# Comparative Filtration of Laundry Wastewater using River Sand & It's Quality Enhancement through Multimedia Filtration


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**BACHELOR OF SCIENCE IN CIVIL ENGINEERING**
**June 2024**

# DECLARATION OF CANDIDATES

We hereby declare that the project/thesis work under the supervision of Dr. Amimul Ahsan entitled "Comparative Filtration of Laundry Wastewater using River Sand & It's Quality Enhancement through Multimedia Filtration", has been performed by us and this work has not been submitted elsewhere for the reward of any degree or diploma (except for publication).

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# APPROVAL OF SUPERVISOR

This is to certify that the project/thesis submitted by Md. Ibrahim Talukdar (190051245) and Faria Tasnim (190051248) have been found satisfactory and accepted as partial fulfilment of the requirement for the degree of Bachelor of Science in Civil Engineering.

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# ABSTRACT

Water is an essential component of our natural environment, often referred to as life. However, human activities have significantly contributed to the contamination of this precious resource. A worthy illustration of water pollution is the wastewater generated from laundry activities. This study aims to assess the quality of laundry wastewater by evaluating various quality parameters and to determine which one sand among two, sourced from the beds of the Turag and Padma Rivers, is more effective for filtration purposes. The reason behind utilizing riverbed sand lies in its composition, which includes silica, mica, and feldspar, all known for their efficacy in wastewater filtration. The study involved installing the more effective riverbed sand into a multimedia filter as a layer to observe enhancements in the removal rates of contaminants. Two separate single-layer sand filters, each using sand from the Turag and Padma riverbeds, demonstrated significant removal capabilities for total solids, total dissolved solids, and total suspended solids. After proper analysis, the results indicated that the filtration process produced quality effluents that met the Environmental Conservation Rules (ECR) 2023 guidelines for industrial effluent discharge into inland water bodies. When subjected to proper filtration through the multimedia filter, which included one layer of better river sand among Turag and Padma in terms of filtration capacity, commercial granular activated carbon, and coarse sand, the average removal rates for colour, turbidity, total solids, total dissolved solids, total suspended solids and chemical oxygen demand were about 95%, 98%, 84%, 84%, 80% and 68% respectively which can be considered as a remarkable example. Additionally, the average dissolved oxygen (DO) increase was 284.3%. These findings underscore the potential of riverbed sand, particularly when integrated into a multimedia filtration system, to significantly enhance the removal of pollutants from laundry wastewater. This study not only provides a viable solution for mitigating water pollution but also contributes to the sustainability of the environment.

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# LIST OF ABBREVIATIONS

TS = Total Solids

TDS = Total Dissolved Solids

TSS = Total Suspended Solids

DO = Dissolved Oxygen

COD = Chemical Oxygen Demand

ECR = Environmental Conservation Rule

GAC = Granular Activated Carbon

EC = Electricity Conductivity

WW = Waste Water

FW = Filtrated Water

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# CHAPTER I
# INTRODUCTION

## Chapter I: Introduction

### 1.1 Background of the Study

Pollution of water is now one of the most important environmental problems we face today, significantly impacting both human health and ecological balance. The sources of water pollution are diverse, encompassing agricultural runoff, industrial discharges, and domestic wastewater. Among these, domestic wastewater, particularly laundry effluents, presents a notable challenge due to the complex mixture of contaminants it carries. Laundry wastewater typically contains a variety of chemicals such as surfactants, detergents, bleaches, softeners, and other additives used in cleaning processes. These substances contribute to the pollution of water bodies, posing risks to aquatic life and human health when released untreated into the environment.

The traditional methods for treating laundry wastewater involve sophisticated and often expensive technologies such as chemical coagulation, advanced oxidation processes, and membrane filtration. While these methods are effective, they are not always feasible for widespread implementation, especially in developing countries where financial and technical resources are limited (Petrovic1 et al., 2011). Consequently, there is an increasing need to explore alternative, low-cost, and sustainable water treatment solutions that can be easily adopted by communities with limited resources (Pooi et al., 2018).

Natural filtration methods, using materials such as sand, have gained attention as a viable alternative for water treatment (Verma et al., 2017). Sand filtration is an ancient and well-established technique that relies on the physical and chemical properties of sand to remove impurities from water. The effectiveness of sand as a filtration medium is affected by factors like particle size, porosity, and mineral composition. These factors vary significantly depending on the geographical origin of the sand, which underscores the importance of evaluating locally sourced materials for filtration purposes (Stevik et al., 2004)

In this context, the present study investigates the use of river sand from the Turag and Padma rivers in Bangladesh for the filtration of laundry wastewater. The Turag River, a tributary of the Buriganga River, flows through the densely populated capital city of Dhaka and is subject to substantial pollution from urban and industrial activities. The Padma River, one of the main distributaries of the Ganges, is a crucial waterway in southwestern Bangladesh, and also facing significant pollution pressures. By comparing the filtration efficiency of sands from these two rivers, this research aims to identify a cost-effective and long-lasting solution for enhancing the quality of laundry wastewater (Martikainen et al., 2023)

## 1.2 Objectives of the Study

The aims of this study are

i. To evaluate the filtration capacity of Turag riverbed sand in treating laundry wastewater.
ii. To evaluate the filtration capacity of Padma riverbed sand in treating laundry wastewater.
iii. To compare the performance of Turag and Padma River sands in terms of contaminant removal, turbidity reduction, and overall water quality improvement.
iv. To identify the key factors that influence the filtration efficiency of river sands.
v. To provide practical suggestions for utilizing river sand in wastewater treatment applications, informed by the study's discoveries.

## 1.3 Scope of the Study

The scope of this study encompasses several key aspects:
**i. Geographical Focus**: The study focuses on the Turag and Padma rivers, two significant water bodies in Bangladesh. Sand samples will be collected from specific locations along these rivers to ensure representativeness.

**ii. Sample Collection and Preparation:** Detailed procedures will be followed for the collection, cleaning, and preparation of sand samples from both riverbeds.

**iii. Experimental Design:** The study will employ a systematic experimental design to evaluate the filtration performance of the river sands. This includes setting up filtration columns, preparing laundry wastewater samples, and conducting filtration experiments under controlled conditions.

**iv. Data Collection and Analysis:** Comprehensive data collection will be undertaken to measure key parameters such as turbidity, pH, and contaminant levels before and after filtration. Statistical analysis will be performed to compare the performance of the two sand types and find important differences.

**v. Recommendations:** Based on the findings, practical recommendations will be provided for the use of river sand in wastewater treatment, with a focus on scalability and feasibility for real-world applications.

## 1.4 Organization of the Thesis

**Chapter I: Introduction** This chapter gives a summary of the study, covering the background, goals, scope, and structure of the thesis. It explains the context of the research and details the main objectives and focus areas

**Chapter II: Literature Review** This chapter reviews existing literature on water pollution, laundry wastewater treatment, and natural filtration methods. It highlights the gaps in current research and positions the present study within the broader context of water treatment technologies.

**Chapter III: Methodology of Study** This chapter details the experimental design and methodology used in the study. It describes the materials and methods for sand sample collection, preparation, and filtration experiments. The procedures for data collection and analysis are also outlined.

**Chapter IV: Results and Discussion** This chapter presents the results of the filtration experiments, comparing the performance of Turag and Padma riverbed sands. It includes a detailed analysis and discussion of the findings, interpreting the data in the context of existing research and theoretical frameworks.

**Chapter V: Conclusions and Recommendations:** The final chapter sums up the main findings of the study, offers conclusions, and gives practical advice on using river sand in wastewater treatment. It also suggests areas for future research and possible applications of the results

# CHAPTER II
# LITERATURE REVIEW

## 2.1 Introduction

The increasing global demand for freshwater necessitates innovative and sustainable solutions for water conservation and reuse. Laundry wastewater, characterized by high volumes and the presence of contaminants like detergents, microfibers, and suspended solids, presents a significant opportunity for treatment and recycling. River sand, a naturally abundant and cost-effective material, has emerged as a promising filtration medium for water purification. This literature review examines the use of river sand for laundry water filtration, focusing on its effectiveness in removing contaminants and enhancing water quality. Additionally, it explores the comparative performance of river sand from different sources, highlighting the importance of source characteristics on filtration efficiency.

## 2.2 River Sand as a Filtration Medium

River sand, primarily composed of quartz, exhibits desirable properties for water filtration, including high porosity, good permeability, and significant surface area for contaminant adsorption (Sand filter - Wikipedia, 2023). The physical and chemical characteristics of river sand, however, can vary depending on its geological origin, influencing its filtration performance. Factors such as grain size distribution, mineral composition, and the presence of organic matter can impact the removal efficiency of suspended solids, dissolved organic matter, and other contaminants (Doménech-Sánchez et al., 2021).

### 2.2.1 Filtration Mechanisms

Several mechanisms contribute to the effectiveness of river sand in removing contaminants from laundry water:

**Physical Straining:** The porous structure of the sand bed acts as a physical barrier, trapping particles larger than the pore spaces.

**Sedimentation**: Gravity causes larger suspended particles to settle within the sand bed, further enhancing removal.

**Adsorption:** The large surface area of sand particles facilitates the adsorption of dissolved organic matter, heavy metals, and other contaminants.

**Biological Activity:** Over time, a biofilm of microorganisms may develop on the sand grains, contributing to the biodegradation of organic pollutants.

### 2.2.2 Comparative Performance of River Sand from Different Sources

The effectiveness of river sand as a filtration medium can vary depending on its source. Studies have shown that sand with a coarser grain size distribution and lower organic matter content generally exhibits higher filtration efficiency (Doménech-Sánchez et al., 2021). For instance, research comparing the performance of sand filters with different grain sizes found that filters with coarser sand achieved better removal of turbidity and suspended solids (Singh et al., 2021). This difference in performance can be attributed to the larger pore spaces in coarser sand, allowing for greater water flow and reduced clogging.

Furthermore, the mineral composition of river sand can also influence its filtration capacity. Sand with a higher content of iron and manganese oxides, for example, may exhibit enhanced removal of arsenic and other heavy metals through adsorption and oxidation-reduction reactions (Petrusevski et al., 2023)

## 2.3 Quality Enhancement of Laundry Wastewater

Filtration through river sand can significantly improve the quality of laundry water by reducing turbidity, suspended solids, chemical oxygen demand, and microbial contamination (Singh et al., 2021). Studies have demonstrated that sand filtration can achieve high removal rates for these parameters, making the treated water suitable for reuse in non-potable applications such as irrigation or toilet flushing (Ciabattia et al., 2009).

## 2.4 Conclusion

River sand presents a promising and sustainable solution for laundry water filtration and quality enhancement. Its natural abundance, cost-effectiveness, and ability to remove a wide range of contaminants make it an attractive alternative to conventional filtration technologies. However, the source of river sand plays a crucial role in determining its filtration efficiency. Factors such as grain size distribution, mineral composition, and organic matter content can significantly impact the performance of sand filters. Therefore, careful consideration of these factors is essential when selecting river sand for laundry water treatment applications. Further research is needed to optimize filter design parameters and evaluate the long-term performance and sustainability of river sand filtration systems for decentralized laundry water treatment and reuse.

# CHAPTER III

# METHODOLOGY

### 3.1 Introduction

The total process is done in two processes. Firstly, the better sand between the Turag River and Padma River was determined using one-layer filtration. Secondly, after determining of better one between Turag River sand and Padma River sand, the better sand was added to the multimedia filter as a layer for better filtration, increasing the removal percentage of pollutants and laundry water quality enhancement.

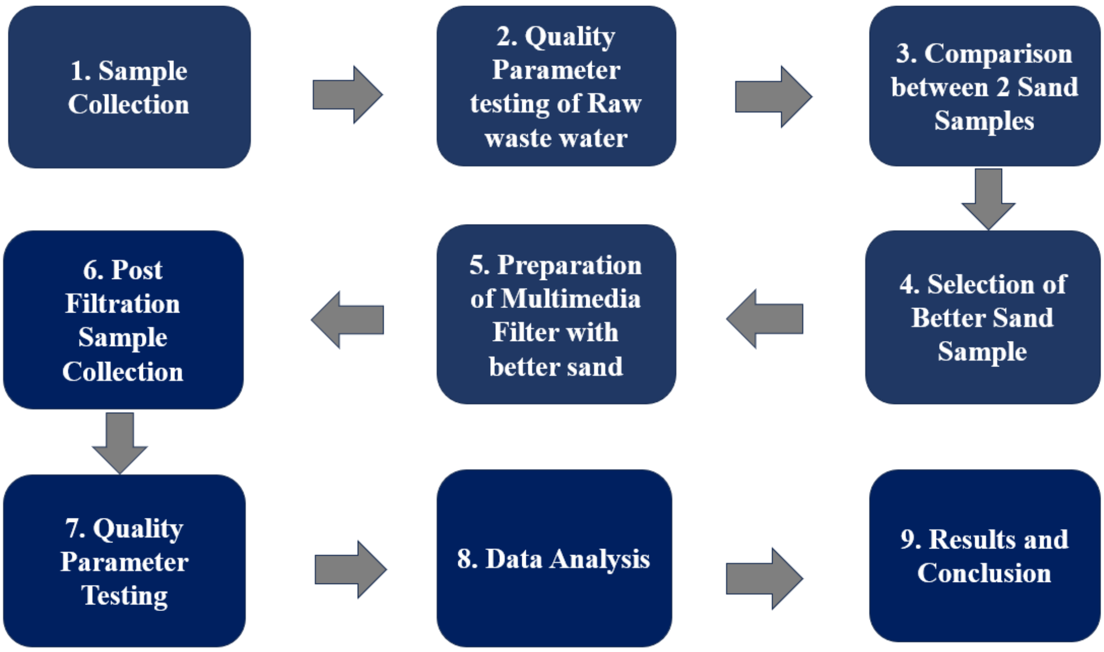



Fig 3.1: Summary of the study

### 3.2 Collection of Sample

Wastewater samples were initially gathered from the laundry facilities at the Islamic University of Technology (IUT). The collection focused on capturing effluent directly from the discharge points to ensure accuracy and relevance. Samples were collected at consistent intervals to maintain uniformity and one sample wasn't used twice. After collection, the necessary parameters (Colour, turbidity, TS, TDS, EC, DO etc.) of wastewater were immediately tested and recorded.


(a) (b)

Fig 3.2: Wasterwater (a) before & (b) after collection from IUT Laundry

### 3.3 Determination of the better river-sand

#### 3.3.1 Collection of River Sand

Two distinct types of riverbed sand from different locations in Bangladesh were collected to compare their characteristics and potential applications. The first set of samples was dragged river bed sand obtained from the bank of Padma River, specifically located in Ishwardi (24°04'08.5"N 89°02'11.1" E). This region is known for its vast and dynamic river system, providing a rich source of sediment. The second set of samples was gathered from the Turag River bank, situated at Beribandh, Mirpur (23.827259,90.345119) and it was also dragged from the Turag River bed. The Turag River, an important tributary of the Buriganga River, has different hydrological and sedimentary properties compared to the Padma. By analyzing sand from these two diverse river systems, we aimed to understand the variations in grain size, mineral composition, and other relevant physical properties. This comparative study provides insights into the geological and environmental factors influencing sand deposition in these regions.

Fig 3.3: Collection of Sand from Turag river bank and Padma river bank respectively

**Turag River Sand**

**Padma River Sand**

### 3.3.2 Grain Size Analysis (Sieve Analysis)

Sieve analysis tests were conducted on the two different types of sand collected from the Turag River and Padma River, as mentioned earlier. The purpose of these tests was to determine the distribution of grain sizes in each sand sample according to the ASTM (American Society for Testing and Materials) C136 Method. This method involves systematically passing the sand through a series of sieves with progressively finer mesh sizes to separate and quantify the particles based on their size.

By performing sieve analysis, we aimed to understand the proportion of different grain sizes present in each sand type. This information is crucial for assessing the filtration capabilities of the sands, as grain size directly influences how effectively they can filter out contaminants from water or other fluids.

The ASTM C136 Method (Taking 500g of each sample) ensures standardized testing procedures, allowing for accurate comparison between the Turag River sand and Padma River sand. Each sample was carefully prepared and analyzed to ensure the consistency and reliability of the results.

The results of the sieve analysis provided detailed data on the distribution of course, medium, and fine grains within each sand type. This data helps in identifying predominant grain sizes and any variations between the sands from different river beds.

Understanding the grain size distribution is essential for selecting the most suitable sand for specific applications, such as water filtration systems. Sands with finer and more uniform grain sizes typically exhibit better filtration efficiency by providing a tighter matrix that effectively traps particles.

In conclusion, sieve analysis according to the ASTM C136 Method was instrumental in characterizing the grain size distribution of Turag River sand and Padma River sand. This characterization is fundamental for evaluating their respective filtration capabilities and making informed decisions regarding their practical use in filtration processes.

Table 3.1: Sieve Analysis of Turag River Sand (With 500g sample)

| ASTM Sieve | Retained (g) | Retained (%) | Cum. Retained (%) | Finer (%) |
|---|---|---|---|---|
| 16 | 0.17 | 0.03 | 0.03 | 99.97 |
| 30 | 0.65 | 0.13 | 0.17 | 99.83 |
| 40 | 3.82 | 0.77 | 0.94 | 99.06 |
| 50 | 0.04 | 0.01 | 0.95 | 99.05 |
| 100 | 441.66 | 89.47 | 90.42 | 9.58 |
| 200 | 45.05 | 9.13 | 99.54 | 0.46 |
| Pan | 2.25 | 0.46 | 100 | 0 |
| **Total (g)** | **493.64** | | | |
| **Loss (%)** | **1.272** | | | |

Table 3.2: Sieve Analysis of Padma River Sand (With 500g sample)

| ASTM Sieve | Retained (g) | Retained (%) | Cum. Retained (%) | Finer (%) |
|---|---|---|---|---|
| 16 | 1.06 | 0.21 | 0.21 | 99.79 |
| 30 | 7.73 | 1.56 | 1.77 | 98.23 |
| 40 | 89.88 | 18.14 | 19.91 | 80.09 |
| 50 | 8.59 | 1.73 | 21.64 | 78.36 |
| 100 | 366.3 | 73.91 | 95.56 | 4.44 |
| 200 | 20.57 | 4.15 | 99.71 | 0.29 |
| Pan | 1.44 | 0.29 | 100.00 | 0.00 |
| **Total (g)** | **495.57** | | | |
| **Loss** | **0.886** | | | |

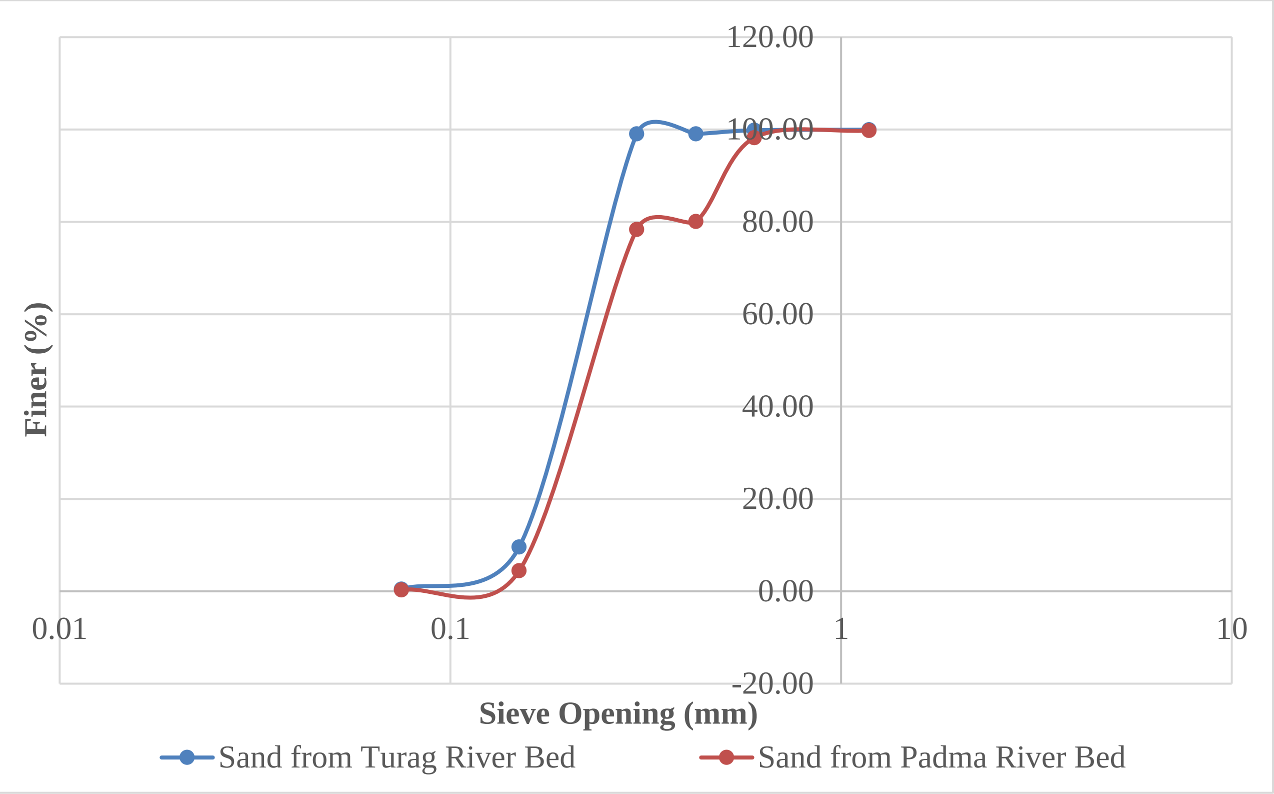



Fig 3.4: Grading curve of Turag River sand & Padma River sand

From the grading curve, a conclusion can be drawn that both the Turag River and Padma River sands are gap-graded. But Turag River sand is more poorly gap graded than the Padma River sand because around 89% of grains are retained on the #100 sieve and the rest are retained on the remaining sieves whereas the Padma River Sand is almost 74% retained on the #100 sieve.

### 3.3.3 Washing & Setting in Identical Bottles:

The sand samples from the Turag River and Padma River were cleaned thoroughly with distilled water to remove soluble/insoluble impurities or contaminants that could affect the filtration tests. This step ensured that the sand samples were in a pristine state before conducting the experiments.

Next, two identical plastic bottles were prepared, each designated for one type of sand sample. We carefully measured and placed 500 grams of each sand into separate layers within these bottles. This ensured consistency and allowed for a direct comparison of filtration performance between the Turag River sand and Padma River sand under controlled conditions.

### 3.3.4 Filtration & Monitoring:

After the preparation of a single-layered bottle filter, distilled water was allowed to pass through several times. Then, the wastewater was introduced into each bottle containing the sand layers, allowing it to pass through the sand bed. This simulated the filtration process where the sand acts as a filter medium to remove impurities from the wastewater.

During filtration, samples of the filtrated water were collected after passing through each sand layer. This allowed us to measure and analyze the effectiveness of each sand type in removing contaminants and improving water quality.

Following the filtration tests, three sets of laboratory tests were conducted on the filtrated water samples. These tests included measuring turbidity levels, assessing pH, and analyzing for specific contaminants or particles that remained in the water after filtration.

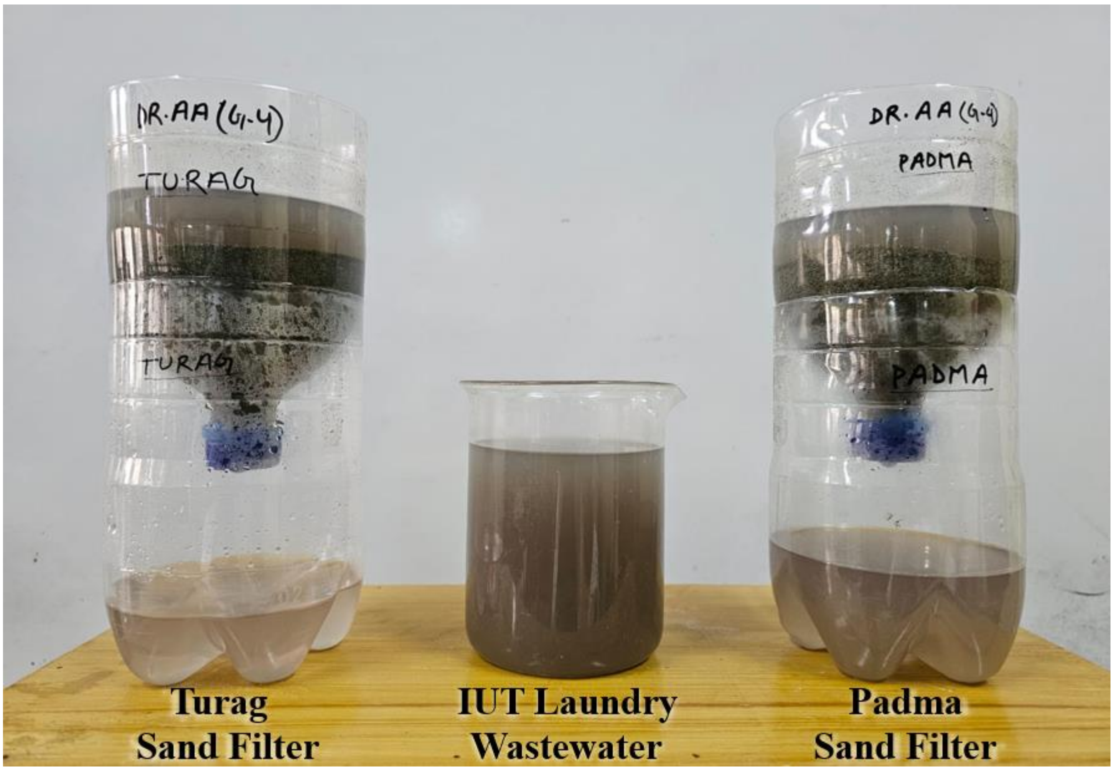



Fig 3.5: Determination of a better one between Turag River Sand & Padma River Sand through single-layered filtration using two identical bottles

### 3.3.5 Test Results:

The results of these laboratory tests provided quantitative data on the filtration efficiency of Turag River sand compared to Padma River sand. We evaluated factors such as turbidity reduction and contaminant removal rates to determine which sand type performed better in improving water quality.

The experimental setup ensured that all variables were controlled, such as the amount of sand used, the flow rate of wastewater through the filters, and the testing conditions in the laboratory.

By comparing the results from both sand samples, we were able to conclude their respective suitability for filtration processes. Sands with finer and more uniform grain sizes typically exhibited better filtration performance due to their ability to create denser and more effective filtration barriers.

In conclusion, the comprehensive experimental approach allowed us to evaluate and compare the filtration capabilities of Turag River sand and Padma River sand using real-world wastewater samples. This study provided valuable insights into selecting the most effective sand type for practical filtration applications, contributing to improved water treatment processes

## 3.4 Formation of Multimedia Filter

### 3.4.1 Media Collection & Preparation:

After collecting media from a construction site at the Islamic University of Technology (IUT) the media samples were thoroughly mixed to ensure a homogeneous blend, crucial for maximizing filtration effectiveness. Following mixing, sieve analysis was conducted using the ASTM sieves to separate particles by size. This identified four distinct grain size fractions from coarse gravel to fine sand.

The sieve analysis provided essential data for designing and optimizing the multimedia filter, guiding the selection of optimal layer ratios and thicknesses to ensure uniform flow and effective particle retention.

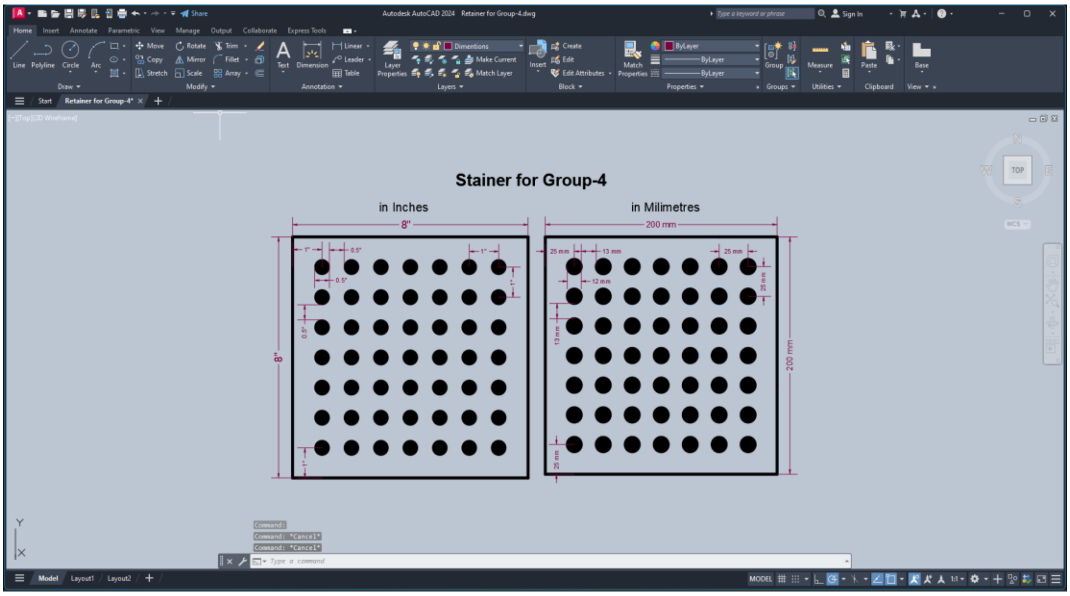
By incorporating various gravel and sand sizes into the filter design, the goal was to maximize filtration surface area and promote efficient water flow, essential for achieving high filtration efficiency and minimizing blockages.

### 3.4.2 Glass Box Preparation:

a glass box was designed and prepared specifically chosen for its transparency, which allows us to visually observe the filtration process from outside the box. The decision to use glass was based on its optical clarity, ensuring clear visibility of the interior throughout the experiment. The dimensions of the glass box were carefully selected to accommodate our experimental needs: it measured 8 inches in length, 8 inches in width, and 18 inches in height. The entire glass box had a uniform thickness of 8 mm, providing structural integrity while maintaining transparency for observation purposes. This design allowed us to monitor and document the behaviour of the filtration media and the flow of water or wastewater through the system in real-time. The transparent nature of the glass box also facilitated easy adjustments and modifications during the experimental setup, ensuring precision in our methodology. Overall, the use of glass in constructing the box enhanced the reliability and accuracy of our observations, crucial for the thorough analysis required in our thesis work on filtration processes. A water tap was set at the bottom of the glass box to collect the filtrated water.

### 3.4.3 Preparation of Strainer

A 2mm thick stainless steel sheet was cut with a laser to create a grid of holes in a 7x7 pattern. Each hole was 0.5 inches in diameter and spaced 0.5 inches apart. Stainless steel was chosen for its ability to resist rust, ensuring long-lasting performance.




(a) Design of Strainer in AutoCAD

(b) CNC Cutting

(c) Prepared Strainer

Fig 3.6: Design & preparation of strainer

### 3.4.4 Installation of Strainer

To support the filtering media inside a glass box, a 0.5-inch diameter stainless steel pipe was welded at the four corners and in the middle of the strainer, extending 4 inches to provide stability.

The strainer was wrapped with three layers of fine stainless-steel mesh, each with 1mm openings, preventing the filter media from passing through.

I was placed inside the glass box filter and the gap between the strainer and the glass wall was sealed using putty.

This setup was durable and suitable for applications requiring precise filtration and resistance to corrosion.

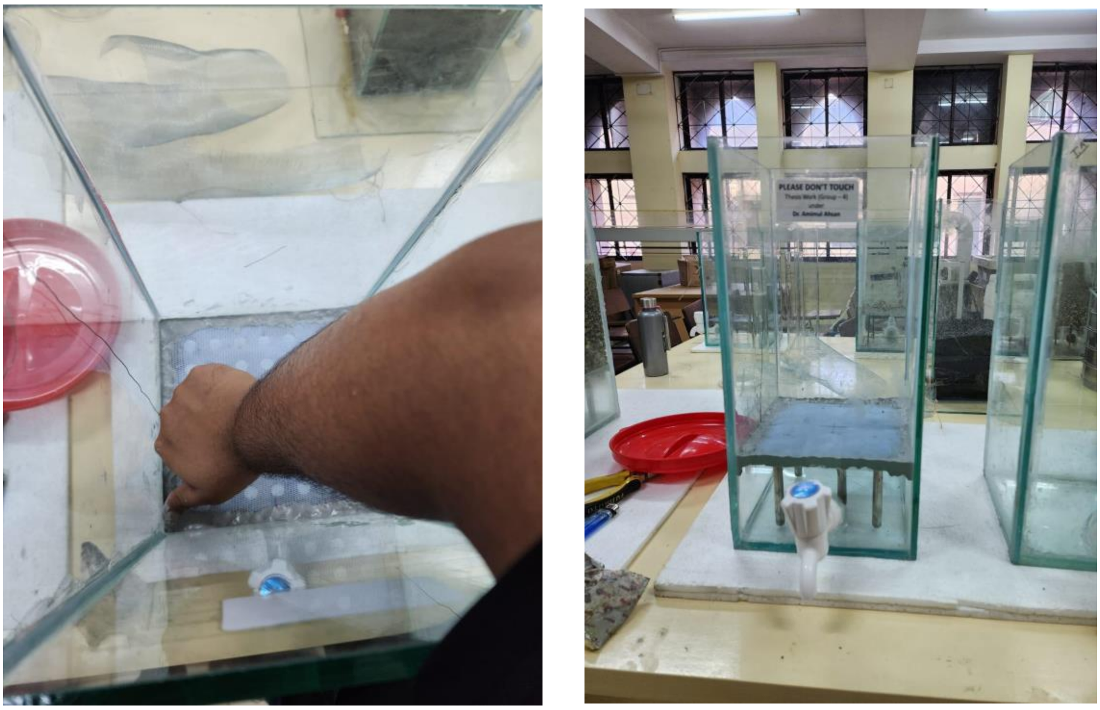


Fig 3.7: Installation of strainer

### 3.4.5 Media Installation

All the media were washed using distilled water and installed according to the picture and table presented below:

Table 3.3: Mass & depth of media used in the multimedia filter

| Media | Weight (gm) | Layer Depth |
|---|---|---|
| 4.75 mm Stone | 2422.33 | 40 mm |
| 2.36 mm Stone | 2157.82 | 40 mm |
| 1.18 mm Stone | 2127.71 | 40 mm |
| 0.6 mm Sand | 2811.63 | 40 mm |
| Turag Sand | 3048.24 | 40 mm |
| GAC | - | 40 mm |

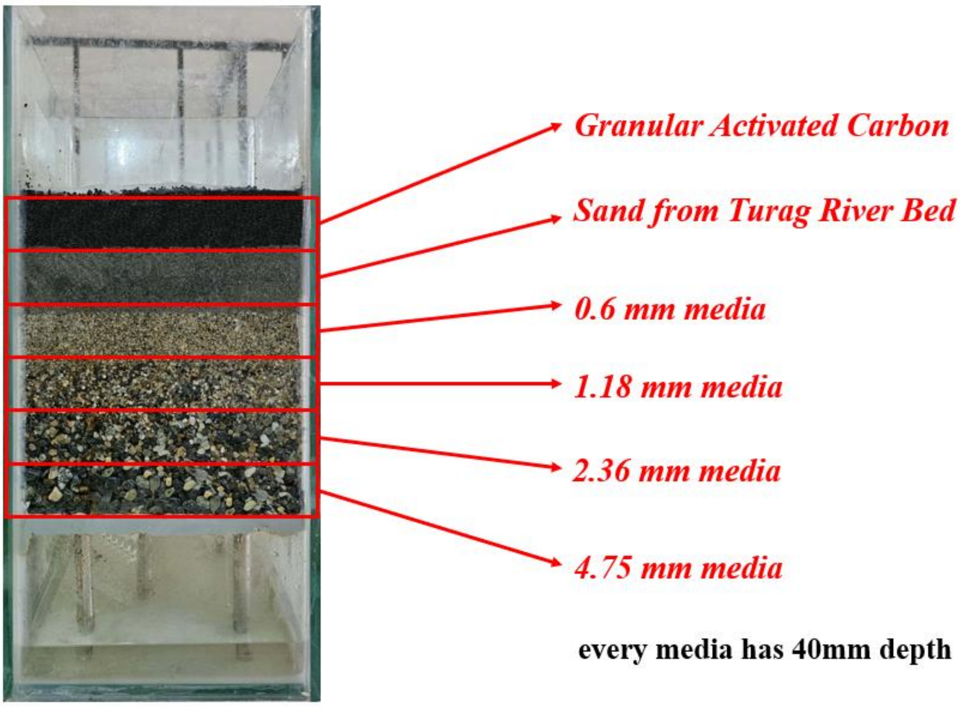



Fig 3.8: Multimedia Filter

### 3.4.6 Filtration & Monitoring

Raw wastewater was collected before every test as samples from the IUT Laundry, ensuring that each batch was representative of the typical effluent produced by the facility. Before filtrating the wastewater in every test, the filtration system was thoroughly cleaned and run with distilled water to establish a baseline. The process of filtration began by allowing the raw wastewater to be filtered through gravity, without any external pressure, to mimic natural filtration processes. This setup was carefully observed and monitored through a transparent glass box, which allowed for continuous visual inspection of the filtration process. The clarity and transparency of the glass box were crucial for detecting any immediate changes or irregularities in the filtration system's performance.

### 3.4.7 Test Results and Drawing Conclusions

10 necessary parameters were tested, including pH, Chemical Oxygen Demand (COD), turbidity, and Dissolved Oxygen (DO). The objective was to determine whether a single-layered river sand filter or a multimedia filter performed more effectively. Each filter's performance was evaluated based on these parameters, and a detailed analysis was conducted to conclude. The effectiveness of the filters was also compared against the Environmental Conservation Rules (ECR) 2023 guidelines to determine which one met the standards more satisfactorily. The results were meticulously recorded, and statistical analyses were performed to ensure the reliability of the findings. The comparison aimed to provide a clear understanding of the advantages and limitations of each filtration method.

All the parameters were measured using the following instruments:

| S/N | Parameter | Instrument Used |
|---|---|---|
| 1 | Colour | HACH DR3900 Spectrophotometer |
| 2 | Turbidity | HACH 2100Q Portable Turbidity Meter |
| 3 | pH | HACH Sension$^+$ pH31 Laboratory pH & OPRP Meter |
| 4 | COD | HACH DRB200 Digital Reactor,<br>HACH DR3900 Spectrophotometer |
| 5 | DO | HACH HQ40d Multiparameter |
| 6 | Salinity | HACH HQ40d Multiparameter |
| 7 | EC | HACH HQ40d Multiparameter |
| 8 | TS | N/A (Manual) |
| 9 | TDS | N/A (Manual) |
| 10 | TSS | N/A (Manual) |


Fig 3.9: Measurement of TS & TDS Manually (Heated at 105 °C for 24 hours)

# CHAPTER IV

# RESULTS AND DISCUSSION

## 4.1 Introduction

There are two types of results in this experiment/research:

1. Which river sand is better in laundry wastewater filtration between Turag & Padma (3 tests were done)

2. After determining the better sand, how will be the performance of a multimedia filter if one layer of that River Sand is used as a media in the multimedia filter (6 tests were done)

The results were determined based on the changes in measurements of the necessary parameters before and after filtration: Colour, turbidity, pH, DO, COD, Salinity, EC, TS, TDS and TSS.

## 4.2 Results and Discussion

### 4.2.1 Determination of the Better One Between Turag River Sand & Padma River Sand

Table 4.1: Quality Parameters Testing to Find the Better Sand for Filtration (Turag VS Padma

| Parameter | Unit | Average Parameters of Laundry Wastewater Sample | Quality Parameters of Sample after Filtration | | | |
|---|---|---|---|---|---|---|
| | | | Using Turag River Sand | | Using Padma River Sand | |
| | | | After Filtration (Average) | % Removal (Average) | After Filtration (Average) | % Removal (Average) |
| Colour | PtCo | 4560 | 601 | 87.48 | 705.67 | 85.21 |
| Turbidity | NTU | 762.67 | 37.07 | 95.54 | 66.77 | 91.69 |
| pH | - | 8.99 | 7.94 | 11.67 | 8.09 | 10.05 |
| DO | mg/L | 2.41 | 4.22 | -116.97 | 4.92 | -175.19 |
| EC | µS/cm | 2693.33 | 1589 | 40.77 | 1549.67 | 41.61 |
| Salinity | % | 1.46 | 0.8 | 45.6 | 0.77 | 47.23 |
| TS | mg/L | 3395.33 | 1513 | 55.18 | 1727.33 | 48.96 |
| TDS | mg/L | 2964.67 | 1451.33 | 50.8 | 1626 | 44.91 |
| TSS | mg/L | 430.67 | 61.67 | 85.01 | 101.33 | 74.83 |

*Note: A negative removal rate of DO indicates increments*

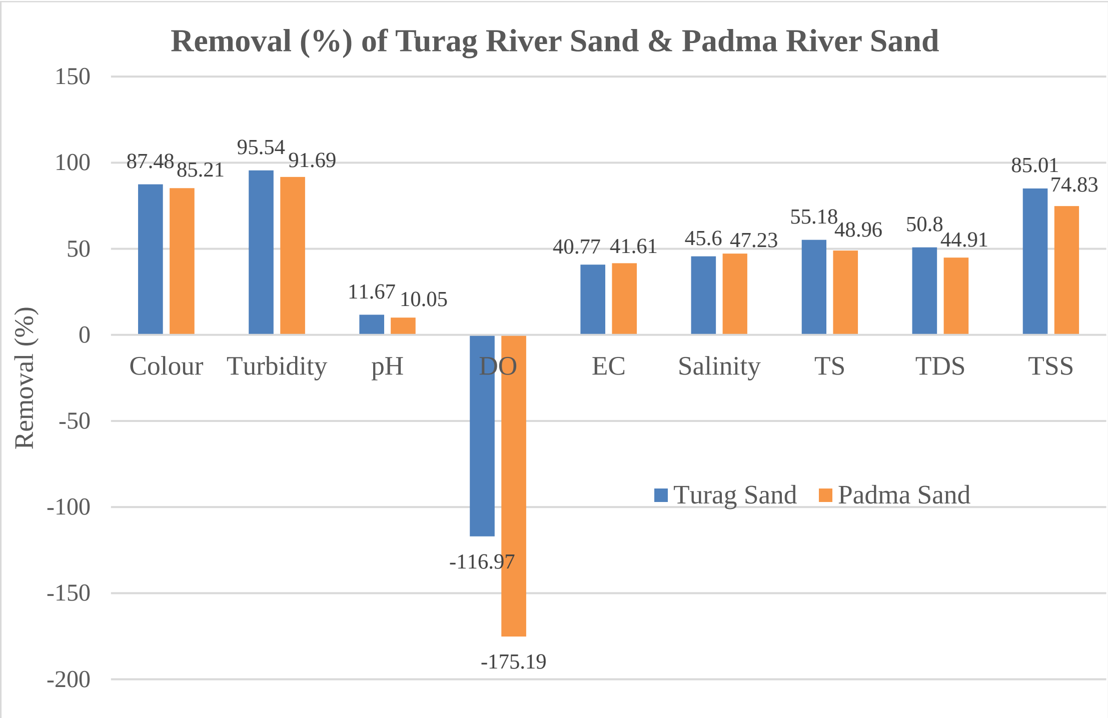
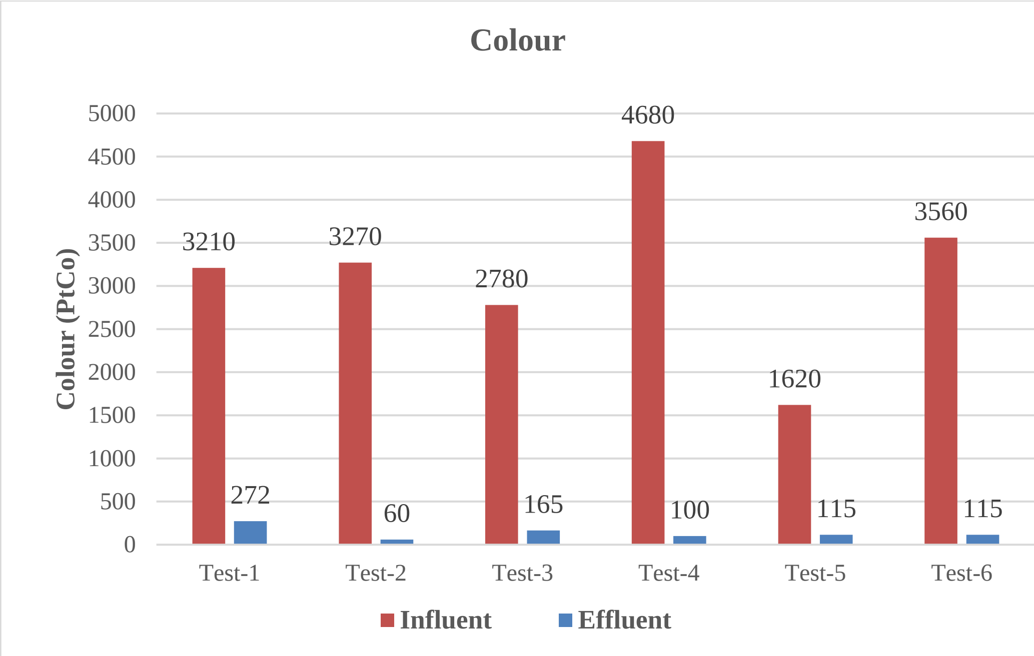


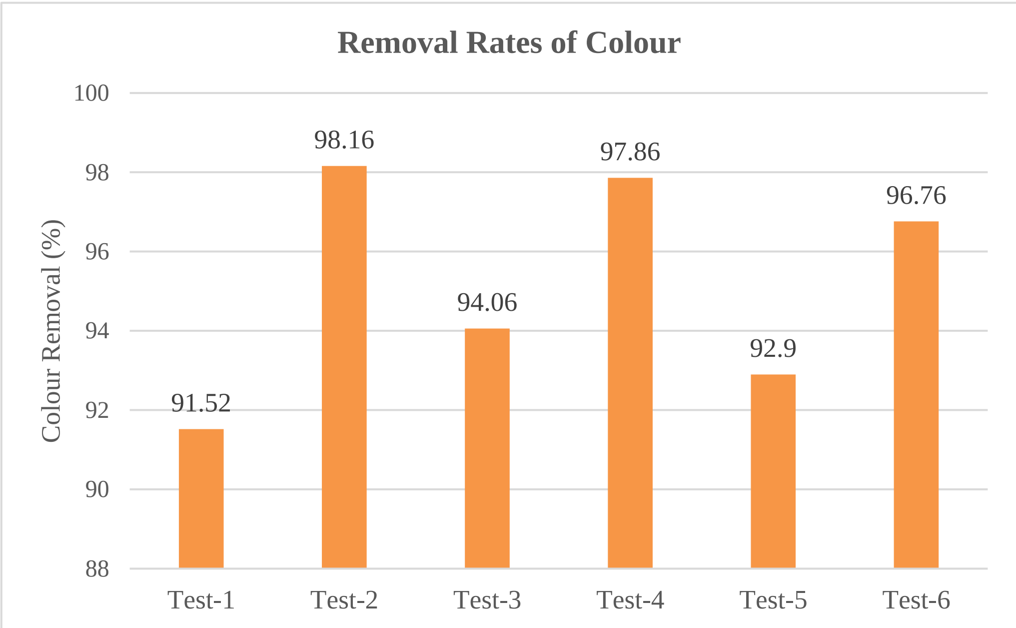

Fig 4.1: Average Removal Efficiencies for Turag & Padma River Sand for Filtration

In most cases, Turag River sand gives better removal rates than Padma River sand in laundry wastewater filtration. Turag River sand showed around 2% better colour removal, around 4% better turbidity removal, around 1.5% better pH removal, around 60% better DO increment, around 7.5% (average) better TS, TDS, TSS removal etc. than Padma River sand (Fig. 4.1).

### 4.2.2 Analysis of Removal Rates of Parameters Using Multimedia Filter



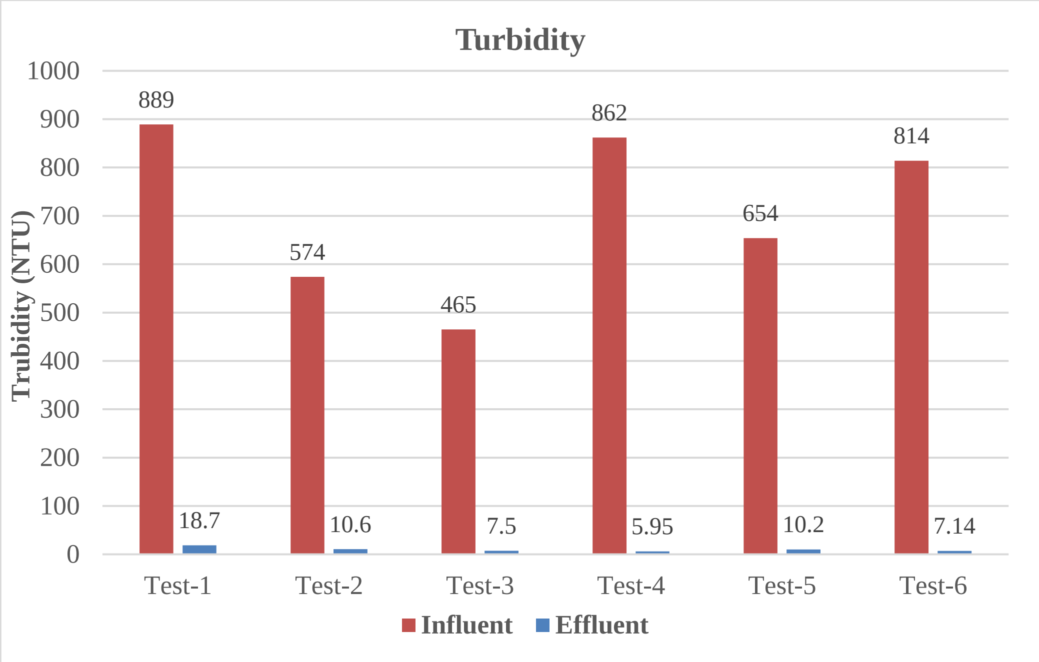

(a)



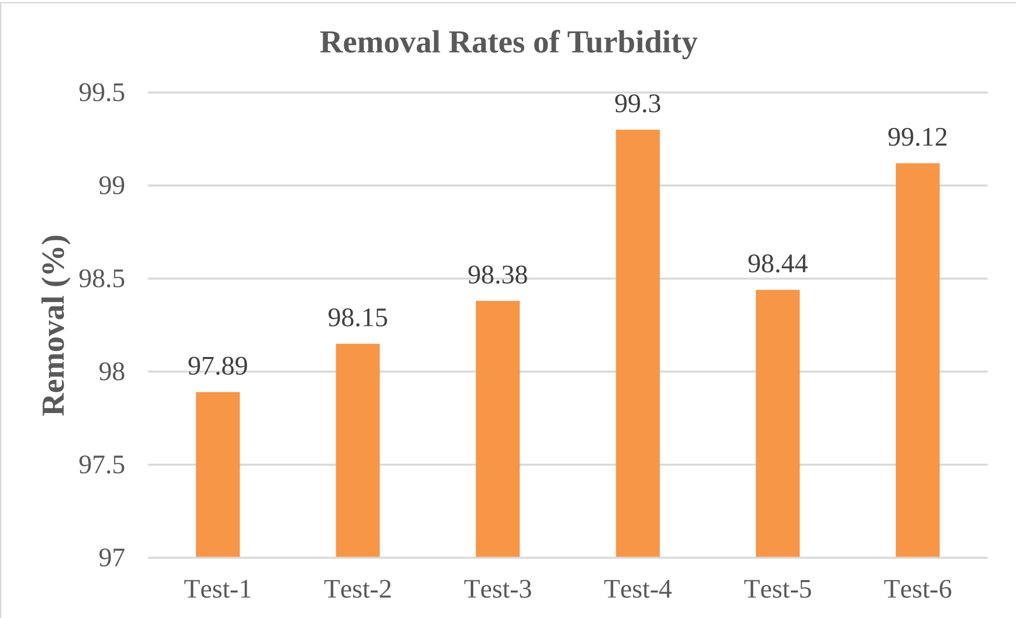

(b)

Fig 4.2: (a) Changes & (b) Removal rates of colour

It was found that removal rates of colour range between 91.52% to 98.16% with an average value of 98.54%. Wastewater had colour ranging between 1620 to 4680 PtCo whereas the test results show colours of 60 to 272 PtCo for effluent. (Fig. 4.2).



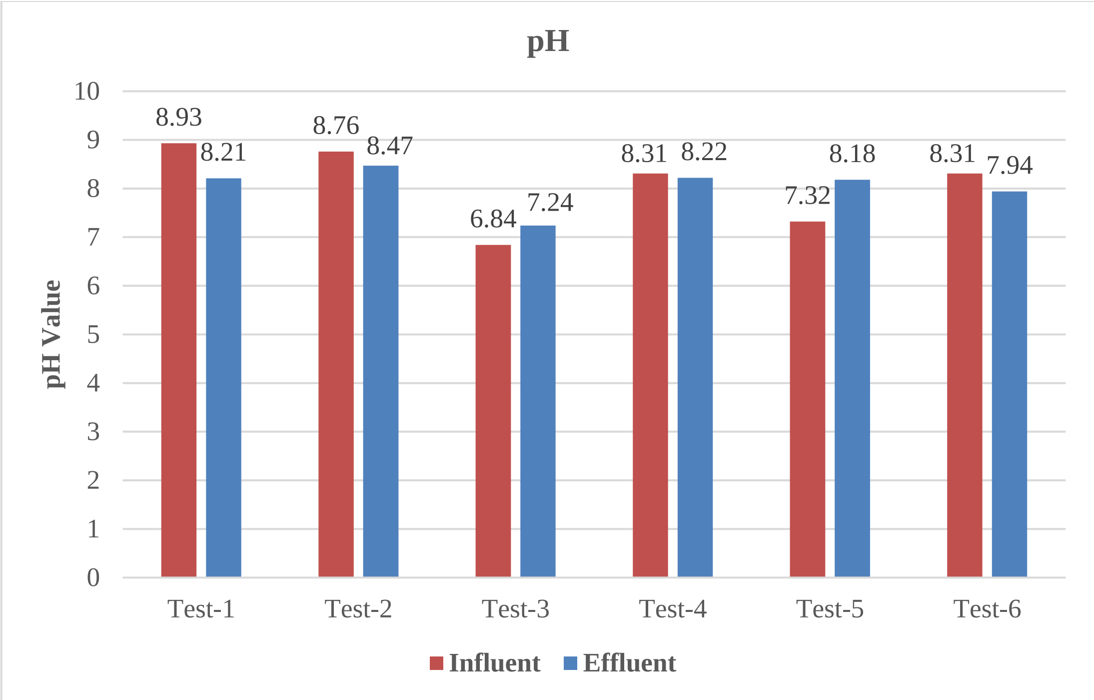

(a)



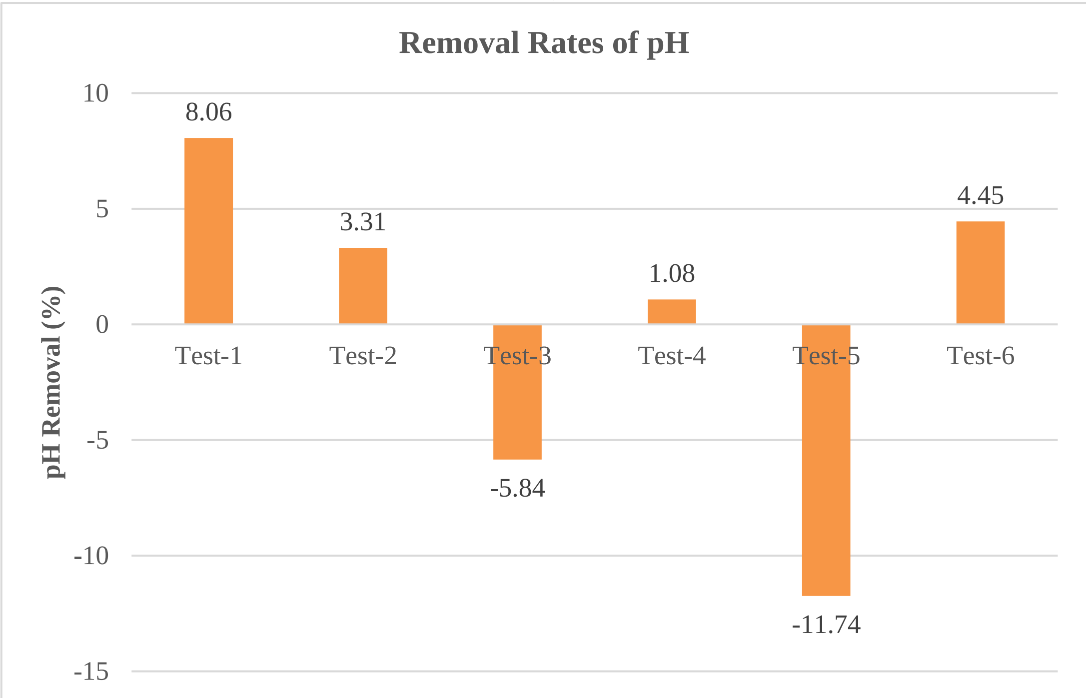

(b)

Fig 4.3: (a) Changes & (b) Removal Rates of Turbidity

Multimedia filter shows removal rates of turbidity range between 97.89% to 99.3% with an average value of 98.54%. Before filtration, the influent showed turbidity ranging between 465 to 889. After filtration, the test results show turbidity of 5.95 to 18.7 NTU. (Fig. 4.3).



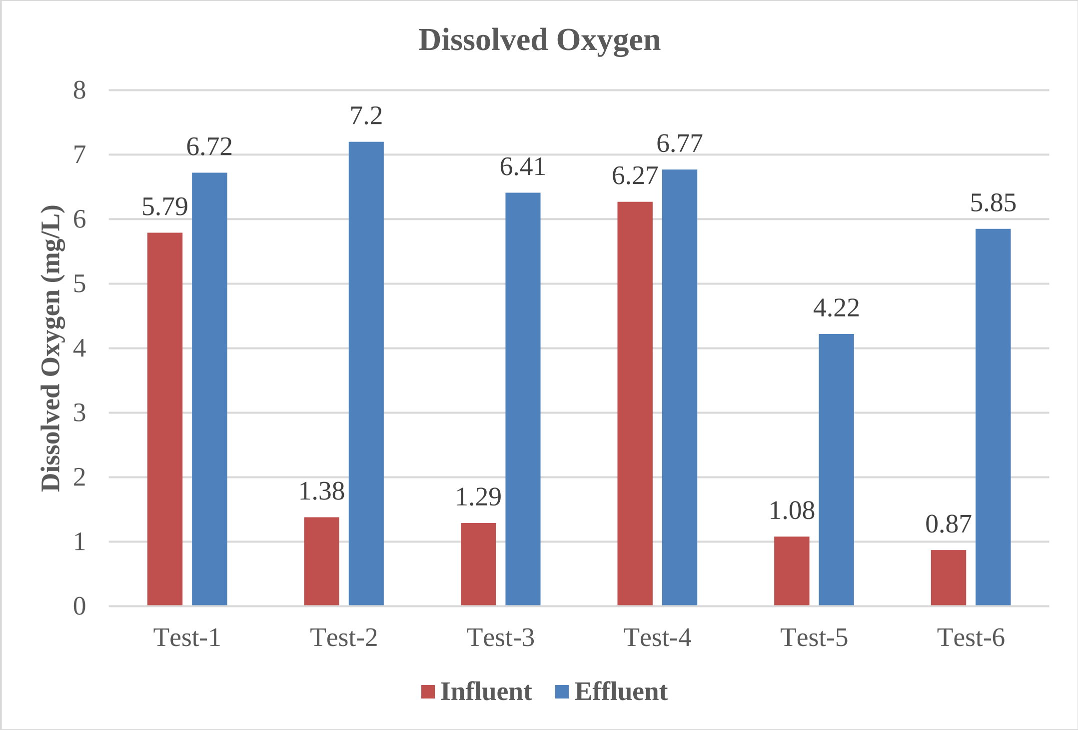

(a)



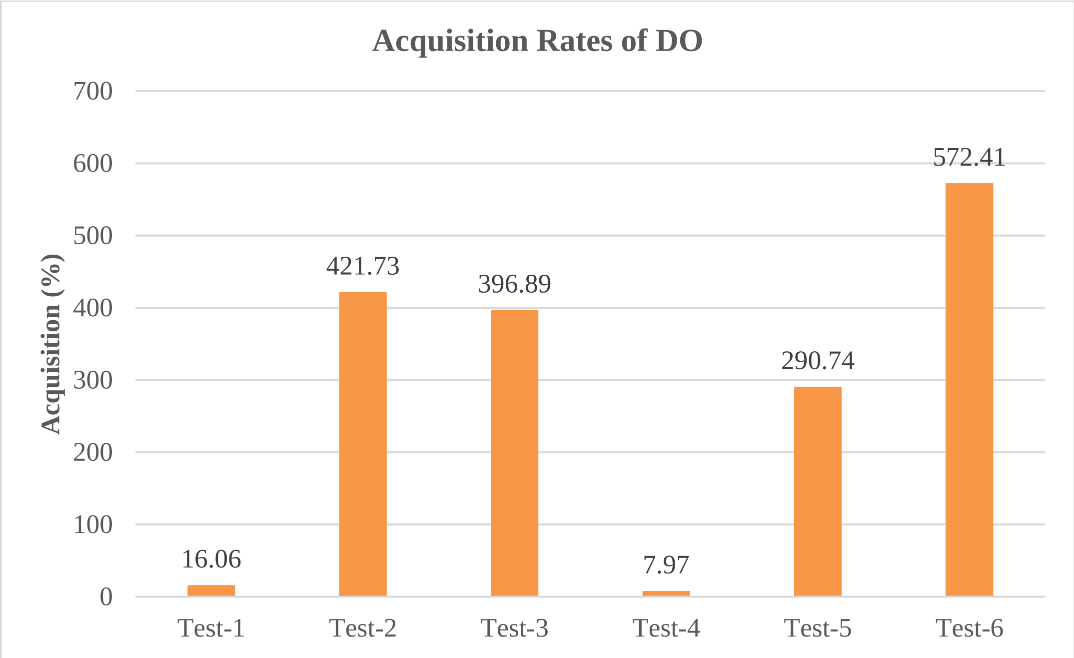

(b)

Fig 4.4: (a) Changes & (b) Removal Rates of pH (-ve indicates increment)

The above graphs conclude that removal rates of pH range between -11.74% to 8.06%. Before filtration, the pH values were between 6.84 to 8.93 and the test results show pH values of 7.24 to 8.47 after filtration (Fig. 4.4).



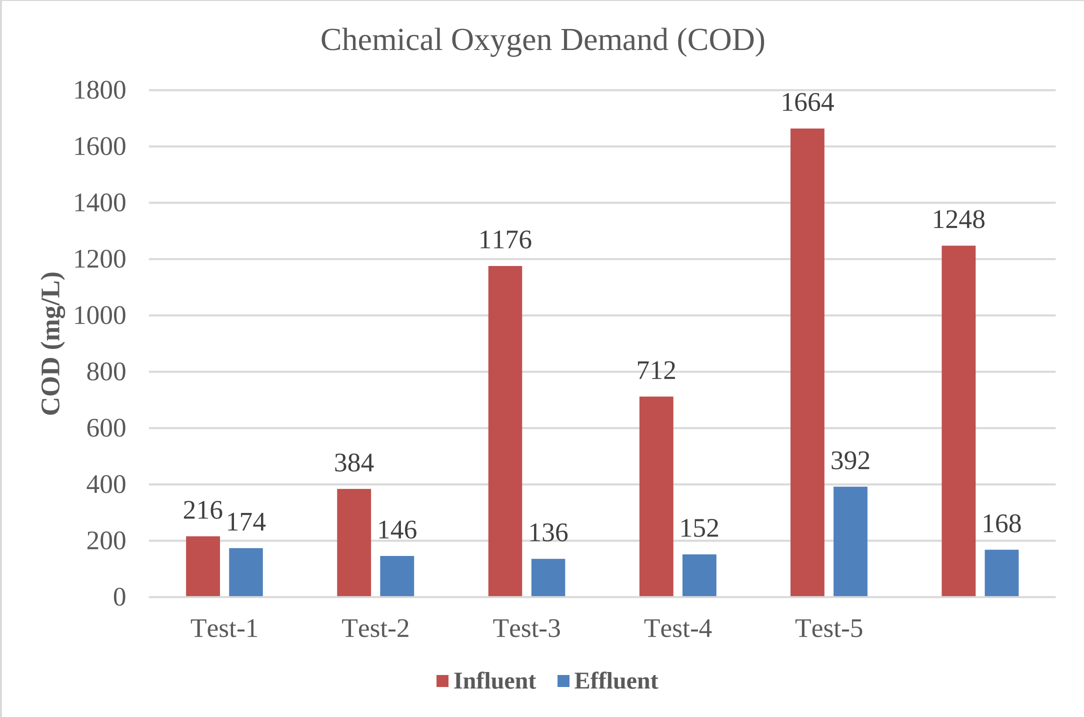

(a)



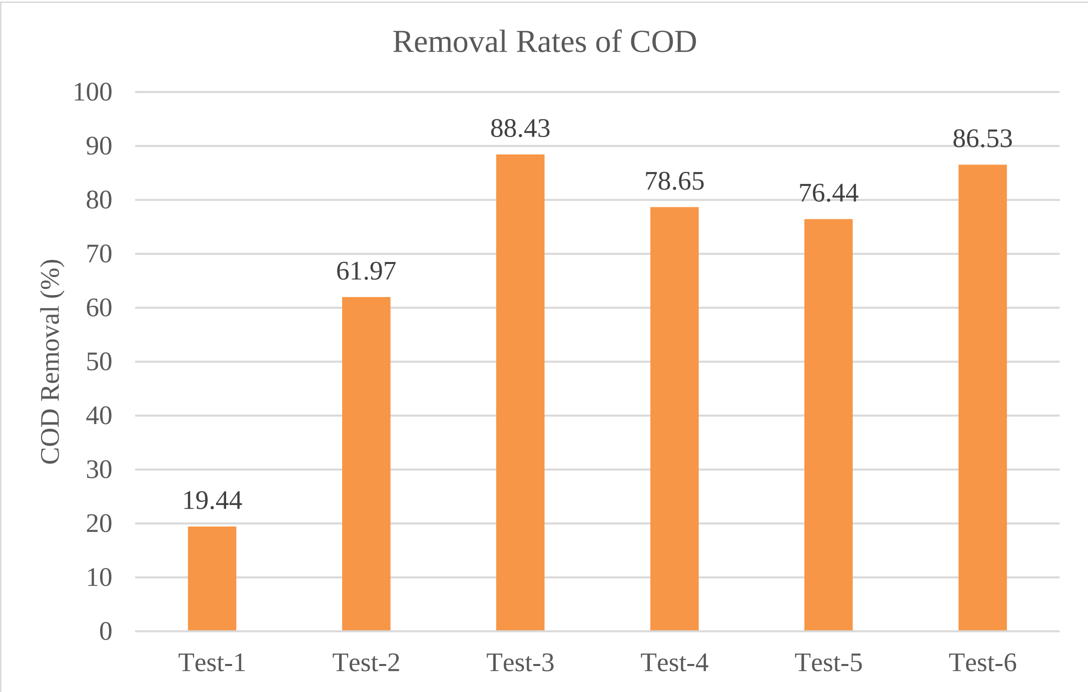

(b)

Fig 4.5: (a) Changes & (b) Removal Rates of Dissolved Oxygen

Initially, the dissolved oxygen was 0.87 to 5.79 mg/L and ended up with good results ranging between 4.22 to 7.2 mg/L. The increment/acquisition rate is between 7.97% to 572.41% (Fig. 4.5).



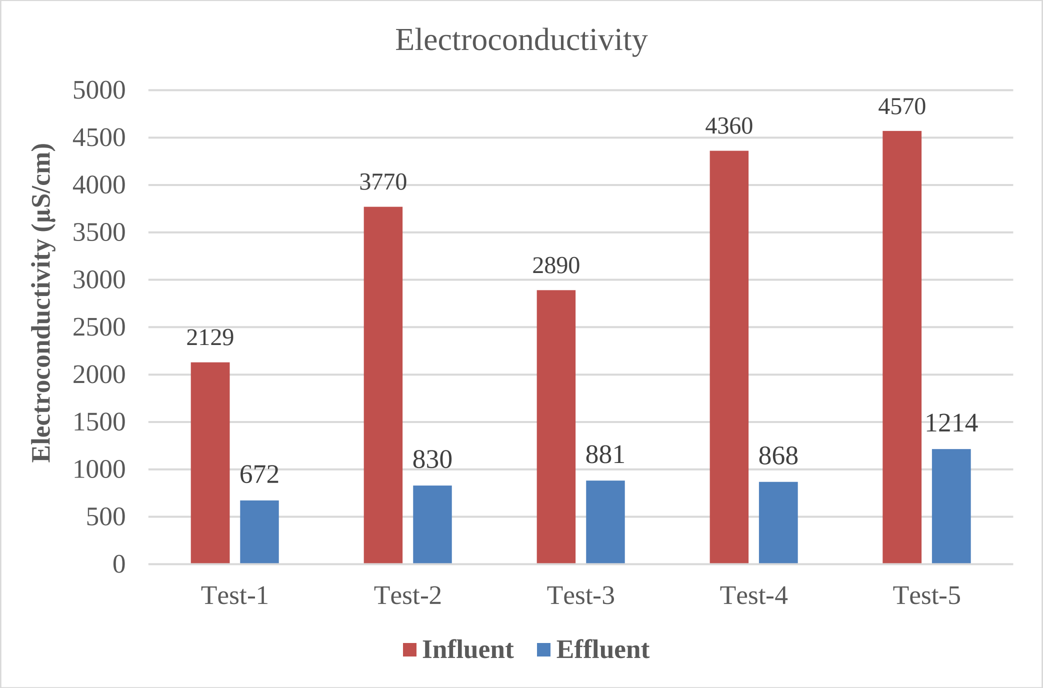

(a)



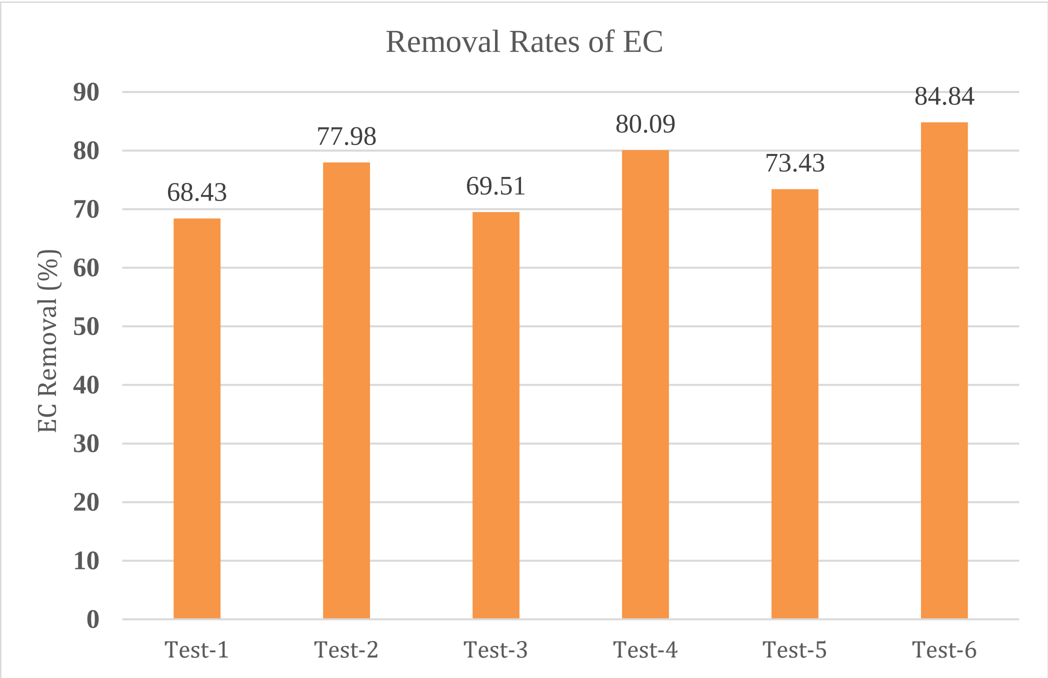

(b)

Fig 4.6: (a) Changes & (b) Removal Rates of COD

Initially, raw wastewater from IUT laundry had COD from 216 to 1664 mg/L and ended up with an average COD of 174 to 392 mg/L after filtration carrying an average removal efficiency of 68.57 % (Fig. 4.6).



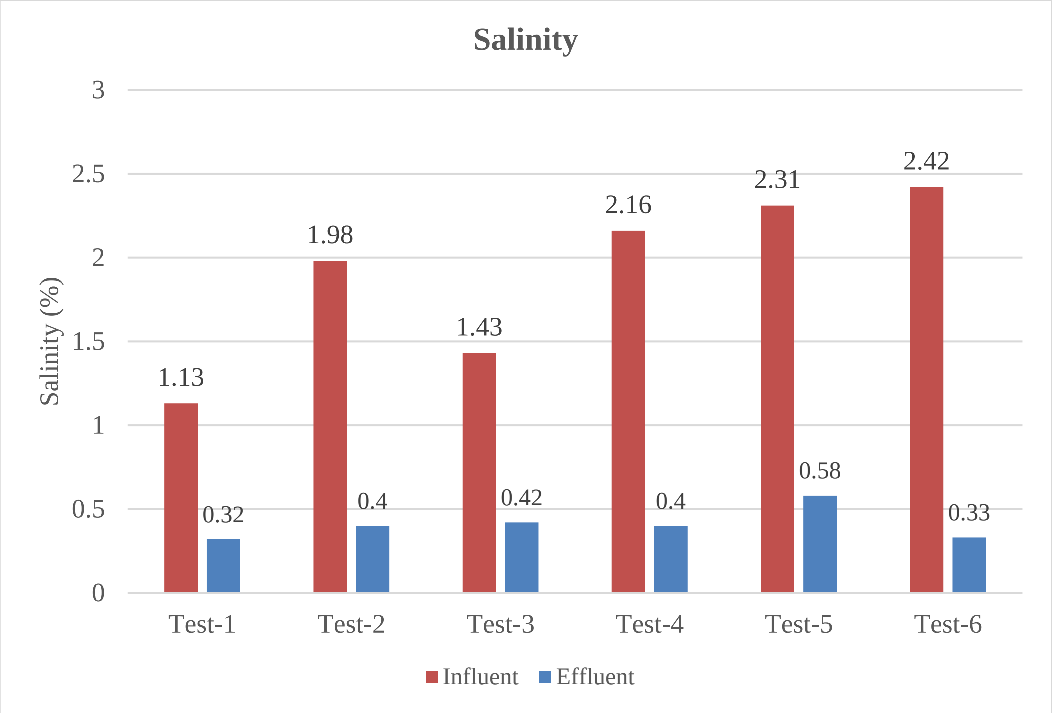

(a)



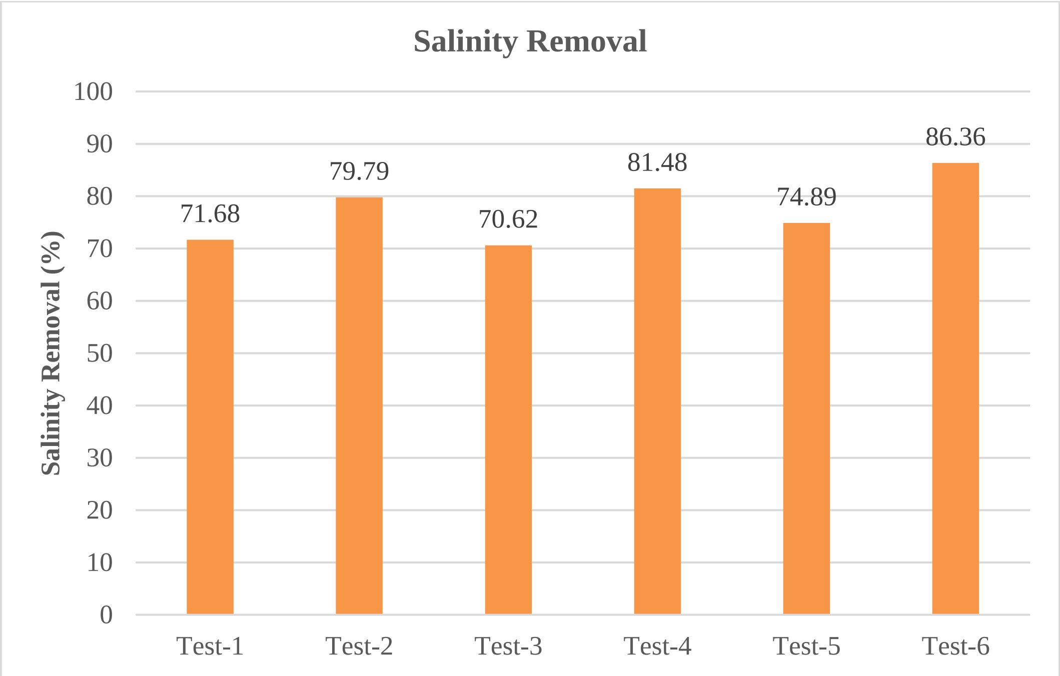

(b)

Fig 4.7: (a) Changes & (b) Removal Rates of EC

The influent was carrying electricity between 2129 to 4750 µS/cm. The effluent had 672 to 1214 µS/cm with an average removal rate of 75.71% (Fig. 4.7).



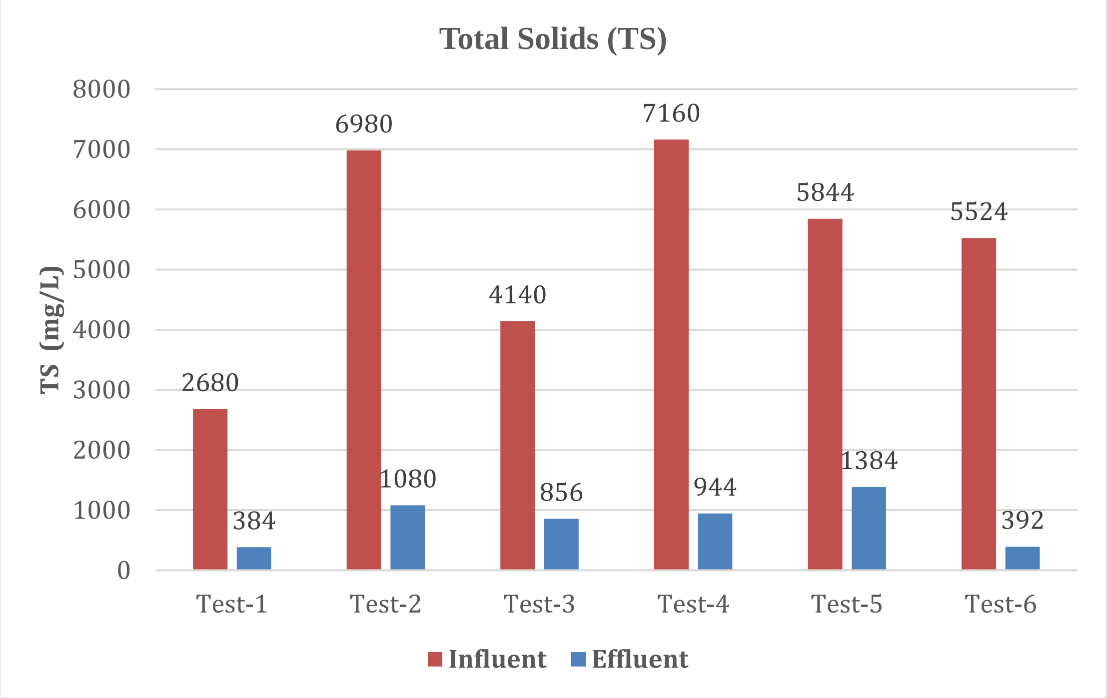

(a)



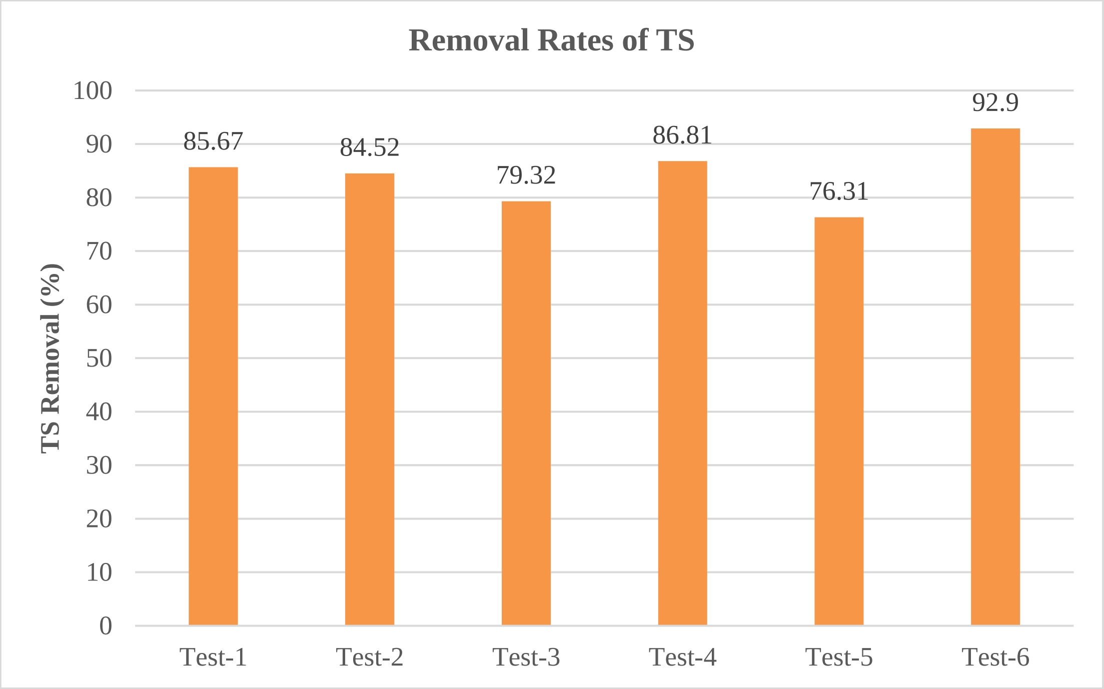

(b)

Fig 4.8: (a) Changes & (b) Removal Rates of Salinity

Removal rates of salinity range between 70.62% to 86.36% with an average value of 77.47%. Wastewater had salinity ranging between 1.13% to 2.42% whereas the test results show colours of 0.32% to 0.58% for effluent (Fig. 4.8).



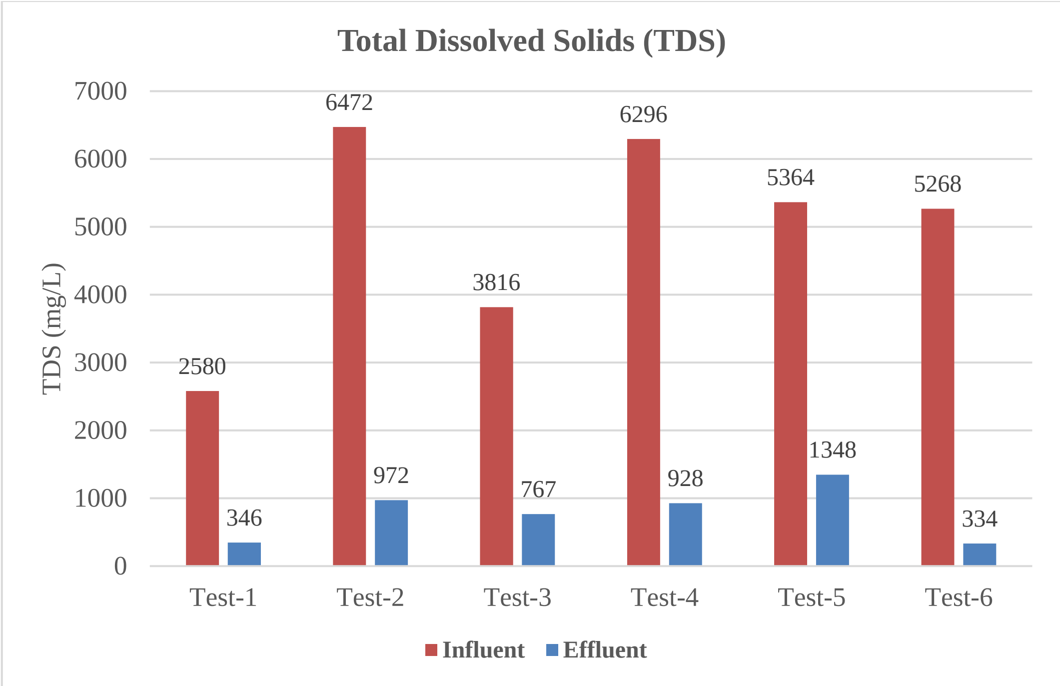

(a)



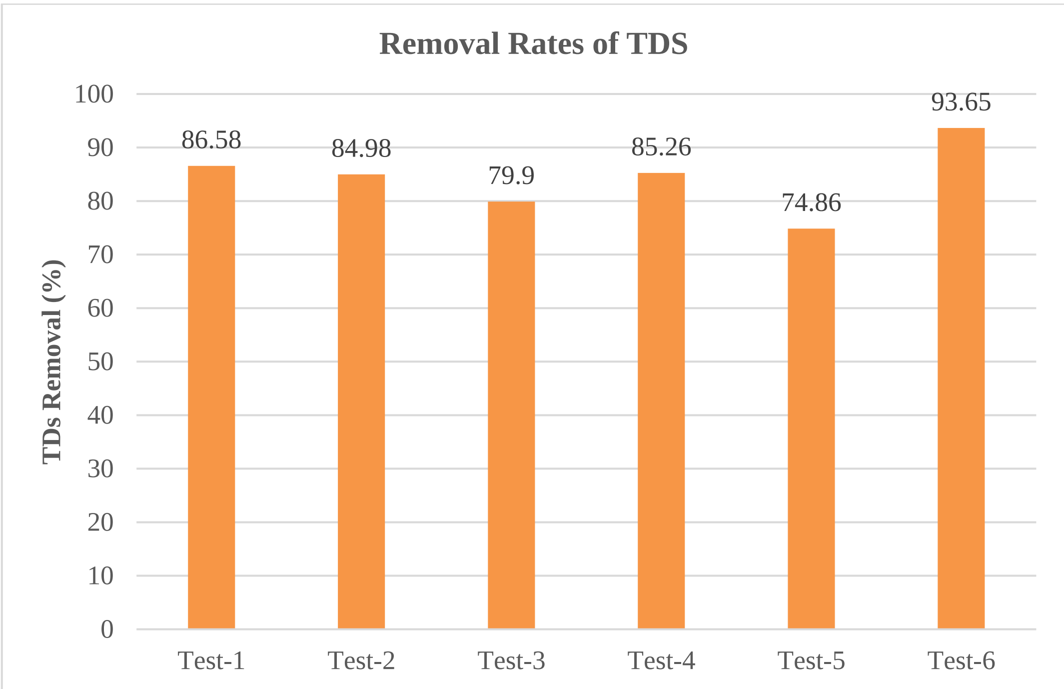

(b)

Fig 4.9: (a) Changes & (b) Removal Rates of TS

Multimedia filter shows removal rates of TDS range between 76.31% to 92.9% with an average value of 84.25%. Before filtration, the influent showed TDS ranging between 2680 to 7160 mg/L. After filtration, the test results for effluent show TDS of 384 to 1384 mg/L from (Fig. 4.9).



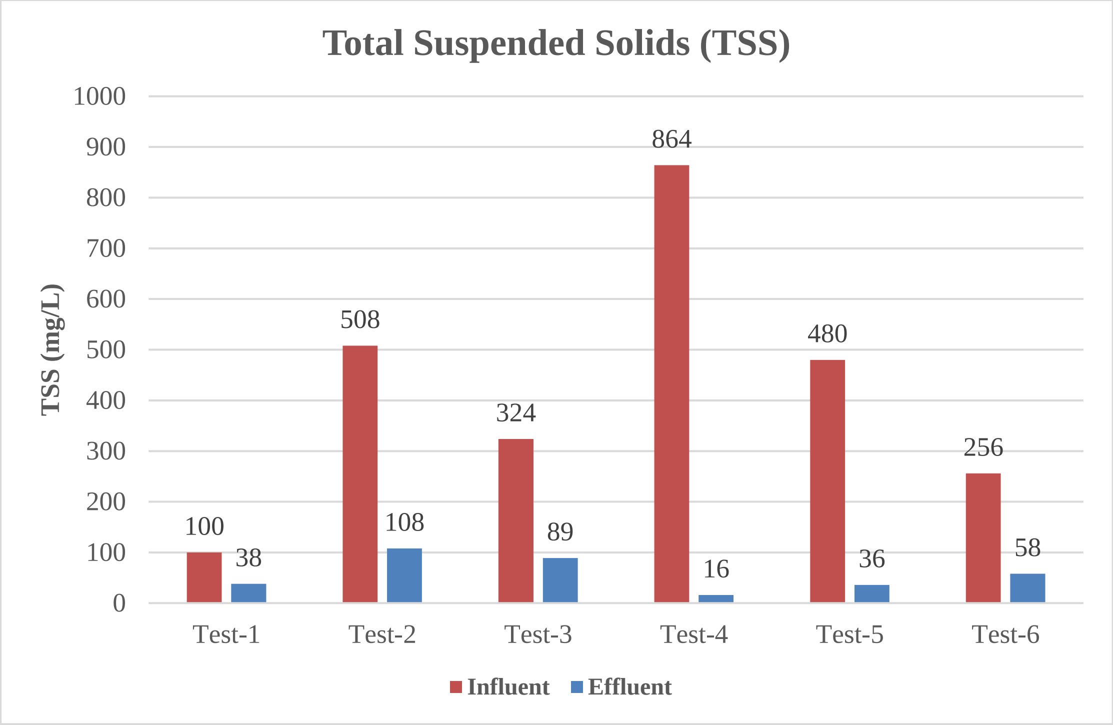

(a)



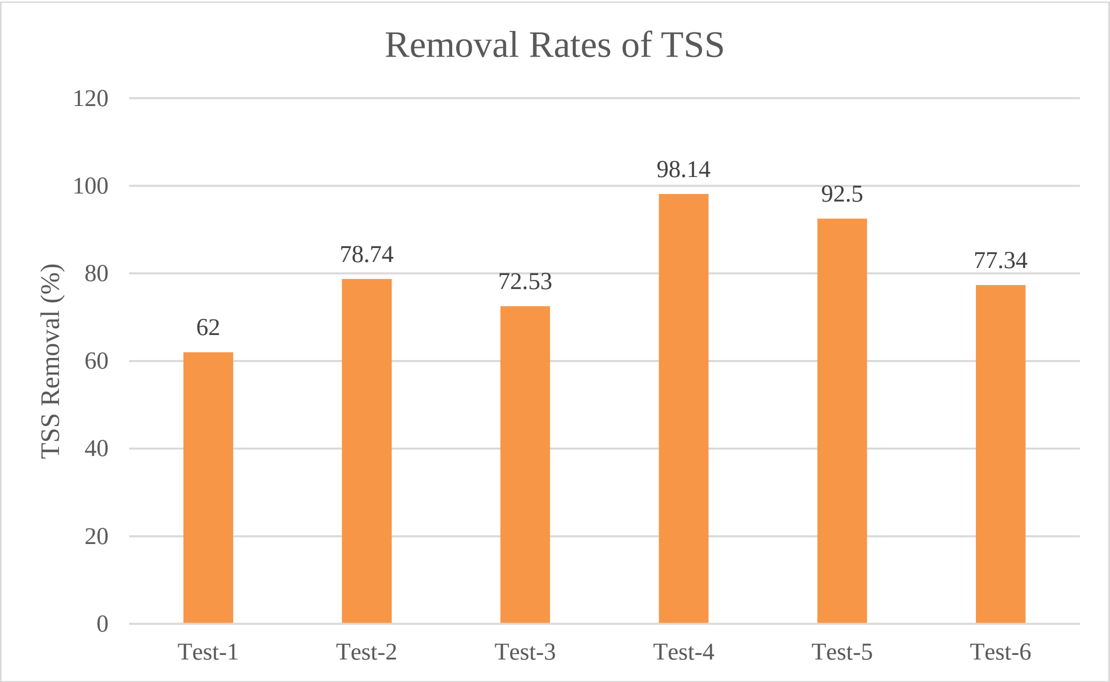

(b)

Fig 4.10: (a) Changes & (b) Removal Rates of TDS

The above graphs conclude that removal rates of TDS range between 74.86% to 73.86%. Before filtration, the TDS values were between 2580 to 6472 mg/L and the test results show TDS values of 334 to 1348 mg/L after filtration (Fig. 4.10).




(a)




(b)

Fig 4.11: (a) Changes & (b) Removal Rates of TSS

Initially, raw wastewater from IUT laundry had TSS from 100 to 864 mg/L and ended up with an average COD of 16 to 10/ mg/L after filtration carrying an average removal efficiency of 80.208 % (Fig. 4.11).

Table 4.2: Summary result of filtration done using multimedia filter

| Parameter | Unit | *ECR 2023 Standards | Quality Parameters for Laundry Wastewater | | % Removal (Range) | % Removal (average) |
|---|---|---|---|---|---|---|
| | | | Influent | Effluent | | |
| Colour | PtCo | - | 1620 - 3560 | 60 - 272 | 91.52 - 98.16 | 95.21 |
| Turbidity | NTU | - | 465 - 889 | 5.95 - 18.7 | 97.89 - 99.3 | 98.54 |
| DO | mg/L | 4.5 - 8 | 0.87 - 6.27 | 4.62 - 6.72 | -572.41 to -7.97 | -284.3 |
| COD | mg/L | 200 | 1664 - 216 | 136 - 392 | 19.44 - 88.44 | 68.57 |
| pH | - | 6 - 9 | 6.84 - 8.93 | 7.24 - 8.47 | -11.74 to 8.06 | - 0.113 |
| EC | µS/cm | 1875 | 2129 - 4780 | 672 - 1214 | 68.43 - 84.84 | 75.71 |
| Salinity | % | - | 1.13 - 2.42 | 0.32 - 0.58 | 70.62 - 86.36 | 77.47 |
| TS | mg/L | 2250 | 2680 - 7160 | 384-1384 | 76.31 - 92.9 | 84.25 |
| TDS | mg/L | 2100 | 2580 - 6472 | 334 - 1348 | 74.86 - 93.65 | 84.205 |
| TSS | mg/L | 150 | 100 - 864 | 16 - 108 | 62 - 98.14 | 80.208 |

**Industrial Effluent Discharge to Inland Water*
*Note: -ve removal rates indicate increment*

### 4.2.3 Comparison Between Turag River Sand Filter & Multimedia Filter

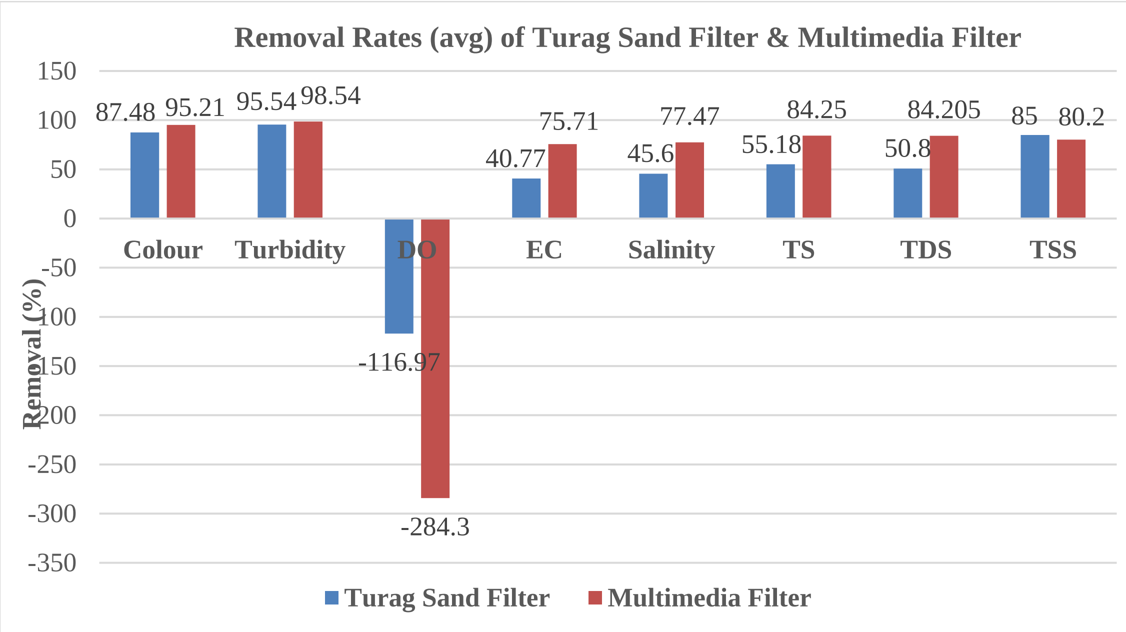



Fig 4.12: Comparison of removal rates of Turag Sand filter & multimedia filter

If the Turag River sand is used as a layer in a multimedia filter containing coarse sand & activated carbon, the quality of the effluents is better (Fig: 4.12) and they meet the ECR 2023 guidelines for discharging into inland water for the measured parameters (Table: 4.2)

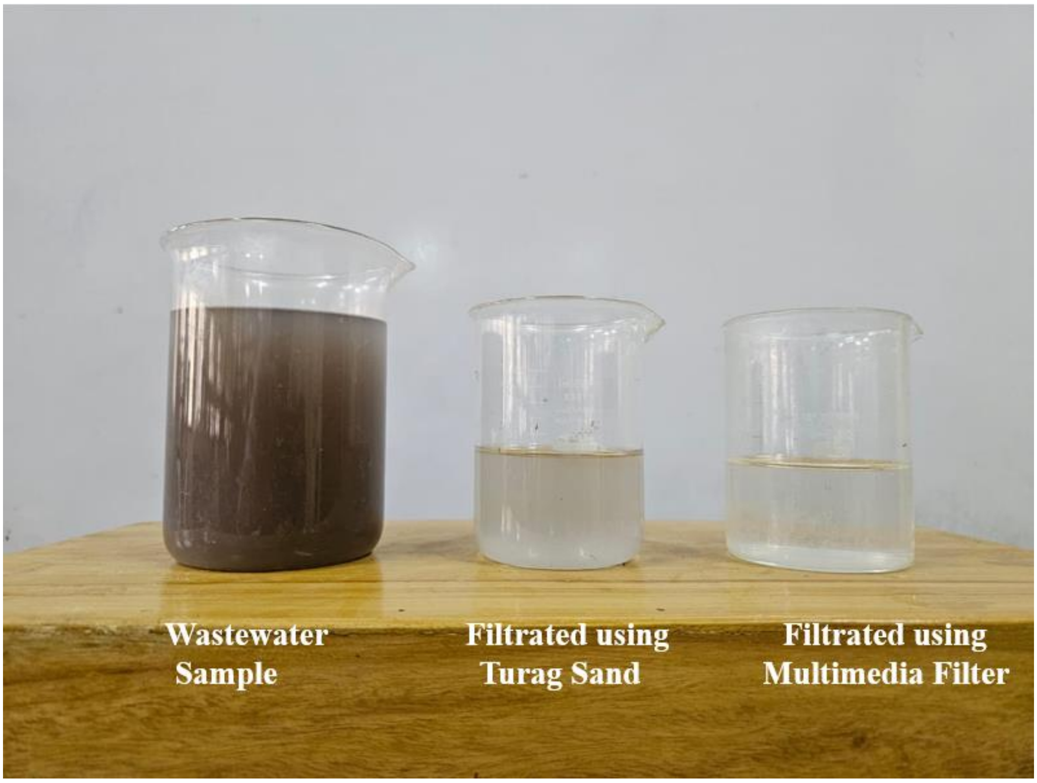



Fig 4.13: Apparent difference between wastewater, Turag Sand filter effluent & Multimedia Filter effluent

# CHAPTER V

# CONCLUSIONS AND RECOMMENDATIONS

## 5.1 General

This chapter provides a summary of the study's findings and discussions, offers recommendations, and suggests potential directions for future research related to the study.

## 5.2 Conclusions

The results were obtained after performing a sufficient number of experiments by which the following conclusion can be brought:

i. Filtration Capacities of both Turag River sand & Padma River sand were determined
ii. Among Turag River sand & Padma River sand, the Turag River sand shows better performance in laundry wastewater filtration (In 6 out of 9 Parameters)
iii. If the Turag River sand is used as a layer in a multimedia filter containing coarse sand & activated carbon, the quality of the effluents is better (Fig: 4.12) and they meet the ECR 2023 guidelines for discharging into inland water for the measured parameters (Table: 4.2)

## 5.3 Recommendations

For further treatments, the following processes can be applied:

**Constructed Wetlands:** Use plants and natural processes to remove pollutants. This method is cost-effective and requires minimal maintenance.

**Activated Carbon:** Adding activated carbon helps to absorb remaining organic compounds, dyes, and odours, making it an economical choice.

**Electrocoagulation:** This process uses electric currents to remove particles, oils, and metals. It's efficient and can be affordable on a small scale.

**Chlorination:** Adding chlorine disinfects the water by killing bacteria and pathogens. It's low-cost but needs careful handling to avoid residues.

**Solar Disinfection (SODIS):** Exposing water to sunlight in clear bottles can effectively disinfect it. This method is extremely low-cost and sustainable.

**Phytoremediation:** Utilizing plants to absorb and break down contaminants is an environmentally friendly and inexpensive option.

These methods can be tailored or combined depending on specific needs and available resources.

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