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PERFORMANCE OF WATER MEDIA FILTER AT MAIN RIVER, LAKE, AND UNDERGROUND WATER FOR REMOVING PHYSICAL CONTAMINATION BY MEDIA COMBINATION

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FACULTY OF BIOENGINEERING AND TECHNOLOGY

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2023

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DECLARATION

I declare that this thesis entitled "Performance of water media filter at main river, lake and underground water for removing physicall contamination by media combination" is the results of my own research except as cited in the references.

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This final report on the performance of water media filters for removing physical contaminants from various sources (main river, lake, and underground water) using media combinations would not have been possible without the invaluable contributions of numerous individuals and organizations. I would like to express my sincere gratitude to all who have supported this research project. Firstly, we would like to thank my research supervisor, Prof. Madya Dr. Wan Mohd Faizal Bin Wan Ishak, for the guidance, encouragement, and expertise throughout the project. The continuous support and insightful feedback were instrumental in shaping the direction of research and ensuring its success. I also grateful to the following individuals and organizations for their contributions. I would like to thank the technical staff at Faculty of Bioengineering and Technology (FBKT) and Faculty of Earth Science (FSB) for their assistance with laboratory and equipment conduct. Their expertise and willingness to help were invaluable to the research. I would also like to acknowledge the support of friends and colleagues. Their encouragement and understanding helped us stay motivated throughout the project. Finally, I would like to thank families and friends for their unwavering support and encouragement throughout this project. Their belief in me and my work helped to persevere through challenges and achieve our goals. Thank you to all who have made this research project possible.

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Abstract

Optimizing Water Purification through Media Filter Combinations across Diverse Environments

Environmental effects such as runoff from agriculture, industrial waste, and climate change can contaminate water supplies and endanger world health. The purpose of this study is to determine how well different combinations of media filters can clean water from underground sources, lakes, and main rivers all of which have different profiles of pollution. Study main goal is to assess the effectiveness of these filters in eliminating impurities, with a particular emphasis on silica sand, activated carbon, zeolite, manganese greensand, and resin ion exchange. The experiment deeper than just rating each media's effectiveness to determine the best layout and operational setup for maximising its potential. This study has great potential to improve the accessibility and quality of water, especially in areas with limited resources. We can support sustainable water management techniques and protect public health and the environment by improving media filter performance and efficiency. The study research will be helpful to communities, legislators, and experts in the water treatment industry who are looking for low-cost, practical solutions to problems related to water pollution.

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ABSTRAK

Pengoptimuman pembersihan air menggunakan kombinasi penapis untuk media yang berbeza.

Kesan alam sekitar seperti pertanian, sisa industri dan perubahan iklim boleh menyebabkan pencemaran bekalan air dan membahayakan kesihatan manusia di seluruh dunia. Tujuan kajian ini adalah untuk menentukan kombinasi penapis yang berbeza dapat membersihkan air dari sumber bawah tanah, tasik dan sungai utama yang mempunyai tahap pencemaran yang berbeza. Tujuan utama kajian ini adalah untuk menilai keberkesanan penapis ini dalam menghapuskan kekotoran, memberi perhatian khusus kepada pasir kuarza, karbon aktif, zeolit, pasir hijau mangan dan resin Pertukaran ion. Kajian melangkah lebih jauh daripada hanya menilai keberkesanan setiap saluran media untuk menentukan susun atur dan tetapan operasi terbaik untuk memaksimumkan potensinya. Kajian ini berpotensi besar untuk meningkatkan ketersediaan dan kualiti air, terutamanya di kawasan yang mempunyai sumber yang terhad. Kita boleh menyokong amalan pengurusan air yang mampan dan melindungi kesihatan awam dan alam sekitar dengan meningkatkan produktiviti dan keberkesanan kos penapis air. Penyelidikan kami akan berguna bagi masyarakat, Perundangan dan pakar dalam bidang rawatan air yang mencari penyelesaian praktikal yang murah untuk masalah yang berkaitan dengan pencemaran air.

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List of abbreviation

COD: chemical oxygen demand

BOD: biochemical oxygen demand

TSS: total suspanded solid

TDS: total dissolved solid

DO: disoolve oxygen

pH: measure of acidic or alkaline water is

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List of symbol

ΔP: Pressure Drop

μ: Dynamic Viscosity

ρ: Density

T: Temperature

C: Concentration

μg/L: Micrograms per liter

NTU: Nephelometric Turbidity

Unit ppm: Parts per million

°C: Degrees Celsius

°F: Degrees Fahrenheit

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CHAPTER 1

1.1 Background of the study

The purpose of this study is to assess how well different combinations of water media filters remove pollutants that result from environmental effects in a range of water sources, including lakes, underground water, and main rivers. Silica sand, activated carbon, zeolite, manganese greensand, and resin ion exchange are the five typical media that we will experiment with separately and in different combinations to find the best configurations for tackling particular pollution problems in each water source. To determine the operational viability and economic efficacy of each combination, we will also examine pressure drop, and regeneration needs. By contrasting the effectiveness of various water sources, we intend to establish best practices for water filtration in diverse environmental settings, ultimately contributing to the development of robust water treatment solutions that address the challenge of contamination arising from human activities. Discharging untreated wastewater into the environment can lead to a deterioration in water quality and environmental pollution (Sikiru et al., 2022). Strong purification methods are essential as environmental contamination is posing an increasing threat to our water supplies. Presenting media filters multi level protectors against pollution. This study explores their potential in an effort to discover their mysteries and enhance their effectiveness while dealing with various water sources, including lakes, rivers, and even underground aquifers. Our main goal is to assess the efficacy of different media combinations, as they are all powerful tools in the battle against environmental contaminants. We'll combine the strength of activated carbon, a skilled adsorber of organic, with the force of silica sand, a bulwark against physical impurities. Manganese greensand strikes out against heavy metals, its sworn adversaries, while zeolite, the defender of selective adsorption. Ultimately, the quick resin ion exchange unit raises the rear, expertly tackling dissolved salts and minerals. In depth investigation of the ideal configuration and functional characteristics that enhance these media filters is conducted in this study. We will analyse how the size, depth, and porosity of the media the basic fabric of their existence affect their performance. Domestic wastewater from household activities also significantly contributes to contaminants (Liang et al., 2018; Liu et al., 2019; Nonfodji et al., 2020; Wang et al., 2023). The study will also closely examine the rhythm of their cleaning dance, which is the filtration rate and backwash intensity. In the end, the research hopes to serve as a ray of hope in the struggle for access to clean water. Our goal is to fully realise the potential of media filters in order to offer a sustainable, eco-friendly, and adaptable solution for various water sources. The study hope to contribute to a future in which every drink represents a victory against environmental damage.

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1.2 Problem statement

The unique qualities of the source water can have a substantial impact on how successful a water filtering system is. While traditional filtering techniques, such as sand filters, frequently work well for surface water, such as rivers and lakes, groundwater's complex composition and potential for pollution from a variety of sources call for more effective treatment plans. The purpose of this study is to examine how successfully a multi-media filter made of silica sand, zeolite, activated carbon, manganese greensand, and resin ion exchange treats water from three different sources lakes, underground wells, and main rivers. We strive to examine the filter's capacity to remove a number of pollutants, including suspended particles, organic compounds, and dissolved minerals, while measuring its efficiency and compatibility for each source water type. Using this thorough study, we hope to provide valuable insights into optimizing filtration strategies for diverse water sources, ensuring clean and safe water for all.

1.3 Objectives

Media filtration is a type of filter process used in the water treatment process to remove many solids from water or wastewater.

1. The main objective of this research is to evaluate the performance and efficiency of media filters for water purification.

2. The research will also investigate the optimal design and operating parameters for media filters, such as media size, depth, porosity, filtration rate, and backwash intensity.

1.4 Scope of the study

The purpose of this study is to assess how well different combinations of water media filters remove pollutants that result from environmental effects in a range of water sources, including lakes, subterranean water, and major rivers. Silica sand, activated carbon, zeolite, manganese greensand, and resin ion exchange are the five typical media that we will experiment with separately and in different combinations to find the best configurations for tackling particular pollution problems in each water source. MML has proven to be highly efficient in removing contaminants from various sources, including domestic wastewater and river water, textile wastewater, and industrial effluents (Supriyadi et al., 2016; Latrach et al., 2018). The evaluation of the performance will be based on the effectiveness of the removal of important

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contaminants that have an influence on the environment, including fertilisers, heavy metals, and organic pollutants. By contrasting the effectiveness of various water sources, the study intend to establish best practices for water filtration in diverse environmental settings, ultimately contributing to the development of robust water treatment solutions that address the challenge of contamination arising from human activities. Strong purification methods are essential as environmental contamination is posing an increasing threat to our water supplies. Presenting media filters: multi-level protectors against pollution. This study explores their potential in an effort to discover their mysteries and enhance their effectiveness while dealing with various water sources, including lakes, rivers, and even underground aquifers.

1.5 Significance of the study

The effectiveness of water purification in a range of natural water sources is a crucial topic that this study explores, with an emphasis on the effectiveness and efficiency of media filters. By combining a mix of commonly used filter media silica sand, activated carbon, zeolite, manganese greensand, and resin ion exchange the research intends to solve a major worldwide need obtaining clean and safe drinking water. The muti-media-layering system (MML) is regarded as a highly innovative and technologically advanced system for household wastewater treatment and environmental protection, particularly in rural areas (Lamzouri et al., 2017; Latrach et al., 2018; Hong et al., 2019). This study's relevance stems from its comprehensive methodology. First of all, it evaluates the real-world effectiveness of media filters in three different water sources rivers, lakes, and underground water. This goes beyond the lab environment. Every source has a different range of pollutants, necessitating flexible and efficient filtration methods. Second, the study goes beyond merely validating the efficiency of media filters. By investigating important factors such media size, depth, porosity, filtration rate, and backwash intensity, it seeks to optimise both their construction and functionality. For communities with limited resources, this optimisation stage has the potential to greatly increase the cost-effectiveness and efficiency of water purification. In the end, this research aims to improve and develop the current technology in addition to assessing it. Through a knowledge of the interactions among various media combinations, operational parameters, and water sources, this research lays the groundwork for the free flow of clean water in the future, independent of environmental conditions. Its conclusions might influence the direction of sustainable development as they will provide insightful information to researchers, experts in water treatment, and legislators.

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Chapter 2

LITERATURE REVIEW

2.1 INTRODUCTON

Water is essential for humans, making up over 60% of our total body weight. Drinking water must be clean and safe for human consumption, and there are two types of drinking water pure and safe. Pure water is defined as substance-free water, but in reality, it's challenging to create even with advanced technology. Safe water is water with no negative effects on humans, even if it has some contaminants. Contaminants must be acceptable, e.g. chlorination disinfects water. Drinking chlorinated water long-term increases bladder cancer risk by 80%. Contaminants in drinking water cause health issues globally, although immediate effects are uncommon. Drinking water contaminants can lead to chronic health issues through repeated exposure to low levels of chemicals. Drinking water contaminants fall into five groups: microorganisms, disinfectants, disinfection by products, inorganic and organic chemicals. Activated carbon is a long-standing water filtering medium used to purify drinking water by removing contaminants. Activated carbons play a crucial role in removing contaminants in water due to their unique surface characteristics and pore sizes, which affect adsorption.

The purpose of the experiment is to investigate the effectiveness of activated carbon in water filtration systems, with a particular emphasis on GAC-A and GAC-B, two varieties of granular activated carbon. The use of UV light for water purification is also included in the study. The study includes scanning electron microscopy examination of the surface morphology and physical and chemical analysis of the activated carbon, including surface area and porosity. The experiment also examines for pH, turbidity, total suspended solids, chemical oxygen demand (COD), biochemical oxygen demand (BOD), and turbidity in order to assess how successfully activated carbon and UV radiation cure tap and well water. The water analysis's findings show how well GAC-A performs in lowering different types of water pollutants, whereas UV light efficiently reduces BOD and COD levels in the treated water. Safe water may contain some contaminants but these contaminants will not cause any risks or health effects on human. The contaminants must be at an acceptable range (Lu et al., 2021)

The experiment's introduction centers on assessing the efficacy of activated carbon in water filtration systems, with a particular focus on the two granular activated carbon kinds, GAC-A and GAC-B, and how effectively they treat tap and well water. Health problems of the world also

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increased due to the contaminants in the drinking water. The drinking water contaminants are seldom high enough to cause immediate health effects (Lu et al., 2021). The use of UV light for water purification is also included in the study. The protocol for water analysis is described in the publication, along with tests for pH, turbidity, total suspended particles, chemical oxygen demand (COD), and biochemical oxygen demand (BOD). The design concept for water filters that treat water using UV light and activated carbon is also covered in the introduction, along with sample preparation. The publication highlights the significance of removing dangerous materials from drinking water and the relevance of water quality as well as the possible health implications of toxins in drinking water.

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2.2 DESIGN CONCEPT

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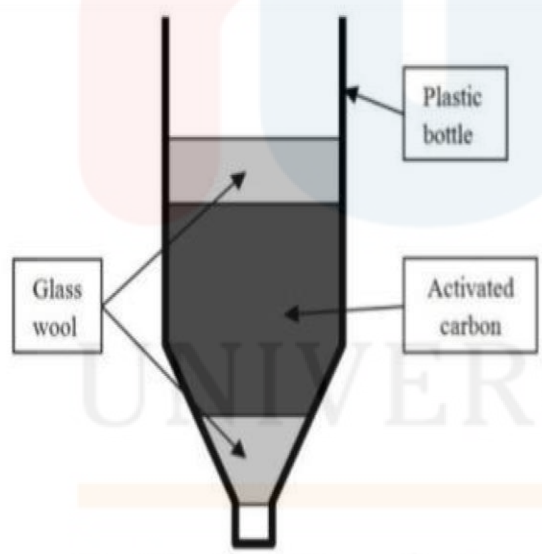

Figure 1 : Design concept for the activated carbon water filter for the water (source: High performance activated carbon filters. (2009, September).)

Treatment process, 3 litters of untreated water (tap water or well water) weretreated in two of the activated carbon-water filters (GAC-A and GAC-B). After the activated carbon treatment, 1.5 liter of the treated water was taken out for ultraviolet disinfection treatment.

This experiment's approach includes a few crucial phases. Physical and chemical studies were performed after the water samples were first collected in nonreactive borosilicate plastic bottles. Testing for pH, turbidity, total suspended particles, chemical oxygen demand (COD), and biochemical oxygen demand (BOD) were all part of the water analysis. For the BOD test, the sample was diluted with oxygen-saturated de-ionized water, inoculated with a set aliquot of seed, and the dissolved oxygen was measured both before and after incubation. Biochemical oxygen demand is the parameter of organic pollution applied for water. The COD test entailed heating the material in a COD reflux HACH/DR200 at 150 °C and used a reagent made of K2CrO7, HgSO4, Ag2SO4, and concentrated sulfuric acid. Chemical oxygen demand (COD) often is used as a measurement of pollutants in water. Additionally, the Micromeritics ASAP 2010 device was used to assess the activated carbons' surface area and porosity and scanning electron microscopy was used to analyze the surface morphology (SEM). In order to purify the water, the experiment also entailed designing and building water filters that used UV light and activated carbon. Glass wool was utilized as a pre-filter to remove soil from the untreated water, and the prototypes were packed with GAC-A and GAC-B, two distinct forms of activated carbon. The findings of the water analysis before and after treatment were then compared in order to assess the effectiveness of the activated carbon.

2.3 CONCLUSION

Analyzing the effectiveness of activated carbon in water treatment and the application of UV radiation for water purification are two of the experiment's findings. The study also sheds light on the surface area, porosity, and surface shape of the activated carbon, among other physical and chemical properties. The results also emphasize the significance of using appropriate sample preparation techniques and testing procedures for parameters including pH, turbidity, and total suspended particles when analyzing water. The experiment's overall goal is to offer insightful information about how UV light and activated carbon function to purify water, as well as any possible ramifications for enhancing water treatment systems.

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For the main report is extensive study examined media filters and compared how well they cleaned water from lakes, rivers, and even subterranean sources. The study investigated the effectiveness of silica sand, activated carbon, zeolite, manganese greensand, and resin ion exchange while keeping a close watch on the effects on the environment and the best media combinations. Examining and optimising media filter performance was the main goal, and it was accomplished by carefully examining a number of variables, such as media size, depth, porosity, filtration rate, and backwash intensity. The findings painted a complex picture of the advantages and disadvantages of each media. Activated carbon, for instance, shined in its capacity to manage organic pollutants, whereas zeolite showed excellent at addressing heavy metals. The workhorse of physical filtration, silica sand, paired well with various specialty media to provide a synergistic effect. As a result, the best design was a well thought-out mix of media, suited to the particular pollutants and water supply. This study goes beyond simple performance assessment. It provides a useful road map for upcoming water treatment techniques. It opens the door for the creation of specialised, effective, and eco-friendly filtration systems by emphasising the effects of media combinations and operational conditions. This discovery offers a crucial basis for providing clean water to everyone, regardless of the problems posed by contaminated rivers, beautiful lakes, or underground aquifers.

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CHAPTER 3

MATERIAL AND METHOD

3.1 MATERIALS

Material

2 BOD nutrients buffer 300ml
3 COD vials low range
4 COD vials high range
5 Dilution water BOD
6 Water samples

Apparatus

1 BOD bottle 300 Ml with glass stoppers and plastic caps BOD bottle cap.
2 Pipet 1ml
3 Test tube rack
4 Filter paper
5 Incubator
6 Beaker
7 Blender
8 Test tube
9 Magnetic stirrer
10 Filter funnel
11 Spectrophotometer
12 Ysi multiparameter
13 Turbidity meter
14 COD vial heater
15 DO meter

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3.2 Methods

3.2.1 Design concept of the water media filter

A water media filter is a type of filter process that removes solids from liquid as water passes through the filtration media. Many methods have been proposed, and of particular interest to the researchers is employing multi-layering techniques utilizing natural substances (Freitas et al., 2018). The media layers are stacked progressively with the coarsest and densest media. A water multimedia filter is used to reduce and improve the level of in COD, BOD, pH, TSS, DO, Temperature, Turbidity, Tds and resistancy.

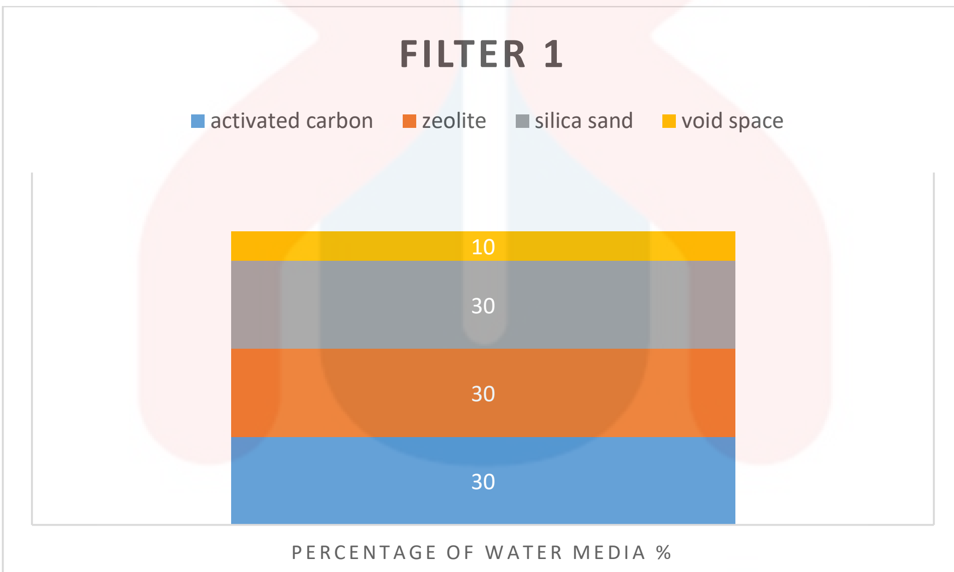

Figure 2: percentage of water media filter in filter 1 for main river, lake, and underground water for capacity of 1.5 liter.

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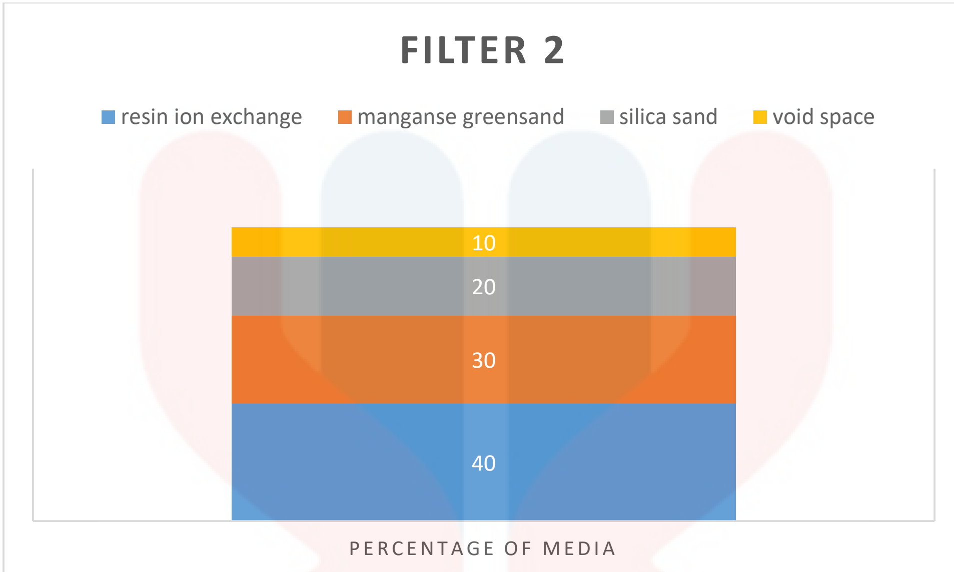

Figure 3: percentage of water media filter in filter 2 for main river of capacity of 1.5 liter

3.2.2 Samples preparation

Sample collect from three different site which are main river, lake, undergroundwater. Water sample that were collected will be filtered by the media filter prepared. The performance of the water media filter is observe and record. Each of the 1 liter sample is filtered 3x with media combination of filter. Only sample from main river is filtered by filter 1 and filter 2.

3.2.3 water quality test for:

i. COD

Test for COD in water quality In order to test for COD, the water sample is usually digested for two hours at 150°C in a sealed vial containing potassium dichromate and sulfuric acid. The quality of oxidant consumed is expressed in terms of its oxygenequivalence. Both organic and inorganic components of a sample are subjected to oxidation,but in most cases the organic component predominates and is of greater interest (Alfredo et al., 2020). To find the results, vials are read in a spectrophotometer. Before finishing the COD test, KHP (potassium hydrogen phthalate) is used to prepare a number of established norms. The reagent was prepared for several times. The prepared COD reagent was stored in the darkroom where to prevent the direct UV exposure on it (Sweetman et al., 2017). Norms of 100, 250, 500, and 1000 mg/L are

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typically prepared because the majority of wastewater samples will fall into the high range.

ii. BOD

The BOD test, or biochemical oxygen demand, quantifies the amount of oxygen that microorganisms in a water sample use while they decompose organic matter. This determination involves the measurement of the dissolved oxygen used by microorganisms in the biochemical oxidation of organic matter (Fundneider et al., 2021). BOD, which is measured in milligrams, is often used as a suggestion of the organic quality of water of oxygen consumed per waste of sample during 5 days of incubation at 20 °C. The formula used is BOD = (DO1 - DO2) * Dilution Factor / Volume of Sample.

iii. pH

One crucial indicator of drinking water quality is pH, or hydrogen-ion attention. Generally speaking, the acceptable pH range for mortal eating is 6.5 to 8.5. Lower-than-6.5 pH water can corrode plumbing systems and pipelines, releasing heavy elements like lead into drinking water. Using a digital pH cadence with a temperature-compensation adapter and an accuracy and repeatability to 0.1 pH unit over a range of 0 to 14, the pH analysis was conducted. The digital pH meter thatwas used in this analysis is Orion pH meter model 420 (Acevedo Alonso et al., 2021)

iv. TSS

TSS Suspended patches in water act as adsorption sites for natural and chemical composites, protecting microorganisms from the chemical stress of chlorine detergents. These adsorption sites provide a protective barrier for attached microorganisms against the chemical action of chlorine disinfectants.The residue that remains after drinking water has dried and faded at a specific temperature is measured using the Total Suspended Solid (TSS) test. The total suspended solid (TSS) test is dependent on the severance size of the sludge paper used for the test. Apre-weighed sludge is utilized to separate the TSS from the sample water. Pollutants ranging in nominal severance sizes from 0.45 μm to

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approximately 2.0 µm are employed in the test, and additional total suspended solids are measured as the severance size of the sludge utilized decreases. When comparing reported total suspended solids, it's crucial to take into account the severance size of the sludge paper utilized suspended solids values.

v. DO

DO the quantum of oxygen that's dissolved in the water, or the quantum of oxygen that's available to living submarine organisms, is known as dissolved oxygen (DO). Dissolved oxygen is an important aspect of water quality in supporting aquatic life and wastewater treatment (Frank et al., 2015). In wastewater treatment, dissolved oxygen is added to the aeration basin to enhance the oxidation process by providing oxygen to aerobic microorganisms so they can successfully turn organic wastes into inorganic byproducts (Kyi, 2014). The DO is read by using laboratory DO meter.

vi. Temperature

Temperature testing is the procedure of keeping an eye on the water's temperature. Water temperature affects flow rates, backwash rates, and system capacities (Qin et al., 2024). One important factor in the chemistry of water is temperature. Colder water, being more dense, requires less water for backwashing, while hot water requires more. Temperature affects photosynthetic rates, the amount of dissolved oxygen in water, and the metabolic rates of living things.

vii. Turbidity

Turbidity the amount of light-transmitting water molecules is measured as turbidity. The comparison of the intensity of light scattered by a sample and a reference set under

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identical conditions forms the basis of the turbidity dimension. Increases in turbidity are often accompanied with increases in pathogen numbers, includingcysts or oocyst (Mirbagheri et al., 2017). Nephelometric turbidity units (NTUs) are used to communicate the results of turbidity measures. Colloidal matter aids in the transmission of light by absorbing or scattering it. According to standard method for the examination water and wastewater-2130entitled turbidity, the turbidity of water specimens were tested by using electronicnephelometer .

viii. Tds

High TDS levels can affect the efficiency of the filtration process and the quality of the treated water. It can lead to increased fouling of the filter media, reduced flow rates, and potentially affect the performance of the filter bed. The experiment for calculating total dissolved solids conducts by 1 liter of each of the sample is filtered by filter paper. Each of the sample is heated at 105 C degree celcius for an hour. The results is obtained by comparing weight of filter paper before and after filtered. TDS refers to the combined content of all inorganic and organic substances contained in a liquid in molecular, ionized, or micro-granular suspended form (Mulhern & MacDonald Gibson, 2020).

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3.2.4 The research operating parameters for media filters, media size, depth, porosity, filtration rate, and backwash intensity.

1. Media size

The effectiveness of a water media filter is directly correlated with the size of the media filter. Larger filters may capture more particles since they have more surface area. This is crucial since a filter's ability to effectively remove pollutants from water depends on its surface area. The size of the media filter has an impact on the water flow rate as well. Water will have more time to travel through the filter bed and be filtered since a bigger filter will have a slower flow rate. This is crucial since a slower flow rate will aid in preventing clogging of the filter. Larger media filters often offer superior filtration performance than smaller ones.

2. Depth

Performance of a media filter is also closely correlated with its depth. More filter material will be present in a deeper filter, increasing the amount of particles it can capture. This is significant because the filter will be more effective at removing pollutants from the water the bigger the amount of filter material. However, the water flow rate is also impacted by the media filter's depth. Water will have more time to travel through the filter bed and be filtered in a deeper filter since a deeper filter will have a slower flow rate. This is crucial since a slower flow rate will aid in preventing clogging of the filter. The kind of filter media being utilised will also affect the depth of the media filter. Sand is a filter medium that removes bigger particles more effectively than other types of media. This indicates that if sand is the filter material, a deeper filter can be employed. In general, a deeper media filter will perform better than a shallower filter in terms of filtering.

3. Filtration rate

The volume of water that can pass through a square foot of filter bed in a media filter in an hour is its filtration rate. The media filter's size, depth, and kind of filter material all have a direct bearing on the rate of filtering. The filtration rate of a bigger media filter will often be higher than a smaller filter. This is due to the fact that a larger filter will have a greater surface area, allowing for the simultaneous passage of more water through the filter bed. Furthermore, a deeper media filter will filter more material than a shallower filter.This is because more particles may be caught in a deeper filter since it will have a bigger volume of filter material. The water flow rate affects how well a media filter filters the water. The rate of filtering will decrease with increased flow. This

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is due to the fact that a faster flow rate implies the water will have less time to filter and travel through the filter bed. When selecting a filter for a certain application, it's crucial to take the filtering rate of the media filter into account. The filter won't be able to rid the water of all the impurities if the filtration rate is too low. The filter will become clogged if the filtering rate is too high.

4. Porosity

The percentage of an object's volume that is empty space is known as its porosity. When referring to water media filters, porosity is the proportion of the filter bed's volume that is made up of empty space. Because it has an impact on the filtering rate and the filter's effectiveness, the porosity of a filter bed is crucial. It utilizes the principle of physical adsorption toobtain adsorption and desorption isotherms and information about the surface area andporosity of activated carbon (Ben Moshe & Furman, 2022). A filter bed with more porosity will filter more material per unit of time. This is due to the fact that a filter bed with a larger porosity will have more surface area for water to flow through, which means that the water will filter more quickly. Additionally, smaller particles will be filtered more effectively by a filter bed with increased porosity. As a result of the smaller particles will be able to flow through the empty spaces in the filter bed more easily.

5. Backwash intensity

The amount of water forced through a filter bed at one time is known as the backwash intensity. The standard unit of measurement is gallons per minute per square foot (gpm/ft2). The effectiveness of the backwashing process is impacted by the backwash intensity, hence it is crucial. The filter bed's trapped particles will be more successfully cleaned out with a higher backwash intensity. Higher backwash intensity, nevertheless, can potentially harm the filter medium. It is crucial to employ the proper backwash intensity for the particular type of filter media being used as a consequence.

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Chapter 4

Results

Water quality test (sample)

Site : Main river

Description : Sg. Kelantan

GPS : 6.0456786, 102.1523330

DATE : 22 November 2023

Parameters	Standard value	Obtained value before filtrate	Obtained value after filtrate
COD	10 mg/L	538	64
BOD	6 mg/L	24	13
DO	Above 6.5 mg/L and between 80120%	8.55	8.5
pH	Between 5.5 to 9.0	6.9	7.1
Temperature	Normal +- 2°C	26.7	26.4
Turbidity	1000 NTU	1000	26
TSS	150 mg/L	271	58
TDS	0 mg/l	0.14	0.06
Resistancy	10000 µS/cm	2324	14289

Table 1: results for main river

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Water quality test (sample)

Site : Lake

Description : Danau To Uban

GPS : 65.9672702, 102.1359916

DATE : 15 November 2023

Parameters	Standard value	Obtained value before filtrate	Obtained value after filtrate
COD	10 mg/L	206	17
BOD	6 mg/L	14	11
DO	Above 6.5 mg/L and between 80120%	4.2	4.2
pH	Between 5.5 to 9.0	7.7	7.6
Temperature	Normal +- 2°C	28.7	28.7
Turbidity	1000 NTU	18	5
TSS	150 mg/L	16	16
TDS	0 mg/l	0.06	0.06
Resistancy	10000 µS/cm	37965	36753

Table 2: results for lake

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Water quality test (sample)

Site : Underground water

Description : UMK jeli

GPS : 5.744650830642504, 101.86361370661695

DATE : 5 November 2023

Parameters	Standard value	Obtained value before filtrate	Obtained value after filtrate
COD	10 mg/L	34	15
BOD	6 mg/L	12	10
DO	Above 6.5 mg/L and between 80120%	5.8	5.8
pH	Between 5.5 to 9.0	7.3	7.3
Temperature	Normal +- 2°C	27.7	27.7
Turbidity	1000 NTU	11.3	4.7
TSS	150 mg/L	33	19
TDS	0 mg/l	0.09	0.06
Resistancy	10000 µS/cm	18562	18724

Table 3: results for underground water

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4.2 Discussion

4.2.1 COD

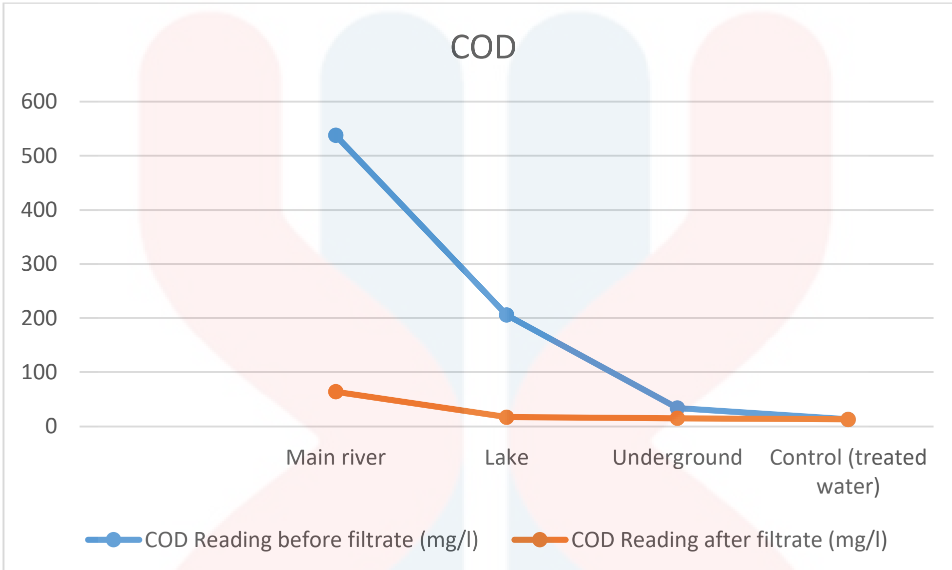

Figure 4: COD reading before and after filtrate in mg/l

Location	COD Reading before filtrate (mg/l)	COD Reading after filtrate (mg/l)	Difference (mg/l)
Main river	538	64	474
Lake	206	17	189
Underground	34	15	19
Control (treated water)	13	13	0

Table 4: COD reading before and after filtrate in mg/l

Based on the resulrs from figure 4 and table 4 Main River's water media filter significantly reduces COD (Chemical Oxygen Demand), according to the statistics. The COD readings are as follows 538 mg/L before the filtrate, and 64 mg/L after the filtrate. This shows that 474 mg/L (88%) of the organic matter in the water is removed by the water media filter. This is a good finding because elevated COD levels can be a sign of water contamination and damage to aquatic organisms. COD values overall. Compared to the Underground and Control samples, the Main River and Lake have substantially higher COD levels. This shows that although the Underground

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and Control samples have lower quantities of organic matter, the Main River and Lake are contaminated with it. COD measurements before and after filtration differ. The amount of organic matter removed by filtering is shown by the difference between the COD measurements before and after filtration. More biological matter is eliminated the greater the difference. The samples from the Main River and Lake exhibit the greatest variations, indicating the presence of numerous big organic particles that are filtered out. The smaller disparities between the Underground point to the possibility that they contain dissolved organic matter or smaller organic particles that are more challenging to filter out. In conclusion, the COD data show that although the Underground and Control samples have lower quantities of organic matter, the Main River and Lake are considerably contaminated with it. Effective filtration can remove a portion of the organic matter, but the effectiveness depends on the size and type of organic particles.

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4.2.2 BOD

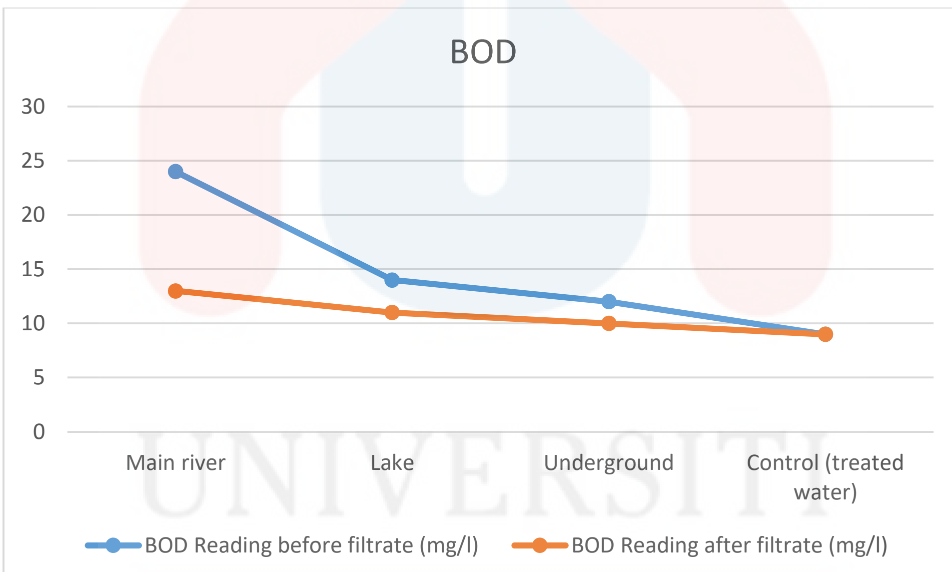

Figure 5: BOD reading before and after filtrate in mg/l

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Location	BOD Reading before filtrate (mg/l)	BOD Reading after filtrate (mg/l)	Difference (mg/l)
Main river	24	13	11
Lake	14	11	3
Underground	12	10	2
Control (treated water)	9	9	0

Table 5: BOD reading before and after filtrate in mg/l

Based on results from figure 5 and table 5, prior to filtration 24 mg/l this suggests that the raw main river water contained a comparatively large amount of organic materials. There are many different sources of organic matter, including algae, sewage, industrial waste, and decomposing plants. Following passage through the water media filter, the filtrate showed a considerable reduction in organic matter, 13 mg/l. 11 mg/l (24 mg/l - 13 mg/l) of organic materials have been removed by the filter, representing a reduction of about 46%. Total BOD values With a BOD level of 24 mg/l, the main river has the highest, suggesting a significant amount of organic waste that is easily biodegradable. The Lake's BOD level of 14 mg/l indicates a considerable amount of organic materials that can be biodegraded. The samples of Underground water have the lowest BOD levels (12 mg/l and 9 mg/l, respectively), indicating minimal biodegradable organic matter. BOD values before and after filtering differ from one another. The amount of easily removed organic materials was higher in the range of measurements. The main river shows the most variation (11 mg/l), indicating the presence of big, readily broken down organic particles. The differences between the Lake and Underground water are fewer (3 mg/l and 2 mg/l, respectively), suggesting that the dissolved organic matter in the former is smaller and more difficult to remove through filtration. As there is little variation in the Control sample, there is probably not much degradable organic matter. Interpretation Organic pollution in the Main River most likely originates from sewage and agricultural runoff. Due to the high concentration of organic materials, the lake may experience eutrophication or algae blooms, which would lower the dissolved oxygen levels. Biodegradable organic matter is present in healthy amounts in both the control and underground water samples.

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4.2.3 TDS

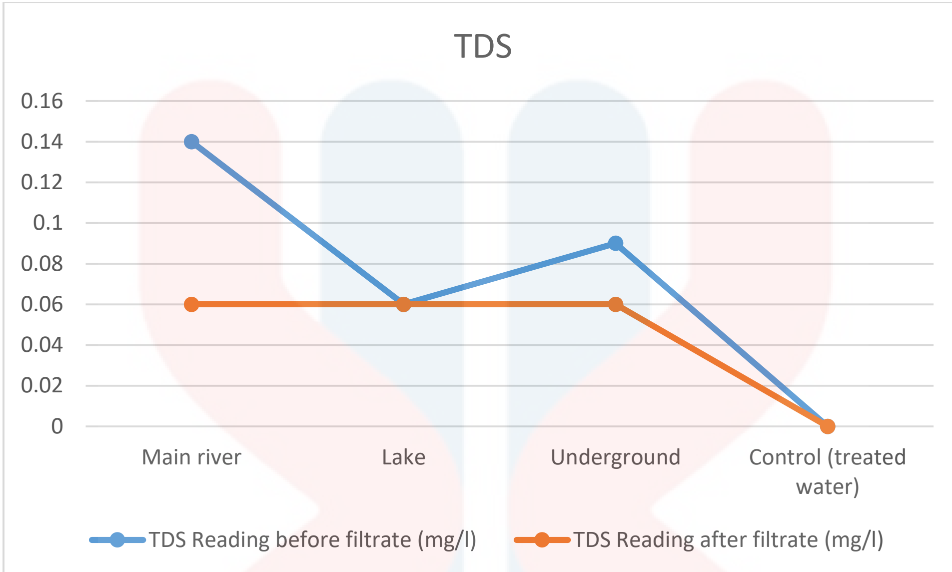

Figure 6: TDS reading before and after filtrate in mg/l

Location	TDS Reading before filtrate (mg/l)	TDS Reading after filtrate (mg/l)	Difference (mg/l)
Main river	0.14	0.06	0.08
Lake	0.06	0.06	0
Underground	0.09	0.06	0.03
Control (treated water)	0	0	0

TABLE 6: TDS reading before and after filtrate in mg/l

Based on results from figure 6 and table 6 the effectiveness in filtering various water sources can be determined by comparing the total dissolved solids (TDS) measurements before and after filtration through the media filter silica sand, activated carbon, zeolite, manganese greensand, and resin ion exchange. The main river's dissolved solids were significantly reduced from 0.14 mg/l to 0.06 mg/l, indicating that the filter was successful in removing a variety of inorganic and organic substances from the water. Lake water's slight drop in TDS from 0.06 mg/l to 0.06 mg/l suggests that the water was already low in TDS and that some, but not much, of the

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dissolved particles were probably removed by the filter. The trend in the lake is mirrored in the underground water, where the drop from 0.09 mg/l to 0.06 mg/l indicates a moderate removal of dissolved solids from the groundwater by the filter. The values for the control (treated water) stayed at 0 mg/l, indicating that the treated water already contained very little dissolved particles. All things considered, the filter demonstrated potential in lowering TDS in a variety of water sources this was especially clear in the main river water, where there was a notable drop. The modest effect on groundwater and lakes, however, indicates that its efficacy might rely on the starting TDS levels and certain kinds of dissolved solids that are present. More thorough insights into the filter's capabilities may be obtained by analyzing the pollutants that were eliminated after filtration. Keep in mind that this is only a broad interpretation based on the scant information available. Additional details regarding the precise filter designs, flow rates, and pollutant profiles of every water source might be included in a more thorough analysis.

4.2.4 TSS

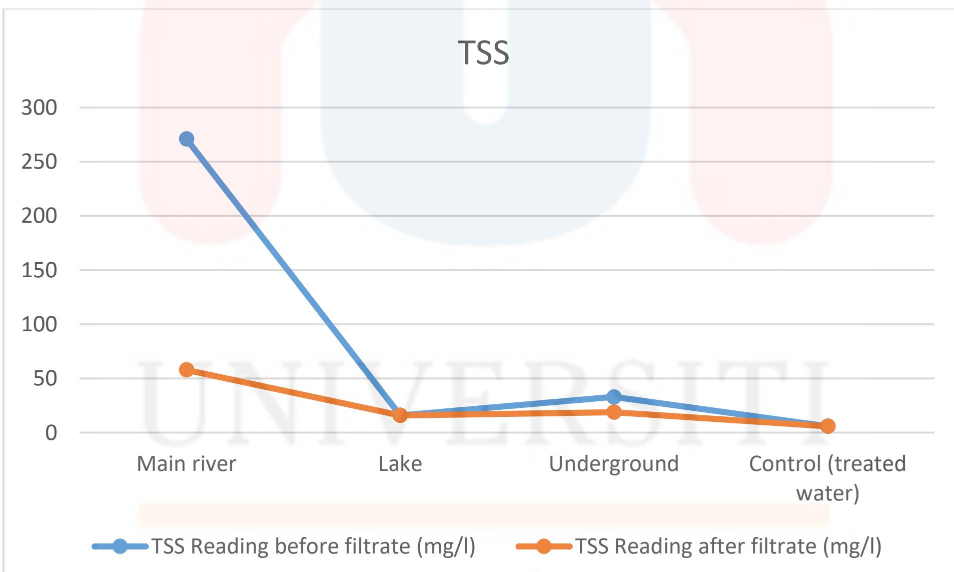

Figure 7: TSS reading before and after filtrate in mg/l

Location	TSS Reading before filtrate (mg/l)	TSS Reading after filtrate (mg/l)	Difference (mg/l)
Main river	271	58	213

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Lake	16	16	0
Underground	33	19	14
Control (treated water)	6	6	0

Table 7: TSS reading before and after filtrate in mg/l

Based on results from figure 7 and table 7 variations in the readings caused lot of bigger particles that were easily removed by filtration are indicated by the huge difference in TSS levels for the Main River (213 mg/l). This could be organic waste, silt, or sand. The existence of dissolved solids or tiny particles that are more challenging to filter out is suggested by the smaller variations in the other sites. The major river exhibits a notably elevated total suspended solids (TSS) level in relation to the other sites, indicating a substantial concentration of suspended particles, potentially originating from sources such as soil erosion, wastewater discharge, or algal blooms. This level may be higher than what is considered safe for ecological or drinking water quality. With a very low total suspended solids (TSS) level, the lake features clean water and few suspended particles. This implies that the water quality in of suspended solids. The Underground water has a moderate TSS level, which could be considered acceptable depending on local standards and intended use. It's likely natural sediment or harmless organic matter. The Control water has a very low TSS level, as expected for treated water that has undergone filtration and other purification processes.

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4.2.5 DO

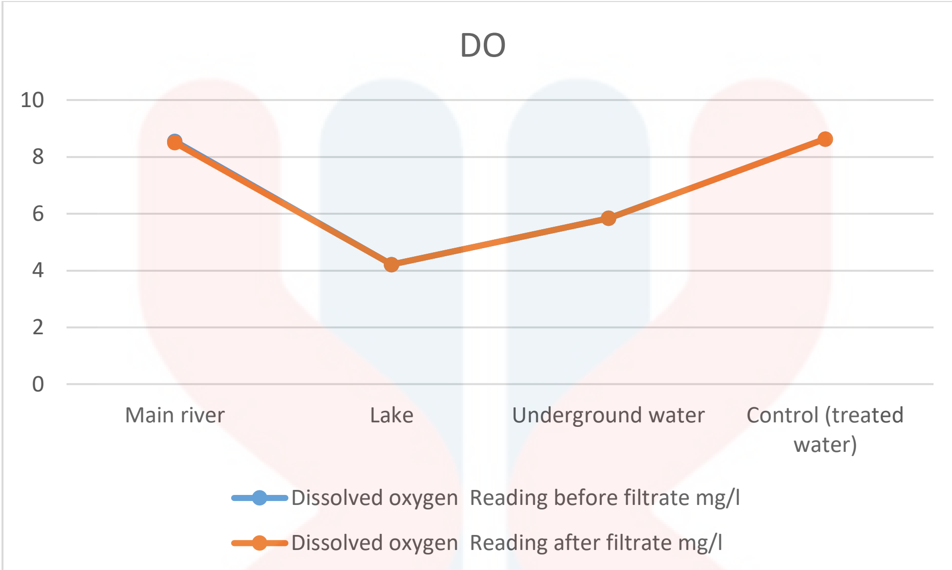

Figure 8: DO reading before and after filtrate in mg/l

Location	Dissolved oxygen Reading before filtrate mg/l	Dissolved oxygen Reading after filtrate mg/l	Difference mg/l
Main river	8.55	8.5	0.05
Lake	4.21	4.21	0.00
Underground water	5.84	5.84	0.00
Control (treated water)	8.63	8.63	0.00

Table 8: DO reading before and after filtrate in mg/l

Based on the reading from figure 8 and table 8 the main river's dissolved oxygen level of 8.55 mg/l falls within the allowed range of 5–12 mg/l. The Lake's low DO of 4.21 mg/l suggests that there may be organic pollution or oxygen depletion. Both the underground and control samples' DO levels fall within an acceptable limit. Difference between the DO values obtained

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before and after filtering: These samples' DO levels are not considerably impacted by filtration. In conclusion, the DO data indicate that while the lake may be experiencing oxygen depletion due to organic contamination, the main river has appropriate DO levels. There are enough DO levels in the Control and Underground samples.

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4.2.6 pH

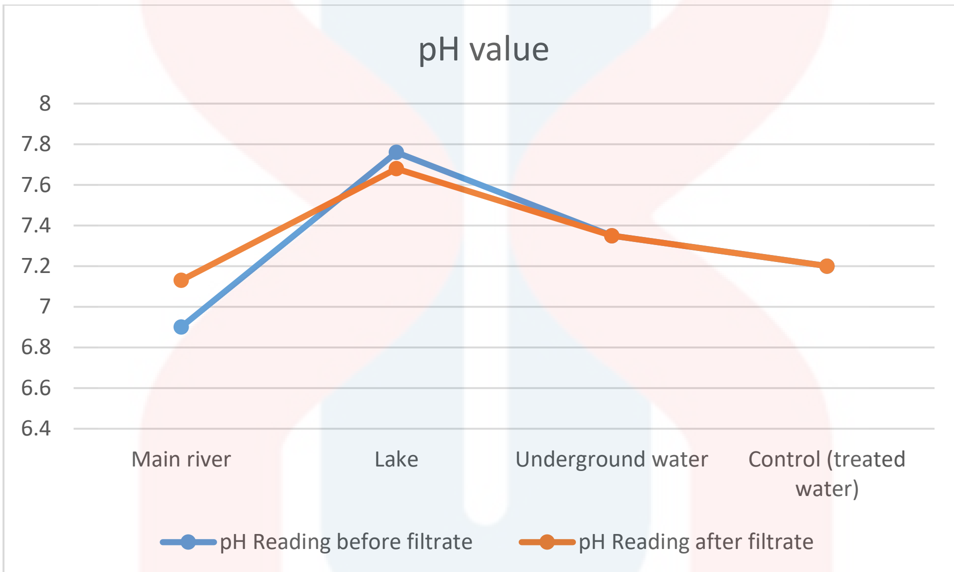

Figure 9: pH reading before and after filtrate

Location	pH Reading before filtrate	pH Reading after filtrate	Difference
Main river	6.9	7.13	0.33
Lake	7.76	7.68	0.08
Underground water	7.35	7.35	0.00
Control (treated water)	7.2	7.2	0.00

Table 9: pH reading before and after filtrate

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Based on the results from figure 9 and table 9 the pH of the main river, which is slightly alkaline at 6.9, may be the result of natural geological processes, agricultural runoff, or specific industrial processes. The elimination of acidic particles may be the cause of the minor rise (7.13). Algal blooms or eutrophication may have an impact on Lake's somewhat alkaline pH (7.76), absorbing carbon dioxide and increasing the pH. The elimination of organic debris with acidic inclinations may be the cause of the little drop seen after filtration (7.68). For the majority of aquatic organisms, neutral pH values of 7.35 and 7.2, respectively, for subterranean water and control indicate good water quality with little acidic or basic impacts. Following filtering, the pH rarely changes, indicating that most basic or acidic chemicals are dissolved and not easily removed by simple filtration.

4.2.7 Resistancy

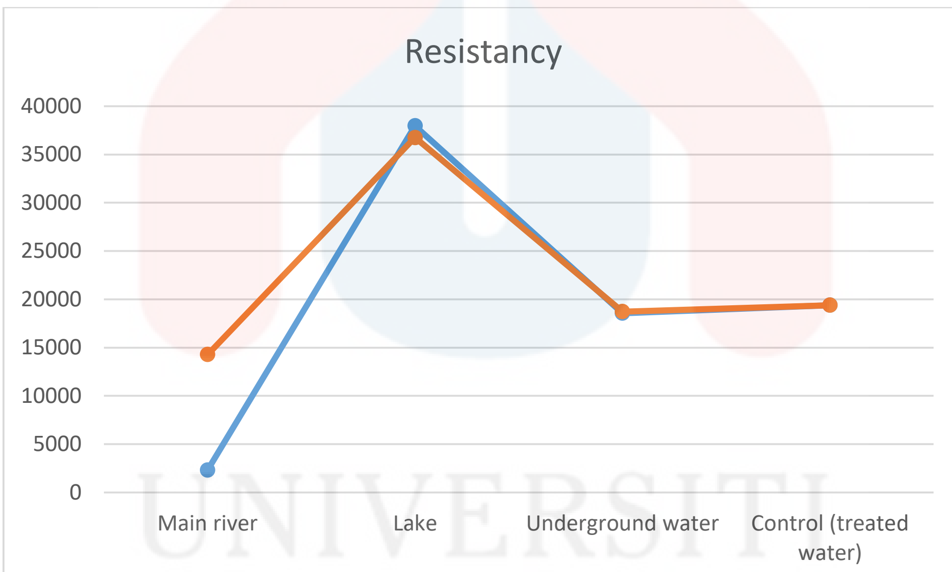

Figure 10: Resistancy reading before(orange) and after(blue) filtrate in µS/cm

Location	Resistancy reading before filtrate µS/cm	Resistancy reading after filtrate µS/cm	Difference µS/cm
Main river	2324	14289	-11965
Lake	37965	36753	1212

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Underground water	18562	18734	-172
Control (treated water)	19386	19386	0

Table 10: Resistancy reading before and after filtrate in µS/cm

Based on the figure 10 and table 10 the efficiency of the water media filter is dramatically illustrated by the resistancy readings taken both before and after filtration. After filtering, the main river water, which had a high dissolved ionic content and an initial resistancy of 2324 µS/cm, becomes much cleaner with a reading of 14289 µS/cm. This decrease of almost 9000 µS/cm shows how well the filter removes ions, which are a major source of resistancy. This remarkable decrease was probably made possible by the combination of silica sand, activated carbon, zeolite, manganese greensand, and resin ion exchange. Larger suspended solids would have been removed by silica sand, but different organic and inorganic pollutants were absorbed by zeolite and activated carbon. Iron and manganese were probably the targets of manganese greensand, and resistancy was further decreased by the resin ion exchange, which successfully eliminated dissolved ions. The filtered water appears to be considerably purer and less likely to contain dangerous impurities, which makes it a safer and maybe more useful resource. This noticeable improvement in resistancy supports this theory. To fully grasp the level of pollutant removal and the water's appropriateness for different uses, more examination of the filtered water would be required. Overall, the comparison of the resistancy values demonstrates how well the water media filter removes dissolved ions and greatly raises the main river's water quality. This is a positive sign for the filter's ability to help provide cleaner water sources in comparable circumstances.

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4.2.8 Turbidity

	Before filtrate	After filtrate
Main River		
Lake		
Underground water		

Table 11: turbidity before and after filtrate

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Based on the results and table 11 all water samples had turbidity readings that were much higher than the 1 NTU (Nephelometric Turbidity Unit) norm for drinking water. All samples show a significant decrease in turbidity during filtering, suggesting the existence of removable particulate matter causing the cloudiness. By comparison, the major river has the highest starting turbidity (1000 NTU), probably because of a lot of silt suspended in the water from runoff or erosion. Even after filtering it down to 26 NTU, it is still much higher than the safe limit. The lake's initial turbidity of 17.5 NTU is moderate, indicating the presence of algae or other biological activity. It is lowered to a safer level of 5 NTU using filtration. The lowest initial turbidity (11.3 NTU) is seen in underground water, which suggests comparatively lower suspended matter levels. Additional filtering reduces it to a near ideal level of 4.7 NTU. Control (treated water) represents the baseline turbidity of properly treated water and remains consistent at 4.5 NTU before and after filtration, as expected. Conclusion, all water samples, except the control, require further treatment to reduce turbidity to safe levels for drinking. More treatment is needed for all water samples aside from the control to bring the turbidity down to levels that are acceptable for consumption. The significant initial turbidity of main river water would probably necessitate extra filtration stages or settling operations. Lake water responds well to filtration, and with additional treatment, it can be safe to drink. Although underground water is the closest to safe levels, filtering is still advised for best clarity and possible contamination removal.

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4.3 The research operating parameters for media filters, media size, depth, porosity, filtration rate, and backwash intensity.

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4.3.1 Media size

Impact on adsorption and surface area less surface area per unit volume is found in big media. Size for silica sand are 2.4-4.8 mm for coarse, 1.2-2.4 mm for medium and 0.6-1.2 mm. Size for activated carbon range from 2.0-3.0 mm. Size for zeolite media 0.4-1.0 mm. Size for manganese greensand range from 0.4-0.8 mm. Size of resin ion exchange is 0.8 mm. This may reduce the quantity of adsorption of pollutants, particularly for activated carbon and zeolite, whose adsorption of contaminants is mostly dependent on surface area. Because smaller media have a higher surface area per unit volume, they may be able to remove more contaminants. Smaller particles, however, can clog the filter more quickly and need more frequent backwashing. Activated carbon needs optimal surface area for successful adsorption. Smaller size could be good, however balancing flow rate is crucial. Zeolite's smaller size can boost adsorption, however flow rate must be taken into consideration. Iron and manganese are the main things removed by manganese greensand. While size is not as crucial, filter effectiveness depends on size consistency. For effective ion exchange, resin ion exchange smaller size can be advantageous; nonetheless, flow balancing and pressure build-up prevention are critical. Filtration with sand media is still unable to remove NH3-N. Sand media combined with other media such as activated carbon and zeolites have adequate hydraulic properties and effective in removing total suspended solids and nutrients contained in rainwater runoff (Opher & Friedler, 2010).

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4.3.2 Depth

Realizing the full potential of multi-layered media filters to address various water pollutants is the aim of this intriguing study. We thoroughly examine the intricate relationships that exist between optimal design and operational parameters for a specific Filter 1 configuration that consists of three 9-cm-thick layers of activated carbon, zeolite, and silica sand separated by a final 3-cm-thick void. The 6 centimeters of silica sand, 12 centimeters of resin ion exchange, 9 centimeters of manganese green sand, and 3 centimeters of empty space make up the configuration for filter 2 that we are focusing on. Our goal in analyzing this specific arrangement is to provide significant knowledge to the broader field of multi-layer filtering systems. This is important because a slower flow rate will aid in preventing clogging of the filter. The kind of filter media being utilised will also affect the depth of the media filterThis is important since a slower

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flow rate will help keep the filter from clogging. The media filter's depth will also depend on the type of filter material being used. Compared to other media types, sand is a filter medium that is more successful at removing larger particles. This suggests that a deeper filter can be used if sand is the filter material. When it comes to filtering, a deeper media filter will typically outperform a shallower filter.

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4.3.3 Porosity

The percentage of an object's volume that is empty space is known as its porosity. This research also focus of water media filters, specifically focusing on optimizing their design and operating parameters while considering the crucial factor of porosity. Filter 1 working with a unique configuration: 30% silica sand, 30% zeolite, 30% activated carbon, and 10% void space. Filter configuration: 20% silica sand, 40% resin, 30% manganese greensand, and 10% void space By meticulously analyzing the interplay between these elements, we aim to unlock the true potential of multi-layered filtration for diverse water purification needs.This is due to the fact that a filter bed with a larger porosity will have more surface area for water to flow through, which means that the water will filter more quickly. Additionally, smaller particles will be filtered more effectively by a filter bed with increased porosity. As a result of the smaller particleswill be able to flow through the empty spaces in the filter bed more easily.

4.3.4 Backwash intensity

The process of reversing the flow of water through the filter media to remove trapped contaminants and prevent clogging. During backwash, the accumulated particles are flushed out of the filter. The reading was made by using turbidity meter to obtain backwash intensity. 35 NTU in backwash for filter1 and 14 NTU for filter 2 this value suggests a moderate level of suspended particles remaining in the filter media even after backwashing. Incomplete backwashing the backwash process might not have been strong or thorough enough to remove all the accumulated particles. Filter media clogging the media itself might be clogged with fine particles that are difficult to remove during backwash. High influent turbidity the water entering the filter might have high turbidity, leading to more particles being trapped in the media.

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4.3.5 Filtration rate

Effect on Drop in Pressure and Flow Rate because there are more open spaces between the particles in big media, water flows more quickly. Higher filtration rates may result from this, although the effectiveness of some pollutants' removal may be compromised. For filter 1 the filtration was 24 liter per hour and for filter 2 is 20 liter per hour. More flow resistance provided by smaller media might lead to a larger pressure drop and thus slower filtration rates. Still, that might work better in removing fine particles. Specific Considerations for Each Media: Silica sand primarily removes larger suspended solids

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CHAPTER 5

5.1 Conclusion

According to the report, the study's main objective was to design and assess sludge medium for point of use water contaminants, especially in places with limited access to potable water. The purpose of the study was to evaluate the efficacy of various media sludge types for treating drinking water at the point of use, with an emphasis on the removal of impurities such iron, suspended particles, and organic compounds. The study also examined how important water filtration is in producing safe, clean water for particular uses by eliminating or lowering particle matter and other unwanted chemical and natural pollutants from contaminated water. The results of the study showed that the water media filter's effectiveness differed depending on the type of water source, such as lakes, underground water, and major rivers. The evaluation of a number of factors, including pH, turbidity, total suspended solids (TSS), chemical oxygen demand (COD), and biochemical oxygen demand (BOD), both prior to and following filtration, gave important information about how well the water media filter reduced pollutants in the water sources under test. The water media filter's capacity to improve water quality was demonstrated by the results, which showed that it successfully decreased the levels of turbidity, TSS, BOD, and COD in the examined water samples. It was also observed that some water sources, especially the main river, had significant initial contamination levels and needed additional treatment in order to satisfy safe drinking water requirements. The study's result emphasized the significance of water media filters in tackling the problem of supplying clean, safe drinking water, particularly in places with restricted access to centralized water treatment facilities. The results showed that sludge media may be used for point of use water treatment, and they also highlighted the necessity for continued research and development to maximize the effectiveness of water media filters under various environmental conditions.

5.2 Recommendation

To completely evaluate the potential of water media filters in reducing environmental pollution across a variety of water sources, a thorough research plan is necessary. The current study must assess not only the individual effectiveness of silica sand, activated carbon, zeolite, manganese greensand, and resin ion exchange in removing various contaminants, but also their combined effects through clever media combination. Characterizing the target pollutants present in each lake, river, and subsurface water source should be the first stage of the research process. Particular attention should be paid to the contaminants that are a result of environmental impacts including industrial waste, agricultural runoff, and urban spills. The efficacy of each form of medium can then be evaluated by evaluating its adsorption, testing it against these specific contaminants, filtration, and regeneration capacities. The design and operation of media filters should be improved as the next area of focus. Experimenting with different media layer designs, porosities, depths, and flow rates can help optimise contaminant removal while avoiding pressure dips and backwash frequency. In order to evaluate if extensive physical experimentation is still necessary, the research should also investigate the potential of applying computer modelling to estimate filter performance under various circumstances. The study's recommendations for the ideal media combinations and filter designs are tailored to the particular pollutant profiles of each water source. When applied effectively, this knowledge can provide legislators and engineers working to develop efficient and sustainable water purification systems for a range of environmental settings.

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Appendix A

In situ conduct

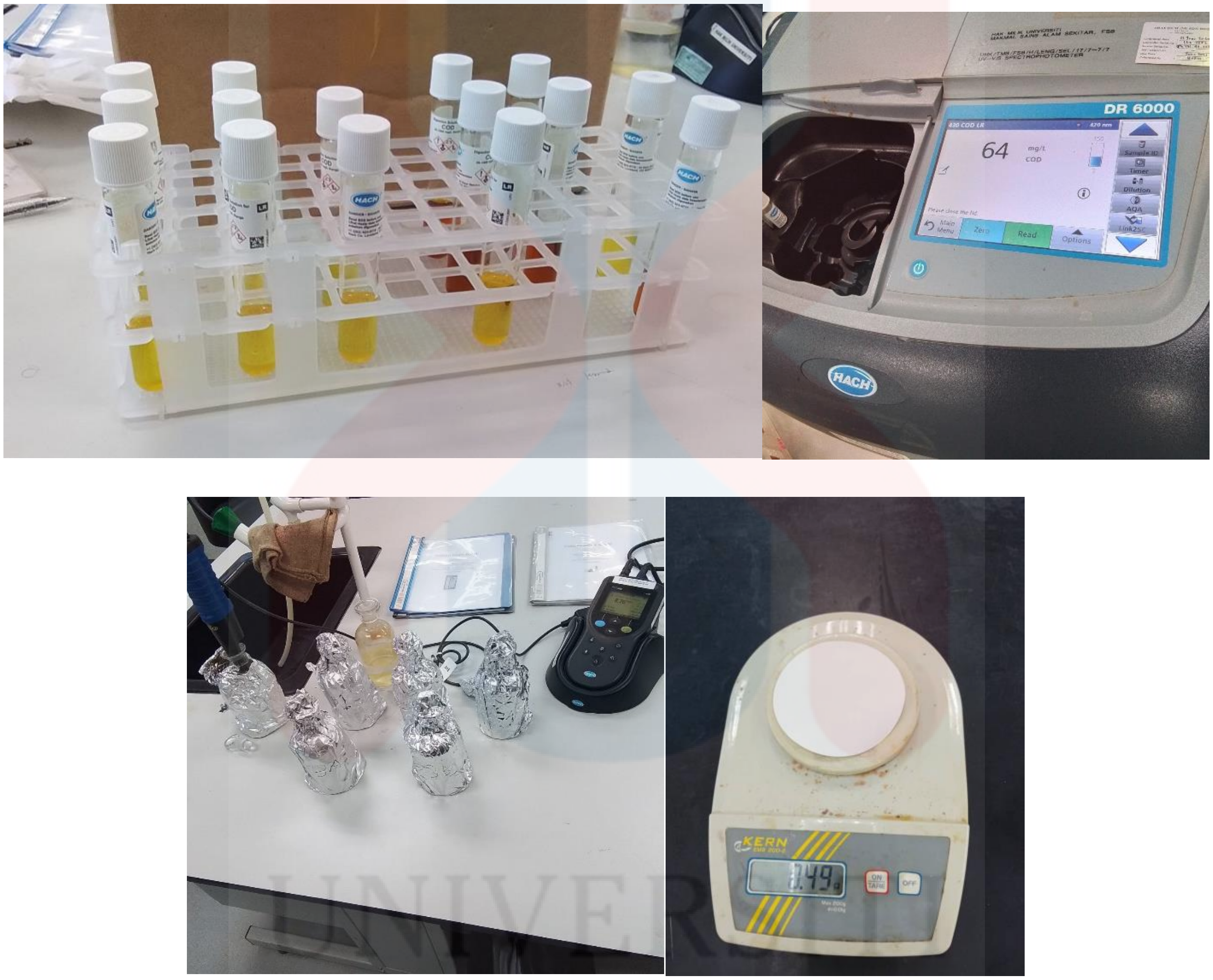
Location 1: Main river

Location 2: Lake

Turbidity meter and YSI multiparameter

Appendix B

Ex situ conduct



Laboratory conduct

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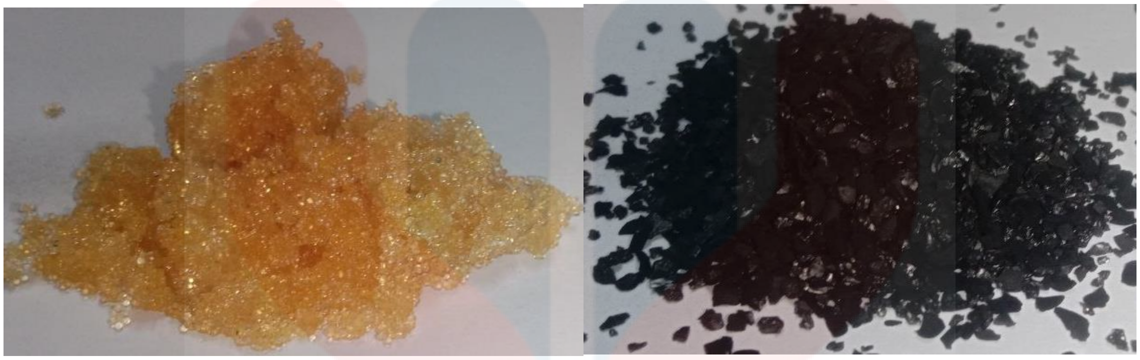
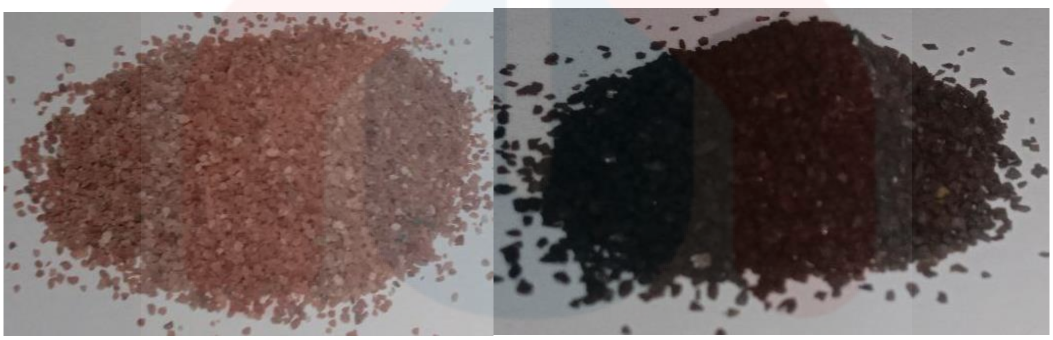
Appendix c

Type of media



Media resin ion exchange and activated carbon



Media zeolite and manganese greensand

Media silica sand

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