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*RESEARCH ARTICLE*

# DESIGNING AND EVALUATION OF BIOLOGICAL TREATMENT PLANT FOR TEXTILE INDUSTRIAL EFFLUENT

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**ABSTRACT**

This study focuses on the reduction of COD, BOD, TDS, TSS, cadmium, lead, arsenic, chloride, and sulphate in textile industries. Microbial presence in the wastewater can treat effectively by providing a favorable environment. Solids Retention Time (SRT) is a key functioning element that affects the AS process efficacy. The efficiency of pH, BOD, COD, TDS, TSS, cadmium, lead, arsenic, chloride, and sulphate is taken into measure. Engineering-oriented approach was adopted to treat the aforesaid parameters through the inoculation of microbes in the biological treatment process. The designed Effluent treatment plant was based on screening, equalization, neutralization, aeration/ biological reactor and biological sedimentation. Treatment proves to be more efficient by the addition of cationic and anionic polymer i.e. Coagulant and flocculant. Overall, the efficiency of the designed treatment is taken into COD, BOD, TDS, TSS, cadmium, lead, arsenic, chloride, and sulphate 86.6%, 88.59%, 63.86%, 89.25%, 94.12%, 98.36%, 50%, 33% and 41% respectively. Statistical analysis has been performed that shows Correlation is high with BOD, TDS, TSS, Cd, lead, and As except chloride. in aforesaid parameter if concentration is decreased it means COD concentration will also decreased and has directly proportional relation with each other. As a result of the designed effluent treatment plant, treated effluent is discharged that has no significant negative impacts on the environment.

**KEYWORDS**

Biological wastewater treatment plant, textile effluent, COD, BOD, heavy metals.

## 1. INTRODUCTION

Industrial wastewater pollution that has multidirectional impacts. Industrial wastewater is by-product of anthropogenic activities, often seen unfavorably because of its pollution effect and odor when dumped into the environment without appropriate management (like eutrophication of rivers, ponds and other expected water bodies) (Million et al., 2013). The research was conducted in textile industry that uses wet processing. The focus of this research was to reduce the wastewater pollution load originated from textile industry by means of biological wastewater treatment system. This research brief about wastewater treatment and its efficiency by applying different techniques for various contaminants that proved helpful in complying with the standards. The growth and existence of microbes in biological treatment plant is very crucial to treat wastewater biologically. In this process, design of wastewater treatment plant need attention to provide retention time to degrade pollutant biologically (Hussein and Scholz, 2017).

## 2. MATERIALS AND METHODS

Water is valuable resource of our sphere, unfortunately textile industries using large amount of water in different processes and contaminate the water that cause pollution. There are various methods to treat wastewater of different nature. Biological wastewater Treatment methodology pay important role to decontaminate the industrial water. Activated sludge process treat wastewater biologically and it is considered environmentally friendly process. Applied biological wastewater treatment approach is cost effective and environmentally friendly technology in textile wastewater treatment. Illustrated methodology having different step processes that made sure the accomplishment of wastewater treatment.

### 3.1 Site selection

This research work was conducted in a textile industry situated in Lahore. The biological treatment plant was designed considering the on site characteristics of the effluent released from the textile industry.

### 3.2 Design criteria

Capacity of the plant was designed at maximum discharge of effluent by estimating the wastewater flow rate and composite sampling of wastewater for 72 hours. On the basis of wastewater sampling, BOD, COD, TDS, TSS and other pollutant was considered to design ETP.

### 3.3 Water flow measurement

Flow measurement was taken for 72 hours because of fluctuation in wastewater generation from washing department of textile apparel unit. Effluent flow rate measurement was done during full fledge operational days to record the discharge and variation trend. Flow rate measurement detail are given below:

End contracted rectangular weir used to measure flow rate:

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“Q” =1.84*(L-0.2H) H1.5
“Q” flow rate (m3/sec)
“L” length of weir (m)
“H” head over weir (m)

### 3.4 Water sampling and testing

Composite sampling was also ensured to analyze the composition of wastewater of facility. The composite wastewater sampling was taken for 72 hours. Collection of sampling frequency was 1-hour. After sampling, it was taken into lab where 10 parameters were analyzed. Targeted tested parameters were following in given table:

**Table 1:** Influent lab-based test

| Parameters | Unit | Results |
|---|---|---|
| pH | ---- | 12 |
| BOD5 | mg/l | 263 |
| COD | mg/l | 368.2 |
| TDS | mg/l | 3320 |
| TSS | mg/l | 186 |
| Cd | mg/l | 0.017 |
| Pb2+ | mg/l | 0.61 |
| As | mg/l | 0.96 |
| Cl1- | mg/l | 750 |
| SO42- | mg/l | 713 |

### 3.5 Experimental Setup

Experimental setup was taken into consideration by flow rate measurement, water testing and analysis of wastewater that carried out in water testing lab. Composite sampling of wastewater was done for 72 hours.

### 3.6 Wastewater Treatment Approach

All calculation and designing are given in results and discussion. Efficiency of wastewater was also tested by applying different techniques. This efficiency analyzed on the basis of tested parameters in lab and evaluated results by statistical approach using correlation and regression approach. Wastewater treatment plant was designed based on aforesaid parameters. Design concept was taken from (Metcalf, 1979). Sedimentation by coagulation and flocculation can microplastic up to 54.8%. microplastic particles primarily originated from textile wastewater (Liu et al., 2019). In textile More than 80% can be removed by biological oxidation (Soares et al., 2017). Free ammonia effects the microbial activity and having negative impact on cell inactivation (Liu et al., 2019). Advanced oxidation processes (AOPs) can be used as an effective and alternative option for industrial wastewater treatment. This process is effective only at neutral or acidic pH (Boczkaj and Fernandes, 2017).

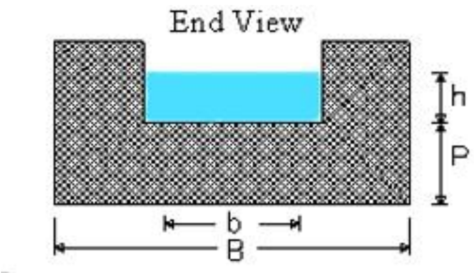


**Figure 1:** End Contracted Rectangular Weir

## 3. Results and Discussion

Effluent treatment plant was designed on 75 m3/hr and pollution load of Aforesaid parameters was given in table 1

### 3.1 Screening

Screen size was taken 30mm, particles greater than 30mm can be removed from screening. Inclination angle of screen 600 and velocity of water through screen was taken 1.2 m/s

### 3.2 Equalization tank

Design criteria for equalization tank given below:
Q (Flow rate) =75m3/hr.
Retention time: 6 hr.
Volume= Q * R. T= 450
Area=112m2
Width= 28m
Length 84m

### 3.3 Neutralization tank

The purpose of this tank was to neutralize the þH after equalization tank. mostly acid was dosed by dosing pump equipped with this tank to neutralize þH level.

### 3.4 Aeration Tank

#### *3.4.1 Calculation of aeration tank*

F:M ratio between 0.25-0.5/day was considered adequate for settling characteristics of sludge.

Food = $\frac{Q*BOD(\frac{mg}{l})}{1000}\ kg/d$

Microorganisms=$\frac{V*MLSS}{1000}\ kgMLSS$

F:M= $\frac{Q*BOD}{V*MLSS}$

V=$\frac{Q(\frac{m3}{day})xBOD(\frac{mg}{l})}{F:M*MLSS}$

#### *3.4.2 Aeration tank blower*

Designing Formula:

Food = $\frac{Q*BOD(\frac{mg}{l})}{1000}\ kg/d$

Aeration tank blower:

Standard O2 transfer Efficiency (SOTE) =20%

Clean water to effluent=0.8

Diffuser fouling=0.8

Oxygen % in atm air=23%

calculation:

O2 requirement=BOD/0.2/0.8/0.8

O2=$\frac{473}{0.2}$ =2365 kg/day

Clean water to effluent factor (0.8)

$\frac{2365}{0.8}$=2956 kg/day

Diffuser fouling factor (0.8)

$\frac{2956}{0.8} = 3695 kg/day$

Air requirement (oxygen % in the atmospheric air=21%)

$\frac{3695}{0.21} = 17595\ kg/day$

Air requirement 17595/24=733 kg/hr.

### 3.5 Biological Sedimentation Tank

Surface Over Flow (S.O.R)

= 30 m3/m2.day

Flow rate (Q)= 1800 m3/day

S.O. R=$\frac{1800}{25} = 72m2$

Diameter of sedimentation tank(D)

$=2\sqrt{72/0.785}$

= 7.5m2

Detention time 3.5hr

Volume of sedimentation tank

=245m3

Dia of circular drum 1.2m

Depth of tank=3m

**Table 2:** Designed capacity of Effluent treatment plant.

| Equalization Tank | | Aeration Tank | Sedimentation Tank |
|---|---|---|---|
| Quantity | 1pcs | 1 pc | 1 pc |
| Material | RCC | RCC | RCC |
| Ret time | 6hr | 12 hr. | 3 hr. |
| Volume | 450m3 | 1052 m3 | 245 |
| Depth | 4m | 5m | 3.5m |
| Blower Capacity | 250m3/hr. | 733 m3/hr. | |
| Diffusers | 112 | 255 | |

### 3.6 Wastewater treatment interventions

Efficiency of effluent treatment plant was analyzed by lab test before and after treatment. Based on that results, efficiency of overall designed treatment plant is examined. Results of targeted parameters before treatment are given in table 1. In this research work, the performance of the effluent treatment plant has been examined, Experimental and theoretical approaches also have been applied. The designed wastewater treatment plant found effective for textile wastewater treatment. It found very effective in COD, BOD5, TDS, TSS, Chloride, sulphate, lead, arsenic and cadmium reduction from textile industrial wastewater. From this thesis work, the effluent quality complies satisfactorily the discharge requirement with BOD5 removal of 88% and 86% of COD. This treatment is cost effective in all aspects as compared to other chemical treatment that is much expensive in operation.

"Effluent 1" Technique: Efficiency without addition of nutrient

"Effluent 2" Technique: Efficiency with addition of microbial nutrients (urea and diammonium phosphate with quantity 1:4) in aeration tank frequently three time a day.

"Effluent 3" Technique: Efficiency with the addition of microbial nutrient and coagulant dosing.

"Effluent 4" Technique: efficiency by addition of microbial nutrient, coagulant and flocculant.

**Table 3:** Final Results after all the interventions

| Sr. No. | Parameters | Unit | Results |
|---|---|---|---|
| 1 | pH | ---- | 6.9 |
| 2 | BOD5 | mg/l | 30 |
| 3 | COD | mg/l | 51 |
| 4 | TDS | mg/l | 1200 |
| 5 | TSS | mg/l | 20 |
| 6 | Cd | mg/l | 0.001 |
| 7 | Pb2+ | mg/l | 0.01 |
| 8 | As | mg/l | 0.01 |
| 9 | As | mg/l | 710 |
| 10 | SO42- | mg/l | 420 |

Graphical representation of all the interventions in provided in Figure 2.

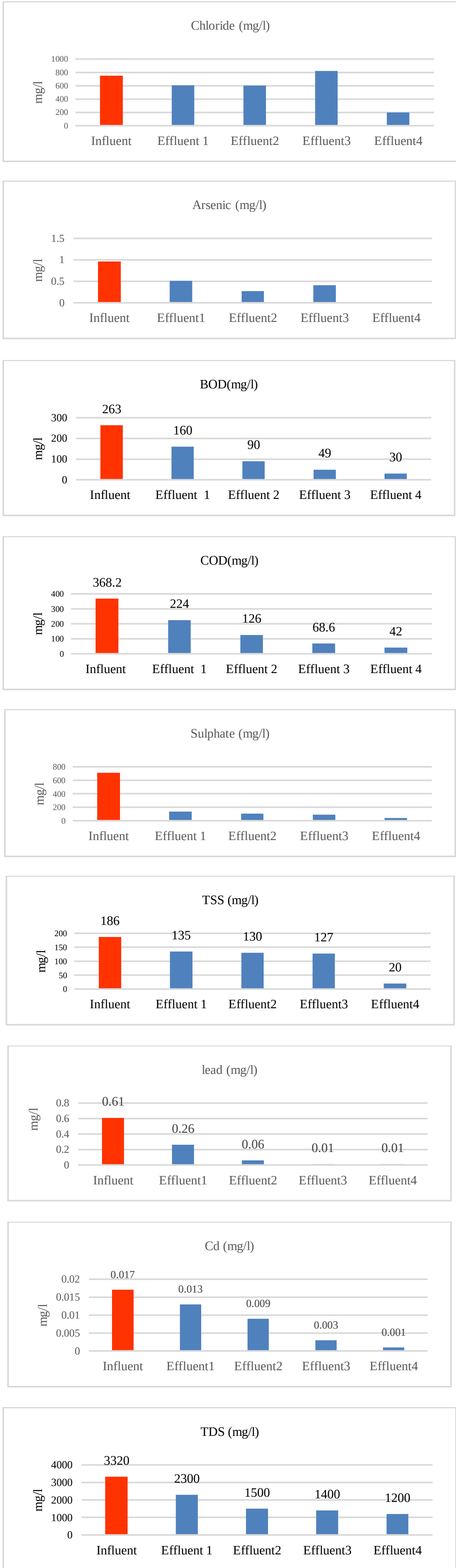


**Figure 2:** Graphical representation of interventions

### 3.7 Statistical Analysis

Correlation is high with BOD, TDS, TSS, Cd, lead, and As except chloride. in aforesaid parameter if concentration is decreased it means COD concentration will also decreased and has directly proportional relation with each other. BOD and COD have strong relation has been compared with is showing the significant correlation of COD with BOD, TDS and TSS (Iloms et al., 2020). It shows the significant relations.

**Table 4:** Correlation method in the removal of pollutants

| Parameters | pH | BOD | COD | TDS | TSS | Cd | Lead | As | Chloride | Sulphate |
|---|---|---|---|---|---|---|---|---|---|---|
| pH | 1.00 | | | | | | | | | |
| BOD | 0.61 | 1.00 | | | | | | | | |
| COD | 0.61 | 0.98 | 1.00 | | | | | | | |
| TDS | 0.55 | 0.97 | 0.96 | 1.00 | | | | | | |
| TSS | 1.00 | 0.65 | 0.64 | 0.60 | 1.00 | | | | | |
| Cd | 0.67 | 0.97 | 0.98 | 0.90 | 0.71 | 1.00 | | | | |
| Lead | 0.42 | 0.94 | 0.96 | 0.99 | 0.47 | 0.89 | 1.00 | | | |
| As | 0.89 | 0.73 | 0.74 | 0.78 | 0.90 | 0.70 | 0.66 | 1.00 | | |
| Chloride | 0.92 | 0.29 | 0.31 | 0.32 | 0.90 | 0.34 | 0.15 | 0.84 | 1.00 | |
| Sulphate | 0.88 | 0.91 | 0.91 | 0.87 | 0.91 | 0.92 | 0.79 | 0.92 | 0.68 | 1.00 |

## 4. Conclusion

In this research work, the performance of the effluent treatment plant has been examined, Experimental and theoretical approaches also have been applied. The designed wastewater treatment plant found effective for textile wastewater treatment. It found very effective in COD, BOD, TDS, TSS, Chloride, sulphate, lead, arsenic and cadmium reduction from textile industrial wastewater. From this thesis work, the effluent quality complies satisfactorily the discharge requirement with BOD5 removal of 88% and 86% of COD. This treatment is cost effective in all aspects as compared to other chemical treatment that is much expensive in operation. With the help of microbes, it is cost effective treatment. This treatment become more active with the dosing of polychem-900 in chemical reaction tank after aeration process. It removes all kind of suspended and colloidal particles. It proved safeguard for environmental protection and human health. Wastewater treatment is being realized a valued resource to produce: nutrients, water and energy for industrial, irrigation purposes. Statistical analysis shows that COD has strong correlation with BOD, TDS, TSS Cd, lead and arsenic.

## References


Boczkaj, G., Fernandes, A.J.C.E.J., 2017. Wastewater treatment by means of advanced oxidation processes at basic ph conditions: A review, 320, Pp. 608-633.

de Barros, V.G., Rodrigues, C.S., Botello-Suárez, W.A., Duda, R.M., de Oliveira, R.A., da Silva, E.S., Faria, J.L., Boaventura, R.A., Madeira, L.M.J.E.P., 2020. Treatment of biodigested coffee processing wastewater using fenton's oxidation and coagulation/flocculation, 259, Pp. 113796.

Du, X., Wang, J., Jegatheesan, V., Shi, G.J.A.S., 2018. Dissolved oxygen control in activated sludge process using a neural network-based adaptive pid algorithm, 8, Pp. 261.

GilPavas, E., Dobrosz-Gómez, I., Gómez-García, M.Á.J.J.O.E.M., 2017. Coagulation-flocculation sequential with fenton or photo-fenton processes as an alternative for the industrial textile wastewater treatment, 191, Pp. 189-197.

Guo, K., Gao, B., Pan, J., Shen, X., Liu, C., Yue, Q., Xu, X.J.S.O.T.T.E., 2020. Effects of charge density and molecular weight of papermaking sludge-based flocculant on its decolorization efficiencies, 723, Pp. 138136.

Hussein, A., Scholz, M.J.E.E., 2017. Dye wastewater treatment by vertical-flow constructed wetlands., 101, Pp. 28-38.

Iloms, E., Ololade, O.O., Ogola, H.J., Selvarajan, R.J.I.J.O.E.R., 2020. Investigating industrial effluent impact on municipal wastewater treatment plant in vaal, south Africa, 17, Pp. 1096.

Kumar, K., Singh, G.K., Dastidar, M., Sreekrishnan, T.J.W.R., 2014. Effect of mixed liquor volatile suspended solids (mlvss) and hydraulic retention time (hrt) on the performance of activated sludge process during the biotreatment of real textile wastewater, 5, Pp. 1-8.

Lekang, O.I., Bomo, A.M., Svendsen, I.J.A.E. 2001. Biological lamella sedimentation used for wastewater treatment, 24, Pp. 115-127.

Li, K., Liu, Q., Fang, F., Luo, R., Lu, Q., Zhou, W., Huo, S., Cheng, P., Liu, J., Addy, M.J.B.T., 2019. Microalgae-based wastewater treatment for nutrients recovery: A review, 291, Pp. 121934.

Liu, X., Yuan, W., Di, M., Li, Z., Wang, J.J.C.E.J., 2019. Transfer and fate of microplastics during the conventional activated sludge process in one wastewater treatment plant of china, 362, Pp. 176-182.

Liu, Y., Ngo, H.H., Guo, W., Peng, L., Wang, D., Ni, B.J.E.I., 2019. The roles of free ammonia (fa) in biological wastewater treatment processes: A review. 123, Pp. 10-19.

Metcalf, T.R., 1979. Land, landlords, and the british raj: Northern india in the nineteenth century [uttar pradesh]: University of California Press.

Million, A., Angelakis, E., Maraninchi, M., Henry, M., Giorgi, R., Valero, R., Vialettes, B., Raoult, D.J.I.J.O.O., 2013. Correlation between body mass index and gut concentrations of lactobacillus reuteri, bifidobacterium animalis, methanobrevibacter smithii and escherichia coli, 37, Pp. 1460-1466.

Sepehri, A., Sarrafzadeh, M.H.J.A.W.S., 2019. Activity enhancement of ammonia-oxidizing bacteria and nitrite-oxidizing bacteria in activated sludge process: Metabolite reduction and co 2 mitigation intensification process, 9, Pp. 1-12.

Soares, P.A., Souza, R., Soler, J., Silva, T.F., Souza, S.M.G.U., Boaventura, R.A., Vilar, V.J.J.S., 2017. Remediation of a synthetic textile wastewater from polyester-cotton dyeing combining biological and photochemical oxidation processes, 172, Pp. 450-462.

Zhou, L., Zhou, H., Yang, X.J.S., 2019. Preparation and performance of a novel starch-based inorganic/organic composite coagulant for textile wastewater treatment, 210, Pp. 93-99.