Potential Additive in Engineered Soil Media for Train Treatment System

By

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24875

Dissertation submitted in partial fulfilment of the requirements for the Bachelor of Engineering (Hons) Civil

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CERTIFICATION OF APPROVAL

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A project dissertation submitted to the
Civil Engineering Programme
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(CIVIL ENGINNERING)

Approved by,

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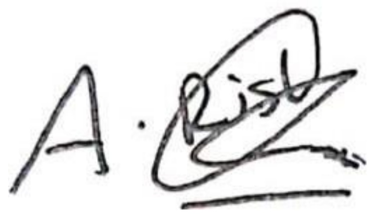
(Dr Husna Binti Takaijudin)

CERTIFICATION OF ORIGINALITY

This is to confirm that I am responsible for the work presented in this project, that the original work is my own except as mentioned in the references and acknowledgements, and the original work contained herein was not undertaken or done by unnamed sources or person.



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Risban A/L Aliges (24875)

ABSTRACT

Treatment train system is a revolutionary best management approach for effluent wastewater, applied to limit the impact of urban during storm events. Bioretention comprises of porous media layers that can remove contaminants from infiltrating by methods that include adsorption, precipitation, and filtration. However, the efficiency of bioretention system with additives has not been examined. The goal of the research is to study the potential additives in engineered soil media to enhance the train treatment system. The train treatment system or bioretention is comprised of 3 sets with 9 columns and each with a fixed single plant, fixed engineered soil but with different soil additions. Set A: Without additive, Set B: Coconut Husk, Set C: Tyre Crumb. The effluent wastewater from UTP STP near ERL laboratory was used in this study. Afterall preparations have been made, the test run in the treatment train system is conducted. The objective is to determine the concentration of COD and effectiveness of TSS removal for different type of additives. The best performance between these there (3) different configurations was set B as it reduced the highest number of COD and TSS concentration level. Thus, Coconut Husk is the best proposed additive compared to tyre crumb in this experiment and the objectives were achieved. It would be recommended that future research include monitoring the treatment train system's performance over a longer length of time to observe. Moreover, it would be recommended to tyre crumb can be replaced with tyre crump for better results.

ACKNOWLEDGEMENT

Most importantly, I want to convey my grateful to project supervisor, Dr Husna bt Takaijudin for her assistance and unwavering support throughout my final year project at University Technology Petronas. Dr. Husna's guidance in completing this research was one of the most important aspects in my success in this research. It also enabled me to acquire crucial skills and knowledge that would otherwise have gone undiscovered.

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TABLE OF CONTENT

LIST OF FIGURES

LIST OF ABBERVIATIONS

BMP	Best Management Practises
BOD	Biochemical Oxygen Demand
COD	Chemical Oxygen Demand
TSS	Total Suspended Solids
UTP	Universiti Teknologi Petronas
R&D	Research and Development
LID	Low Impact Development
WWTP	Wastewater treatment facilities
ERL	Environmental Research Laboratory
FYP	Final Year Project
MSMA	Urban Storm Water Management

CHAPTER 1

INTRODUCTION

1.1 Background Study

Sufficient water resource conservation is crucial as freshwater systems provide several environmental services such as maintaining numerous species, supplying water for drinking and irrigation, and absorbing wastes through abiotic/biotic cycles. Estimates show that 60 percent of the globe will reside in urban areas by 2030 with the combined effect of increased people and greater water consumption (Postel et al.,2016) causing larger quantities of wastewater in concentrated locations

As the volume of effluent wastewater from impermeable regions is multiplied and accelerated, it causes downstream soil erosion, transports more contaminants, and changes the temperature of downstream water bodies. Some of the most serious water quality issues include high nutrient inputs, suspended particles, and heavy metal concentrations (Vandar,2016). Due to the obvious pollution in rivers, water suppliers must make sure a consistent supply of tap water and supply drinkable water. It produces large amounts of sediments, nutrients, and chemicals to accumulate in water bodies. Pollution in large quantities is typically found in urban stormwater runoff. It is extremely harmful to both living things and the environment. As a result, it is recommended to use restrictive water quality testing practises and to conserve water.

Land runoff is increased with more nutrients, such as phosphorus and nitrogen, as a caused by land clearing and the development of towns and cities. Municipal grey water, fertilisers, and urban agricultures contribute additional nutrients in urban areas. These nutrients cause an excessive growth of algae, which affects the natural food web in rivers, but also reduces the amount of dissolved oxygen in the water, increasing the death rates of aquatic animals and plants. As a result, implementing Best Management Practices (BMPs) for water managementhas become a vital feature of urban development (Raspati et al., 2017).

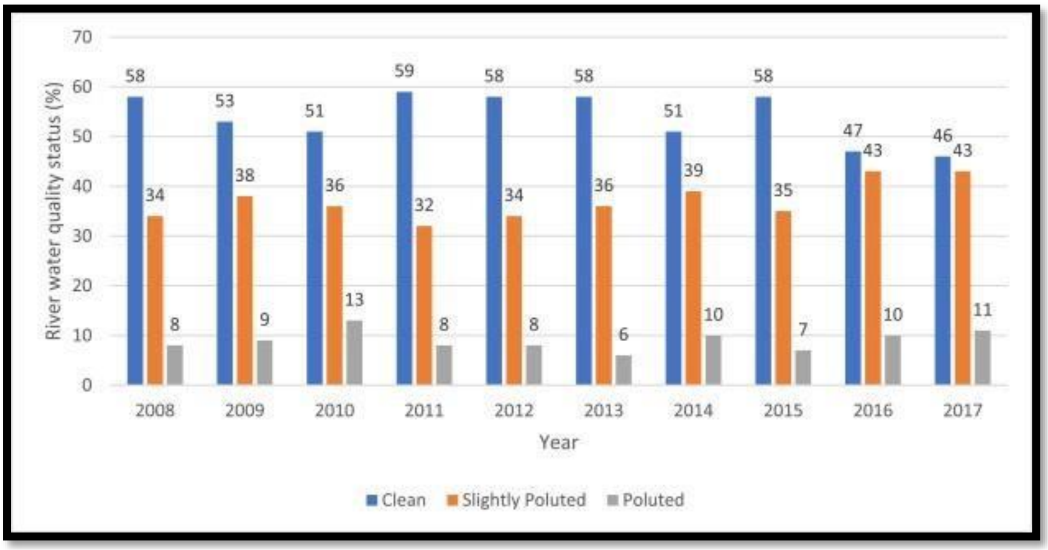

Figure 1.1: Water quality status of Malaysia from year (2008 -2017) Citated from Laurenson (2015)

Bioretention, is one of the best management practises (BMPs), collectively known as water control measures are being used increasingly frequently in urbanized areas to provide flow management and treatment to improve quality (District,2021). The term "bioretention" was invented inthe early 1980s and has since been revived for a variety of new applications. For pollutant removal, bioretention uses underlying filter medium and vegetation. Biofiltration systems, in particularly, have been found to be effective in eliminating numerous contaminants from water due to their multilayer filter media. Treatment train systems are a modified version of biofiltration systems, which are used in the treatment processes of wastewater. It was used to filter water for nutrients, sediments, and pollutants. Stormwater enters thetreatment train system, where it ponds on the surface before being progressivelyfiltered using soil filter media.

Before treated water is discharged into the sewage system or directly into receiving waters, it is allowed to permeate into the surrounding soil or collected through an underdrain placed in the drainage layer. Water captures and treats all of these contaminants as it passes through the underground soil,increasing in Total Suspended Solid (TSS) and Chemical Oxygen Demand (COD) concentration in stormwater. Furthermore, a treatment train system can be applied to meet a range of water management requirements, consist of preserving groundwater recharge and base flow, removing surface and groundwater pollutants, reducing peak flow, and channel protection. They can be installed into existing structures and widely used in residential and industrial locations, as well as residential gardens, parking lots, and highways.

These designs emphasis water infiltration into the soil, onsite treatment, and connection to natural water supplies. Wetland is one of the system's techniques for removing fertilizer and heavy metals from water, although it performs poorly when trash and gravels are present. The treatment train system was well-known for its versatility in water runoff treatment as well as its ability to remove pollutants. Water infiltrated into subsurface soil will eventually go through a bioretention process to decrease water pollution. Treatment train systems are best management practise stormwater systems that treat water and improve water quality by utilising vegetation, mulches, and addictive designed soil media (District,2021).

1.2 Problem Statement

Estimates show that 60 percent of the globe will reside in urban areas by 2030 with the combined effect of increased people and greater water consumption (Postel et al.,2016) causing larger quantities of wastewater in concentrated locations. As the volume of wastewater from impermeableregions is multiplied and accelerated, it causes downstream soil erosion, transports more contaminants, and changes the temperature of downstream waterbodies. Some of the most serious water quality issues include high nutrient inputs, suspended particles, and heavy metal concentrations (Vandar,2016).

A treatment train system is a series of trains that deploy a bioretention system to filter water and reduce pollutants in the water to protect our ecosystem. Wastewater was chosen because it is the most polluted body of water on the earth, with sediments, pollutants, and nutrients among itscomposition. Thus, potential addictive in engineered media soil was applied in bioretention system to determine concentration of COD, concentration of TSS and its removal for different type of additive.

1.3 Objectives

The sole purpose of this research is to show the enhancement performance by using potential additives in engineered media soil using treatment train system approach on stormwater runoff. The objectives are shown below:

a) To differentiate the type of additives which can be used to enhance the pollutant removal.

b) To evaluate the effectiveness of COD and TSS removal for wastewater effluent in a treatment train system with presence of tyre crumb and coconut husk additives.

1.4 Scope of Study

In this research, the aim is to show gradual improvement on the result of TSS and COD experiment by using potential additives in engineered soil media using treatment train system. The treatment train system will be an experimental research prototype of additives in engineered soil media that will be done on the developed treatment train system using stormwater runoff.

a) Setup of train treatment system with differential additive in soil interpretation added into each column and vegetation.
b) Prepare and collect the effluent of wastewater treatment.
c) Determine the COD and TSS concentration on water sample collected from each outlet of column.
d) Compare the difference result of initial and final in TSS removal concentration and COD removal.
e) The result will be analyzed comparing with initial and final COD and TSS removal concentration then compare the performance of single treatment train with series of treatment train approach.

CHAPTER 2

LITERATURE REVIEW

The literature review explains about the characteristics of effluent from wastewater treatment, study the usage of potential additive in engineered soil media treatment train system and Stormwater management practices. Moreover, the literature review clarifies about the TSS and COD experiment that evaluate the effectiveness of removal concentration from wastewater effluent in a treatment train system with presence of additives. It also characterizes the type of additives which can be used to enhance the pollutant removal.

Wastewater treatment is a leading causing pollution that develop sludge level and frequently results in sludge with poor settling and dewatering characteristics and a pH depression, biological treatment. This effect is mainly due to high level of Total Suspended Solid (TSS) and Chemical oxygen demand (COD) concentration. Therefore, treatment train system with different additive in soil media is developed to reduce the water pollution and save our mother nature by enhance the effectiveness of COD and TSS removal level of water.

2.1 Discharge effluent from wastewater treatment

Globally, the effluents that are emitted by wastewater treatment facilities represent one of causes of pollution. The harmful impacts of these influent to aquatic ecosystems and to humans from dangerous compounds present in them have been documented both at national and international levels Some of these effects can include extinction of aquatic life, algal blooms, habitat loss from erosion, debris, and increased water flow and other immediate and long-term toxicity from chemical pollutants; in conjunction with chemical build up and magnification at higher stages of the food chain (Akpor et al., 2018).

Previously, many treatment plants were designed to remove nutrients through chemical addition. Due to the reason that chemical treatment is known toincrease sludge volume and frequently results in sludge with poor settling and dewatering characteristics and a pH depression, biological treatment has gainedpopularity in recent years (Postel,2016).

Wastewater treatment facilities (WWTPs) are popular around the world and are a vital stage in enhance the effectiveness of wastewater before it is released to surface or groundwater or reintroduced into drinking water supplies. Many countries have worked to limit the volume of untreated wastewater discharged into rivers and streams during the last 50 years by closely monitoring and constantly improving municipal and industrial WWTPs (Tchobanoglous, 2017). While WWTPs are a desirable alternative to unregulated discharges, they do not discharge water of the same quality as the receiving body of water and also affect the receiving system physically. Influent discharges have the capability to drastically modify a variety of features of aquatic including the efficiency with which nutrients are absorbed.

2.2 LID & BMP

According to most of the article, the number of countries has implemented water management practises that require to be directly discharged into nearby bodies of water. Even if these management practises arein existence, te public is unaware of pollution occurring in waterbodies (Raspati et al., 2017). Additionally, climate change will have a significant impact on water management practises (Shafique, M.2016). As a result, water management practises should be strictly enforced.

To minimize the environmental consequences of water pollution, a cost-effective strategy would be to implement best management practises (BMPs) and low-impact development (LID). BMPs and LIDs are both water management techniques that have been utilised to manage runoff as close to the source as possible, its source (Seo et al., 2017). Urban Stormwater Management Manual for Malaysia (MSMA) has identified bioretention systems as a component of BMPs that can help enhance the quality of influents. Bioretention systems work by capturing water that infiltrates vertically through a soil media and treating it through evaporation, transpiration, sedimentation, filtration, sorption, increased denitrification, and biological activities (Laurenson et al., 2015).

A treatment train system is the successive implementation of best management practises (BMPs) and low impact development (LID). The usage of single-system BMPs and LIDs is ineffective (Revitt et al.,2017). Additionally, the study indicates that soil layers may become saturated with pollutants over time, reducing the system's ability to remove pollutants. Following that, a study conducted by Goh et al. (2017) discovered that a well-designed engineered soil is critical for establishing a bioretention system, since it ensures that the required pollutant removal standards are met.

2.3 Treatment Train system

A treatment train system, also known as a bioretention system, is another innovation in urban water management that was highlighted in the Malaysian Urban Water Management Manual (MSMA) is also accessiblelocally. The usage treatment train has a numerous advantage than carrying out our single treatment, including an increase in pollution expulsion with the number of different cycles. In Malaysia, it is suggested that a treatment train system be used. In Malaysia, the treatment train system can be considered another development in wastewater management practises that have yet to be widely implemented throughout the country (Winston,2020). However, there arecurrently no studies evaluating their performance in terms of hydrologicalcharacteristics and treatment performance toward quality via a treatment train system (Trowdale et al.,2011).

The treatment train system is made up of essential filter media and plants with the purpose of removing pollutants. The water enters the treatment train system at the surface level and is ponded, followed by vertical filtering through soil channel medium (Jiang et al.,2019). The benefit of treatment train systems is their capacity to drastically lower water quantities via infiltration and evapotranspiration. The results reveal that the peak flow rate and water polluted contamination reduction of a bioretention cell were greater than those of a swale (District,2020).Bioretention often outperformed swales in terms of removing pollutants. Water that passes through the biofiltration system is treated physically, chemically, andbiologically (Tirpak,2019).

2.4 Total Suspended Solid (TSS)

Total Suspended Solid particles in influent wastewater are a significant indicator of the presence of organic matter, particulate nutrients, heavy metals, and other pollutants (Wang,2019. Additionally, influent wastewater can suspend particles clog water, conveyance systems and harm aquatic ecosystems (Geronimo,2019). The research conducted a series of 9 bioretention column tests using influent wastewater as high TSS removals were observed in most of the mesocosm, high removals of particle bound pollutants could also be expected (Dutta,2021). The main mechanism involved in TSS removal for bioretention is settling and filtration. The TSS removal efficiency could be explained by a fundamental filtration model, where steady state particulate removal is affected by particle size and sticking coefficient (Wang,2019). The consistency of TSS removal performance in the presence of additives demonstrates the potential and adaptability of enhanced bioretention systems for usage in a variety of applications.

2.5 COD Removal

The chemical oxygen demand (COD) is a unit of measurement for the oxygen equivalent of the organic matter in water. Figure 3 illustrates the COD elimination results in C1 and C2 during a 10-cycle period. COD concentrations in the influent ranged between 150 and 250 mg/L. (Jiang et al.,2019). Bioretention columns significantly reduced COD levels during the experiments. C1 removed COD with an average effectiveness of 79.5 percent, while C2 removed COD with an average efficiency of 84.1 percent. Clearly, the WTR amendment (C2) revealed not only increased COD elimination efficacy but also decreased volatility, with the benefits becoming more apparent after the sixth cycle. A bioretention system typically eliminates COD by adsorption, filtering, microbial breakdown, and plant absorption (Wang et al.,2020). Among these activities, adsorption is critical because it provides a rapid capture process and a temporary storage reservoir for other slower processes such as biodegradation and plant absorption (Wang et al.,2020). Early cycles are less successful at removing COD, which could be due to COD leaching from the WTR (Jiang et al.,2019).

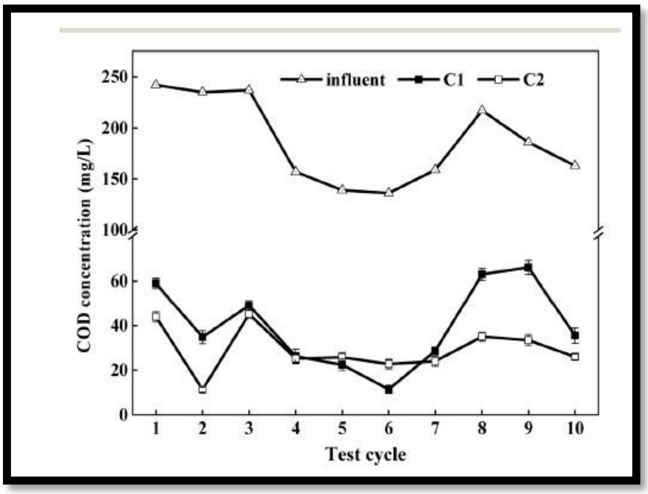

Figure 2.1: COD removal results by bioretention columns with or without the potential additives in soil. (Jiang et al.,2019)

2.6 Potential additive in engineered soil media (Coconut Husk)

Many additives have been shown to be effective in removing nutrients from water bodies in a variety of applications in recent years. This demonstrates that the potential for employing additives in bioretention filter media has been extensively explored. Coconut husk has also been demonstrated to be a potential bio-adsorbent for heavy metal clean-up (Tota-Maharaj and Cheddie 2015). Coconut husk is a fibre formed from the inner shell of the coconut that can be put to compost soils to improve their plants and soil performance (Shrestha et al,2019). Previously seen as a waste product and hence abandoned or burned, new uses for coir havebeen developed over the last decade, including its use as a soil amendment for deteriorated soils (Abad et al.,2002). However, most results are extrapolated from laboratory batch sorption tests with aqueous solutions containing heavy metals at concentrations comparable to those seen in wastewater. Coconut huskis an organic waste product that can be put to compost soils as a substrate to improve the soil's and plants performance. It is a source of organic matter, and while it contains few nutrients on its own, it has a great capacity for retaining nutrients and hence increases the overall quality of the soil, although it cannot be used alone as a growing medium (Tota-Maharaj and

Cheddie 2015). Coconut husk is resistant to biodegradation in the environment; as a result, the slow decomposition of coir can also provide a consistent source of carbon. (Noguera et al. 2003).

Figure 2.2: Coconut Husk

2.7 Potential additive in engineered soil media (Tyre crumbs)

Since the top layer of crumb rubber media is the least compressed and the bottom layer is the most compressed, the media has an optimum porosity gradient. In compared to sand or anthracite filters, the crumb rubber filter promotes in-depth filtration, allowing for longer filtration durations and higher filtration rates (Xie,2007). The crumb rubber filter performed comparable to the sand filter in terms of turbidity and total suspended solids removal. Because crumb rubber has a longer filtration duration and a greater filtration rate, using it as a filter media has the potential to greatly improve filtration efficiency (Battista et al.,2021). the tyre crumb could not able to absorb the water and it also has ability to produce Zinc leachate and polycyclic aromatic hydrocarbon as well (fort et al., 2022)

Figure 2.3: Tyre crumb

CHAPTER 3

METHODOLGY

The main objective of this research is to differentiate the type of additives which can be used to enhance the pollutant removal. In beginning, it is necessary to identify and study the configuration of the treatment train system. The information about the treatment train system was gathered from articles and other sources. The UTP research laboratory constructed the treatment train system. The treatment train system is carefully analyzed to make sure that no errors occur throughout the experimental process. The prime consideration is toevaluate the effectiveness of COD and TSS removal for wastewater influent ina treatment train system with presence of additives.

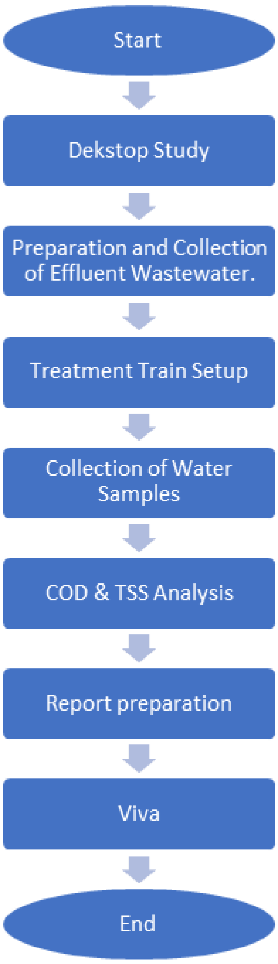

FIGURE 3.1: Project flowchart

Firstly, the study challenge and objective were identified. The investigation discovered a problem in that influent wastewater that is discharged into bodies ofwater has a low water quality rating. Additionally, the primary parameter was todo study on COD, and TSS, all of which can endanger to human and aquatic life.After that, data is analyzed and compiled from related publications found on the internet. After that, a treatment train system is established. At UTP's Environmental Research Laboratory (ERL), the treatment train system was established. There is total three (3) sets used which is control and vegetation planted. The sample water used in this study was influent wastewater flow created in the ERL laboratory. After all preparations have been made, the test run in the treatment train system is conducted. Each column was sampled and the COD and TSS concentration was determined in the UTP block 14 environmental lab. Finally, the results were evaluated to determine the COD concentration and TSS removal efficiency.

Figure 3.1: Location of collection of discharge effluent wastewater

3.1 Treatment train system setup

A series of 3 sets with 9 bioretention columns were set up as shown in Figure 3.2 below. Each column has cordyline Fruticose plant as ponding layer. Three distinct column configurations will be employed, each containing a different configuration:

I. Column A: Plant control (CF) + Engineered soil without additive

II. Column B: Plant control (CF) +Engineered solid with additive (Coconut Husk)

III. Column C: Plant control (CF) + Engineered solid with additive (Tyre crumb)

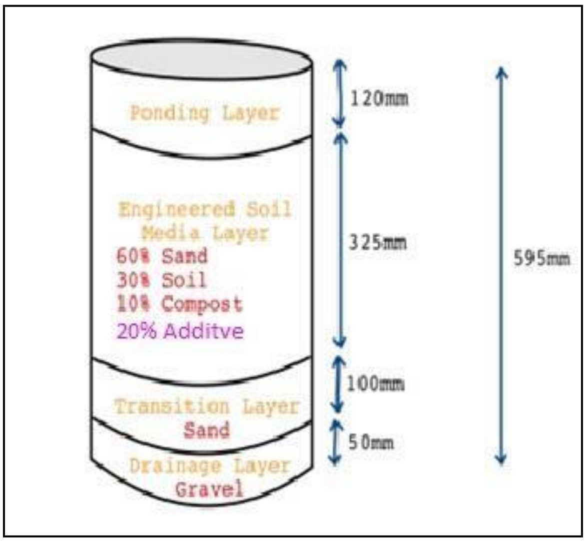

Figure 3.2: Column with layers

A The bioretention column is composed of a ponding area, soil medium, a sand layer, and a gravel layer. In the ponding zone, a Cordyline fruticose (CF) is planted as the ponding layer for 9 columns. The soil medium is 60% sand, 30% topsoil, 10% compost and 20% additives. 300mm is the depth of the soil media layer, 95mm is the depth of the sand layer, and 100mm is the depth of the gravel layer. The water tank has a capacity of 150L for runoff, which acts as an influent. The valves controlled the adjustment flow of sample water that allow to enter column 1, where it eventually flows to columns 2 and 3. Each column's outlets replicate free falling runoff, which helps in aerating and dichlorination the runoff.

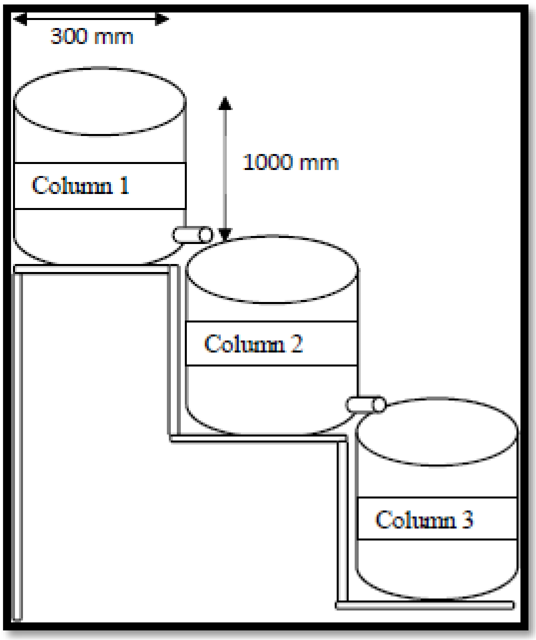

Figure 3.3: Treatment train cross-section

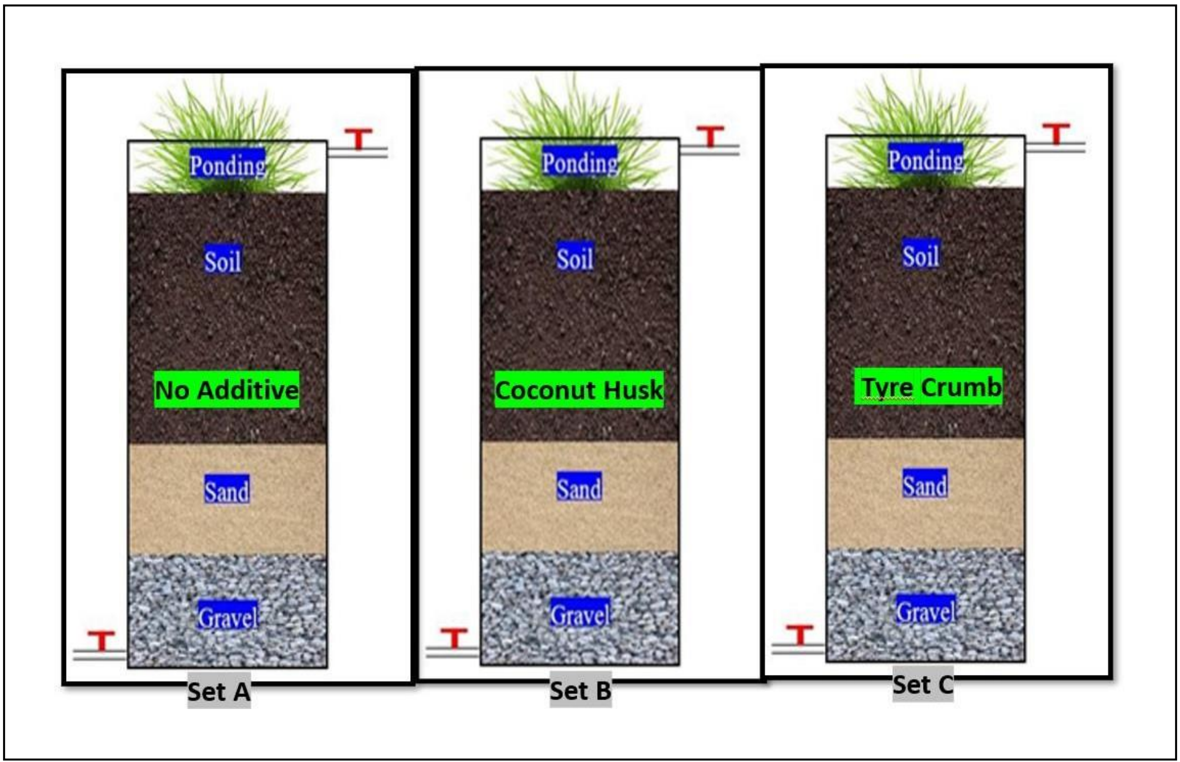

Figure 3.4: Column Set A is without additive whereas Set B and Set C is with additive

Limiting the saturated zone is accomplished by connecting an L-shaped tube to the outlet. Thus, depending on the length of the L-shaped tube, the columns will hold water to a depth of up to 10mm and will naturally release due to the built-up pressure head. The saturated zone is utilised to prolong the period duringwhich runoff is retained inside the column construction. Additionally, prior study has included testing in a saturated zone.

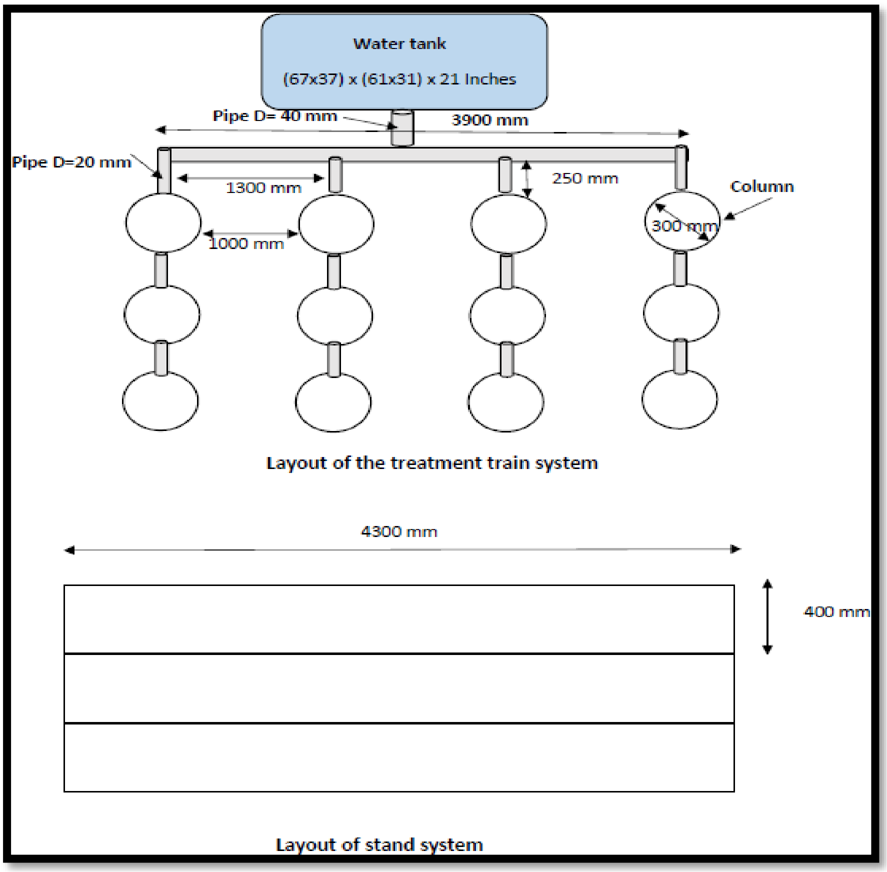

Figure 3.5: Layouts of the treatment train system (top) and stand (system)

Figure 3.6: The setup of the treatment train system

The few soils sample was taken from the Research and Development (R&D) buildingat UTP and some was bought from the Sri Iskandar Nursery. To ascertain the type of soil collected, soil classification was performed.The plant, compost, sand, additive, mosquito net and soil was purchased near SriIskandar Nursery. Following a 24-hour oven drying period, the soil was tested for specific gravity, particle size distribution, and hydrometer readings. Following that, the soil is combined using an industrial mixer at a ratio of 60% dirt, 30% sand, and 10% compost. The columns were then formed with a layer of gravel, a layer of sand, and a layer of soil mixture separated by filter media. At the bottom of each column, holes were drilled, and PVC tubing was added for the outflow. Additionally, each column has an aperture at the top to prevent overflow**.**

Figure 3.7: Location of soil collected

3.2 Preparation potential additives in engineered media soil (Coconut husk & Tyre crumb)

A density test was performed to convert the volume of selected additives and filter media components to weight including medium sand, topsoil, and leave compost. Three columns were made using PVC pipes with a diameter of 50mm and a length of 750mm. Geotextile cloth was used to separate the outlet and filter media. Two columns were filled with the filter media composition specified in MSMA plus 20% of Coconut husk and Tyre crump, the columns were filled to a height of 500mm. The additive use for column B is coconut husk, for column C is tyre crump and Column A is without addictive. As a baseline study, an additional column with the MSMA-recommended filter media composition (standard column) was used. All columns were inundated with water daily for three days following soil mixing to achieve hydraulic compression of the soil. The texture of additives must be thick enough when mix with clay content in topsoil. It is to avoid blocking the voids in the soil and to increase the soil infiltration rate.

3.3 Preparation and collection of discharge effluent wastewater

To conduct this study's experiment, discharge effluent wastewater was used to preserve and manipulate the stormwater's physical and chemical characteristics. Additionally, it is chosen over actual discharge to avoid collecting several samples for each test run. Additionally, the pollutant content of each day will vary, resulting in inconsistent results. The effluent was collected using three small water collection tank which volume is 75 liters. For each run, 75 liters will be poured into the storage tank and the valve will control the flow of sample of each column. The run was repeated for several times and pipe water used earlier to flush the contaminant in the tank. The collected samples from each column were examined in UTP's Block 14 Environmental Lab to determine the COD and TSS concentration.

3.4 Soil preparation

The soil samples were categorised according to their specific gravity, which was determined with the aid of a pycnometer top and jar. The specific gravity of soil was determined by dividing the mass of soil particles by the mass of water in the same volume. To begin, an empty pycnometer jar was weighed to the nearest 0.05kg; the weights are denoted by W1. After filling the jar with oven dried soil samples, the jar was weighed and recorded as W2. The jar was topped off with water until it was two-thirds full. After settling the soil particles, the jar was filled with water to the tip of the pycnometer's top. The jar was weighed once more and gave the weight W3. Finally, the jar was emptied and cleaned before being refilled with water to the tip of the pycnometer's top, weighed, and W4.

The distribution of soil particle sizes was studied to characterize the soil. After 24 hours in the oven, the soil was sieved through a succession of sieves with gradually finer mesh sizes, and the amount of material retained in each sieve was weighed and expressed as a fraction of the total mass.

Following that, hydrometer test was performed on the soil fines greater than 63m. The hydrometer test was conducted using a 152H hydrometer. Soil was taken from an oven dried sample that was sieved into the pan using a 63m sieve. The dirt is poured in a dispersing solution inside a conical flask and stirred for 24 hours on a mixing rack. After that, the dirt is progressively added to a 1000mL measuring cylinder. A disposable 1000mL measuring container is filled with distilled water for cleaning the hydrometer bulb in between measurements. Both measurement cylinders are placed inside a water bath to maintain a consistent temperature. 30 seconds, 60 seconds, 2 minutes, 4 minutes, 8 minutes, 15 minutes, 30 minutes, 1 hour, 2 hours, and 24 hours are pre-set on the timer. The hydrometer measurements are corrected for the temperature of the water bath.

3.5 Experimenting Total Suspended Solid (TSS)

The samples will be placed into TSS filter paper with pan and labelled as follows:

I. I (1, 2, 3) – for the influent:
II. A (1, 2, 3) – vegetated column (without additive)
III. B (1, 2, 3) – vegetated column (coconut husk additive)
IV. C (1, 2, 3) – vegetated column (tyre crump additive)

The laboratory experiment was done according to the protocol outlined in the TSS experiment manual. The technique is as follows: initially, aluminium pans are labelled so they may be easily identified (A1, A2,A3,B1,B2,B3,C1,C2 and C3). Weighing and recording the filter paper Plus pan. Cleaning the TSS filter pump with distilled water and a filter paper affixed to the top of each filter holder. Using a measuring cylinder, 50 mL influent was measured and poured into the filter. This procedure was performed for eight additional samples. The measuring cylinder was then washed thoroughly with distilled water. Switch onthe pump to allow the wastewater sample and distilled water to be pumped out, ensuring that no suspended solids adhere to the filter's side. After pumping out all of the water, the watch glass was removed and the filter paper containing thesediments was placed on the pan. Place the pan and filter paper in the drying oven set to 105 degrees Celsius for 1 hour. After an hour, the pan containing the filter was removed from the drying oven and placed in a desiccator to cool to room temperature for ten minutes. The pan, filter paper, and solids were all measured and tabulated. The targeted concentration of raw wastewater effluent is less than 20mg/L.

3.6 Experimenting Chemical Oxygen Demand (COD)

The samples will be placed into COD bottles and labelled as follows:

I. X (1, 2, 3) – for the effluent:
II. A (1, 2, 3) – vegetated column (without additive)
III. B (1, 2, 3) – vegetated column (coconut husk additive)
IV. C (1, 2, 3) – vegetated column (tyre crump additive)

Each sample was placed in COD bottles of varying volumes and topped off with aerated distilled water prepared 24 hours prior to testing with the addition of a selected additive. After determining the volume of distilled water, half of the bottle's neck is filled with it, and a stopper is fitted into each of the prepared sample bottles to prevent trapped air bubbles. The bottle is sealed, coated with aluminium foil, and labelled to prevent evaporation. Then, take a 2 mL sample of wastewater and place it in a test tube containing potassium dichromate. Following that, properly shake the test tube. When heat is generated, an exothermic process has occurred. This procedure is then repeated for additional samples. The test tubes were then placed in the COD reactor, along with a blank as an indicator, and left for two hours. Finally, using a spectrophotometer, take three readings and average them. As for this project, Low Range Value (LR) would be used to determine the COD value. The targeted concentration of raw wastewater effluent is less than 80mg/L.

3.7 Gantt chart

Gantt chart for FYP 1

Project Activities	WEEK											
	1	2	3	4	5	6	7	8	9	10	11	12
Research Topic Confirmation	■	■										
Literature Review		■	■	■	■	■	■	■	■	■		
Treatment Train System Setup											■	■
Research Proposal Defense										■		
Submission of Interim Draft Report											■	
Submission of Interim Report												■

Table 3.5: Gannt chart for FYP 1

Gantt chart for FYP 2

Project Activities	WEEK													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Treatment train setup	■	■	■	■	■	■	■	■	■					
Collection of Samples and Data				■	■	■	■	■	■	■				
Data Analysis					■	■	■	■	■	■				
Preparation of Dissertation and Viva							■	■	■	■	■	■		
Viva											■	■	■	■
Dissertation Submission													■	■

Table 3.6: Pre-planned Gantt Chart for FYP 2

CHAPTER 4

RESULT AND DISCUSSION

4.1 Chemical Oxygen Demand (COD)

The amount of oxygen required to oxidize the organic matter in water is known as chemical oxygen requirement. The rate of oxidizing that will happen and the percentage of organic components in a water sample are evaluated using chemical oxygen demand testing. The number of inorganic compounds in a sample is also evaluated using chemical oxygen demand testing. Typically, chemical oxygen demand tests are performed on wastewater. The percentage of organic matter in the water is used to calculate the contamination level. Water containing too much organic material might damage the ecosystem where the influent is deposited. Chemical oxygen demand and biological oxygen demand are both methods for evaluating the oxygen demand of a water sample. Chemical oxygen demand is different from biochemical oxygen demand in that it measures everything that can be oxidized, whereas biochemical oxygen demand merely examines the oxygen required by organisms.

For this experiment, a total of three runs were carried out. A limit of 1.5 hours was spent on each run. Several run trials were performed before the actual runs to see if the sample was alright or not. After that, COD tests were performed on the water samples from the run trials, and it was discovered that all of the COD levels were incorrect. Because the value displayed on the screen of the DR 3900 Spectrophotometer was negative or out of range, the COD readings were nil. To address this issue, it was proposed that the soils in each column be cleaned with distilled water before every run to guarantee that no pollutants were trapped within the soil.

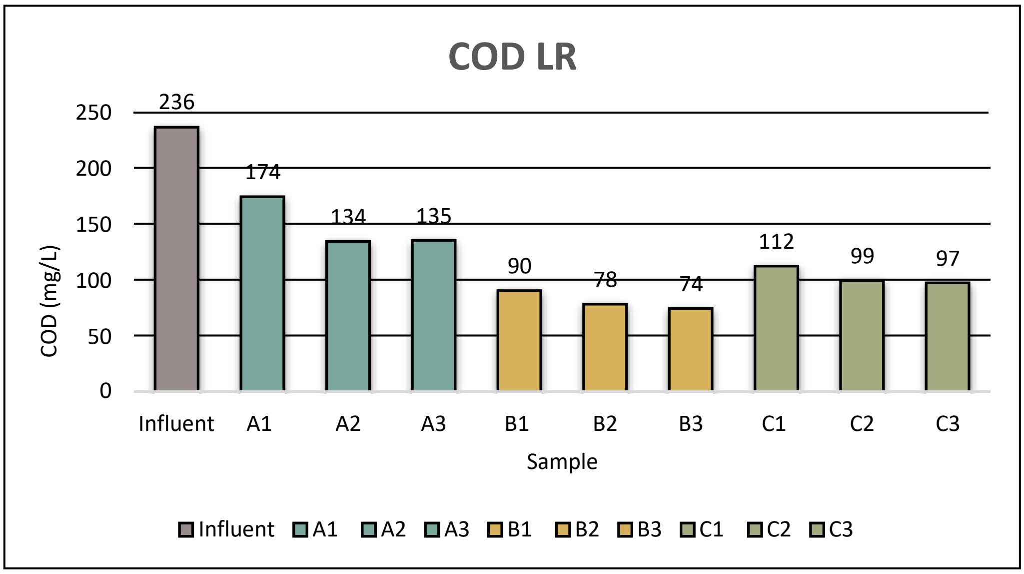

Figure 4.3: COD Results

Based on the graph above, it can be seen that the COD reading of influent is 236 mg/L. A is influent wastewater runoff without any additives, sample B is added with coconut husk while sample C is added with tyre crumbs. The COD level in sample A which is only influent wastewater is relatively high compared to the other samples. The concentration of COD is not compromised through the experimental work because soluble organic compounds are most likely to contribute to escalated COD concentrations. Residual food waste from bottles and cans, antifreeze, emulsified oils are all high in COD and are common sources of COD for industrial wastewater. Sample B is added with coconut husk whereby the COD level is the lowest comparing to the other samples.

Adsorption is recognized as an effective and low-cost technique for the removal of organic pollutants from water and wastewater and produce high-quality treated influent. Coconut husk gives maximum reduction efficiency constant time than tirecrumbs. Sample C is added with tire crumbs whereby the COD level is higher than sample B which shows the coconut husk do aid with COD reduction. CODlevel for run in sample A is 174 mg/L, 134 mg/L,135 mg/L for A1, A2 and A3. In run, B1, B2 and B3 the COD level is 90 mg/L, 78 mg/L and 74 mg/L. whereasfor sample C, the COD level is 112 mg/L, 99 mg/L and 97 mg/L respectively forC1, C2 and C3.

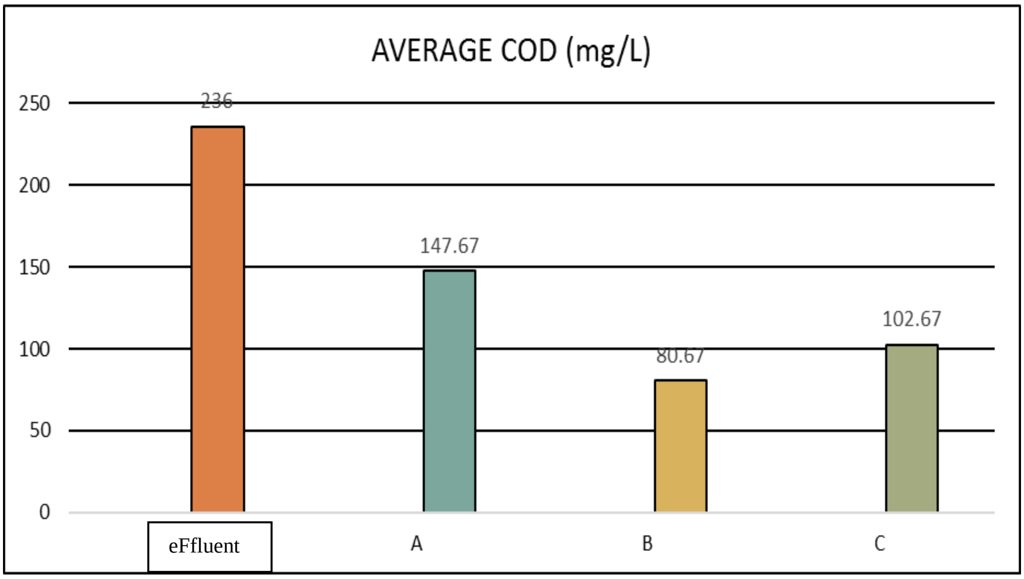

Figure 4.4: Average COD Results

Based on the graph above, the average of COD level in all the samples A, B and C respectively. It could be concluded that sample with coconut husk has the lowest chemical oxygen demand in the influent wastewater.

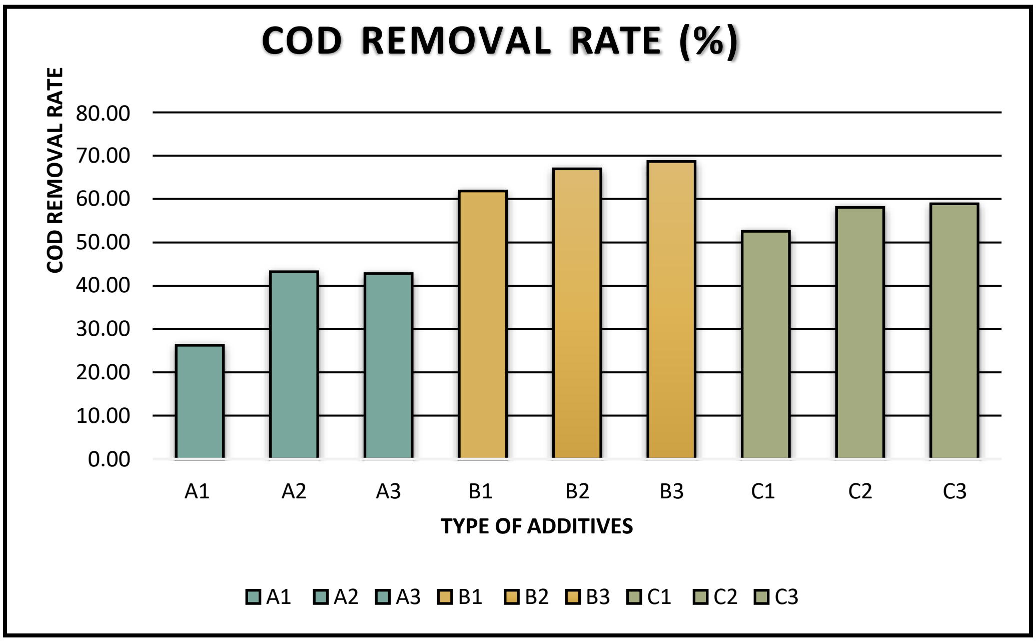

Figure 4.5: COD Removal Rate Results

The COD removal rate in sample B is the highest because coconut husk is the best additives used in this experimental work. The coconut husk had aided in removing the COD from the effluent wastewater. Followed by sample C whereby the COD removal rate is relatively near to sample B. Sample A has three runs and each run showed a COD removal rate at the percentages of A1 is 26.27 %, A2 is 43.22 % and A3 is 42.80 %. Sample B meanwhile has the percentage of 61.86%, 66.95% and 68.64% respectively for run B1, B2 and B3. Besides that, for sample C it has the COD removal rate at the percentages of 52.54%, 58.05% and 58.90% for run CI, C2 and C3.

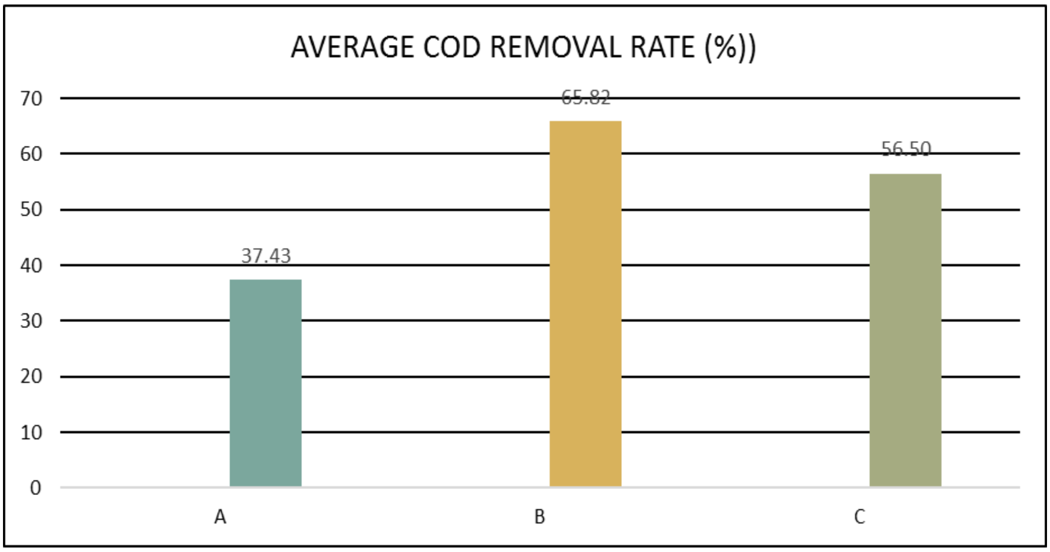

Figure 4.6: Average COD Removal Rate Results

Graph above shows the average of COD removal rate by each sample. Coconut husk has proven to be the effective way of removing COD from the influent wastewater compared tyre crumbs. This is because tyre crumbs have the properties ofhydrophobicity whereby the surface of crumb rubber repels water, this causes the crumbs not to be able to combine with the water and remove the COD.

4.2 Total Suspended Solids (TSS)

Total suspended solids, or TSS, are particles larger than 2 microns in diameter that float in water. On the other hand, a totally dissolved solid is defined as any particle less than 2 mm (TDS). While inorganic items account for the bulk of total suspended solids, algae and bacteria can be included as well. Sand, silt, or plankton are all examples of TSS, as is anything else that floats or "suspends" in water. When certain waterways become polluted with rotting plants or animals, organic components discharged into the water are typically suspended solids. While some silt settles to the bottom of a body of water, TSS floats to the surface or floats in the middle.

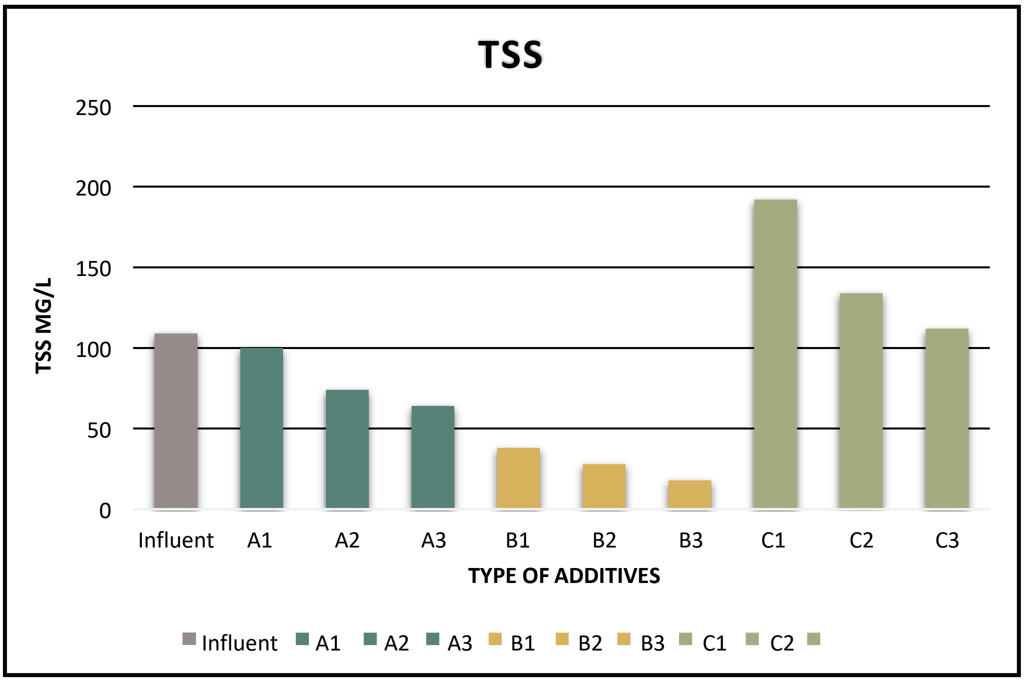

Figure 4.7: TSS Results

Based on the graph above, the TSS reading of influent is 109mg/L. A is influent wastewater without any additives, sample B is added with coconut husk while sample C is added with tire crumbs. The TSS level in sampleA is relatively similar compared to initial influent. Theconcentration of TSS is not compromised through the experimental work because soluble organic compounds are most likely to contribute to escalated TSS concentrations.

Sample B is added with coconut husk whereby the TSS concentration level is the lowest comparing to the other samples. Adsorption is recognized as an effective and low-cost technique for the removal of organic pollutants from wastewater and produce high-quality treated influent. Coconut husk gives maximum reduction efficiency constant time than tirecrumbs. Sample C is added with tire crumbs whereby the TSS level is higher than sample B which shows the tire crumbs adds the suspended solid level. TSSlevel for run in sample A is 100 mg/L, 74 mg/L,64 mg/L for A1, A2 and A3. Inrun, B1, B2 and B3 the TSS level is 38 mg/L, 28 mg/L and 18 mg/L. whereas for sample C, the TSS level is 192 mg/L, 134 mg/L and 112 mg/L respectively for C1, C2 and C3.

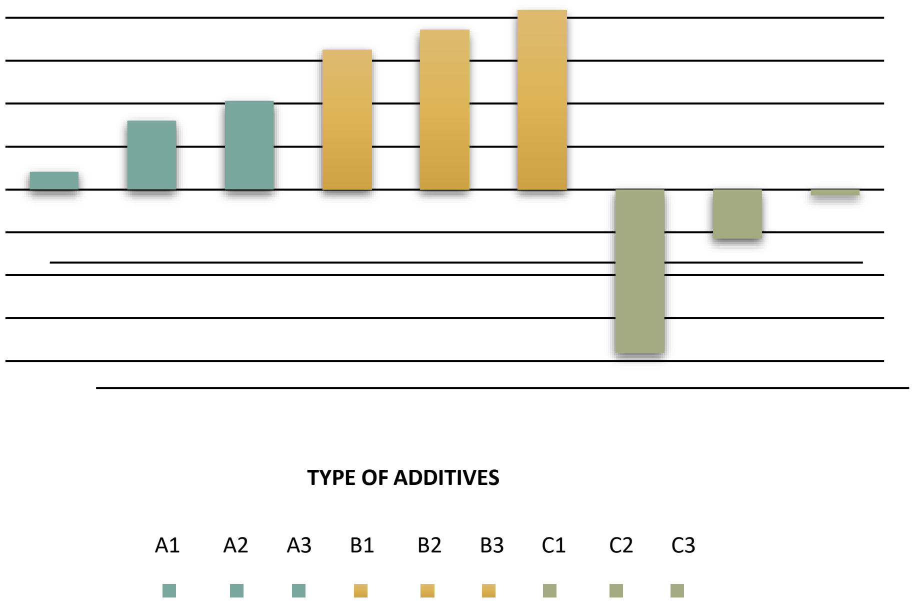

Figure 4.8: Average TSS Removal Rate Results

The TSS removal rate in sample B is the highest because coconut husk is the best additives used in this experimental work. The coconut husk had aided in removing the TSS from the influent wastewater. Followed by sample C whereby the TSS removal rate is relatively near to sample B. Sample A has three runs and each run showed a TSS removal rate at the percentages of A1 is 8.26 %, A2 is 32.11 % and A3 is 41.28 %. Sample B meanwhile has the percentage of 65.14%, 74.31% and 83.49% respectively for run B1, B2 and B3. Besides that, for sample C it has the TSS removal rate at the percentages of -76.15%, -22.94% and -2.75% for run CI, C2 and C3. The removal rate of sample C obtained in negative value because the tyre crumb could not able to absorb the water and it also has ability to produce Zinc leachate and polycyclic aromatic hydrocarbon as well. Thus, these effect the engineered soil media and worsen the quality of discharge sample from treatment train system.

CHAPTER 5

CONCLUSION

In the objectives of this project were achieved. The effluent wastewater parameters were characterized by referring to past research/study and set as source benchmark for this experiment. This study applies a wide range of pollutant removal from effluent wastewater. Other additives have been shown to be effective in removing nutrients and pollutants from water bodies in a variety of applications in recent years. Among the two additives, Coconut Husk is the best additive compared to tyre crumps as it indicates the better result and graph during the experiment. The COD concentration level of Column B which use Coconut husk as additive gives maximum reduction efficiency constant time than tyre crumbs. It concluded that sample with coconut husk has the lowest CODin the effluent wastewater. Moreover, the TSS removal rate in sample B is the highest where the additive is coconut husk used in this experimental and it has low TSS concentration level compared to tyre crumps. The best performance bioretention set was B1 as it reduced the highest number of COD and TSS concentration level. Thus, Coconut Husk is the best proposed additive in this experiment and the objectives were achieved.

5.1 Recommendation

It would be recommended that further study involve monitoring the performance of the treatment train system for a longer period to observe. Aside from that, the installation of treatment train system was simple and accessible and putting this system in urban area would produce more convincing result as it would enhance the water parameters and quality. Moreover, the tyre crump would be recommended to use instead tyre crumb

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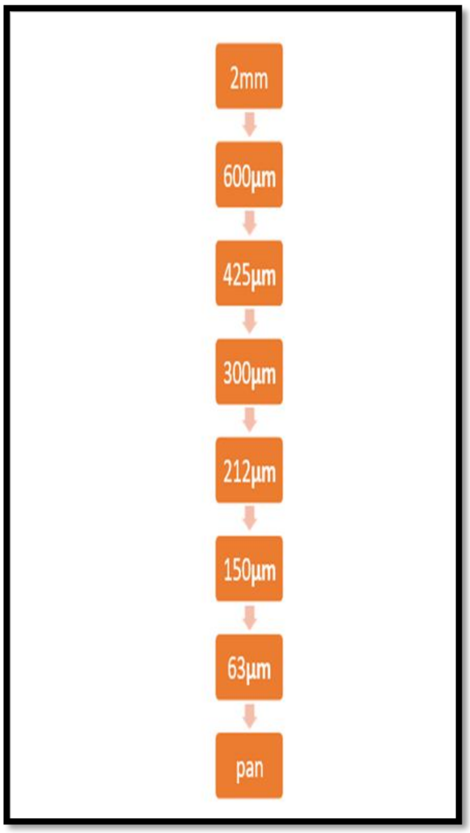
APPENDICES

APPENDIX A- Specific Gravity of Soil by Pycnometer Method

APPENDIX B – Particle size distribution of soil



APPENDIX C - Experimenting Total Suspended Solid (TSS)

APPENDIX D - Experimenting Chemical Oxygen Demand (COD)


HACH
DRB 200


DR 3900

APPENDIX E – TSS and COD Sample Experimental Result obtained from treatment train system

SAMPLE	WEIGHT OF SOIL		COD		COD	TSS	TSS
	Initial	After	HR (mg/l)	LR (mg/l)	Removal	(mg/l)	(mg/l)
					Rate (%)		
Influent				236		109	
A1	1501.5	1506.5	206	174	26.27	100	8.26
A2	1497	1500.7	194	134	43.22	74	32.11
A3	1508.5	1511.7	164	135	42.80	64	41.28
B1	1493.9	1495.8	149	90	61.86	38	65.14
B2	1488.9	1490.3	114	78	66.95	28	74.31
B3	1471.5	1472.4	77	74	68.64	18	83.49
C1	1503.3	1512.9	455	112	52.54	192	-76.15
C2	1487.9	1494.6	302	99	58.05	134	-22.94
C3	1494.7	1500.3	211	97	58.90	112	-2.75