Annals. Food Science and Technology
2013

ADVANCED BIOLOGICAL PROCESS FOR WASTEWATER TREATMENT

Mortuza Ahmmed[1*] and Shahidullah Miah[2]
[1]* Lecturer, Department of Statistics, International University of Business, Agriculture and Technology (IUBAT), Sector 10, Uttara Model Town, Dhaka 1230, Bangladesh
[2] Director and Coordinator, College of Agricultural Sciences, International University of Business, Agriculture and Technology (IUBAT), Sector 10, Uttara Model Town, Dhaka 1230, Bangladesh
E-mail: mortuza@iubat.edu

Abstract
Bangladesh is heavily involved in textile production and export. A lot of textile mills were established in the country mostly in and around Dhaka city in last two decades. A large number of these mills generate and discharge waste waters. It was reported by the various organization and monitoring authority that the pollution of the rivers and canals in and around Dhaka is well above their acceptable level. Most of the textile industry discharges the polluted textile wastewater directly into the waterways as the cost of treatment process is high. To minimize the cost, an effective and advanced treatment process has been setup at Mascom Composite Textile Ltd and Dalas Fashion Ltd. at Gazipur, Dhaka. The treatment process consists of a combined process (anaerobic and bio-filtration process) which is mentioned as High Rate Biological Treatment (HRBT) process. This biological treatment process is successfully operating without chemical process. The raw textile wastewater is highly polluted with high level of alkalinity in nature. The pollution parameters were removed successfully with standard quality by using the HRBT process. The ETP treatment capacity was 50,000 Liter/hour. Case study on chemical ETP process has revealed that taka 89.84 lac is required for chemical ETP against taka 17.84 lac for HRBT ETP process. Thus HRBT ETP process has been proved to be highly economical than the Chemical ETP process.

Keywords: Up-flow Anaerobic Sludge Blanket (UASB), High Rate Biological Treatment (HRBT), Hydraulic Retention Time (HRT), Down-flow Hanging Bio-filtration (DHB), Effluent Treatment Plant (ETP).

Submitted: 23.04.2013 Reviewed: 03.06.2013 Accepted: 05.07.2013

1. INTRODUCTION

Most of urban areas in Bangladesh are facing severe long-term aquatic environmental pollution primarily caused by direct discharge of liquid of Textile wastewater in the waterways. High organic loaded wastewater creates environmental pollution. As a result most particularly in the vicinity of urban areas rivers around Dhaka city are found to be severely polluted in Dhaka city. In Bangladesh, there are very few wastewater treatment facilities; mainly due to high costs of treatment. The result is severe water pollution in the Dhaka city, even more during dry season when all rivers become severely polluted. The textile wastewater contains organic compounds and synthetic chemicals. Certain chemicals which are used in the textile industry cause environmental or health problems. Due to presence of chemicals, it causes instance allergic skin reaction or even causes cancer. The major raw material for textile processing is grey fabric and most of materials consist of cotton and blended fabric. Textile processing employs a variety of chemicals depending on the nature of raw material and products such as; enzymes, detergents, dyes, acids, soda and salt. The textile wastewater is a highly polluted in terms of organic matter and suspended matter such as fibers, grease and chemicals. The textile wastewater is usually hot and alkaline with strong offensive smell and color due to use of dyes and chemicals. Some studies showed that wastewater from textile industry is highly toxic and has inhibitory effects on an activated sludge and nitrification. In the textile wastewater situated with high values of chemical oxygen demand (COD) and biological oxygen demand (BOD). Most of the developing countries did not maintain any treatment process for wastewater and some of

the countries just follow the traditional methods such as stabilizing ponds for wastewater treatment without applying the treatment process (de Sousa *et al*., 1996). Stabilizing pond takes very long time, extensive land area is required, spread a serious noxious smell and affects the air pollution, creates the potential breeding field for mosquitoes which affect seriously the public health and spreads diseases.

2. MATERIAL AND METHOD

2.1 Objectives of the study

i) To find out the treatment efficiency of the advanced biological ETP process
ii) To verify the cost effectiveness for Chemical and advanced biological ETP
iii) Find out the recommended ETP process based on economic analysis.
To minimize the pollution, a cost-effective biological treatment process has been set up at Mascom Composite textile dyeing factory, Gazipur, Dhaka and Dalas Fashion Ltd., Shofipur, Dhaka. The treatment process consists with a combined process to remove the pollution materials through biological process.

2.2 Equalization process

The raw waste from factory is collected in the equalization tank. It is needed to use a bar screen to protect any solid materials. The equalization tank is designed based on hydraulic retention time (HRT) of around 8-9 hours. Under this process air grids connection is required for mixing the wastewater to protect the solid materials in suspension.

2.3 Feeding Tank

Raw wastewater is stored in the feeding tank which is collected from the equalization tank and pH is maintained at neutral level for auto-biodegradation. The equalized wastewater is then filled into the Feeding Tank. From feeding tank wastewater is fed into the co-digester. Feeding is started by using pump under up-flow mode of action to the anaerobic reactor.

2.4 Anaerobic Process

The anaerobic process followed by Up-flow Anaerobic Sludge Blanket (UASB) process and Bio-filtration was maintained by polyurethane materials followed by down-flow process. The anaerobic process is a high quality treatment process. The anaerobic process is having some favorable opportunities such as; low cost, simple operational mechanism and able to produce less volume of excess sludge and the organic matter can be converted in to energy in the form of biogas. Therefore, anaerobic process is a beneficiary process in terms of environmental protection and the process is economically viable. In Bangladesh, the anaerobic process is completely a new technology by which it can reduce environmental pollution and can generate energy in terms of biogas from wastewater. The successful application of anaerobic technology to the treatment of textile wastewater depends on the development of high rate bioreactors which can achieve a high reaction rate per unit reactor volume by retaining the biomass in the reactor for long period of time (Solid retention time, SRT) independent of the hydraulic retention time (HRT). The Up-flow Anaerobic Sludge Blanket (UASB) process is a “high rate” anaerobic treatment process. During the earlier development of anaerobic treatment, the main drawback was the low rate of treatment process i.e., the reactor operated under the long Hydraulic Retention Time (HRT).
It has already been proved that the UASB system can be widely used in low and high temperature conditions with shorter retention time. The UASB system is a high rate treatment process. Organic loading rate is the most important for determining the shape and size of the reactor. The UASB is successfully used under mesospheric temperature ranged from 25-35°C. The basic concept of UASB is based on the fact that the flocks of anaerobic bacteria will tend to settle under gravity, when applying a moderate up-flow velocity. The

anaerobic bacteria make granule in the size of 3-7 m^2.

2.5 Bio-filtration process

The Down-flow Hanging Bio-filtration (DHB) system has been developed first-time in Japan to make the standardized effluent quality of municipal wastewater. The novel combined process of UASB and DHB system is very appropriate technology for the significant reduction of organic matter with pathogenic microorganisms from the UASB effluent. The UASB and DHB combined system has been developed by Professor Heideki Harada and his research group, Nagaoka University of Technology, Nagaoka, Japan. The author was a Post-doctoral student under his guidance and continued higher level of research.

3. RESULTS AND DISCUSSION

3.1 Characteristics of Textile wastewater

The raw textile wastewater is highly polluted with the characteristics of high alkaline in nature, (pH=9-12), suspended biomass (TSS= 1229 mg/l), Chemical Oxygen Demand (COD = 1448 mg/l), and Biological Oxygen Demand (BOD t= 550 mg/l). Textile Effluent Treatment process operates under the UASB and Bio-filtration process which have shown a good treatment process.

3.2 Increase of Dissolved Oxygen (DO) level Mechanisms under HRBP

Reduction of pollution parameters were markedly removed such as; TSS biomass (90%) through bio-filtration process. Dissolved oxygen was increased 5-6 mg/l in the final effluent from 0.0 DO level of raw effluent. In addition in the final effluent COD was removed 98%, BOD 97% and TSS 98% removed which shown highly reduction of pollution parameters which also fulfill the standard quality. Basically our advanced technology is a complete high rate biological process but another type of biological process also operating in Bangladesh which is followed by a lagoon process. The lagoon process is not a cost effective process due to requirement of huge area which is costly. A case study on chemical processes was conducted near Dhaka city. The Chemical ETP process is commonly used in Bangladesh.

Total amount taka 11.2 million for a period of 50 years as fixed costs required to install the plan. Data were calculated on the basis of straight line method. The annual cost is taka 224,000.00 only.

Considering ETP treatment capacity of 50,000 Liter/hour, in Bangladesh, the traditional process on textile wastewater treatment (basically on chemical process) requires total cost taka 89.84 million per year for the chemical ETP process. On the contrary, the new high rate biological ETP requires a total cost taka 17.84 million per year (Table-3 & 4). The chemical cost for chemical ETP is required taka 60.0 million (66.79%) and under the HRBT biological ETP the lump sum chemical cost is required 6.0 million (33.63%) which is $1/10^{th}$ low chemical cost. The 50,000 Liter /hour flow rate capacity Biological ETP, it is more economical than the chemical ETP process. The operational cost of HRBT ETP is much lower than the chemical ETP process. The advanced biological ETP process is successfully operating without using any chemicals. It is more economical than the chemical alternate process.

Table 1: Textile wastewater treatment by using High Rate Biological process

Pollution Parameters	Raw textile wastewater	Treated textile	DOE Standard in Bangladesh
pH	9-12	7.5	6-9
Dissolved Oxygen (DO) mg/L	0.0	6.4	4.4-8.0
Total Suspended Solids (TSS) mg/L	1229	38	150
Total dissolved Solids (TDS) mg/L	3500	1320	2100
Biological Oxygen Demand (BOD) mg/L	550	20	50
Chemical Oxygen Demand (COD) mg/L	1448	56	200

Table 2: The Capital Cost of Chemical ETP (with capacity: 50,000 L/Hour)

Cost item	Amount (Taka)	% of total amount
Design and supervision for construction	2,00,000.00	1.78
Civil Construction	80,00,000.00	71.43
Electro-mechanical	30,00,000.00	26.79
Total capital cost	112,00,000.00	100

Table 3: Total Cost for Chemical ETP (with capacity: 50,000 L/Hour)

Cost item	Amount/year (taka)	% of total cost
Capital cost (Depreciation cost)	2,24,000.00	2.50
Operational Cost		
a). Electricity for Blower and pump	24,00,000.00	26.70
b). Chemical used for treatment	60,00,000.00	66.79
c). Labor cost	2,40,000.00	2.67
d). Others	1,20,000.00	1.34
Sub-total	87,60,000.00	97.50
Total Cost	89,84,000.00	100.00

Table 4: Total cost of new biological ETP technology (with capacity: 50000 L/Hr)

Cost item	Amount/Year (taka)	% of total cost
Capital cost (Depreciation cost)	2,24,000.00	12.56
Operational Cost		
a). Electricity for Blower and pump	6,00,000.00	33.63
b). Biological ETP maintenance cost	6,00,000.00	33.63
c). Labor cost	2,40,000.00	13.45
d). Others	1,20,000.00	6.73
Sub-total	15,60,000.00	87.44
Total Cost	17,84,000.00	100.00

Table 5: Textile Millers` opinion about chemical ETP and Biological ETP

Opinions	% of Millers Chemical ETP	Biological ETP
1.Choice of ETP	00	100
2. Cost effectiveness	95	05
3. Expanses of Input materials	90	10
4.Chemicals required	90	10
5.Environmental pollution control (By chemical)	100	00
6.Environmental pollution control (By Bacteria)	00	100

The interesting finding from the textile millers was that more than 90% millers complain against the chemical ETP process due to high costs, hazardous chemicals and impact on environment. On the other hand most of the millers opined that the environmental pollution control can be controlled 100% biologically i.e. without chemical process.

4. CONCLUSIONS

This study revealed that textile effluent treatment with biological methods is highly efficient and cost-effective as well as eco-friendly. Though there are some constraints specially, extremely high initial investment and space requirements which are major obstacles for small and medium scale factories. Government can take efforts to initialize bank loan to establish effluent treatment plants with minimum interest. Further development is essential to treat inorganic compounds by biological process.

5. REFERENCES

[1] Ciftci C & Oztiirk I (1995) Nine years of full-scale anaerobic-aerobic treatment experiences with fermentation industry effluents. Water, Sci. Technol. 32(12): 131-139.

[2] De Sousa JT & Foresti E (1996), Domestic sewage treatment in an up flow anaerobic sludge blanket-

sequencing batch reactor system, Water Sci. Technol. 33 (3): 73-84.
[3] Joseph Egli Italia srl (2007), Wastewater treatment in the textile industry, Dyeing Printing Finishing 10(2007)60-66
[4] Lettinga G & Vinken JN (1980) Feasibility of the up flow anaerobic sludge blanket (UASB) process for the treatment of low strength wastes. 35th Purdue Industrial waste Conference Proceedings 625-634.
[5] Lettinga G, Roersma R, & Grin P (1983), Anaerobic treatment of raw domestic sewage at ambient temperature using a granular bed UASB reactor, Biotech and Biogenic. 25: 1701-1723.
[6] MS. Miah, Chika Tada and Shigeki Sawayama (2004), Enhancement of Biogas production from sewage sludge with the addition of Geobacillus sp. Strain AT1 culture Journal of water Treatment Biology, 40(3): 97-104.
[7] Mohidus Samad Khan, Knapp J, Clemett A, Chadwick M, Mahbub Mahmood, Moinul Islam Sharif, Managing and Monitoring Effluent Treatment Plants, Page-3,5,7.
[8] Samiya Ahmed, Alexandra Clenett, Matthew Clark, Kelvin Tapley, Choosing an Effluent Treatment Plant, page-29,30.
[9] Sen, S. and Demirer, G.N. Anaerobic treatment of real textile wastewater with fluidized bed reactor. Water Research 37, 2003: 1868-1878.
[10] Sheng H.Lin, Ming L.Chen (1997), Treatment of textile wastewater by chemical methods for reuse. Wat. Res 31(1997)868-876.
[11] Sheng-Jie You; Dyi-Hwa Tseng; Jun-Yu Deng (2008), Using combined membrane processes for textile dyeing wastewater reclamation. Desalination 234 (2008) 426–432
[12] Tanveer Ahmed, Shafi M Tareq, Textile industries in Bangladesh-A rising environmental degradation down the drains, Bangladesh Textile Today, issue 1,January 2008
[13] Thomas E. (Tom) Schultz, Biological wastewater treatment, October 2005, page 3.