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INDUSTRIAL EFFLUENT TREATMENT BY AERATION AND FILTRATION (MULTIMEDIA FILTER)

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Industrial Effluent Treatment by Aeration and Filtration (Multimedia Filter)

A Thesis by

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DECLARATION OF THE CANDIDATES

We hereby declare that the thesis work under the supervision of Dr. Amimul Ahsan entitled " INDUSTRIAL EFFLUENT TREATMENT BY AERATION AND FILTRATION (MULTIMEDIA FILTER)", has been performed by us and this work has not been submitted elsewhere for reward of any degree or diploma (except for publication).

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ABSTRACT

Tannery industries produces large amount of wastewater containing huge amount of pollutants that doesn't satisfies the standard values of ECR. It should be treated before contaminating river water. This study focuses on treating tannery wastewater without using any chemical products. The Study aimed to reach Bangladesh guideline levels for industrial wastewater of which were pH(6-9),TS (2200mg/L), EC(1200 micro siemens per centimeter), DO (6mg/l), At first aeration and sedimentation was done of the wastewater for various retention times like 1 hour, 2 hours, 3 hours and so on. After completing aeration and sedimentation finally filtration was done using a multimedia filter which contains five layers of filter materials. These filter materials can reduce turbidity, color, total suspended solids etc. The main aim of this project is reducing the chemical oxygen demand (COD) value. These three steps process (aeration + sedimentation + filtration) resulted in 80-90% reduction in COD. Pollutant removal efficiency was measured in terms of total dissolved solids, total suspended solids, color, turbidity and COD. Dissolved oxygen level of the wastewater was increased due to aeration. Most values were found to achieve standard values.

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CHAPTER 1

INTRODUCTION

1.1 General

Textile industry has been one of the most important industry for Bangladeshi economy in last 20 years or so. It has quickly risen to the top and is still expanding. Bangladesh is the second largest garment exported in the world. Which is a huge feat as the first position is held by China; a country much bigger and much higher population. Readymade garments make up to eighty percent of the country's annual export and fifteen percent of the annual GDP. Currently it accounts for 45% of all industrial employment [Mazedul et al., 2013].

However due to textile industry activities, huge amount of wastewater is produced by these industries. And this effluent is dumped into water sometimes treated or sometimes untreated. The textile industry is a very chemical heavy industry. And as a result, it's effluent also showed huge amount of chemical pollutant properties. The physiochemical characteristics of textile effluents in Bangladesh were found as, Temperature (25-65°C), pH (3.9-14), TDS (90.7 – 5980 mg/L), DO (0-7 mg/L), COD (41-2430 mg/L), BOD (10 – 786 mg/L), TSS (24.9 – 3950 mg/L) and EC (250-63750µS/cm) from 2005 to 2014. And these values fail to uphold to the Bangladesh standards of industrial effluent requirements. Thus, present the importance of textile wastewater treatment before releasing in to the water body. As most wastewater is dumped without any treatment [Shuchismita et al.,2015].

1.2 Wastewater and Its Treatment Techniques

Water can be a life saver when it is pure but can be a killer when it's polluted. Bangladesh is a riverine country consisting of 907 rivers. Its capital city is Dhaka, which is surrounded by rivers cause a huge influx of industries. Unfortunately, these rivers are polluted the most by these industries. Heavy deposition of waste killed all aquatic life. The rivers that haven't died yet are dying fast [www.dhakatribune.com].

Wastewater refers to all effluent from household, commercial, establishments and institutions, hospitals, industries and so on. It also includes storm water and urban runoff, agricultural, horticultural and aquaculture effluent. The wastewater is the primary and the most polluting component of the textile industry's effluent. The conventional techniques adopted to treat the wastewater are physical, chemical and biological methods [Ghaly et al., 2014].

1. Physical – sedimentation (clarification), screening, aeration, filtration, flotation and skimming, degasification, equalization.

2. Chemical – chlorination, neutralization, coagulation, absorption, ion exchange.

3. Biological-

a. Aerobic – activated sludge treatment methods, trickling filtration, oxidation, ponds, lagoons, aerobic digestion.

b. Anaerobic – anaerobic digestion, septic tanks, lagoons.

The treatment process can be sequenced as below:

I. Primary treatment – removal of suspended solids, oil, grit etc.

II. Secondary treatment – use of microorganisms in either aerobic or anaerobic condition for the reduction of the BOD, removal of color, oil and phenol.

III. Tertiary treatment – use of electro dialysis, ion exchange and reverse osmosis for the final removal and purification of the wastewater.

Aeration treats water by introducing air to increase dissolved oxygen levels, essential for aerobic microorganisms that metabolize organic pollutants. It also helps in mixing the water, ensuring even distribution of pollutants for more efficient treatment. Additionally, aeration aids in the volatilization of volatile substances and odor control by preventing anaerobic conditions, enhancing overall water quality [Wastewater engineering: Treatment and Resource Recovery,5th Edition, 2014].

Sedimentation treats water by letting gravity do the work, allowing suspended solids to settle at the bottom. This process helps clear up the water by reducing turbidity and removing particles. Sedimentation tanks or clarifiers are specially designed to give solids enough time to settle, making the next steps in treatment more effective [Wastewater engineering: Treatment and Resource Recovery,5th Edition, 2014].

Filtration treats water by running it through materials like sand or membranes that catch and remove impurities and particles. This step helps make the water even clearer and safer by getting rid of contaminants that sedimentation might not catch. Filtration systems are specially designed to effectively trap a wide range of pollutants, significantly improving the quality of the treated water [Wastewater engineering: Treatment and Resource Recovery,5th Edition, 2014].

1.3 Objectives of the Study

The objective of this study is to treat textile wastewater from Apex Holdings ltd using various techniques and test the parameters.

The specific objectives are given below:

- To study the efficiency of treating textile wastewater using aeration, sedimentation and filtration.
- To conduct a comparative study of the effects of various retention times for both aeration and sedimentation techniques.

1.4 Scope of the Study

The scope of the study is shown below:

- In this study, some wastewater quality parameters were tested such as pH, EC, TDS, TSS, TS, Color, Turbidity, Salinity, DO, COD and BOD.
- In this study, the effluent of only Apex Holdings Ltd were used as raw textile wastewater sample.

1.5 Organization of Thesis

This thesis is organized into 5 different parts. They are:

Chapter I: Introduction

Chapter II: Literature Review

Chapter III: Methodology

Chapter IV: Results and Discussion

Chapter V: Conclusions and Recommendations

CHAPTER 2

LITERATURE REVIEW

2.1. Wastewater condition in Bangladesh

The Bangladesh country environmental analysis (CEA) of the World Bank finds water and other environmental pollution cause 2,72,000 premature deaths and 5.2 billion days of illness annually [www.dhakatribune.com].

Most of the rivers of Bangladesh are now facing a severe decline in water quality due to industrial waste discharge. These wastes contain high amounts of plastics, untreated sewage etc. Several initiatives were taken to shut the pipelines of industries that connect the industrial waste and rivers but Dhaka Water and Sewage Authority (WASA)- failed to achieve any success in saving the rivers from industrial pollution [www.dhakatribune.com].

Bangladesh Water Act 2013, the National River Protection Commission Act 2013, and the Environmental Conservation Act, 1995 all have the provision for the protection of the environment and control and mitigation of environmental pollution. But they are greatly affected by corrupted political members. These policies cannot be implemented for these corruptions [www.dhakatribune.com].

2.2. Sources of Wastewater

Agricultural

Variety of farm activities, including animal feeding operations and agricultural products process etc. produce a large amount of wastewater. Milking center wash water, barnyard and feedlot runoff, egg washing and processing, slaughterhouse wastewaters, horse washing waters and runoff are some common examples of agricultural waste water [Connecticut's Official State Website].

Domestic

Domestic wastewater is a point source pollution as all the used water from a house meets a single discharge or outfall pipe. Up to 90% domestic potable water is discharged as wastewater [Wastewater: Sources of Pollutants and Its Remediation].

Industrial

Different manufacturing processes like petrochemical, textile, electroplating, pharmaceutical, and food produces industrial wastewater [Tabassum et al., 2021].

Hence, this waste contains a variety of organic and inorganic matter. It also contains a large amount of toxic and hazardous substances including dyes and metal ions [Bakr et al., 2021].

Moreover, the industrial effluents also contain higher levels of fats, cleaning agents, volatile compounds, and oil that pose risks to human health and the environment. In addition, notable amount of wastewater-containing heavy metals (e.g., chromium, cadmium, lead, copper, zinc, and nickel) which are threat to human health are generated from the petrochemical industries [Fawzy et al., 2019].

2.3. Operations in Textile Industry

Textile industry mainly produces textile related products like fiber, yarn and fabric by processing it into apparel, home furnishing and industrial goods. Textile establishments receive and prepare fibers, transform fibers into yarn, thread, or webbing, convert the yarn into fabric or related products and dye and finish these materials at various stages of production [Textile Industry: Unit Operations (p2infohouse.org)].

Carding

Is the first process in spun yarn manufacture. The fibers are separated, distributed, equalized, and formed into a thin web and condensed into a continuous, untwisted strand of fibers called a sliver. This process also removes impurities and a certain amount of short, broken or immature fibers [Textile Industry: Unit Operations (p2infohouse.org)].

Spinning

In this process of yarn are made from fibers by a combined drawing out and twisting operation or from filament tow by the combination of cutting with drafting and twisting in a single series of operations [Textile Industry: Unit Operations (p2infohouse.org)].

Sizing

The yarn is run being dried so that it has the strength and stiffness required to withstand the abrasion and friction generated in the weaving operation [Textile Industry: Unit Operations (p2infohouse.org)].

Desizing

Desizing mainly removes the sizing of compounds applied to yarns to impart tensile strength. The starch sizing compounds are solubilized with alkali, acid or enzyme, and the fabric is washed thoroughly. Alkaline desizing uses a weak alkaline solution to facilitate size removal, while acid desizing employs a dilute acid solution to hydrolyze the size and render it water soluble. Enzyme desizing is done by utilizing enzymes to decompose size. After solubilizing the size, the fabric is rinsed clean [Textile Industry: Unit Operations (p2infohouse.org)].

Scouring

Removal of natural and acquired impurities from fibers and fabric is done here. Synthetic fibers require less scouring than cotton or wool. Scouring agents include detergents, soaps, and various assisting agents, such as alkalis, wetting agents, defoamers, and lubricants. After scouring, the goods are thoroughly rinsed to remove excess agents [Textile Industry: Unit Operations (p2infohouse.org)].

Mercerizing

Mercerizing is only applied to 100% cotton fabrics and sewing threads. It is used in improving strength, luster and dye affinity, albeit at the expense of extensibility of fiber. It is accomplished by the application of a cold solution of sodium hydroxide, causing the fibers to swell and adopt a circular cross-section. The alkali is then removed by an acid wash [Textile Industry: Unit Operations (p2infohouse.org)].

Dyeing

It can be performed in the stock, yarn or fabric state, and single or multiple-fiber types can be dyed [Textile Industry: Unit Operations (p2infohouse.org)].

It is performed before the fiber is converted to the yarn state and it can be a batch or continuous process. Yarn dyeing is done on yarns used for woven goods, knit goods, and carpets. Usual methods include skein, package, and space dyeing [Textile Industry: Unit Operations (p2infohouse.org)].

Printing

Printing is similar to dyeing, except the application of paint on specific areas of the cloth. Dyes and auxiliaries are similar to those used in fabric dyeing. But the color application techniques are not similar. Textiles are usually wet-printed by roller, rotary screen or flatbed screen printing methods [Textile Industry: Unit Operations (p2infohouse.org)].

Finishing

The principal purpose of the finishing process is to change the properties to affect the care, comfort, durability, environmental resistance and human safety associated with the fabric. It can be applied to make a fabric wrinkle resistant, crease retentive, water repellant, flame resistant, mildew resistant and stain resistant. Finishes include a very large group of chemicals. In wet-finishing, the sequence of steps typically includes chemical finish application together with mechanical techniques, the advantages of the latter being improved feel, strength and abrasion resistance and lower chemical consumption and waste. Finishing produces less amount of wastewater [Textile Industry: Unit Operations (p2infohouse.org)].

2.4. Water Usage in Textile Industry

Water use can vary widely between similar operations. For example, knit mills average 10 gallons of water per pound of production, yet water use ranges from a low of 2.5 gallons to a high of 45.2 gallons. On average, 90–95% of the water used by the factory ends up as effluent. Textile operations vary greatly in water consumption. Below Figure summarizes the water consumption of various types of operations in textile processing industry. Wool and felted fabrics processes are more water intensive than other processing subcategories such as knits, stock, and carpet [textilelearner.net].

Table 2.1: Water Consumption by Textile Industry in Various Processes

Processing Subcategory	Water Use Minimum, gal/lb of production	Water use Maximum, gal/lb of production
Wool	13.3	78.9
Woven	0.6	60.9
Knit	2.4	45.2
Carpet	1.0	19.5
Yarn	0.4	66.9
Felted fabrics	4.0	111.8

2.5. Textile Wastewater Characteristics

Textile wastewater consumes huge amount of water in different operation process. Then produces wastewater containing large amount of BOD, COD, turbidity, salinity etc. Table 2.2 shows the percentage of water consumption during different phases in textile industry [Shaikh, (2009)].

Table 2.2: Total water consumed during wet processing [Shaikh, (2009)]

Process	Percent water consumed
Bleaching	38%
Dyeing	16%
Printing	8%
Boiler	14%
Other uses	24%

Table 2.3: Water Usage in textile mills [Shaikh, (2009)]

Purpose	Cotton Textile (% water use)	Synthetic Textile (% water use)
Steam generation	5.3	8.2
Cooling water	6.4	--
Demineralized water	7.8	30.6
Process water	72.3	28.3
Sanitary use	7.6	4.9
Miscellaneous	0.6	28.0

2.6. Treatment Process of Wastewater

2.6.1. Aeration

Aeration in waste water treatment is mainly used for the transfer of oxygen in the activated sludge process. This oxygen transfer is usually done by diffusion from air bubbles discharged from submerged pump. The rate of oxygen transfer depends on the nature of the diffusion flow, the submerged depth and the airflow rate [Sewage and Industrial Wastes].

Table 2.4: Effluent Characteristics of Textile Industry Processes [Dey and Islam, 2015]

Process	Effluent Composition	Pollutant Nature
Sizing	Starch, waxes, carboxymethyl cellulose (CMC), polyvinyl alcohol (PVA), wetting agents.	High in BOD, COD
Desizing	Starch, CMC, PVA, fats, waxes, pectin	High in BOD, COD, SS, dissolved solids
Bleaching	Sodium hypochlorite, Cl_2, NaOH, H_2O_2, acids, surfactants, $NaSiO_3$, sodium phosphate, short cotton fiber	High alkalinity, high SS
Mercerizing	Sodium hydroxide, cotton wax	High pH, low BOD, high DS
Dyeing	Destuffs urea, reducing agents, oxidizing agents, acetic acid, detergents, wetting agents.	Strongly colored, high BOD, DS, low SS, heavy metals.
Printing	Pastes, urea, starches, gums, oils, binders, acids, thickeners, cross-linkers, reducing agents, alkali.	Highly colored, high BOD only, appearance, SS, slightly alkaline.

Aeration process mainly increases the dissolved oxygen level in water. BOD and DO have an inversely proportional relationship. A decline in DO levels reflects a high level of BOD. If DO level increases, BOD level decreases [www.vedantu.com] .

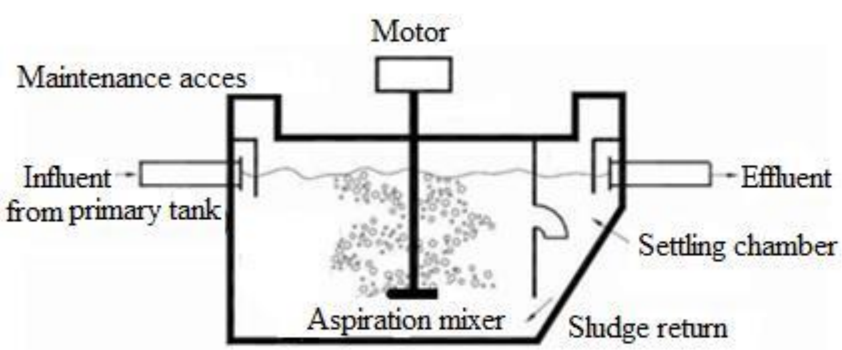

Fig. 2.1: Aeration Tank [www.vedantu.com]

Aeration brings water and air in close contact. It removes dissolved gases and oxidizes dissolved metals, including iron, hydrogen sulfide, and volatile organic chemicals. This is the first major process at drinking water treatment plan and also occurs in the secondary treatment processes of activated sludge treatment in wastewater treatment plants. An evenly distributed oxygen supply in an aeration system is necessary for effective wastewater treatment for fostering microbial growth [https://www.wwdmag.com/].

Aeration promotes microbial growth in the wastewater. The microbes then feed on organic material, forming flocks that easily settle out. Once the organic materials are settled in a separate settling tank, bacteria form the "activated sludge" flocks which are continually recirculated back to the aeration basin, increasing decomposition rates [https://www.wwdmag.com/].

In industrial use, the most common method of aeration is water-fall aeration, with the use of spray nozzles. Air diffusion is another method of aeration, in which air is diffused into a receiving vessel containing counter-current flowing water [https://www.wwdmag.com/].

2.6.2. Sedimentation

Sedimentation is a common way of treating water. It is a process that removes solids that float and settle in the water. The process relies on the use of sedimentation tanks that remove larger solids. Subsequent treatment processes may be used after sedimentation. Sedimentation is one of the methods that municipalities use for treating water. It is a physical water treatment process. Gravity is used to remove suspended solids from water [https://www.fondriest.com/environmental-measurements].

The size and weight of the particles affect the effectiveness of sedimentation. Particles that have higher specific gravity than water settle. But particles with similar specific gravity with water float. The sedimentation process in wastewater treatment usually done in tanks. The wastewater is retained in a homogenization tank or basin for a period of time, allowing the heavier particles to settle to the bottom. Then they are removed from there. Sedimentation process settles total dissolved solids, total suspended solids and turbidity [https://www.fondriest.com/environmental-measurements].

Turbidity produces from suspended sediment such as silt or clay, inorganic materials, or organic matter such as algae, plankton and decaying material. Turbidity can also contain colored dissolved organic matter (CDOM), fluorescent dissolved organic matter (FDOM) and other dyes. In sedimentation process these materials easily settle down and eventually it reduces turbidity [https://www.fondriest.com/environmental-measurements].

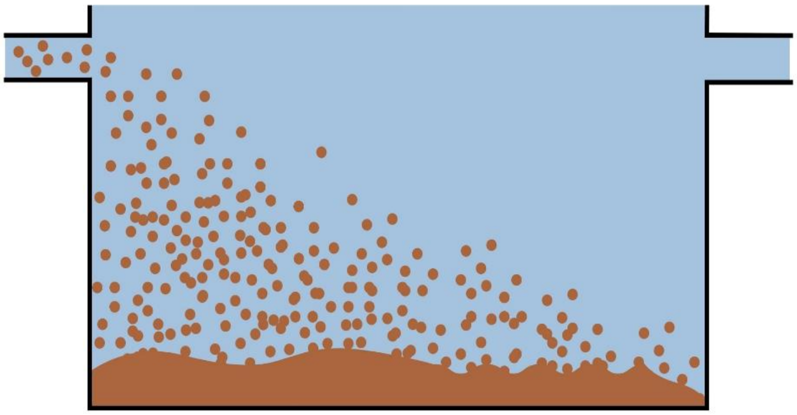

Fig. 2.2: Sedimentation Tank [https://www.fondriest.com/environmental-measurements]

2.6.3: Filtration

Multi-Media Water Filter is a process that uses one or several filter media to pass high-turbidity water through a certain thickness of granular or non-granular materials to effectively remove suspended impurities and clarify the water. The filter material is quartz sand, anthracite, manganese sand, etc. It is mainly used for water treatment to remove turbidity, soften water, and pre-treatment of pure water. The effluent turbidity can reach below 3 degrees. [https://kysearo.com/].

Multi-media filter, which is made of more than two media as the media filter of the filter layer, is used to remove impurities and adsorb oil in sewage in industrial circulating water treatment system. Filtrations is mainly to removes suspended or colloidal impurities in water, especially to remove tiny particles and bacteria that cannot be removed by precipitation technology. BOD5 and COD also have a removal effect from filtration [https://kysearo.com/].

The filter materials in multimedia filter are high-quality uniform grain gravel, quartz sand, magnetite, anthracite, etc. The filter material is distributed orderly in the filter tank according to its specific gravity and particle size distribution, such as anthracite with a small specific gravity and slightly larger particle size is placed in the uppermost layer of the filter bed, quartz sand with a moderate specific gravity and small particle size is placed in the middle layer of the filter bed, and gravel with a larger specific gravity and larger particle size is placed in the lowermost layer of the filter bed . This ratio ensures high capacity of multimedia filter [https://kysearo.com/].

Quartz sand filter uses quartz sand as filter material. It can remove suspended matter in water, and has a significant removal effect on colloid, iron, organic matter, pesticide, manganese, bacteria, virus and other pollutants in water. It has low filtration resistance, large specific surface area, strong acid and alkali resistance, oxidation resistance, PH applicable range of 2-13, good pollution resistance, etc. that are some good qualities for the filter. Quartz sand filter has a strong self - adaptability to operation conditions and raw water concentrations. It also has the advantages of rapid filtration speed, high filtration precision and large dirt interception capacity [https://kysearo.com/].

Chapter III

METHODOLOGY

3.1 Introduction

The chosen method for our experiment were aeration, sedimentation, filtration with multimedia filter. There were 10 parameters tested. The treatment process and the parameters tested are given below in a detailed manner.

3.2 Sample collection

The source of our textile wastewater was the inlet of the central ETP of Apex Holdings limited. It is located in Apex road, Chandra Gazipur, Bangladesh. The textile wastewater is released from the factory in two different times to the ETP. They are 5 AM in the morning and 5 PM in the evening. To maintain the integrity of our tests and get as realistic result the water was collected at both times in plastic jerricans as storage containers. Sample when collected was warmer than atmospheric temperature. Sample was collected during different days to get optimum results.

Fig. 3.1: Sample Storage

3.3 Multimedia Filter

A filter was created to filter the textile effluent after aeration and sedimentation process. A filter that has two or more filter medium to achieve more efficient and effective filtration that single media filter is known as multimedia filter. The multimedia filter consists of 5 layers. They are:

1. Cotton
2. Coarse particles
3. Fine Particles
4. Finer Particles
5. Sand

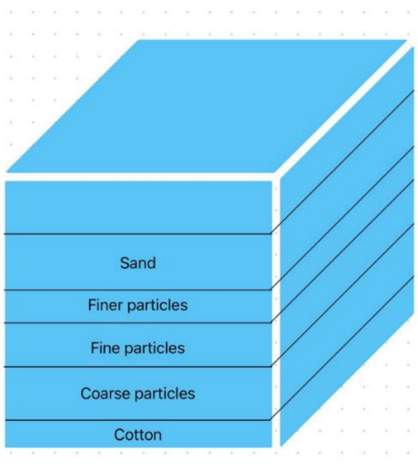

Fig. 3.2: Different layers of multimedia filter

All the mediums are situated over the stainless-steel strainer.

Fig. 3.3: Stainless steel strainer

3.4 Aeration

Aeration refers to the process of introducing air in water to enhance water quality by increasing oxygen content of water. It can also remove gasses and volatile components. It is the first process of our treatment system. A small water pump was used to introduce air to the wastewater in a plastic container. Water was measured before beginning the process.

Fig. 3.4: Aeration process

3.5 Sedimentation

The process of letting wastewater in a tank to naturally separate its solid particles from water, which allows them to settle at the bottom. This is the second process in our treatment process. It is a widely used process to treat wastewater, reduce chemical concentration. A plastic container was used to allow wastewater to settle after aeration process.

Fig. 3.5: Sedimentation process.

3.6 Filtration

The process of running wastewater through a medium to improve the quality of water s known as filtration. It is the final step of our process. A multimedia filter of 5 layers is used to filter wastewater. Water after sedimentation is poured onto the filter. And then the effluent from the filter is collected in a collection container and later its quality parameters are tested.

The multimedia filter is made of glass to ensure transparency to observe the movement of water and its change by the filter. The filter was cleaned after and before each use with clean water to ensure impartial results.

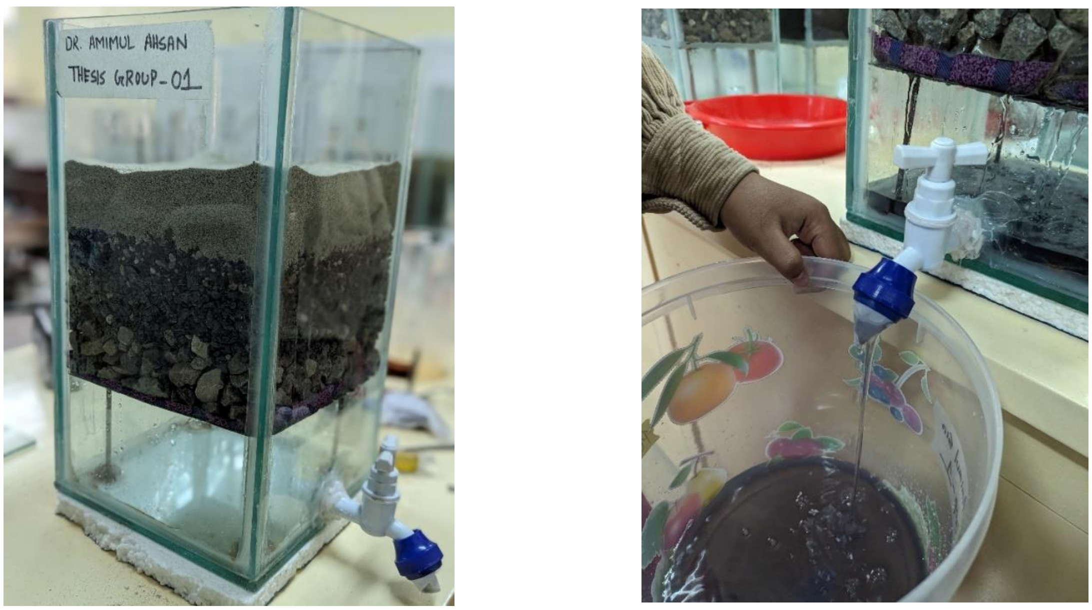

Fig. 3.6: Filtration Process

Fig. 3.7: Treatment Process

3.7 Laboratory tests

pH

Quantitative measure of the acidity or basicity of aqueous or other liquid solutions. The term, widely used in chemistry, biology, and agronomy, translates the values of the concentration of the hydrogen ion—which ordinarily ranges between about 1 and 10−14 gram-equivalents per liter—into numbers between 0 and 14 *[The Editors of Encyclopedia Britannica] .*

Fig. 3.8: pH meter

Apparatus:

1. pH meter (model: pH31, Origin: USA, Brand: HACH)
2. Beaker
3. Wash bottle
4. Tissue paper

Chemicals required:

1. Distilled water

Procedure: [APHA,2005]

1. Cleaned pH meter electrodes with distilled water
2. In a clean dry 100mL beaker took the water sample
3. Placed the electrode of pH meter in the beaker containing water sample. Waited until we get a stable reading.
4. After taking measurements, took the electrode from the water sample and washed it with distilled water.

EC

Conductivity is a measure of the ability of water to pass an electrical current. Conductivity in water is affected by the presence of inorganic dissolved solids such as chloride, nitrate, sulfate, and phosphate anions (ions that carry a negative charge) or sodium, magnesium, calcium, iron, and aluminum cations (ions that carry a positive charge).

Fig. 3.9: Multimeter

Apparatus:

1. Multimeter (Model: HQ40d, Origin: USA, Brand: HACH)
2. Electric probe
3. Beaker
4. Distilled water

Procedure:

1. Rinsed the probe with distilled water.

2. Took water sample in a 100mL beaker.

3. Placed the electric probe in the beaker

4. Selected the appropriate range beginning with the highest range and working down. Read the conductivity of the water sample. If the reading is in the lower 10 percent of the range, switched to the next lower range. If the conductivity of the sample exceeds the range of the instrument, we may dilute the sample. Performed the dilution according to the manufacturer's directions because the dilution might not have a simple linear relationship to the conductivity.

5. Rinsed the probe with distilled or deionized water and repeat step 4 until finished.

(Ref. APHA. 1992. Standard methods for the examination of water and wastewater. 18th ed. American Public Health Association, Washington, DC.)

TDS

Apparatus:

1. Multimeter (Model: HQ40d, Origin: USA, Brand: HACH)
2. Electric probe
3. Beaker
4. Distilled water

Procedure:

1. Washed the probe and beaker with distilled water.
2. Took water sample in the beaker
3. Before we started measuring, we calibrated the multimeter by setting it to the reference solution with a known TDS. This will ensure that the readings you obtain are accurate and reliable.
4. Placed the electric probe in the beaker. The probe often has two electrodes or pins that need to be inserted into the sample containers.
5. Submerged the probe into the reference solution and wait for the multimeter to stabilize the reading. Noted down the TDS value, and then repeated the process with the sample container.
6. Rinsed the probe with distilled or deionized water and repeat step 5 until finished.

TSS

Total suspended solids (TSS) refer to visible particles floating or suspended in water, such as sediments and organic matter, making the water appear cloudy.

Fig. 3.10: Spectro photometer

Apparatus:

1. Spectro photometer (Model: DR 3900, Origin: USA, Brand: HACH)
2. Cuvette
3. Blank solution

Procedures:

1. Selected a blank cuvette and place it in the spectrophotometer. Closed the lid.
2. Clicked on 0 ABS 100%T button, the instrument now reads 0.00000 A.
3. Now filled another cuvette with our sample water and closed the lid
4. Clicked on the 'Read' option
5. Took the value of TSS of our sample in stable condition.

DO

Dissolved oxygen is a measure of the amount of gaseous oxygen contained in water.

Apparatus:

1. Multimeter (Model: HQ40d, Origin: USA, Brand: HACH)
2. Electric probe
3. Beaker
4. Distilled water

Procedure:

1. Rinsed the probe with distilled water.
2. Took water sample in a 100mL beaker.
3. Placed the electric probe in the beaker. Waited until we get a stable reading.
4. Rinsed the probe with distilled or deionized water and repeat step 4 until finished.

Salinity

Salinity is the dissolved salt content of a body of water. It is a strong contributor to conductivity and helps determine many aspects of the chemistry of natural waters and the biological processes within them.

Apparatus:

1. Multimeter (Model: HQ40d, Origin: USA, Brand: HACH)
2. Electric probe
3. Beaker
4. Distilled water

Procedure:

1. Rinsed the probe with distilled water.
2. Took water sample in a 100mL beaker.
3. Placed the electric probe in the beaker
4. Waited until we get a stable reading
5. Rinsed the probe with distilled or deionized water and repeat step 4 until finished.

Calculation:

Test result = a%

Salinity in ppm = a% x 10,000 ppm

Turbidity

Turbidity is the amount of cloudiness in the water.

a) Turbidity meter

b) Turbidity vial

Fig. 3.11: Turbidity meter

Apparatus:

1. Turbidity meter (Model: 2100Q, Origin: USA, Brand: HACH)
2. Turbidity vial
3. Distilled water
4. Tissue paper

Procedure:

1. Filled the turbidity vial (has white line around top of glass with downward arrow) to the line (about 15 mL) with unfiltered water. Took care to handle the sample cell by the top. Cap the cell.
2. Wiped the cell with a tissue paper to remove water spots and fingerprints.
3. Pressed I/O - the instrument will turn on. Placed the instrument on a flat surface. Did not hold the instrument while making readings.
4. Put the sample vial in the instrument cell compartment so its diamond mark aligns with the raised orientation mark in front of the cell compartment. Closed the cover.
5. Set automatic range by pressing the RANGE key. The display would show ``AUTO RNG".
6. Selected signal averaging (reports average of 10 measurements) by pressing ``Signal Average" key, display should show ``SIG AVG"
7. Pressed READ - the display will show ``--NTU" and the light bulb icon will flash 10 times (once for each reading). The final average will be displayed as numbers in NTU after the lamp symbol turns off.

Color

Apparatus:

1. Spectro photometer (Model: DR 3900, Origin: USA, Brand: HACH)
2. Cuvette
3. Blank solution

Procedures:

1. Selected a blank cuvette and place it in the spectrophotometer. Closed the lid.
2. Clicked on 0 ABS 100%T button, the instrument now reads 0.00000 A.
3. Now filled another cuvette with our sample water and closed the lid
4. Clicked on the ‘Read’ option
5. Took the value of color of our sample in stable condition.

COD

A chemical oxygen demand (COD) test is used to measure the amount of organic compounds in a water sample.

a) Dry thermostat reactor

b) COD vial

Fig. 3.12: Dry thermostat reactor

Apparatus:

1. Dry thermostat reactor (Model: DRB 200, Origin: USA, Brand: HACH)
2. COD vial

Procedure:

1. Preheated the digestor block to 150oC (302oF).
2. Removed the cap from each COD vial. Store the vials in a vial rack to prevent any spillage.
3. Pipet two milliliters of sample into each vial.
4. Secured the cap onto each COD vial. Did not to overtighten the cap as it could damage the closure.
5. Immediately inverted each vial ten times while holding the vial by the cap only as the vial will be hot from the reaction caused when adding the sample.

6. Prepared the reagent blank by removing the COD vial cap and pipetting deionized water rather than sample into the vial. (Note: At least one reagent blank must be run with each set of samples with each new lot number of COD test vials.)
7. Wiped the vials with a tissue paper to remove smudges and fingerprints from the vial and placed them in the preheated digestor block.
8. Allowed the vials to heat in the digestor block at 150oC (302oF) for two hours.
9. Once the two hours are finished, turned the digestor block off and allow the vials to remain in the unit for 15 to 20 minutes to cool. Removed the vials and return them to the vial rack.
10. Ensured all caps are secured tightly, then inverted each vial several times.
11. Stored the vials in the dark for 30 minutes as they cool to room temperature.

BOD

It is the measure of amount of dissolved oxygen consumed by microorganisms in a water body. It denotes the pollution in the water body and is thus an important parameter to gauge the quality of wastewater.

Fig. 3.13: BOD incubator

Fig. 3.14: BOD track apparatus

Apparatus:

1. BOD incubator (Origin: USA, Brand: HACH)
2. BOD track apparatus (Origin: USA, Brand: HACH)
3. BOD bottles

Procedure:

1. Add 10 ml of the water sample to two of the 300 ml BOD bottles and fill the remaining space with dilution water.
2. Fill the remaining two BOD bottles with dilution water for the blank sample.
3. Seal the bottles immediately without any air bubbles inside.
4. Incubate one sample and one blank bottle at 20°C for five days.
5. Analyze the remaining one sample and one blank vial of dissolved oxygen immediately.
6. Analyze the bottles incubated for 5 days for DO.

Ref. https://testbook.com/civil-engineering/bod-test-and-measurement

Chapter IV

RESULTS AND DISCUSSION

4.1 Introduction

In this chapter properties of textile effluent from apex holding limited were discussed against Bangladeshi effluent standards. Later, the properties of water after going through 3 step (Aeration, Sedimentation, Filtration) treatment process were described. Various aeration and sedimentation time combinations were used to find the effect of each process within time difference.

4.2 Quality of wastewater from existing ETP system

Apex holdings have an existing wastewater ETP. The parameters of the effluent are described in Table 4.1.

Table 4.1: Properties of effluent of ETP

Test parameters	**UNIT**	**Effluent from ETP**	**ECR, 2023**
Date		11/1/2024	
pH	-	7.4	6-9
EC	µs/cm	869	1200
TDS	mg/L	459	2100
TSS	mg/L	55	100
TS	mg/L	514	2200
DO	mg/L	1.22	6
Salinity	ppm	4600	800
Turbidity	NTU	34.5	25
Color	Pt/Co	1276	150
COD	mg/L	170	200

4.3 Properties of raw wastewater

Properties of raw wastewater from the inlet of the ETP are described in the Table 4.2 and they are compared to Bangladesh standards.

Table 4.2 Properties of raw wastewater and Bangladesh standards

Test parameters	**UNIT**	**Raw WW from ETP Inlet**	**ECR, 2023**
Date		24/1/24	
pH		7.4	6-9
EC	µs/cm	1185	1200
TDS	mg/L	579	2100
TSS	mg/L	113	100
TS	mg/L	692	2200
DO	mg/L	0.81	6
Salinity	ppm	5900	800
Turbidity	NTU	145	25
Color	Pt/Co	798	150
COD	mg/L	200	200
BOD	mg/L	38	30

4.4 Properties of Treated Wastewater with Varying Sedimentation Times

To understand the effect of sedimentation time on the treatment process varying sedimentation time with fixed 1-hour aeration time and filtration has been done. The properties are shown in the Tables (4.3, 4.4 and 4.5) below and compared to Bangladesh standards.

Table 4.3: Properties of treated wastewater (1-hour Aeration and 1-hour Sedimentation and Filtration)

Test parameters	UNIT	Raw	Aeration+ Sedimentation	Aeration+ Sedimentation + Filtration	ECR, 2023
pH		7.4	8.1	7.71	6-9
EC	µs/cm	1185	1250	570	1200
TDS	mg/L	579	624	277	2100
TSS	mg/L	113	78	18	100
TS	mg/L	692	702	295	2200
DO	mg/L	0.81	5.95	8.6	6
Salinity	ppm	5900	6300	2800	800
Turbidity	NTU	145	120	17.1	25
Color	Pt/Co	798	714	120	150
COD	mg/L	200	93	23	200

Table 4.4: Properties of treated wastewater (1-hour Aeration and 2-hour Sedimentation and Filtration)

Test parameters	UNIT	Raw	Aeration+ Sedimentation	Aeration+ Sedimentation + Filtration	ECR, 2023
pH		7.4	8.15	7.83	6-9
EC	µs/cm	1185	1052	1025	1200
TDS	mg/L	579	580	337	2100
TSS	mg/L	113	77	32	100
TS	mg/L	692	657	369	2200
DO	mg/L	0.81	4.83	8.4	6
Salinity	ppm	5900	5700	5400	800
Turbidity	NTU	145	99.6	54.1	25
Color	Pt/Co	798	668	650	150
COD	mg/L	200	111	99	200

Table 4.5: Properties of treated wastewater (1-hour Aeration and 3-hour Sedimentation and Filtration)

Test parameters	UNIT	Raw	Aeration+ Sedimentation	Aeration+ Sedimentation + Filtration	ECR, 2023
pH		7.26	8.06	7.59	6-9
EC	µs/cm	1249	1213	604	1200
TDS	mg/L	575	615	293	2100
TSS	mg/L	154	126	24	100
TS	mg/L	729	741	317	2200
DO	mg/L	1.61	3.02	8.03	6
Salinity	ppm	6200	6200	2900	800
Turbidity	NTU	235	202	26.5	25
Color	Pt/Co	744	626	114	150
COD	mg/L	127	107	26	200

4.5 Effect of Sedimentation Times

Effects of sedimentation time on various parameters are shown below with Figs. 4.1 – 4.9.

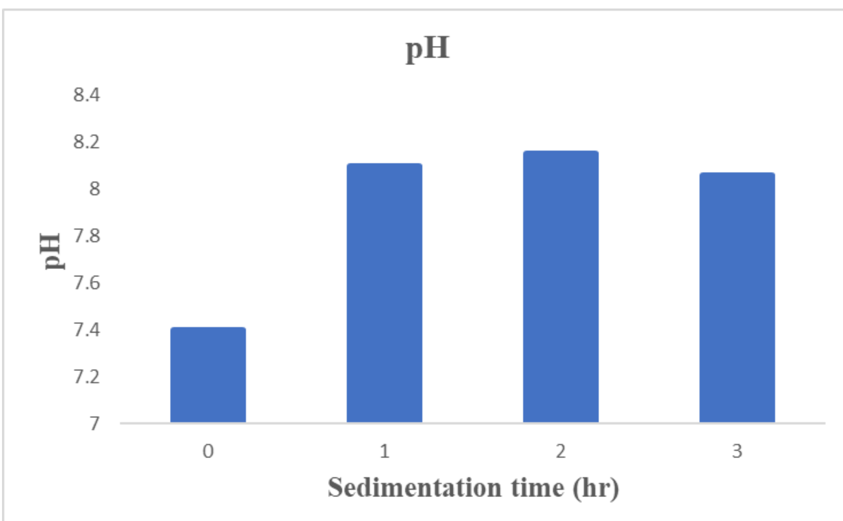

Fig. 4.1: Variation of pH with sedimentation times (1hr aeration)

Fig 4.1 presents the variation of pH with sedimentation times (1hr aeration). From Fig 4.1 it was observed that sedimentation times have less significant effect on pH values.

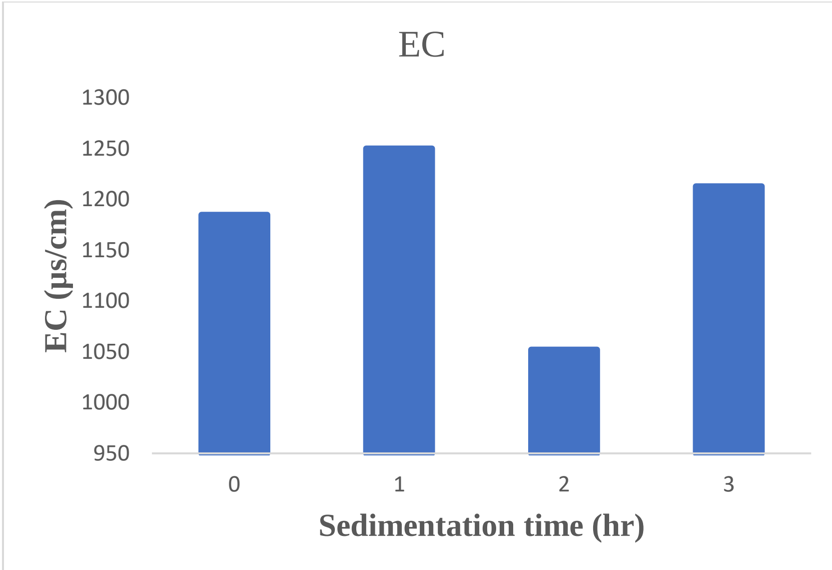

Fig. 4.2: Variation of EC with sedimentation times (1hr aeration)

Fig 4.2 shows the variation of EC with sedimentation times (1hr aeration). From Fig 4.2 it was observed that no clear trend was seen in the EC value due to sedimentation times.

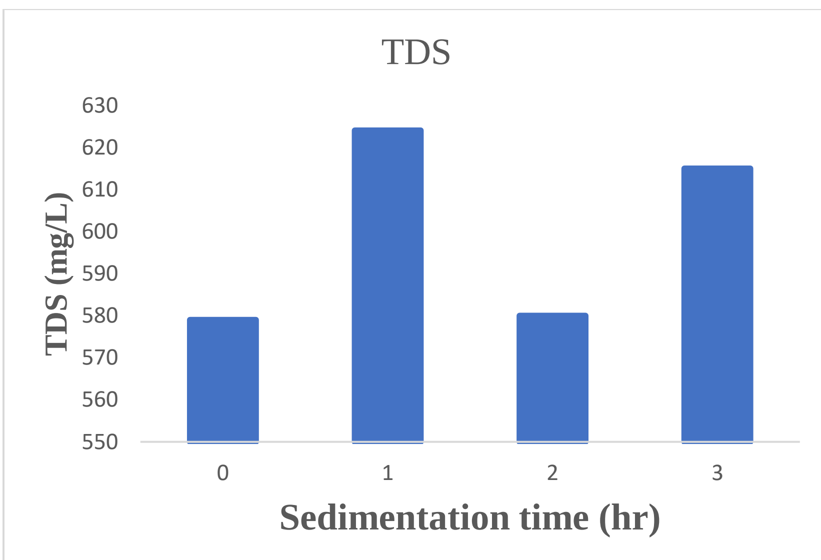

Fig. 4.3: Variation of TDS with sedimentation times (1hr aeration)

Fig 4.3 demonstrates the variation of TDS with sedimentation times (1hr aeration). From Fig 4.3 it was observed that sedimentation times have less significant effect on TDS values.

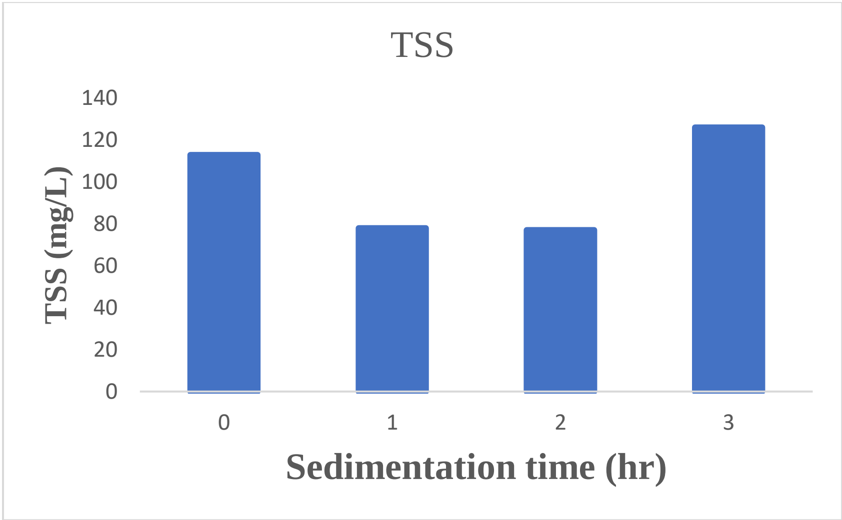

Fig. 4.4: Variation of TSS with sedimentation times (1hr aeration)

Fig 4.4 presents the variation of TSS with sedimentation times (1hr aeration). From Fig 4.4 it was observed that sedimentation times have less significant effect on TSS values.

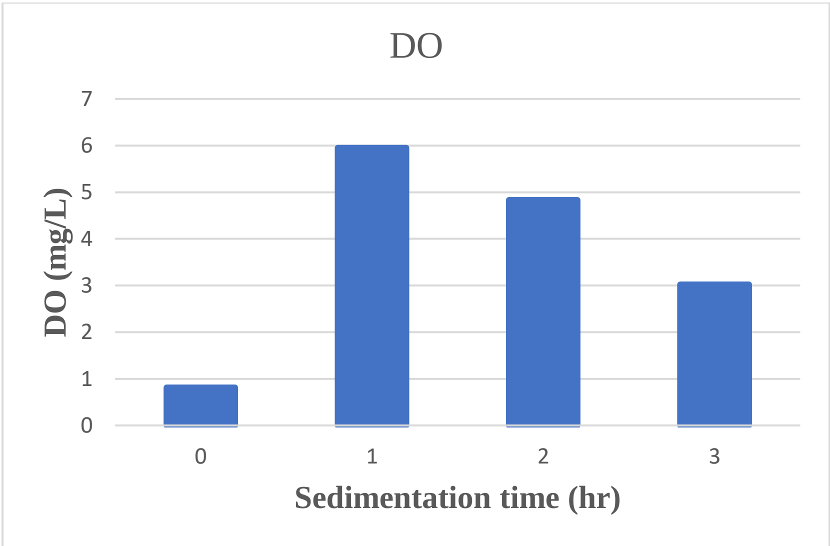

Fig. 4.5: Variation of DO with sedimentation times (1hr aeration)

Fig 4.5 shows the variation of DO with sedimentation times (1hr aeration). It was observed that DO decreased with increase of sedimentation times.

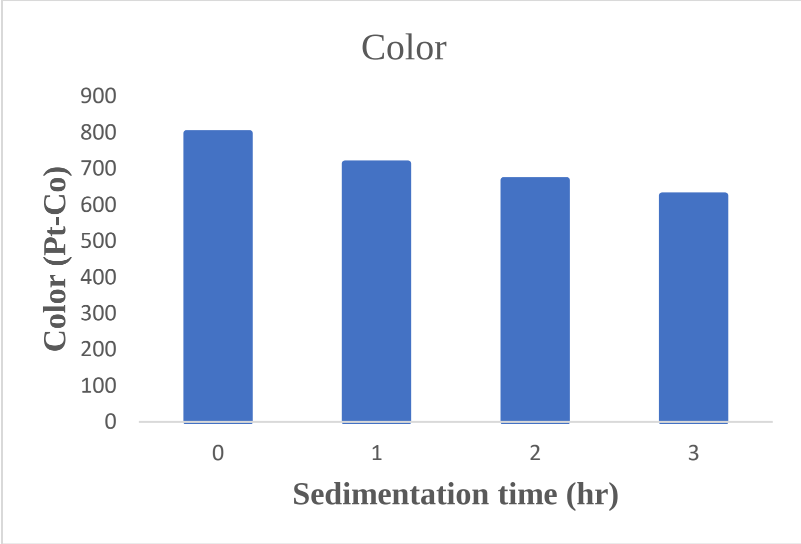

Fig. 4.6: Variation of color with sedimentation times (1hr aeration)

Fig 4.6 displays the variation of color with sedimentation times (1hr aeration). It was seen that there are less significant changes due to sedimentation times.

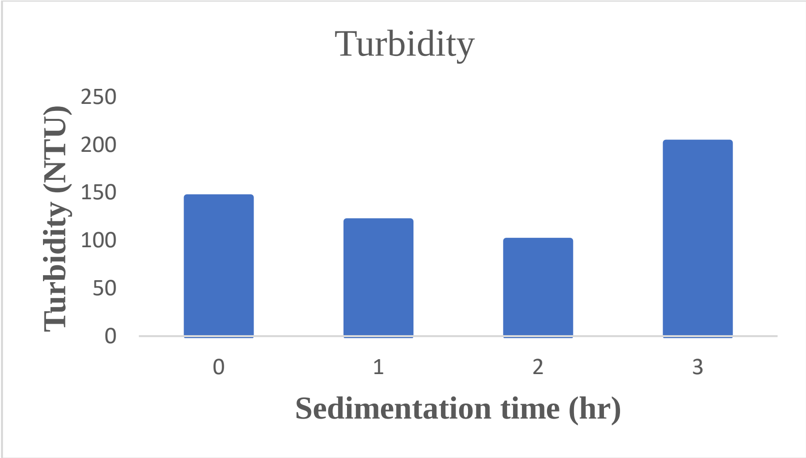

Fig. 4.7: Variation of turbidity with sedimentation times (1hr aeration)

Fig 4.7 demonstrates the variation of turbidity with sedimentation times (1hr aeration). No Clear trend was observed due to change of sedimentation times.

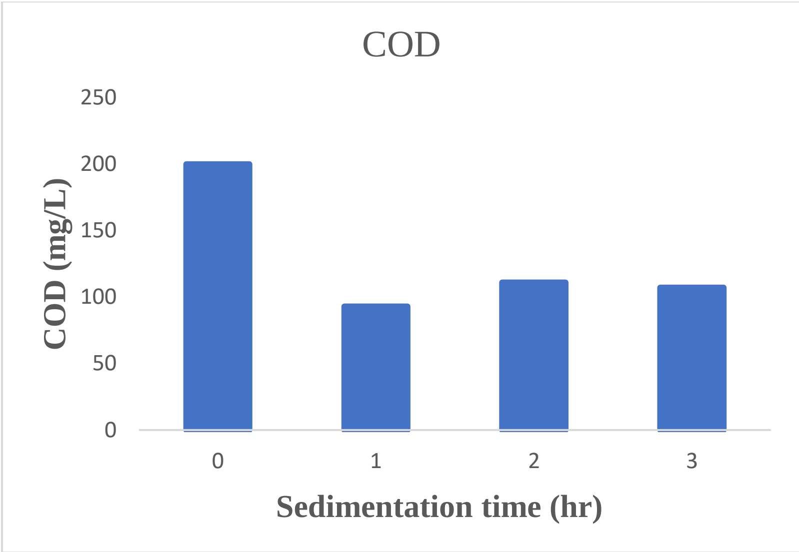

Fig. 4.8: Variation of COD with sedimentation times (1hr aeration)

Fig 4.8 shows the variation of COD with sedimentation times (1hr aeration). No clear trend was seen in the change of COD within sedimentation times.

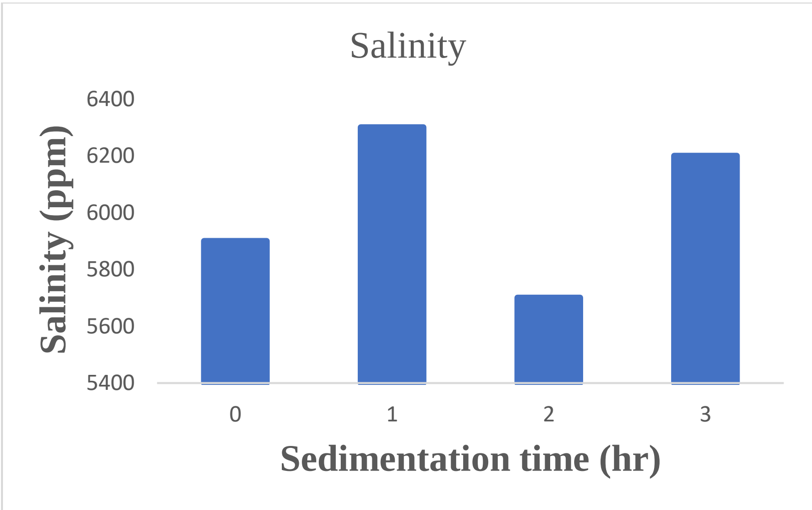

Fig. 4.9: Variation of salinity with sedimentation times (1hr aeration)

Fig 4.9 displays the variation of salinity with sedimentation times (1hr aeration). No clear trend has been observed in salinity changes due to sedimentation times.

4.6 Properties of Treated Wastewater with Varying Aeration Times

To understand the effect of aeration time on the treatment process varying aeration time with fixed 1-hour sedimentation time and filtration has been done. The properties are shown in the Tables (4.6 and 4.7) below and compared to Bangladesh standards.

Table 4.6: Properties of treated wastewater (2-hour Aeration and 1-hour Sedimentation and Filtration)

Test parameters	UNIT	ECR, 2023	Raw	Aeration+ Sedimentation	Aeration+ Sedimentation + Filtration
pH		6-9	8.35	8.4	7.96
EC	µs/cm	1200	1227	1275	1018
TDS	mg/L	2100	608	637	501
TSS	mg/L	100	20	36	20
TS	mg/L	2200	628	673	521
DO	mg/L	6	7.24	8.15	7.11
Salinity	ppm	800	6100	6200	5000
Turbidity	NTU	25	16.7	16.5	15.6
Color	Pt/Co	150	247	287	139
COD	mg/L	200	200	101	21

Table 4.7: Properties of treated wastewater (3-hour Aeration and 1-hour Sedimentation and Filtration)

Test parameters	UNIT	ECR, 2023	Raw	Aeration+ Sedimentation	Aeration+ Sedimentation + Filtration
pH		6-9	9.06	8.82	7.81
EC	µs/cm	1200	3880	4110	688
TDS	mg/L	2100	2038	1951	355
TSS	mg/L	100	106	87	25
TS	mg/L	2200	2144	2038	380
DO	mg/L	6	0.19	7.5	8.09
Salinity	ppm	800	3300	2100	1800
Turbidity	NTU	25	45.6	57.5	18.1
Color	Pt/Co	150	912	1196	180
COD	mg/L	200	171	90	20

4.7 Effect of Aeration Times

Effects of sedimentation time on various parameters are shown below with Figs. 4.10 – 4.18.

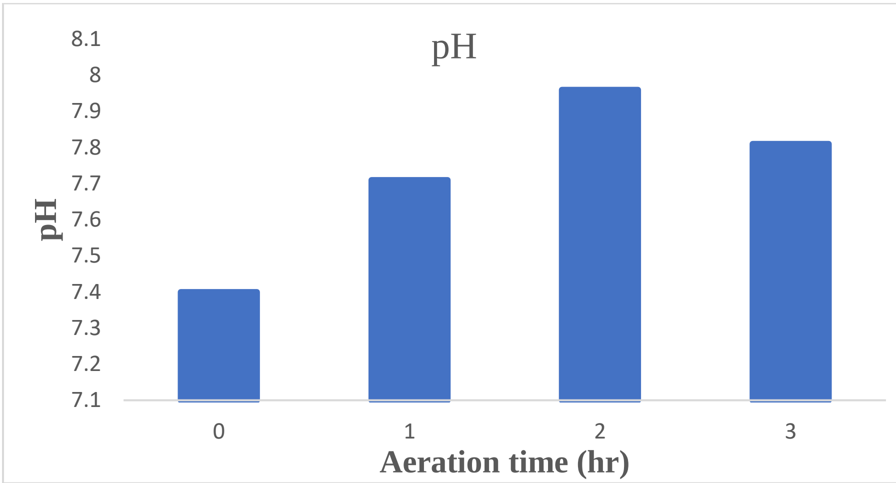

Fig. 4.10: Variation of pH with aeration time (1hr sedimentation)

Fig 4.10 shows the variation of pH with aeration time (1hr sedimentation). It is observed in Fig 4.10. that increase in aeration time raised the pH value.

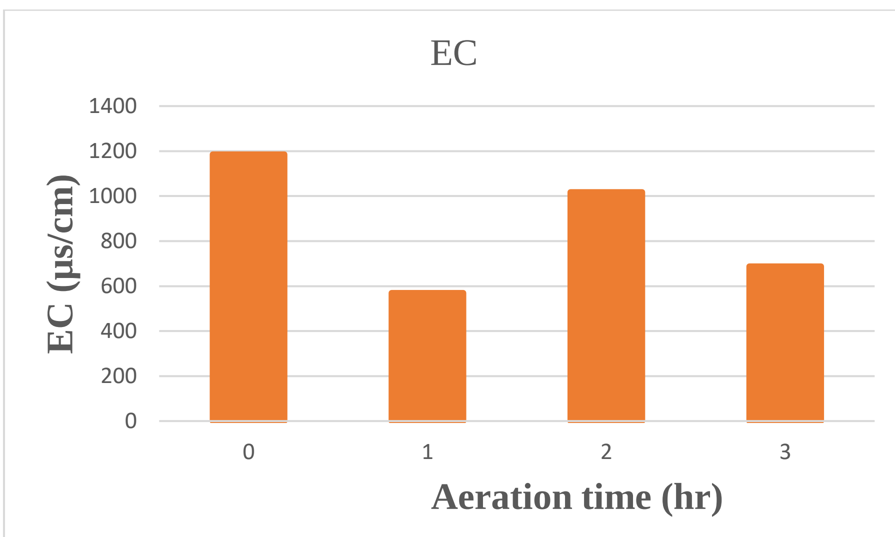

Fig. 4.11: Variation of EC with aeration time (1hr sedimentation)

Fig 4.11 presents the variation of EC with aeration time (1hr sedimentation). It can be noticed that the variations are less significant.

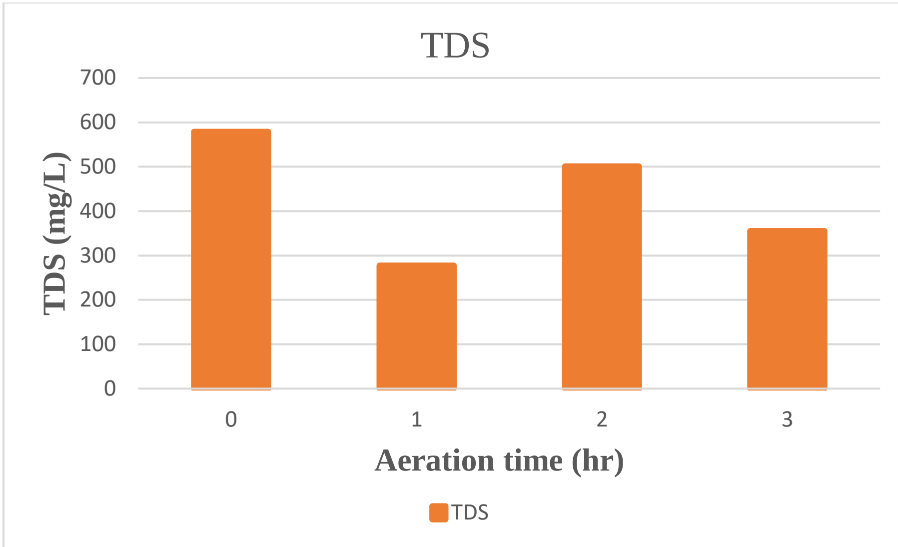

Fig. 4.12.: Variation of TDS with aeration time (1hr sedimentation)

Fig 4.12 demonstrates the variation of TDS with aeration time (1hr sedimentation). It was examined that overall TDS value decreased with aeration time.

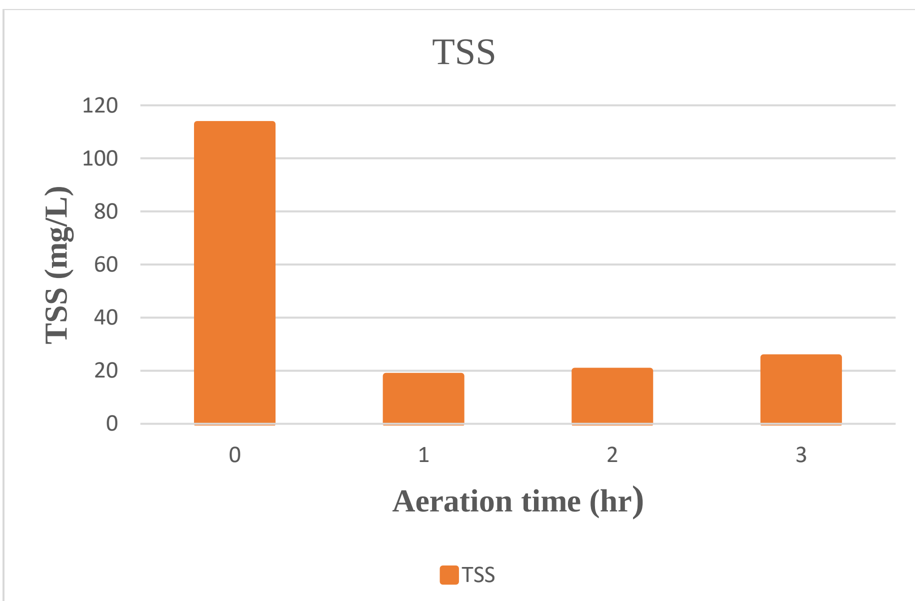

Fig. 4.13: Variation of TSS with aeration time (1hr sedimentation)

Fig. 4.13 displays the variation of TSS with aeration time (1hr sedimentation). It was observed that TSS reduced drastically but the reduction decreased slightly within time.

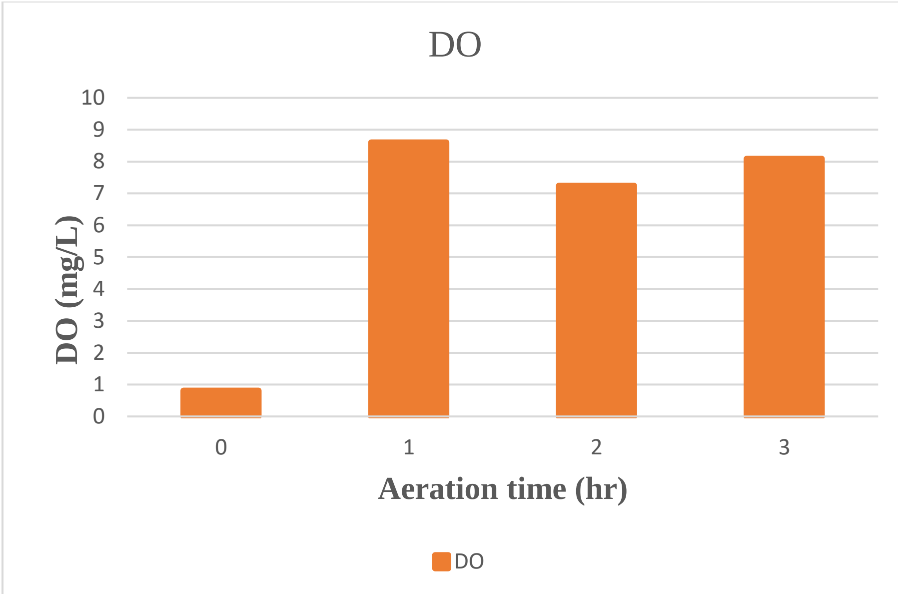

Fig. 4.14: Variation of DO with aeration time (1hr sedimentation)

Fig. 4.14 shows the variation of DO with aeration time (1hr sedimentation). It was seen that aeration time increased the DO level on a standard value.

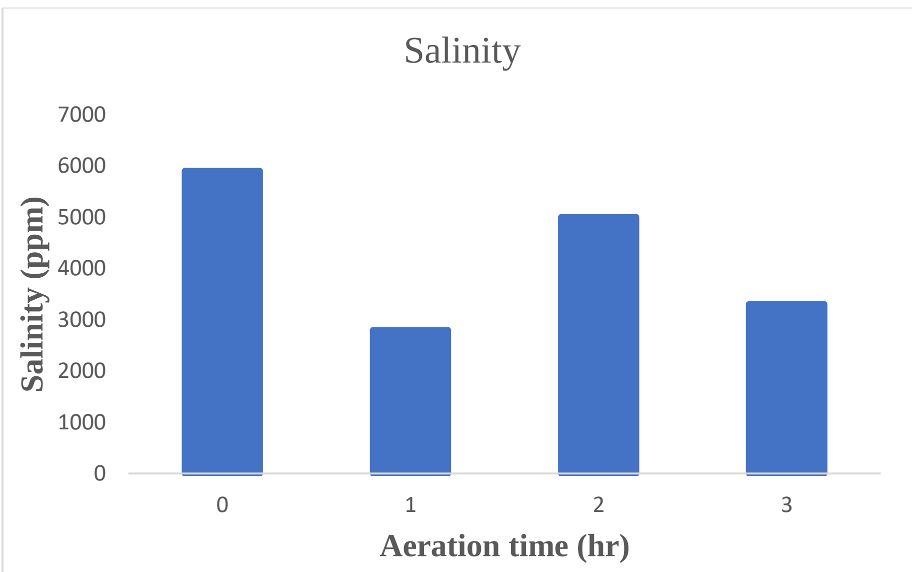

Fig. 4.15: Variation of salinity with aeration time (1hr sedimentation)

Fig. 4.15 presents the variation of salinity with aeration time (1hr sedimentation). It was observed that no significant change in salinity level occurred due to variation of aeration times.

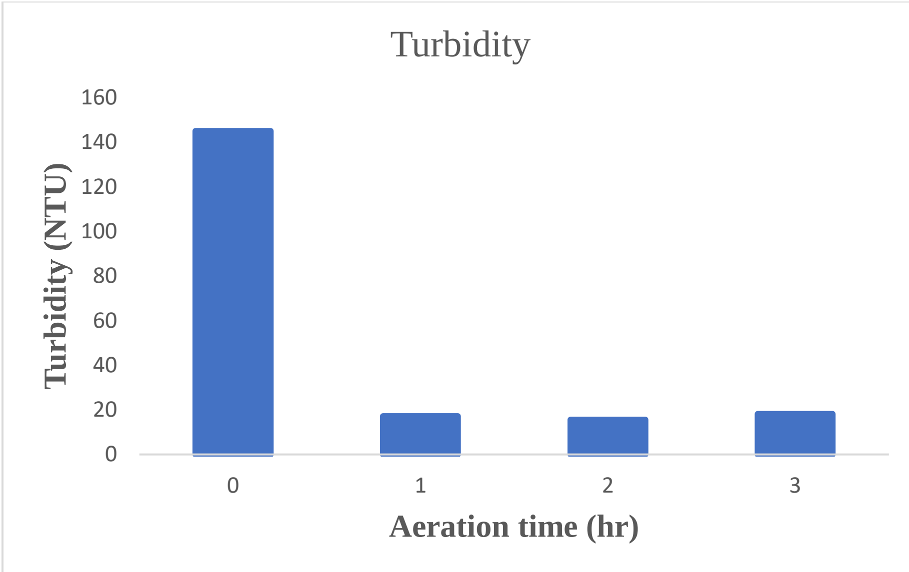

Fig.4.16: Variation of turbidity with aeration time (1hr sedimentation)

Fig.4.16 displays the variation of turbidity with aeration time (1hr sedimentation). It was observed that aeration time showed less significant effect on turbidity.

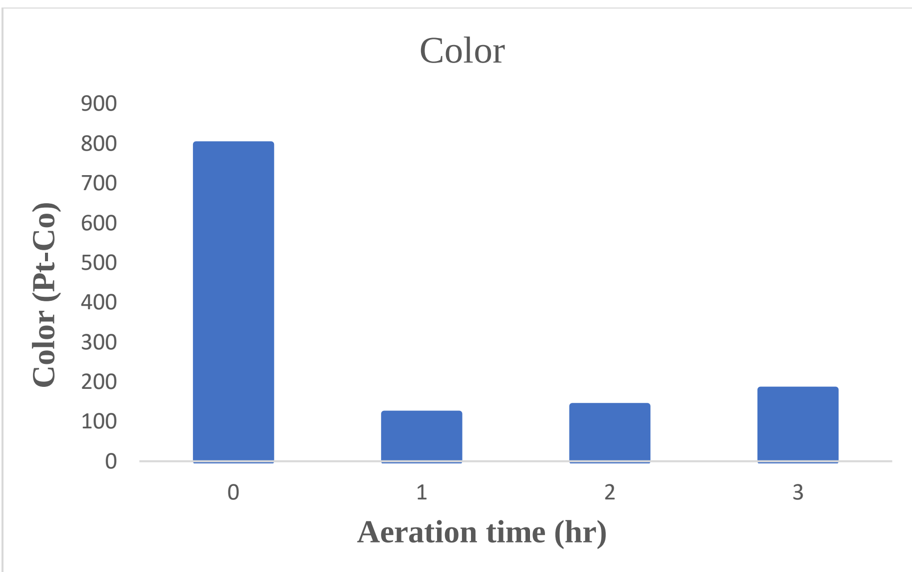

Fig. 4.17: Variation of color with aeration time (1hr sedimentation)

Fig. 4.17 demonstrates the variation of color with aeration time (1hr sedimentation). It was noticed that color increased with aeration time.

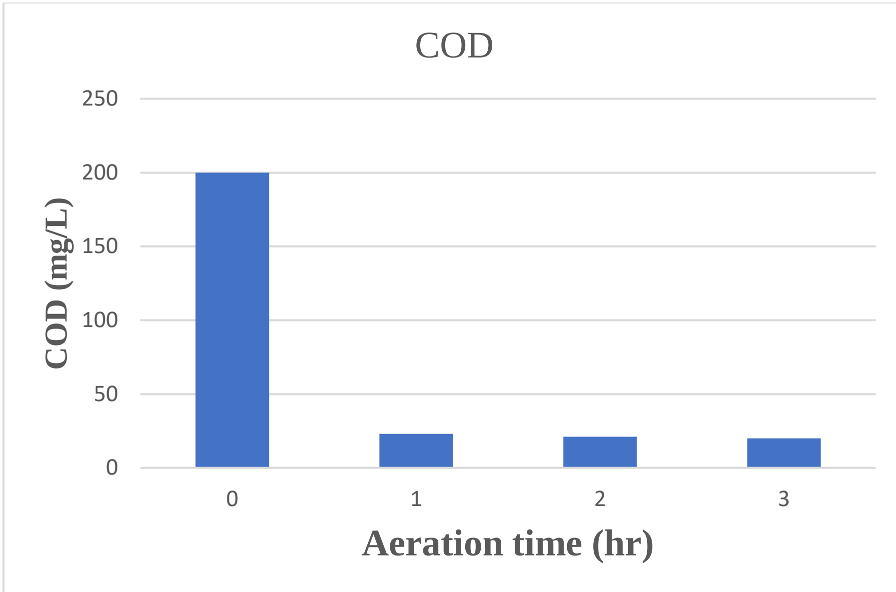

Fig. 4.18.: Variation of COD with aeration time (1hr sedimentation)

Fig. 4.18 shows the variation of COD with aeration time (1hr sedimentation). It was observed that aeration time had less significant effect on COD level.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusions

The following conclusions can be drawn from this study:

- The combined efficiency of treating waste water from textile waste water using aeration, sedimentation and filtration was around 50-60%. COD removal was 50% after aeration and sedimentation. About 90% COD removal was achieved after filtration.
- One-hour treatment process is more efficient than three hours. About 70% turbidity was removed after 1-hour aeration and sedimentation but the removal became constant at 30% as the time increased.

5.2. Recommendations

The recommendations for future study are given below.

- More wastewater samples should be collected from the source.
- Multiple retention times of aeration and sedimentation should be performed.
- Multimedia filter should be cleaned with distilled water before every test.

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Textile Industry: Unit Operations (p2infohouse.org)

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Appendix

Table A-1: Water quality parameters for inlet and outlet water of ETP of Apex Holdings Ltd.

Test parameters	UNIT	Raw WW from ETP Inlet	Outlet WW from ETP
Date		24/1/24	11/1/2024
pH		7.4	7.4
EC	µs/cm	1185	869
TDS	mg/L	579	459
TSS	mg/L	113	55
TS	mg/L	692	514
DO	mg/L	0.81	1.22
Salinity	ppm	5900	4600
Turbidity	NTU	145	34.5
Color	Pt/Co	798	1276
COD	mg/L	200	170
BOD	mg/L	38	35

Fig. A-1: Beaker for wastewater sample

Fig. A-2: 500ml beaker for BOD sample

Fig. A-3: Glass funnel to pour wastewater

Fig. A-4: Washing process of filter Materials

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