-} (mg/l)	10	-	-	-	15	8	10
Turbidity(NTU)	10	-	-	-	26	17	21
TS (mg/l)	1000	-	-	-	3900	3200	3700
pH	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	8.6	7.4	7.8

Calculating NSF Water Quality Index:

TABLE 6
Water Quality Factors and Weights

Factor	Weight	Water Quality Index :
DO	0.17	
F.C	0.16	
pH	0.11	
BOD	0.10	
ΔT	0.10	
PO_4^{3-}	0.10	
NO_3^{2-}	0.10	
T	0.08	
TS	0.07	

WQI=0.17 I_{DO}+0.16 I_{FC}+0.11(I_{pH}+I_{BOD})+0.10 (Δ_T+I_{PO4}+I_{NO3})+0.08I_T+0.07 I_{TS} --------(1)

Where I is the water quality

Table 7
Process Followed for Calculation of WQI for Station -A.

Test Results For	Raw Data	WQI Value	Weighting Factor	Total
DO	1.4	3	0.17	0.51
F.C	1565	20	0.16	3.2
pH	8.6	63	0.11	6.93
BOD	750	5	0.10	0.5
ΔT	1.5	87	0.10	8.7
PO_4^{3-}	2.01	27	0.10	2.7
NO_3^{2-}	15	43	0.10	4.3
T	26	56	0.08	4.48
TS	3900	20	0.07	1.4
Over All WQI Value=				32.72

Table 8
Process Followed for Calculation of WQI for Station-B

Test Results For	Raw Data	WQI Value	Weighting Factor	Total
DO	2.1	3	0.17	0.51
F.C	1134	21	0.16	3.36
pH	7.4	93	0.11	10.23
BOD	630	5	0.10	0.5
ΔT	1	89	0.10	8.9
PO_4^{3-}	1.79	29	0.10	2.9
NO_3^{2-}	8	56	0.10	5.6
T	17	65	0.08	5.2
TS	3200	20	0.07	1.4
Over All WQI Value=				38.6

Table 9
Process Followed for Calculation of WQI for Station-C

Test Results For	Raw Data	WQI Value	Weighting Factor	Total
DO	1.7	3	0.17	0.51
F.C	1285	21	0.16	3.6
pH	7.8	90	0.11	9.9
BOD	680	5	0.10	0.5
ΔT	1	89	0.10	8.9
PO_4^{3-}	1.8	28	0.10	2.8
NO_3^{2-}	10	51	0.10	5.1
T	21	60	0.08	4.8
TS	3700	20	0.07	1.4
Over All WQI Value=				37.51

5.2 WQI AND FINDING

Putting water quality index of all individual parameters and NSF water quality equation (1), WQI of the Main water station level were calculated. WQI are found to be 32.72, 38.6 and 37.51.For Station A, B and C respectively.

This result lies in the range 25-50 which is bad (polluted) and).This is not satisfactory level for livestock and fishery. The effluent is also not allowed for irrigation, fisheries and live-stock purpose.

6 CONCLUSION

The present study was carried out on the environment pollution level of the Hazaribagh. During this study, various physico-chemical parameters of water and their seasonal fluctuations were observed with a view to Water Quality Index and spatial variations in the water quality parameters.

The following conclusions may be drawn from he results of the present study:

i) The water quality of the canal deteriorates during lean flow period (December toApril)

ii) The increased hardness, chloride levels in water indicate the presence ofchemicals in water added from industries, factories etc.

iii) The higher BOD values indicates higher organic load that probably came along withsewerage water,

iv) Discharges from Rayerbazar and Kamrangirchar are the main sources of pollutants because most of the indicators physico-chemical parameters, e.g. DO, CO_2, hardness, and BOD showed waste results in those stations in comparison to other stations.

v) The water quality of the Hazaribag is not within the acceptable limit for the Survival of fish or other organisms.

Hence, the polluted water may have adverse impact on the biodiversity in the canal and river.

7 RECOMMENDATIONS

The results of the present study demand the accomplishment of the following recommendations:

1. Establishment of Central Effluent Treatment Plant (CETP) for treating the waste water.
2. Less amount of chromium should be used in tanning process
3. Using of chemicals within acceptable limits according to the regulation provided by the Department of Environment (DOE)
4. Effective Environmental Management Plan (EMP) should be introduced for minimize the pollution.
5. Several researches should be continued to replace the chrome tanned leather.
6. Recovery, recycle and reuse the chromium.
7. Considering the socioeconomic aspect of Bangladesh low cost coagulant such as alum, lime and ferric chloride can be chosen for the treatment of tannery effluents.

REFERENCES

[1] Publication:EnvironmentalConcerns regarding *Hazaribagh*/ResearchGate

[2] http://www.water-research.net/watrqualindex.

[3] http://www.emecs.or.jp/01cd-rom/section_3_e/sec3_a_ro_b_6_e.html

[4] Reference of the Experimental Procedure-

4.1. For total solid followed method is SLC- 114

4.2. For COD followed method is DIN-38 40^{o}

4.3. For BOD_5 followed method is OXITOP measuring system.

4.4. For pH, followed method is SLC-120.

4.5. For Sulphide content followed method is SLC-101.

4.6. For chloride content followed method is SLC- 316.

4.7. For chloride oxide determination from used liquors followed method is SLC-208