INDUSTRIAL TRAINING FIELD REPORT (CHE 353)

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Diploma in Chemical Engineering (EH 110)

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ACKNOWLEDGEMENT

In the name of Allah, the Most Gracious and the Most Merciful.

Assalamualaikum w.b.t, Alhamdulillah all praises to the almighty Allah and His blessings for giving the strength and ability to complete this industrial training despite the current pandemic, COVID-19, that currently happened in order to finish my diploma programme. My humblest gratitude to the holy Prophet Muhammad (pbuh) whose way of life has been a continuous guidance in life for me. Furthermore, I showed my deepest gratitude for all the opportunities, trials, and experiences that have been showered on me during the whole process.

First and foremost, I would like to sincerely thank my supervisors Prof. Dr. Azmi Aris, Director of Centre for Environmental Sustainability and Water Security (IPASA), and Mrs Juhaizah Talib, Research Officer (IPASA), for their supervisions, guidances, understandings, patience, constant supports and most importantly for providing positive encouragement and a warm spirit in welcoming me towards this company. Despite of their pack working time, they manage to provide various time to check up on me by delivering new ideas and advices throughout the challenges exist since the beginning of the internship period.

Secondly, I would like to express my grateful towards both of my senior mentors, Dr Ihsan Wan Azelee and Mst. Kaniz Fatema that had thought me various lessons and skills throughout the projects. Along with their helps, I obtained various skills such as lab works, critical thinking, and problem solving when the project requires observation and manpower. Their invaluable helps of constructive comments and suggestions throughout the experimental and writing works have contribute the success in the internship. Apart from that, sincere thanks to IPASA staff who diligently thought me professional skills. Their continuous supports had built a family-friendly atmosphere and their advices played a big role in preparing myself for future working attachment.

Furthermore, the appreciation goes to my fellow coordinator, Ms Hidayu and Sir Omar for keeping touch with the students to make sure the internship goes as planned nevertheless the obstacles especially during this COVID-19 pandemic. Finally, a big thank you I bid to my honour family and friends for the endless support through thick and thin of my time during the internship. Their supports uplift myself to be independent and a positive encouragement for me to finish my diploma studies. Last but not least, I am honourably wishing the best of luck to Centre for Environmental Sustainability and Water Security (IPASA) and hoping that the company will always strive to be the best in Malaysia for people to see them globally.

INTRODUCTION

Industrial training exposed the students towards actual working environment to enhance student knowledge and skill from what had been learn in the university. This also to instil student quality of integrity, self-confidence, and responsibility. The training prepares students to implement their knowledge and theories learned in working to enhance technical skills and also communication skills. With a particular time-frame, the training indicates real time exposure of the engineering world as if it is mandatory for professionalism and building soft skills. Students may perform basic engineering practices during handling a project or generating proposal that will be beneficial for their experience. Thus, higher ethical and accountability can dissolve in person as they practicing engineering for the betterment of industries.

Apart from that, writing a technical report manage to sustain a critical thinking skills and problem solving as it drives the students to make observations on their own hypothesis. Problems may encounter especially during works, therefore these types of skill encounter student to think outside the box to find the perfect fit for the solutions. Moreover, communications are the basic needs to provide harmony and good relationship with colleagues. The training provides inter-departmental communications through projects and meeting whereas switching ideas is compulsory during the discussions. This will boost the network with professionals especially in engineering field to gain confidence and perform well in the job.

Therefore, for the industrial training, the company that provide internship is Centre for Environmental Sustainability and Water Security (IPASA), Universiti Teknologi Malaysia (UTM) which integrates expertise in various types of fields to work with problems related to environment in UTM. The duration for industrial training is from 21st March 2021 until 15th July 2021. Through this programme of having students to undergoes industrial training for several months, it introduces an opening for the industry to locate and identify potential employees and at the same time may enhance company reputations among the other graduates. The method of industry-university partnership can be strengthened through this programme since it involves university students to cope an experience working in a different surrounding.

Plus, intern students are required to fulfil most of the task given by supervisors and complete the project arrange for them. From this idea, it would encounter students to be more responsible that exhibit a discipline behaviour from the rules and regulations provide by the company. Also, industrial training will demonstrate students with a good punctuality and moral values that would be beneficial for future. Most importantly, this programme provides the most positive impact towards students as they managed to experience a real-life working culture, exposing themselves to a new knowledge, enhancing social skills, demonstrate a constant building skill, and even gearing up their potentials to work with professionals. In a nutshell, industrial training could be beneficial towards both side that would demonstrate a better company reputations and chances to be seen globally.

TABLE OF CONTENT

1.0 INTRODUCTION OF COMPANY

1.1 Background of Company

Figure 1.0: Logo of RISE and IPASA

The Centre for Environmental Sustainability and Water Security (IPASA) has been established by the Research Institute for Sustainable Environment (RISE) in Universiti Teknologi Malaysia (UTM). The research centre was founded in 1994 and was formerly known as Institute of Environmental and Water Resource Management. The centre provided expertise that was professional in various fields to work with problems related to environment in UTM. The flexible organisation had provided many achievements and is well-known by many publications as they response to any new issues that had arised. This interdisciplinary centre has their own main objectives and missions to strive for a better environmental-surroundings culture. The centre required such activities whereas they perform research, consultation and services, publication, post graduate supervision, continuing education and promote environmental awareness by professionals. Their excellent track records in various achievements had contributes to many sectors involving private agencies and various public.

1.2 Vision and Missions

Their vision is to be a leading centre of excellent in any activities that are related to environmental sustainability and water security specifically in Asian region. IPASA holds various mission to their success such as to stimulate and enhance research programs in area related to environmental sustainability and water security. They establish many collaborations among academics to enhance the research programme especially with other local and international universities as well as agencies in various disciplines. IPASA provides advisory and consultancy services to all public and private agencies on water security issues and any environmental-sustainability related problems. As the consultation and advisory begins it provides environmental awareness among the society and it had been enhanced through their awareness program at various levels of society. This involves all generations despite their ages to emphasize their senses towards environmental problems.

1.4 Facilities and Services

IPASA is one of the biggest research centres specifically towards environmental sustainability and water security that requires professionals to conduct quality testing and experiments in their research. IPASA successfully provide analytical services on water quality analysis that require several parameters in accordance with the DOE requirement. Currently, the team is in a process of applying accreditation from the Department of Standards Malaysia. Other than that, IPASA contain a Mobile Laboratory that is equipped with analytical equipment mainly for in-situ assessment for water quality analysis. This modern technology also consists rainfall simulator and modelling software for hydrological research.

Figure 1.3: IPASA Mobile Laboratory

Figure 1.4: IPASA Mobile Laboratory (Staff)

Consultancy is one of the services IPASA had provide in most of environmental related areas that involves variety of private and government agencies. There are many assessments had been carried out such as the environmental impact assessment (EIA), environmental management plan (EMP), and life cycle assessment (LCA). Other than that, the current areas are climate change impact, water footprint, waste and material recovery, urban runoff management, flood mitigation, water reuse, carbon footprint, water and wastewater treatment technology, and integrated water resources. IPASA had successfully carried out huge projects under the consultancy to provide a better change due to its organization flexibility.

NO.	PROJECTS	YEAR
1.	Development of Malaysia Environmental Performance Index, Ministry of Natural Resources and the Environment	2010 - 2015
2.	Study on Impact of Climate Changes on Water Resources for Selected Plantation Areas in Malaysia for Paddy, Rubber and Oil Palm, National Hydraulic Research Institute of Malaysia (NAHRIM)	2014
3.	Study of Aluminium and Flouride Violations in SYABAS Distribution System, SYABAS	2013 - 2014
4.	Development of Awareness Programs for Safe and Sustainable Rural Water Supply in Cambodia, Ministry of Higher Education (MOHE)	2013 - 2014
5.	HAZOP, Modelling and Review of Wastewater Treatment Plant, EVYAP SABUN MALAYSIA Sdn. Bhd., 2013. » Preliminary Environmental Impact Assessment for Waste Oil Recovery at PTD 153786, Jalan Makmur 1, Taman Perindustrian Cemerlang, Mukim Plentong, Ulu Tiram, Johor Motorol Oils Sdn. Bhd.	2014
6.	Carbon Accounting Assessment for Water Production and Water Supply, SAJ Holdings Sdn. Bhd.	2012 - 2014
7.	Study on the Current Status and Needs Assessment of Water Research in Malaysia. Funded by Academy Science of Malaysia (ASM)	2012 - 2014
8.	Environmental Impact Assessment, Risk Hazard Assessment and Quantitative Risk Assessment in Langsat Bulkers Biodiesel Tank Farm, Tanjung Langsat Industrial Park, Johor Bahru, Johor, Tanjung Langsat Port Sdn. Bhd.	2013
9.	Rancangan Pengurusan Hutan Tadahan Air bagi Negeri Johor, Johor State Forestry Department	2013
10.	Preliminary Environmental Impact Assessment for Quarry Opertion on Lot 20954-20965 and 17714-17715 Mukim Simpang Kanan, Batu Pahat, Johor, Min Fong Quarry Sdn. Bhd.	2013

Table 1.1: List of Previous Consultancy Projects (2010 – 2015)

1.5 Research

Centre for Environmental Sustainability and Water Security (IPASA) had implied research that provides practical and sustainable solutions in environmental areas. These researches are funded by both public and private agencies thus manage successfully to collaborate with other huge researchers from other countries such as Denmark, Cambodia, Sweden, Japan, Indonesia, and United Kingdom. Generally, the centre currently undertakes many research areas that involves water and waste water treatment technologies or any water resource management. This research is strengthened with multiple testing and observations to prevent problems from occurring or to enhance the system better from damages. The research may help in building new technology and discover modern inventions towards a greater and healthy environment.

NO.	RESEARCH PROJECTS
1.	Characterization of resin extracted from cactus (Opuntiaficus-indica) as natural coagulant for water purification
2.	Kinetics of Sewage Effluent Organic Matter on the Removal of Pharmaceutical Compounds during Wastewater Ozonation
3.	Optimization of Conventional Water Treatment Plant Operational Practices in Removing New Emerging Pollutants
4.	Micro-Pollutants Removal using Combined Membrane Filtration, Advanced Oxidation Process and Adsorption for Safe Drinking Water
5.	Characterization of the Stereochemical Transformation of Reactive Azo, Anthraquinone and Triazine Dye Catalysed by Ligninolytic Enzymes Secreted from White-Rot Fungi
6.	Evaluation on the Fate and Transport Behaviour Mechanisms of Nanosilver Particles in the Water Environment
7.	Molecular Structural Transformation of Organochlorine and Organobromine catalyzed by Lignin-Metabolizing Enzymes Secreted from Basidiomycetes Fungi
8.	Development of Polycylic Aromatic Hydrocarbons (PAHs) Degradation Method using Consortium of Crude Enzyme Isolated from Fungus and Earthworm (Eiseniafetida)
9.	Treatment of Poultry Slaughterhouse Wastewater Using Integrated Anaerobic/Aerobic Sequencing Batch Reactor
10.	Phosphorus Removal from Domestic Wastewater Treatment Plant Effluents using Serratia Marcescens

Table 1.2: List of Selected Research Topic

1.6 Company Organizational Chart

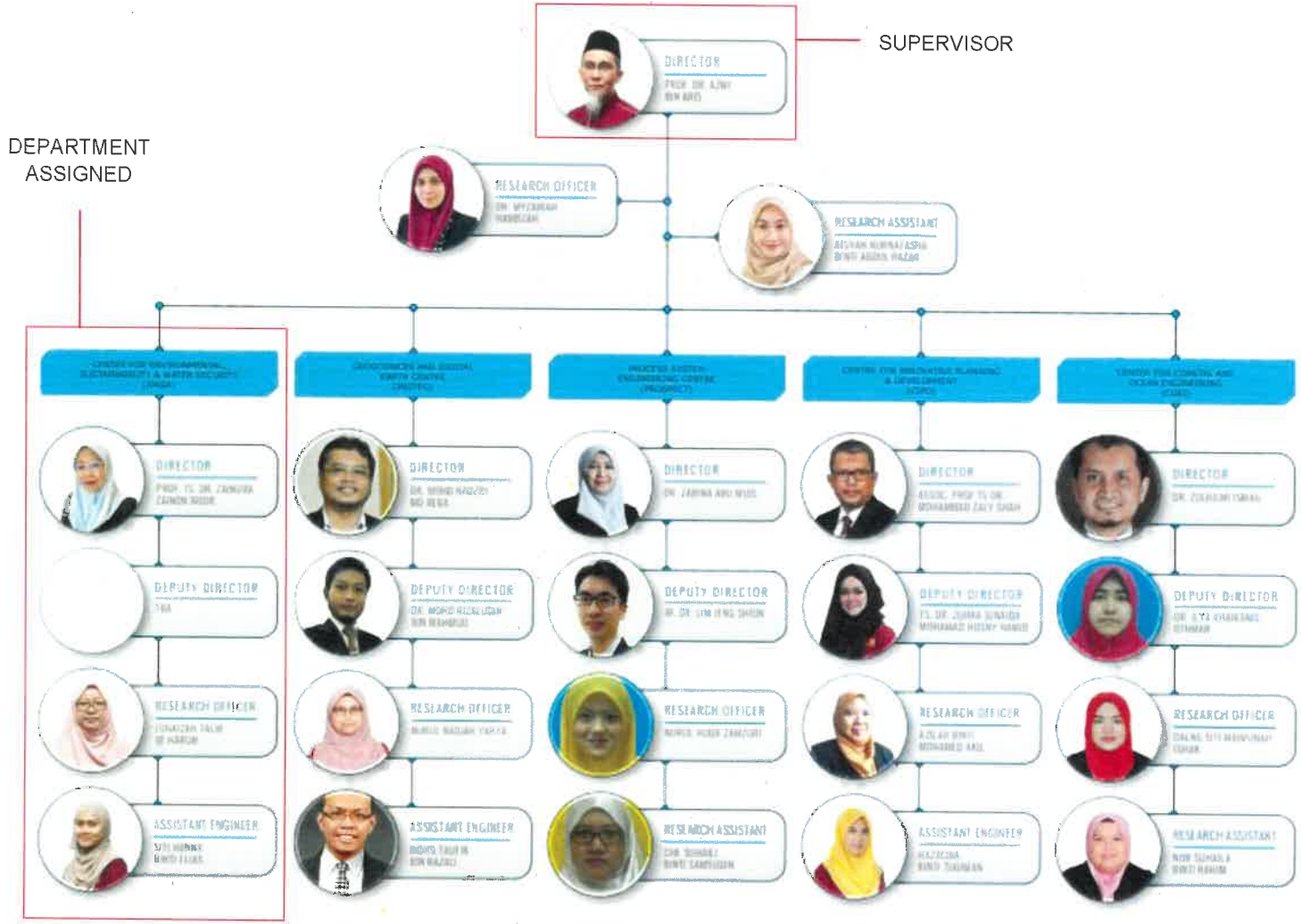


Figure 1.5: Research Institute for Sustainable Environment (RISE) Organizational Chart

Figure 1.6: Centre for Environmental Sustainability and Water Security (IPASA) Organizational Chart

2.0 PROCESS FLOW

3.0 BRIEF WEEKLY ACTIVITIES

3.1 WEEK 1-2 (21ST MARCH 2021 – 1ST APRIL 2021)

I attend briefing session with supervisor Prof. Dr. Azmi Aris, Director of IPASA whereas he introduced about the company backgrounds. My supervisor also introduced me to the staff while went for a tour around the office department. Apart from briefing regarding on the project currently in IPASA, he then assigned some division of duties for the Mini Project. I was assigned under two mentors which is a Postdoctoral, Dr Ihsan Wan Azeelee, and a Postgraduate student, Mst. Kaniz Fatema. The whole first week was an overview towards both project through research which is the Floating Treatment Wetland held by Mst. Kaniz Fatema and Sand Filtration project organised by Dr Ihsan Wan Azeelee. Part of the day also were also filled with site visit to investigate the wetland system, plus laboratory visit to observe sand filtration system as an introductory of the projects. I also manage to attend small meeting to discuss the overview of work throughout the internship with my mentors whereas this **Mini Project will be carried out daily from the first day of internship until the last period**. From the activities for the past two weeks, I managed to understand the basic knowledge and simple mechanism on how both project works to retrieve any problem that occur during the investigation. These problems are more likely to be solve by discussions, laboratory work, and also review article research.

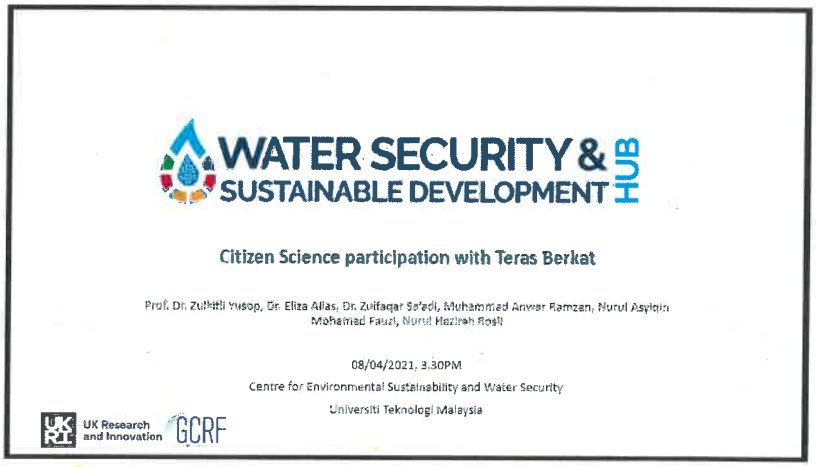
(i) (ii)

Figure 1.7: (i) Floating Wetland Site Visit (ii) Sand Filtration System Laboratory Visit

3.2 WEEK 3 - 5 (4TH APRIL 2021 – 22ND APRIL 2021)

3.2.1 River VR and River AR Powered Book

I was assigned to attend formal meetings with the other internship held by Dr Zulfaqar Sa'adi regarding Citizen Science participation with Teras Berkat. The project involvement also been taking part by the GCRF Hydrology Team in River Online Camp. The meeting purpose was to appropriately discuss the new launch of River Virtual Reality (VR) and River AR Powered Book. The projects contribute many collaborations that involves school students to be part of the virtual reality (VR) through River Online Camp. One of the main purposes is to expose students towards environment through technologies as well as to educate society regarding rainfall. This also can be seen as to increase the awareness despite that was one of the company's mission to recreate a new world that responsible towards their environment surroundings.



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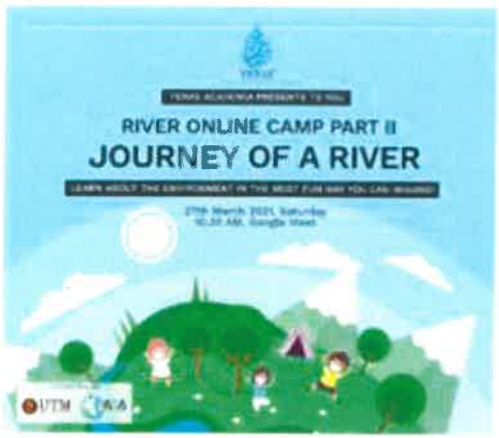

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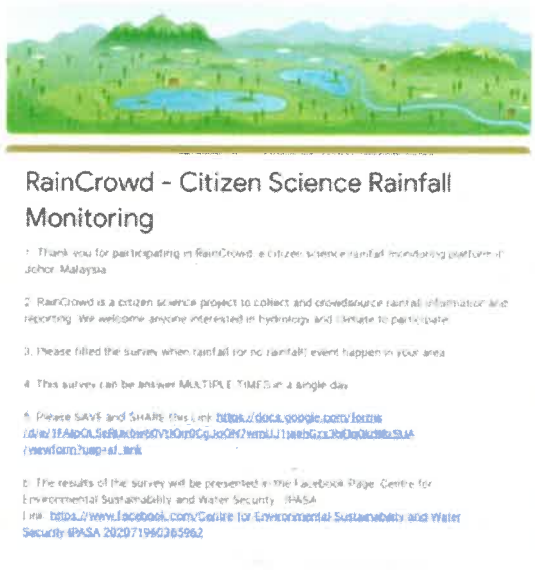

(iv) (v)

Figure 1.8: (i);(ii) Citizen Science Participation with Teras Berkat (iii) Students River Online Camp (iv) RainCrowd Monitoring through Google Form (v) RainCrowd Mobile Application

Moreover, this new project also on the achievement of one buildable application named "RainCrowd" that involves citizen science rainfall monitoring. This project contributed the monitoring of rainfall in certain area that will be carried out among the citizen in Johor. The crowd sourcing process are within primary and high school student, teacher, and community. Various platform used to achieve more data through Google Forms, IPASA website, RainCrowd Mobile Applications and Video Instruction through YouTube. The project welcoming people that interested in hydrology and climate to participate for contributions.

After a few weeks contributing in the VR project, the equipment was out to be tested by the involving staff and Dr Zulfaqar Sa'adi. The River VR display a massive high-graphical image of environment scenery in the forest that requires upstream and downstream. The upstream river flow shows the waterfall meanwhile the lake and small river was considered as downstream. This River VR illustrate the cycle of rainfall and river flows that are important especially when introducing to people about rainfall monitoring. Plus, from the VR students may experience hydrological cycle, river anatomy, pollution sources, river beautification, and waste segregation. Other than that, this project demonstrates the River AR Powered Book that suggesting the idea of futuristic education especially towards school students. The powered book requires 2D image that can be turn alive into 3D pictures. This book has various educational purpose that contains environmental sustainability related topics.

(i)

(ii)

(iii)

(iv)

(v) (vi)

Figure 1.9: (i);(ii) River VR Setup (iii);(iv) VR Try Out Session (v) River AR Powered Book Setup (vi) Book Try Out Session

Hence, from the following activity I managed to understand more regarding rainfall water through monitoring and modern technologies. This ensure that the environment awareness had been carried out and I acknowledge the importance of keeping our surroundings in a better position. Through the virtual reality and e-books helps me understand the basic principle of nature regarding rain water since it contributes various syllabus of environment. From the knowledge delivered, I managed to widen my knowledge especially when it discussing about river anatomy and its beautification. The upstream of rainfall and downstream really demonstrates water source that are generated since water is the most crucial parts in our living.

Due to better understanding, I believe that by exceeding knowledge through layers of society may helps contribute many hands in helping to save our lake and river also towards the whole nature. Not only that, the idea of using applications and constructed online camping would be another good alternative to reach more audience and achieve the goals of this project. This is because environment is a whole responsibility that need to be carried out by communities despite ages. Therefore, I learned that resources are crucial to be taken care of regardless the harms human made throughout years.

3.2.2 River Exploration

The training continues with exploration at one of the largest lakes in UTM that consider to be one of the main water resources for their facilities. Along the sidewalk, I observe the water quality and major factors that contribute waste in the river. Apparently, the biggest factors were from household and restaurant sectors exist near the river. Not only that the 2 hours of exploration could maintain a healthy body, but also to increase knowledge regarding water and river quality.

There are few issues had been brought and problem-solving discussion to see if the river were capable to work on a good quality in another period of time. From the discussions with the team, if a large amount of waste were drained into the river the concentration of nitrate and phosphate will increase rapidly in the water. Algae might use these substances to grow multiply constantly and turning the water green. The pollution occurs when massive growth of algae turning the whole system into eutrophication. Moreover, the blooms of algae may produce toxins that might harms other aquatic life in the river and resulting in a contaminated condition.

Also, when pathogens and bacteria were found in this river water breed disease, it will cause of health-related issues in humans and animals alike. Therefore, from this activity I manage to investigate and observe that river water needs to be treated so that there will be no contamination or disease will occur. Moreover, I manage to identify problem encounter with the sewage system and scientific explanation behind the issue.

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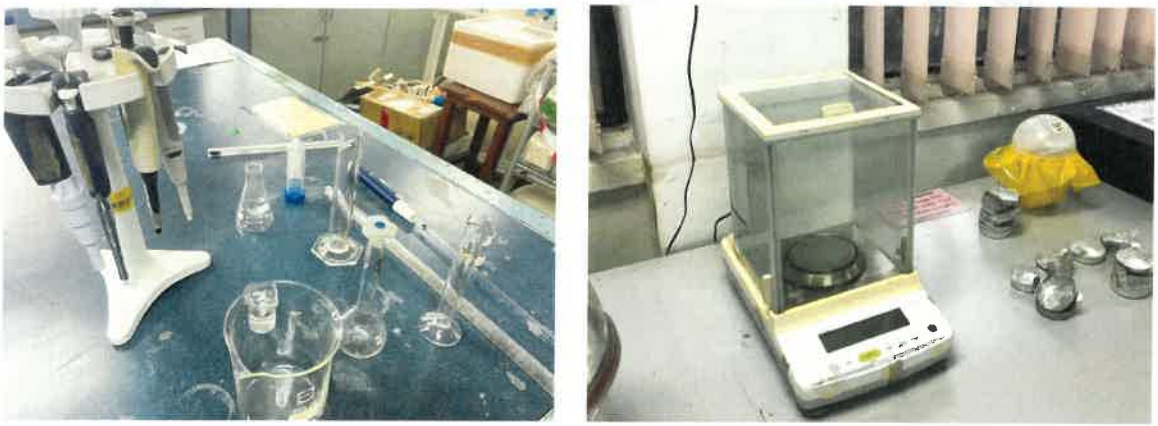
Figure 2.0: (i); (ii); (iii); (iv); (v); (vi); (vii); (viii) River Exploration with IPASA Staff

3.2.3 *Laboratory Equipment Handling and Safety Session*

During the internship period, laboratory works is one of the compulsory testing methods to investigate the water analysis by various of experiments. Thus, safety precautions are very important especially in handling hazardous chemicals and rigid equipment. Therefore, a session by Dr Ihsan Wan Azeelee, were carried out in conjunction to introduce basic knowledge on the safety measurement and avoid any hazard from happening during the experimental works.

Moreover, this session also demonstrates by mentors on how to operate equipment and utilize all the apparatus needed during experiment such as analytical scale, flask, incubator, furnace and micropipette. The whole process of safety handling acknowledged me to always prioritise safety when performing experiments. I managed to learn the safety precautions to avoid hazard and danger that may contribute to accident. Furthermore, by preparing and handling equipment in a correct way may prevent error in resulting data and to avoid malfunction of the working equipment. Hence, it is very compulsory to use laboratory equipment in exact way to prevent failure that may cost more than needed.



(i) (ii)

Figure 2.1: (i); (ii) Laboratory Equipment Handling and Safety Session

3.3 WEEK 6 - 7 (25TH APRIL 2021 – 6TH MAY 2021)

3.3.1 Water Footprint for Service Sector

Through this week, I had been assigned to help former IPASA staff, Mrs Hana, on her side project that required survey from participant. The survey conveyed a collected data of water footprint for service sector such as hotel and resort that usually uses water as their basic needs to continue overgrowing the sectors economically. The survey consists few determinations of water footprint such as direct water usage, food consumption, electricity, and transportations. These determinations are specified based on common daily water usage by the management of hotels. Furthermore, ten sets of questionnaires are vital for each participant whereas they need to collect as much as possible complete data by the hotel manager.

This side project begins with small discussion through online meeting where participant voices out their opinion and problem encounter through out the collecting data process. It is presented that most manager of hotel did not submit any responds through email and usually did not have much information for some of the question. I encounter that lack of communication was the main problem due to pandemic that neglected people to interview through face to face. Apart from that, the discussion provides various solution to prevent any further problem and consequences from happening.

The next week was to understand deep regarding water footprint specifically in economy sectors. Research had been made on how the value may affected water usage such as in food department or the use of vehicles. Besides, from the research it can be provided list of hotels and homestay above 3 stars in Johor Bahru that might help giving information for the questionnaire. Data collected such as email and contact number are taken to helps other participant in getting their desired information and increase new knowledge regarding water footprint.

3.4 WEEK 8 - 17 (9TH MAY 2021 – 15TH JULY 2021) / WFH

3.4.1 *A Review of Wastewater Treatment Using Filter Media*

The remaining weeks were setup by mentors to fulfil work assignment from home by projecting a review article through research. Since physical working were restricted, online research was implemented to continue the Mini Project with a further explanation regarding the system. Dr Ihsan Wan Azeelee constructed two different sub topics for the task which is; *Conventional and Alternatives Media Filtration for Wastewater* and *Multi-media Filtration and Combined Filter Media with Advanced Treatment*. I was assigned with the first sub topics that involved research regarding various media wastewater filtration in the review. The first few 'Work from Home (WFH)' week was searching suitable article that might helps in building the writing report. Some article involves different media used for wastewater filtrations such as activated carbon, sand and gravel, and zeolites. Specific research required such as the efficiency different type of media towards filtration percentage of wastewater. The review article had been on-going for few weeks and submitted within the dateline given.

Contents lists available at ScienceDirect

Journal of Cleaner Production

journal homepage: www.elsevier.com/locate/jclepro

Review

A review on conventional and novel materials towards heavy metal adsorption in wastewater treatment application

Wai Siong Chai [a, b], Jie Ying Cheun [b], P. Senthil Kumar [c], Muhammad Mubashir [d], Zahid Majeed [e], Fawzi Banat [f], Shih-Hsin Ho [a, **], Pau Loke Show [b, *]

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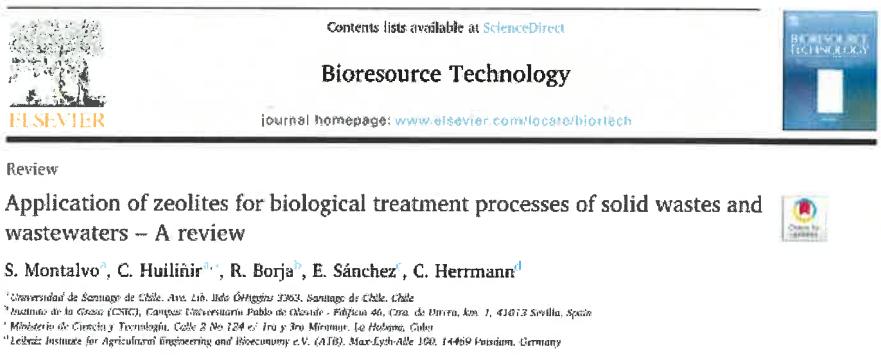
(iii)



Contents lists available at ScienceDirect

Bioresource Technology

journal homepage: www.elsevier.com/locate/biortech

Review

Application of zeolites for biological treatment processes of solid wastes and wastewaters – A review

S. Montalvo [a], C. Huiliñir [b, c], R. Borja [b], E. Sánchez [c], C. Herrmann [d]

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(iv)

Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

Review

Activated carbon coupled with advanced biological wastewater treatment: A review of the enhancement in micropollutant removal

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(v)

Figure 2.2: (i); (ii); (iii); (iv);(v) Sample of Review Article Collected

EXAMPLE OF REVIEW ARTICLE (BY: HAZIRAH ROSLI)

1.0 Conventional and Alternatives Media Filtration for Wastewater

1.2 Activated Carbon

Despite various technological advancements and breakthroughs, wastewater treatment remains a critical issue globally. Moreover, the major threat to human health are the heavy metals presents in wastewater that are not treated properly, which happens to make its removal of utmost importance. Heavy metals are the group of trace elements such as metalloids and metals with greater atomic density than 4 ± 1 g/cm³ [1, 2], e.g., Cu, Zn, Pb, Mn, Cr, Ni, As, Co, Hg, Cd, Sn, Al, Fe, Ag etc. These elements generally considered as the most widespread toxic mineral contaminants that will affect the soil and water systems.

Furthermore, there are few main sources of heavy metals in wastewater effluents which takes place as natural and anthropogenic [2, 1]. The natural sources comprise by bedrock weathering such as soil erosions, volcanic activities, and rocks weathering. Meanwhile, some study shows that anthropogenic sources derived from industrial production, sewage discharge and the use of fertiliser whereas this involves in the agricultural and industrial activities [3]. As result from the migration activities of heavy metals in aqueous media, untreated metal-contaminated wastewater effluents may cause a variety of health and environmental impact after had been released into open surroundings. Table 1 illustrate the negative effect towards human body when exposed with heavy metals and demonstrates the maximum contaminant level (MCL) standards for drinking water set by the US Environmental Protection Agency. These environmental and health impacts lead when the structure of atom electron shells is defined based on their high reactivity, consequently, high biochemical, physiological activity, and their tendency to form complexes.

Table 1
MCL Standards and ill effects of hazardous heavy metals. [2, 3]

Heavy Metal	Effects	MCL, mg/L
As	Skin and vascular diseases, Visceral cancer	0.05
Cd	Renal disorders and damage, Carcinogenic	0.01
Cr	Headache, Diarrhoea, Nausea, Carcinogenic	0.05
Cu	Liver damage, Wilson's Disease, Insomnia	0.25
Hg	Rheumatoid arthritis, Circulatory, Nervous disorders	3.0×10^{-5}
Ni	Dermatitis, Chronic asthma, Carcinogenic	0.20
Pb	Cerebral disorders, Renal, Circulatory, Nervous disorders	6.0×10^{-3}
Zn	Depression, Lethargy, Neurological signs, Increased thirst	0.80

Generally, various techniques had been implemented in wastewater treatment such as ion exchange, chemical precipitation, membrane filtration, solvent extraction, coagulation, and electrochemical technologies [1]. The selection of approaches usually relied by the cost of usage, material efficiency, environmental impact, reliability, feasibility, operation difficulties, and practicality. Among these methods, adsorption emerges the best solution and most common techniques used as the flexibility of design, operation, and cost applied are effectives in removing heavy metals during wastewater treatment. In addition, adsorption often accompanied with an inverse process called desorption that represents transfer of adsorbed ions from the surface of adsorbent to the solution. The reversibility of the adsorbent can be identified depending on the adsorbate amount desorbed from the adsorbent. Therefore, the more reversible the adsorption process define that there is more adsorbate been desorbed. Adsorption can be considered to be an efficient and low-cost techniques to remove heavy metal ions from wastewater effluents. The flexible design allows high-quality treated effluents plus the desorption process can regenerate adsorbents since the adsorption is reversible in some cases.

This adsorption process links with the most efficient elements which is activated carbon where it replaced as the conventional adsorbent material to remove heavy metal ions in wastewater. This is due to its microporous structure and better surface functionalization. In this study, the technical feasibility of coconut shell activated carbon is investigate to observe the efficiency of filtration and heavy metals removal towards wastewater during its treatment. Coconut shell activated carbon are develop to be one of the promising solutions. The sorption properties of coconut shell activated carbon are due to the presence of functional groups such as carboxylic, lactone, and hydroxyl which identified as having higher affinity for metal ions. Conversion of coconut shell, will represent as an unused resource, that can be turned into useful material such as activated carbon and designated as adsorbent in water purification. This will not only help to increase the economic value, but also to reduce the cost involves in waste disposal and what most importantly is provide a potential of inexpensive adsorbent alternative for wastewater treatment [10].

The adsorption performance of activated carbon depends on the surface functional groups and pore size distribution. However, activated carbon will react with oxygen under a moderate temperature at 300 °C. Commercial activated carbon present in various form such as granular, powder, cloths, and fibrous form but normally the material that usually used as a precursor in the manufacturing of activated carbon is by using coal, coconut shell, or wood. Therefore, from the info given shows that size generally adopt an important role especially when it is considered to influenced by the role of pore size. The major characteristic that usually used in many investigations are Brunauer-Emmet-Teller (BET) that conclude a specific formulation in calculating the specific surface area to see the potential available in promoting different removal mechanism of heavy metals removal.

Table 2
Main characteristics of the activated carbon used in the reviewed studies.

Type	PAC	GAC
BET specific surface area (m^2/g)	328 to 1363	895 to 1250
Particle size (μm)	15 to 40	1000 to 4750
Pore volume (cm^3/g)	0.228 to 0.88	0.043
Pore diameter (nm)	2.6 to 3.13	3 to >100
Iodine number (mg/g)	850 to 1250	920 to >1200
Bulk density (g/cm^2)	0.25 to 0.42	0.42 to 0.50
pH_{pzc}	7 to 11	-
Ash content (%)	6 to 14	3

Table 2 demonstrates the role of different size activated carbon (granules – GAC and powder – PAC) in the removal of micropollutants by reviewing the characteristic for each case. The activated carbon characteristics are categorised by a higher surface due to the presence of micropores, mesopores, and macropores. Reviewing the Figure 1 below can be seen that there are active sites where compounds such as micropollutants occur in the wastewater definitely can bind on the whole surface. Sorption mechanism via liquid phase happens towards the activated carbon surface whereas penetration occurs on the internal surface or so called as an adsorption process. Therefore, organic particles tend to enter the macropores resulting a barrier in their movement to reach the active sites of the micropores. Furthermore, in the presence of dissolved organic matter in liquid phase can favouring microorganisms to develop on the surface area of activated carbon and its macropores. As result, the process may promote growth of biofilm that enhanced

(i) (ii)

Figure 2.3: Few Parts of Review Article Written Regarding Media Filtration

4.0 DESCRIPTION OF TASK ASSIGNED (MINI PROJECT)

4.1 Floating Treatment Wetland

Floating Treatment Wetland (FTW) provide a foundation for plant to grow which is their natural system to enable plant roots to spread and create vast activated surface for microbes and bacteria. Their matrix opened a porous structure for digesting and growth of microorganism. Microbes and bacteria will digest organic biochemical oxygen demand (BOD) matter such as nitrogen and phosphorus through a process named bioremediation. Hence, the microbes attached to the plant microscopic roots and recreate a sticky film called biofilm. Therefore, the total suspended solid (TSS) are trapped among the film that commonly be seen as algae. The floating wetland system concept mainly regarding the surface area which larger surface area will contribute to a cleaner effluent. The system works since floating wetland uses 100% recycled polyethylene terephthalate (PET: Plastic bottles) that coated with UV- resistant material.

Biological water treatment efficiency required three main elements that are vital to sustain a greater wastewater treatment which is their surface area, hydraulic retention time, and vegetation. The larger surface area might create network of surface area for pollutant eating microbes and bacteria meanwhile vegetation occurs during photosynthesis. The plant roots will secreate sugar and oxygen in order to feed bacteria that attached on the micro roots. As a result, bacteria will provide nutrient towards the plant such as nitrogen, phosphorus, and ammonium. From the discussion, researcher conveyed plant as one of the best optimum solution since they undergo this process or can be called as phytoremediation. The floating treatment wetland consist various processes such as anaerobic digestion by microbes and bacteria, nitrification and de-nitrification, polishing, removal of total suspended solid that will produce a reduction towards turbidity, BOD, pH, and Fecal Coliforms.

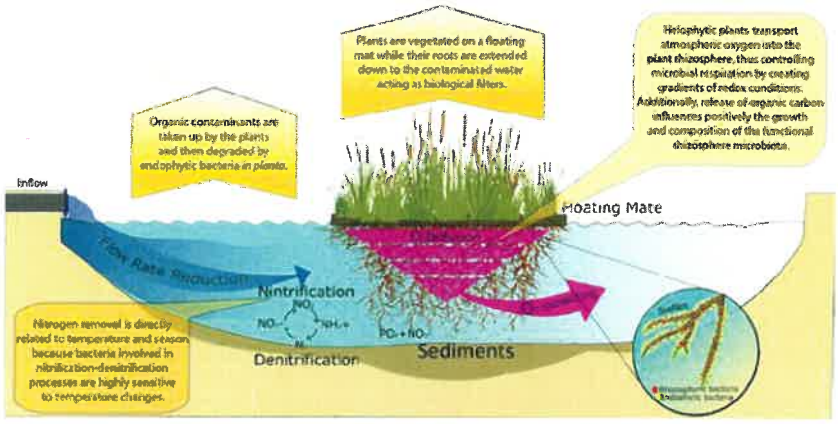


Figure 2.4: Floating Treatment Wetland System

4.1.1 *Project Frame Work*

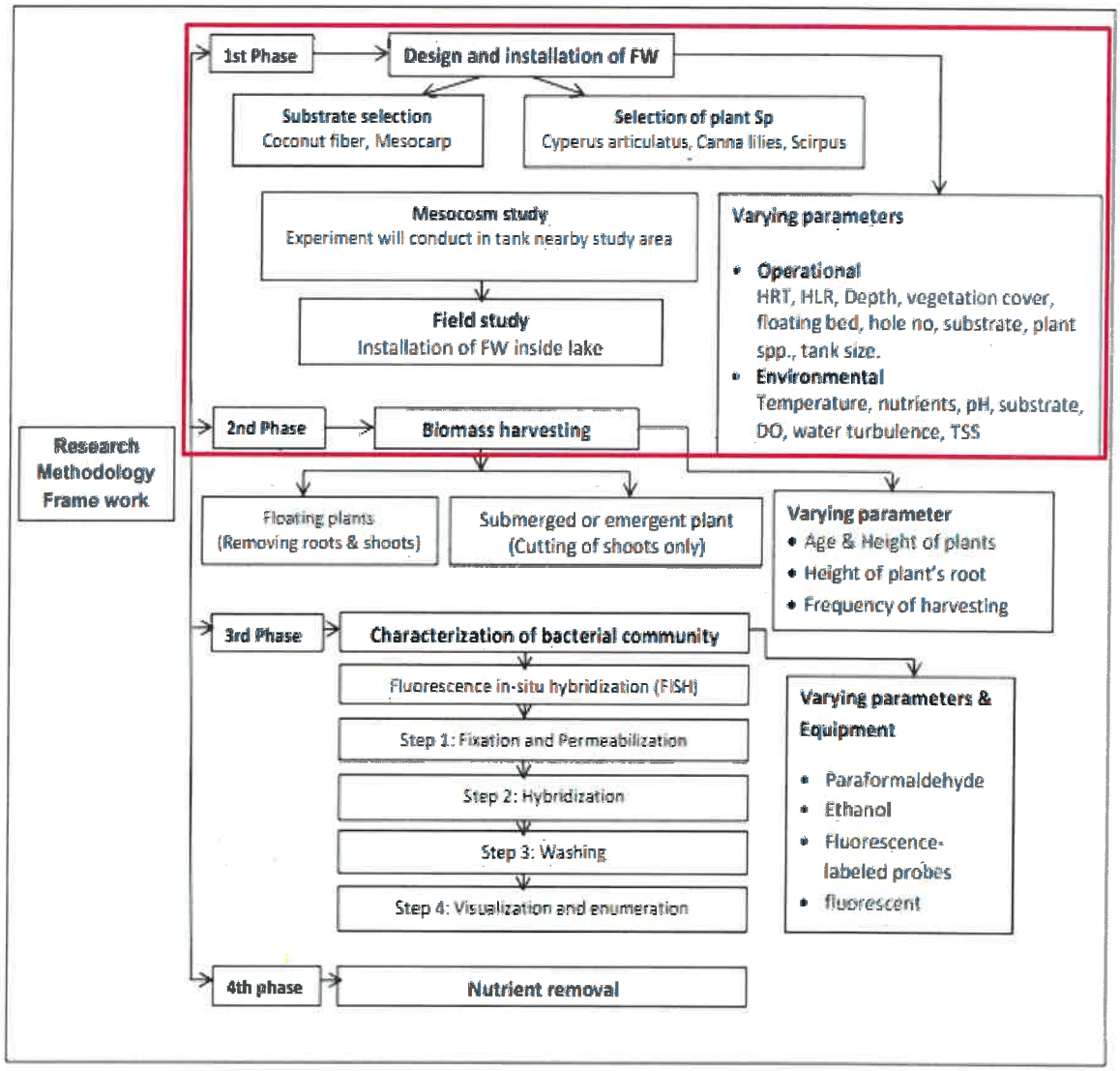


Figure 2.5: Research Methodology Frame Work

Industrial Training Duration

4.1.2 Design of The Project

The installation had been made before internship period therefore the system had already been started to get on the line. During the first briefing, Mst Kaniz Fatema introduce the system and manage to deliver all information regarding the basic mechanism on how it will work. The **frame bed** required correct measurement as if it will affect the whole process including the plant. Polyethylene terephthalate is the major component for the frame therefore PVC pipe were used as a substitute material.

(i)

(ii)

(iii)

Figure 2.6: (i); (ii; (iii) Floating Treatment Wetland System (Real View)

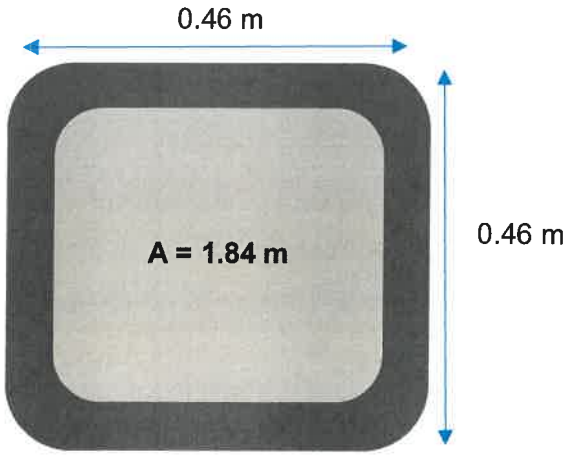
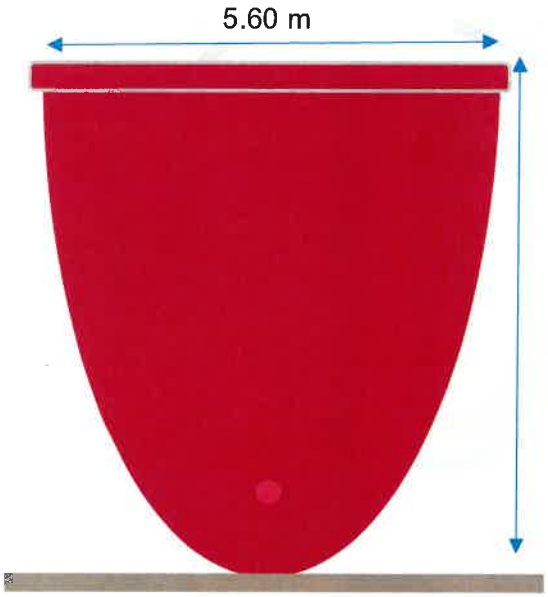


Figure 2.7: Plant Frame



BUCKET:

Diameter of bucket = 5.60 m

Height of bucket = 0.55 m

Floating media width = 0.30 m

Plywood for bucket =

0.80 x 0.80 x 4 (m) = 2.56m

PIPING:

Diameter of main tank big pipe = 3 inch

Diameter of small pipe = 1 inch

Figure 2.8: Bucket

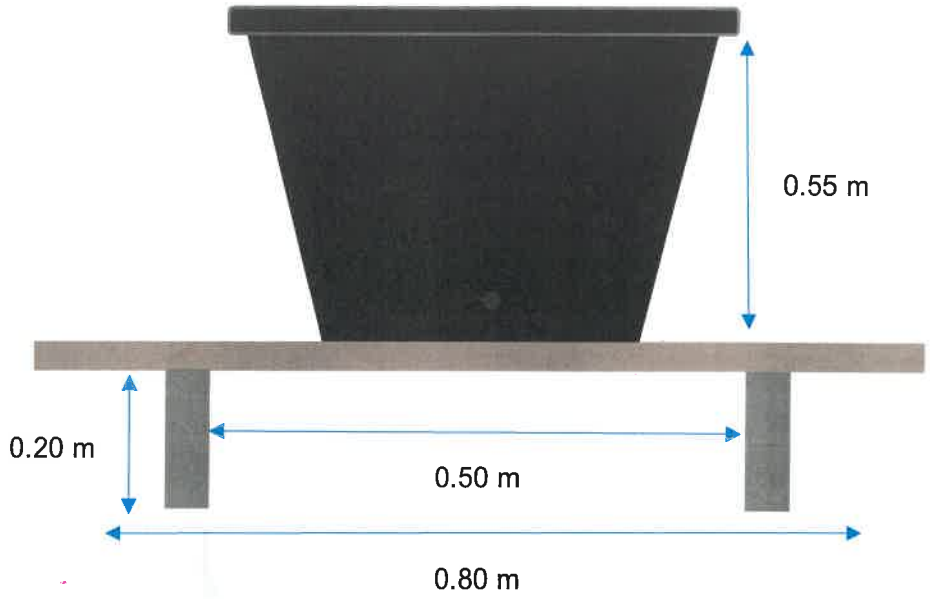
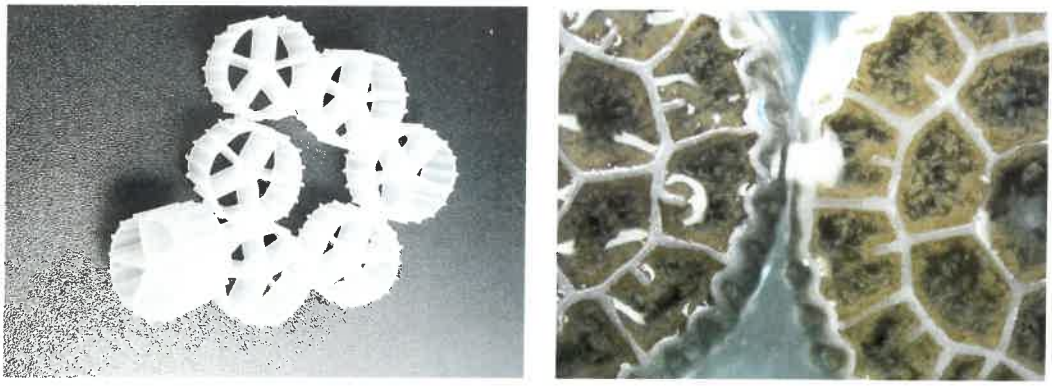


Figure 2.9: Big Tank Layout

Plywood for big tank = 1.20 x 1.20 (m) = 1.44 m Metal stand for bucket = 0.30 x 4 x 4 (m) = 0.30 m x 16 Metal stand for big tank = 1.2 x 8 (m) = 9.6 m Metal tank platform = 6 m	Horizontal frame = 0.50 x 4 x 4 (m) = 0.5 m x 20 Middle connected stand = 0.50 x 4 x 4 (m) = 0.5 m x 16 Stand cross = 1.2 x 8 (m) = 9.6 m

Furthermore, the system consist **biofilm carrier** to provide solid substrate for the growth of microorganism and denitrification for anaerobic bioreactors that modified the surface for promoting biofilm formation. The biofilm dominated by rod-shaped microbes in which cells are embedded. This biofilm shaped as multi-cellular communities that may caused by bacteria and it provide protection from antibiotics and host defends. In the floating treatment system, the biofilm carrier used as to multiply the surface area for microorganism growth that will rapidly increase the process of trapping total suspended solid. Not only that, more nutrient will be delivered from the bacteria and microbes and surely the plants will last in a good condition and will not affect the efficiency of treating wastewater. The biofilm will then mix under the floating bed for the biofilm growth.



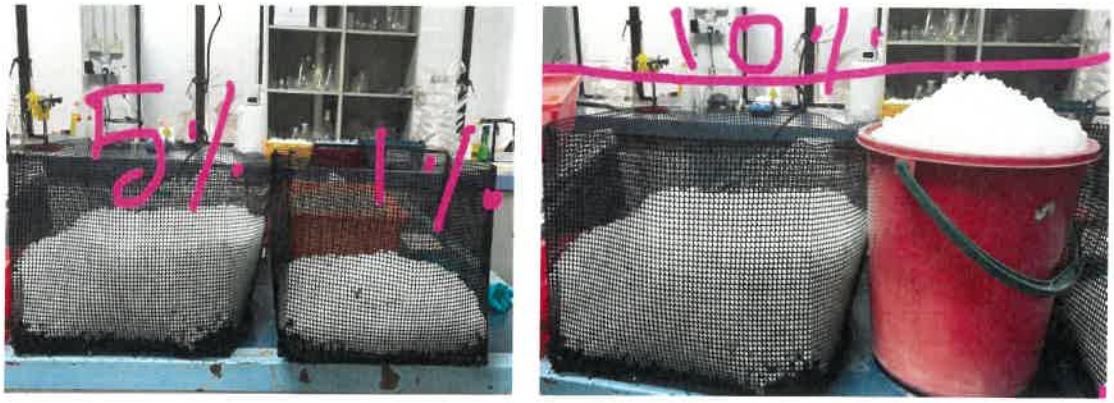
(i) (ii)

Figure 3.0: (i); (ii) Biofilm Carrier

Further studies and research had been going and the discussion between supervisor and mentors discovered that single biofilm carrier (media) would be efficient if were tied together. This is due to more surface area for the microbes to breed and easy for them to gain more nutrients from the roots. Plus, the amount of biofilm carrier also not more than 2% since crowded media will disturb the flow of system.

(i) (ii)

Figure 3.1: (i); (ii) Media/Membrane (Tied Together)



(i) (ii)

Figure 3.2: (i); (ii) Percentage Acquire for Single Floating Bed

Apart from that, **coconut husk** is used inside the floating bed through its frame to provide high nutrient for the microbes. Plus, this material is easy to find and to be carried out within the system. Research stated that coconut husk capable to inhibit the growth of biofilm forming various typed of bacteria. But the main objectives of exhibiting the coconut husk into the system is to act as a rigid structure and base for the plant. Since turbulence of air may occur towards the floating system in the river, a strong grip of base is vital to keep plants from being destroyed by nature. Therefore, when the structure of plant had been changed, it might as well disturb the efficiency of the treatment process. This is why coconut husk is the best option to perform best not only as a strong holder but also might provide nutrient for the microbes.

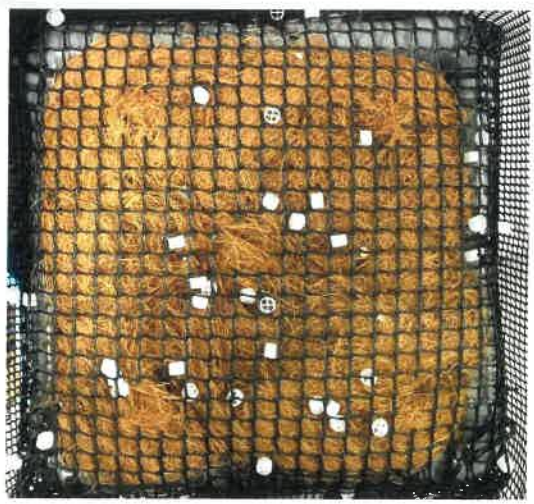


Figure 3.3: Coconut Husk

Last but not least, the **type of plant** is one of the crucial parts of succeeding this project since different kind of plant may influence the system efficiency. The typical plant needs to be selected according to the reserve buoyancy required for the applications. As an example, wetland sedges, rushes, and grasses. This can develop a superior root structure within the water to provide for increase in surface area. Once the system is carried out, the plant will grow taller for several weeks and this may result in less efficiency. The facts behind the statement is because when plant reach their higher stakes of being adult stem, it will no longer need the nutrient since it can provide their own nutrient to grow. This activity can reduce the efficiency since no nutrient that provided by the bacteria being taken, therefore the nutrient will return back to the water ground. To avoid this from occurring, the plant needs to be harvest by specific measurement calculated to ensure that the bacteria provide enough nutrient for the plant to adsorb. There are many types of useful plant that exist and easy to find near Johor Bahru such as *Eichonia Grasspes, Pistia Strahotes, Salvinia Molesta, Water Hyacinth, Centella Asiatica, Water Lettuce, and Parrots Feather.*

(i)

(ii)

(iii)

Figure 3.4: (i); (ii); (iii) Various Type of Plant Provided

4.1.3 Problem Statement

Floating treatment wetland is a manual hand project that require manpower to achieve its goal. Nevertheless, the system needs more correction and observation in order to find the best result of treating wastewater. During the industrial training, there are some problems encountered by the whole system that needs to be fix. First problem is the unparallel platform, during discussion it was concluded that different level of platform may influence the pressure of water. Secondly is the manual valve provide through out the pipeline. Since the size of manual valve is much bigger, it is very difficult to get the accurate flowrate desired as the calculated one.

The water flow is hard to manage and the valve produce bigger flow than normal. Apart from that, major issue that will be the challenging situation is the existence of plant that suitable with the system. It is difficult to find one since the restricted area had been closed down due to pandemic and majority of the plant normally exist in other place of state. The better usage of plant endures in due to the performance and longevity but hard to find in this current area. Therefore, from the problem consist through out the process of doing the system, it is crucial to think outside the box and retrieve a new solution to avoid from the same mistake happening again. Mst Kaniz Fatema assigned to do more research to solve the problem and discussions were made between intern and mentors.

4.1.4 Project Flow

The project consists few problems that need further investigation in order to retrieve precise data from the system. Therefore, a betterment is needed to ensure that the system works properly and valid within the research made. First step during the industrial training is **Levelling**. This work loads are made by interns and Dr Ihsan Wan Azeelee alongside with Mst. Kaniz Fatema by digging to ensure that the wooden platforms are at the same height. Moreover, the pressure in each bucket pipeline eventually will be same if the bucket was located at the same rate as the others. The wooden platforms are strengthened with steel legs that were cut by the same length and few cement rocks to ensure that the system is sturdy. Not only that, wood planks are used to accommodate output pipeline that connected with water reservoir to make certain that purified wastewater will move directly back into the lake. This whole process required 3 hours of manual manpower and 15 minutes for testing wastewater flow by make sure that the water flow system is continuous. If the water flow is continuous, this will outstand the rate of bioremediation of microbes and bacteria so that all water from each bucket have the same flow process when it passes the floating bed. Therefore, by having the same rate will encourage better data and easy to make a comparison between each bucket output.

(i)

(ii)

(iii)

Figure 3.5: (i); (ii); (iii) Floating Treatment Wetland Levelling Process

After the levelling process is done, the next important step is **Piping**. During the first discussion with mentors, it is observed that the old pipeline uses PVC pipe that have bigger diameter. Due to the big diameter will caused the water flowrate to increase and the efficiency of floating bed can be disturbed. Therefore, after making appointment with supplier, the piping process is done. During the installation of new piping (blue pipe), the water flow needs to be observed to ensure that it follow the correct direction in the system. The new pipeline had been checked multiple time and tested all manual valve for opening and closing. Apart from that, during the pipeline a new component had been store named flow resistor. The flow resistor has one vital function whereas it decreases big flowrate into small flowrate. Since part of the problem are water flowrate, the flow resistor would be beneficial in helping lowering down the water flow to be as desired. This piping process took about 2.5 hours since there are some components that need to be changed and measurement are different than expected. The observation had been made and it has been discussed that the output blue pipe needs to be long enough to reach the bottom of bucket base. This is because floating treatment wetland is a process that involves microscopic roots and plant base nutrient where microbes and bacteria will stick at the root of the plant. Therefore, the output water flow needs to be located at the bottom of bucket base so that the water will move upwards and eventually touching the roots.

(i)

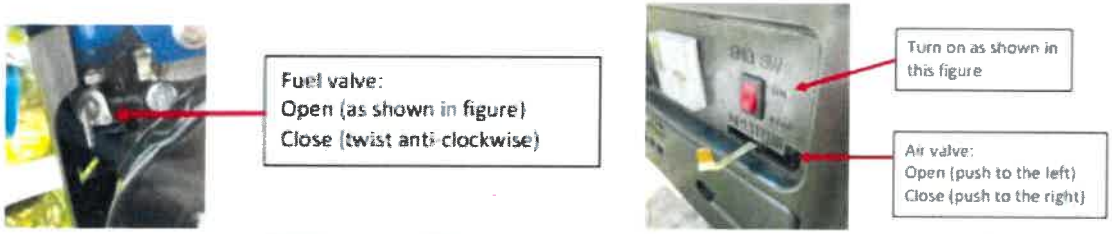
(ii)

(iii)

(iv)

Figure 3.6: (i); (ii); (iii); (iv) Piping system for Floating Treatment Wetland

The process continues by **Pumping** the wastewater from lake into the red bucket and black tank by using portable pump. During this process, there are a few standard operation procedures (SOP) introduced by Mst. Kaniz Fatema for the genset and water pump. The following SOP for generator to supply power is by mixing 20 mL of engine 2T oil and 1 L of fuel in the opened hole. Fuel valve need to be open alongside with air valve that need to be fully opened and then half opened. The air valve then is closed during running the generator. Press ON button and detach all connection as well as pull the recoil cord until engine start. Turn off air valve and the generator need to be run for about 3 minutes for a fresh warm start up. Then the generator can be connected with water pump.



Meanwhile, the standard operation procedures for water pump begins with opening the outlet hose pipe and nut to fill in tap water. The valve at inlet hose pipe needs to be open and the filling process may begin. Fill up tap water at the nut to push out air bubble until observing water coming out from outlet after a few seconds. Then, continue filling water at inlet hose pipe until water coming out from outlet hose pipe. Reinstall the valve and ensure that there is no water leaking from the valve. Reinstall the hose pipe at the outlet of water pump and fill again at the nut. Close tight the nut and make sure that before connect to generator, the inlet hose pipe needs to be put into the river meanwhile the output located at big tank. After finished the pumping process, all of valve and hose pipe need to be disconnected and stored safely in room. Note that protective equipment such as rubber glove and rubber boots are highly important to prevent any harmful bacteria or finger cut.

(i) (ii)

Figure 3.7: (i); (ii) Installation of Generator and Portable Pump

Moving on to the next step is **Filling** by connecting inlet and outlet of hose pipe into a separate source. The wastewater from lake being pump straight into the big tank and the filling process took about 35 minutes to fill up the whole black tank. Apart from the big tank, the four buckets also be filled in with wastewater carefully and each bucket holds 20 minutes to fill until up. When the filling is done, the floating bed are put into bucket 3 and 4 while leaving bucket 1 and 2 to be empty without any frame bed. This is to differentiate floating bed efficiency and establish a research to see which bucket succeed during the experiment to remove access microbes.

Figure 3.8: (i); (ii); (iii); (iv) Water Filling from Lake into The Tank

After filling process succeed, the remaining wastewater in hose pipe will be removed into the lake back and generator will be turned off. This filling process need to be done each time when the wastewater in big tank begins to empty. During 2 months of observations, the wastewater in black tank decrease until lower level will take 8 -10 days to finished. Therefore, the same process will be implemented each time when filling new wastewater into the tank and to maintain continuous water flow in the system.

Next part of the flow project required huge amount of time to set the water flowrate by using manual valve. With the helps of flow restrictor, the workload time can be reduced. Nevertheless, the flowrate calculated need to be set for each valve connected with all four buckets. Constant flowrate is very crucial to implement a constant process during the system running to gain desired value and making a differentiation between the buckets. Although this was seemed as an easy task, the manual valve was the challenge. This is because by changing flowrate manually for all connected pipeline would be a tough work since the pipeline is parallel with each other and changes will affect the other pipelines. The statements define that when one manual valve is changed by its own flowrate, when setting for the second manual valve it will affect the first valve that already been set. Such a theory that pressures change during the setting process.

Therefore, a few observations and experimental works had been on to investigate the best way to gain all constant flowrate at the same time without messing the pressure in the pipeline. The method that had been worked on is One-By-One Valve Setup, One-At-A-Time Valve Setup, All Valve Fully Opened, One Valve Opened (Bucket 4), Two Valves Opened (Bucket 3 and 4). All methods had produced different value but with the same discussion. Despite all reading are taken with different methods, it still did not achieve the objectives whereas to find the best solution and method to gain constant flowrate for all buckets. Down below illustrate the calculated amount of flowrate desired:

CALCULATIONS:

V = A . D

d = 0.75 m

$V = \frac{\pi D^2}{4} . d$

V = 0.152 m^2 = 152 L

t = 5 days

WASTEWATER FLOWRATE:

$Q = \frac{L}{d}$

$Q = \frac{152}{5} = 130.40 \times 4 = 122 \frac{L}{d}$

$Q = 1.27 \frac{L}{hr}$

$Q = 0.021 \frac{L}{min}$

RESULTS AND DATA:

RECORDED DATA (25TH APRIL 2021)					
DATE	METHOD	FLOWRATE (ml/min)			
		BUCKET 1	BUCKET 2	BUCKET 3	BUCKET 4
25th April 2021 (First Observation)	One-By-One Setup	22.0	21.5	21.5	21.0
	One-At-A-Time Setup	15.5	20.0	10.5	21.0

Table 1.3: Data Recorded on 25 April 2021

RECORDED DATA (26TH APRIL 2021)					
DATE	METHOD	FLOWRATE (ml/min)			
		BUCKET 1	BUCKET 2	BUCKET 3	BUCKET 4
26th April 2021 (Morning)	One-By-One Setup	20.5	21.0	21.5	21.0
26th April 2021 (Evening)		16.0	21.0	0.0	19.0

Table 1.4: Data Recorded on One-By-One Setup Method

RECORDED DATA (27TH APRIL 2021)					
DATE	METHOD	FLOWRATE (ml/min)			
		BUCKET 1	BUCKET 2	BUCKET 3	BUCKET 4
27th April 2021 (Morning)	All Valve Opened	0.0	10.0	10.0	11.0
27th April 2021 (Evening)		0.0	5.0	0.5	7.0

Table 1.5: Data Recorded on All Valve Opened Method

RECORDED DATA (28TH APRIL 2021)					
DATE	METHOD	FLOWRATE (ml/min)			
		BUCKET 1	BUCKET 2	BUCKET 3	BUCKET 4
28th April 2021 (Morning)	One-At-A-Time Setup	4.0	14.0	6.5	15.5
28th April 2021 (Evening)		10.0	15.0	20.0	22.0

Table 1.6: Data Recorded on One-At-A-Time Setup Method

RECORDED DATA (29TH APRIL 2021)					
DATE	METHOD	FLOWRATE (ml/min)			
		BUCKET 1	BUCKET 2	BUCKET 3	BUCKET 4
29th April 2021 (Morning)	One-By-One Setup	3.5	10.0	4.5	4.5
29th April 2021 (Evening)		Closed	Closed	4.5	2.5

Table 1.7: Data Recorded on One-By-One Setup Method

RECORDED DATA (4TH MAY 2021)					
DATE	METHOD	FLOWRATE (ml/min)			
		BUCKET 1	BUCKET 2	BUCKET 3	BUCKET 4
4th May 2021 (Morning)	One-By-One Setup	Closed	Closed	Closed	5.5
4th May 2021 (Evening)		Closed	Closed	Closed	21.5

Table 1.8: Data Recorded on One-By-One Setup Method

RECORDED DATA (5TH MAY 2021)					
DATE	METHOD	FLOWRATE (ml/min)			
		BUCKET 1	BUCKET 2	BUCKET 3	BUCKET 4
5th May 2021 (Morning)	One-By-One Setup	Closed	Closed	Closed	3.0
5th May 2021 (Evening)		Closed	Closed	Closed	12.5

Table 1.9: Data Recorded on One-By-One Setup Method

DATA CALCULATION:

1 Litres = 1.37 minutes

21 mL = 0.021 L

0.021 L x 60 mins x 24 hrs = 30.24 L/day (15 L each for Morning and Evening)

READING GAINED (OBSERVATION)			
BUCKET	VALVE	FLOWRATE (min/L)	CALCULATED TIME TO FILL 15 L (min)
1	Fully Opened	2.65	39
2	Fully Opened	1.83	27
3	Fully Opened	3.25	49
4	Fully Opened	3.00	45

Table 2.0: Calculated Time to Fill Bucket with 15 L Wastewater in One Day

The data and results above are the collected information during observation towards the system. One of the methods is One-By-One Valve Setup. During running the system, the valves for each bucket had been closed except for one valve that need to be set. After one valve already been reset to 21 ml/min, the first valve will let be opened while resetting the next valve. Other than that, for One-At-A-Time Setup involves by opening all valves and resetting each flow restrictor at the same rate while continuing the flow in all four buckets. Different than the other method, this One-At-A-Time eventually will continue the water flow while the One-By-One method needs to close each time when resetting. Furthermore, All Valve Fully Opened method require when all flow restrictor were opened fully and the water flow is count without resetting.

During the process, after all valves had been reset to 21 ml/min it will be leave on for 24 hours. The next day then the investigation begins during morning to check the decreasing in flowrate. Once the results achieved, the valves been reset again to 21 ml/min to be checked again in the evening at the same day. But all three methods stated above did not achieved the objectives of having constant flowrate which is 21 ml/min. Each time the valve had been reset, the water flow will decrease again and needs to reset manually which is could be a burden for a long-term project. During the discussion, it has been appointed that the water level that flow from the big tank could be the possible problem that it will lower down the water pressure. By that, when pressure keep decreasing it allows the water to flow slowly resulting the flowrate to be affected.

From the problem encountered, the next solution is by closing valve at bucket 1 and 2 to see if the decreasing number of valves will affect the water flowrate. Also, the same basic apply to the other methods whereas all valves are closed except for bucket 4. It can be seen that when decrease the number of valves, some time it will remain the same flowrate which is 21 ml/min but further observation had been made and the same results occur that it did not achieve the same flowrate as how it has been reset. Therefore, this concludes that the methods used did not receive a constant flowrate from time to time.

Along side with that, there are some solutions had been discussed with supervisor and mentors by choosing to fill in water by days instead of minutes. A calculation had been made and a method of All Valve Fully Opened apply in the process. Some value collected to fill in 15L at morning and evening whereas it is approximately the same as filling the water flow by 21 ml/min. Therefore, the setting process of valve may had been easier since the value much bigger and desired flowrate can be achieved.

Last but not least from the project, when the desired value of flowrate had been taken the next crucial step is by collecting sample and harvest the plant. **Sampling** is done to investigate the efficiency of the floating bed in each bucket by experiment during laboratory work. But, due to the pandemic we still could not achieve the flowrate and the laboratory work needs to be hold until a certain time intern students are allowed to work in the office again. Therefore, we collect some research sample as a guidance to understand and elaborate more on the efficiency of floating treatment wetland system towards wastewater and environment. It is noted that there are many subjective preferences that would be the main factors for the system to be efficient enough in removing microbes and bacteria. Some of them are the type of plant, flowrate of the system, measurement of plant and roots, and even the amount of biofilm carrier. Further analysis had been made whereas **harvesting** would be the next step in order to maintain a good quality system. This is because plant can grow older and taller, when stem at a higher state they will produce their own nutrient and will no longer need the nutrient from bacteria. Nutrient will turn back to the ground and the system unsuccessfully did not manage to remove them from wastewater.

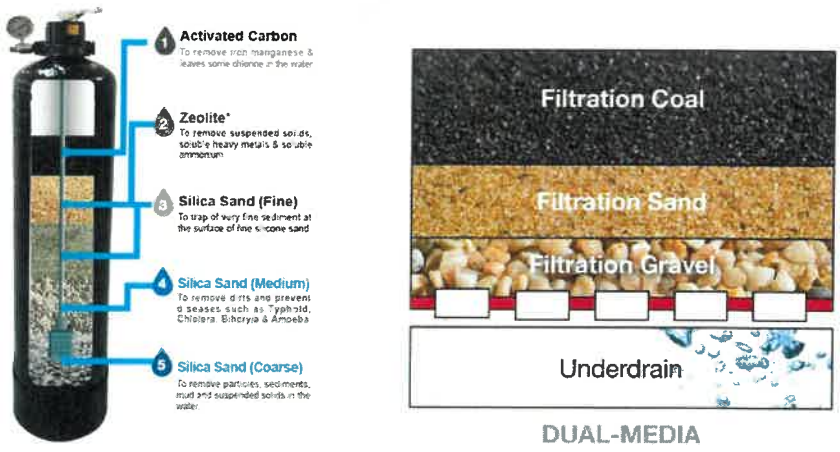
4.1.5 Overall Project

In a nutshell, the overall project demonstrates a cleaner and healthier biological method to sustain environment especially for treating polluted water. This is because water works as basic needs and main important element for living things to survive. Water could help in many other ways that it is a must for society to keep our water clean and healthy. Floating treatment wetland is a great discovery that leads to a scientific society to use technology and biological remedy in improving the ecosystem. This project manages to bring environment to a whole new level by giving a treating solution without harming the surroundings. The floating treatment wetland gives positive impact and it is a double win method whereas the system may be beneficial for both bacteria and plant. To deduce, the environmental-friendly system may helps removing harmful bacteria and microbes in wastewater to avoid dangerous disease from occurring. A cleaner water will help to improve various activities and people can rely on the system built without any hesitation. This project worth the trophy among researchers that successfully understand the basic mechanism of bioremediation process and anaerobic digestion that leads to a bigger scope in treating wastewater. Moreover, from the project assigned it helps myself to receive new knowledge and physical skills since the floating treatment wetland required a lot of manpower and observation to work the system out.

4.2 *Sand Filtration System*

Generally, sand filtration act as water purification and used to remove suspended solid matter especially in treating wastewater as well as floating and sinkable particles. In the system, the wastewater will flow vertically through a fine bed of sand and gravel and many other materials. The particles will be removed by way of absorption or physically encapsulation. Moreover, heavy metals may be removed by advanced media such as zeolites and activated carbons. Alongside with that, reclamation process involves where this technique of claiming something back or even reasserting a right, in this matter is to reclaim polluted water into a cleaner one. Moreover, reclamation involves in many other ways such as upward flow sand filters, slow sand filters, and rapid (gravity) sand filters. Upward flow required flocculant chemicals as well as the rapid gravity.

Schematically, grains of sand filters will form a layer of filter that can be penetrated by the water and may stop different kind of particle size. The concept held in the system where smaller diameter of grains, the longer the particle remains in the filter and will lead to a higher filter stopping power. This mini project is more likely towards rapid filtration instead of slower one that involves sedimentation. Since the system is by allowing wastewater through the sand bed it will require backwashing to clean them more frequently and efficiently. The backwashing method is when the water direction being reversed during running the system to gain a cleaner effluent. Moreover, an effective sand filtration system is when it produced a higher value of removal in suspended solid, nitrogen, and phosphate in the particular wastewater.



(i) (ii)

Figure 3.9: Sand Filtration Basic Mechanisms

4.2.1 Design of The Project

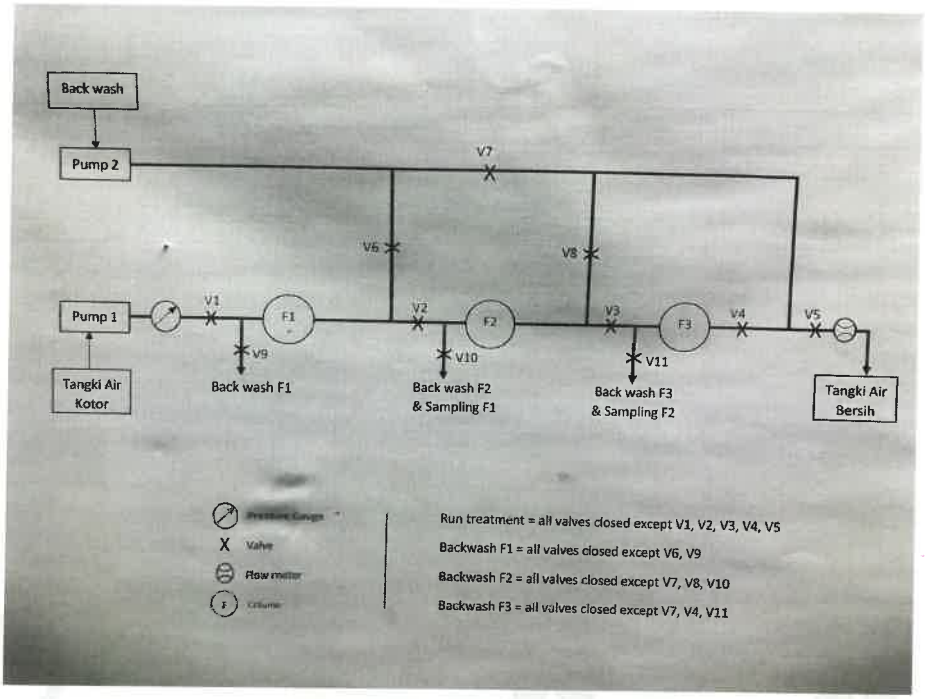
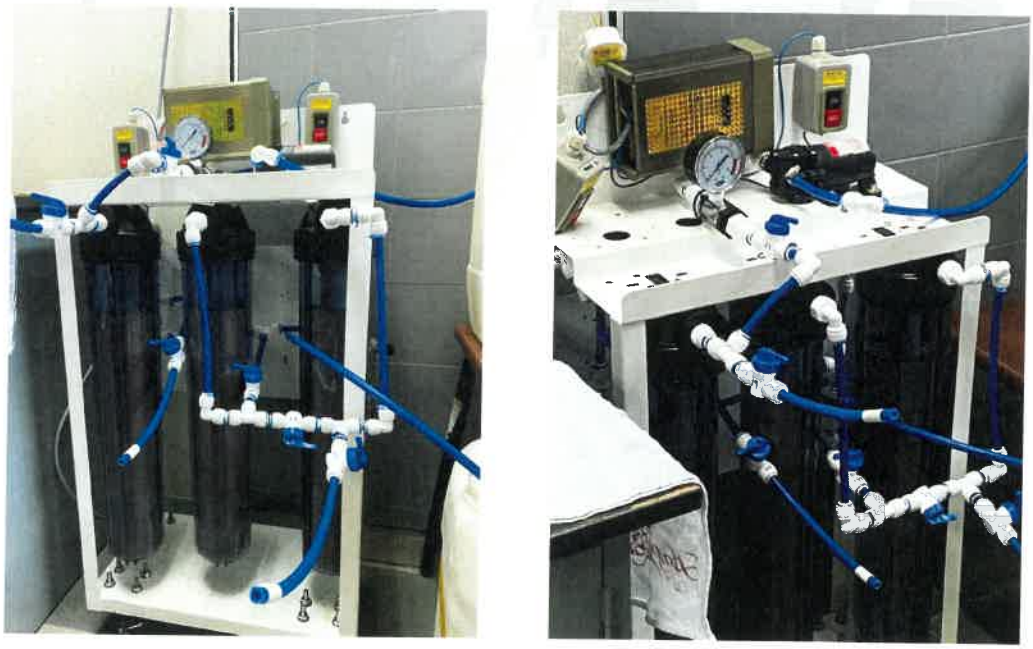


Figure 4.0: Flow of The System



(i) (ii)

Figure 4.1: (i); (ii) Laboratory Sand Filtration System (Small Scale)

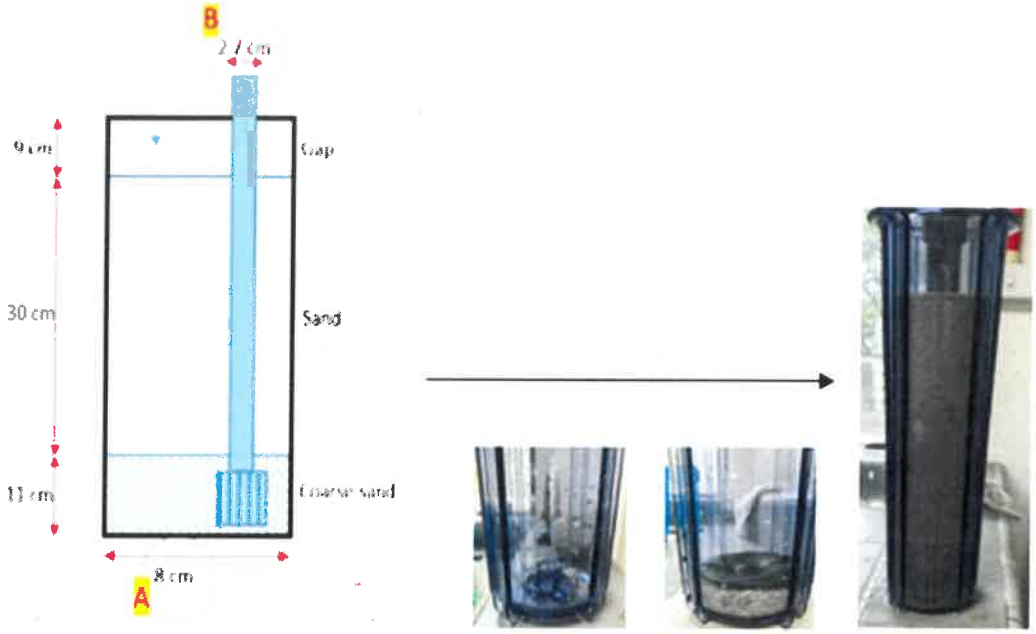
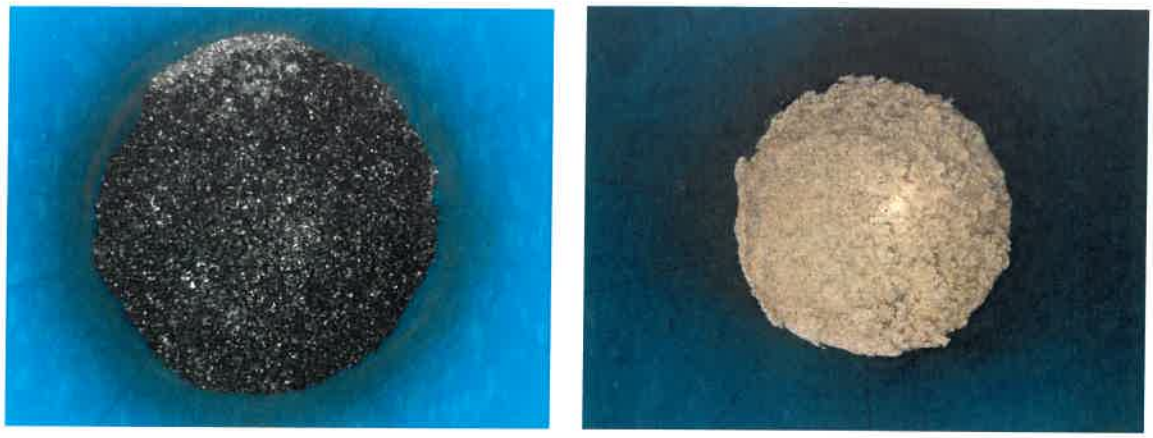


Figure 4.2: Project Measurement

INSTALLATION OF FILTER MEDIA INSIDE THE COLUMN

Priorly, rinse all the filter media with tap water and let dry at room temperature before use. Then, fill up the column with coarse sand media (1.2 – 2.4 mm) followed by sand media (0.6 – 1.2 mm). Initially pump the water into the column to wet all the filter media. At the desired flowrate, pump the wastewater into the column to begin the water treatment process. The filtered water was sampling at the time interval of 30 minutes, 1 hours, 3 hours, and 6 hours. The wastewater before and after the treatment process will be analysed for COD, BOD, Ph, TSS, Nitrogen, and Turbidity Test.

Filter media verification is very important to understand and observe the efficiency of water particle removal. Sand is use in the system such as silica sand specially graded to trap smaller particles. Their small diameter helps to retain water longer during the filtration process and removed tiny particles better. Meanwhile, gravel is used to support the internal water outlet distributor especially in the filter. Water will enter the filter through the top, and they percolate down the filter bed under a maintained pressure. The gravel also helps to remove larger particle that trapped down between the gap.



(i) (ii)

(iii)

Figure 4.3: Sand and Gravel Media in Sand Filtration Column

Therefore, from the beginning it had been observed that both sand and gravel had different size between each other. When the sand has a smaller diameter then the resistance will be increase. This will result in less flow and the water remain longer. This small diameter less capacity will require a backwashing thus sand is easily to wash away dirt due to its smaller design and lighter material. Moreover, frequent backwashing is compulsory for grain since bigger diameter will captured larger particle and dirt in wastewater.

4.2.2 Problem Statement

The second project is not as complicated as floating treatment wetland since it involves small scale of experimenting and observations. Therefore, the problem encountered was not much to be compared with others project. One of the is the cleanliness rate of effluent. During the industrial training period, a few of sampling had been made in three different area. All effluent sample collected will be brought back to laboratory for filtration process. To gain a better outcome value, the effluent cleanliness needs to be as low as possible to observe the filtration rate and efficiency before and after running the system. If the wastewater is clean enough would be difficult to investigate the amounts of particles succeed to be filtered. Therefore, it is very vital to gain an effluent that contain more particles and metals so that it would be beneficial during experimental works.

Next part of the problem exist during the project is the type of media filtration. Since sand filtration is a broad research, it is quite difficult to investigate which media happen to be correspond during the filtration process. There are some advance researches regarding other media such as activated carbon and zeolites. Some of the paper also demonstrate an advance technology and backwashing in their studies. In this project, the media filtration still undergoing with the studies to observe which will be the best option in removing small and large particles in wastewater. Since the water effluent cleanliness is high, the experimental work did not receive the desired amount of value. Therefore, the numbers outcome did not alleviate either the media used during running the system happen to be successive.

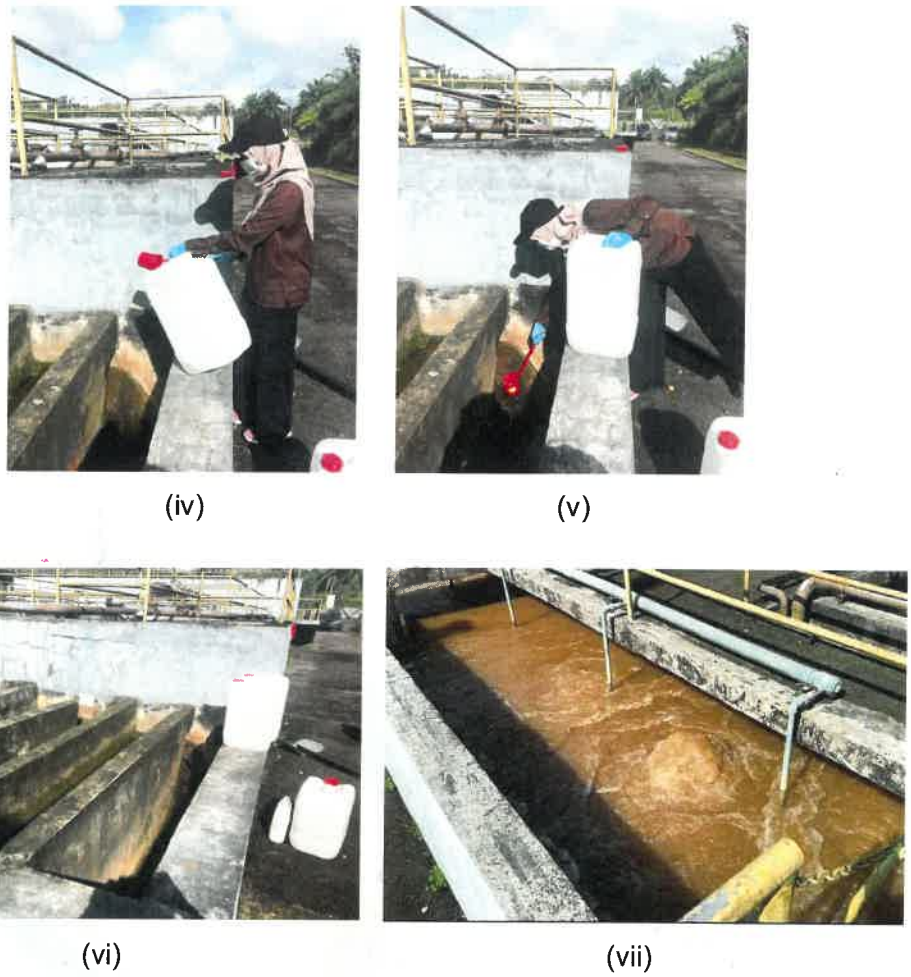
4.2.3 *Project Flow*

Sand filtration project is a non-complex system that require less manpower and focuses more to observation and experimental works. The project begins with **Sampling** process. Dr Ihsan Wan Azeelee locate a few sampling places such as Indah Water in Taman Teknologi Johor. Indah Water in Taman Mutiara Mas, and Sewage Treatment Plant (03) in UTM. During the sampling, three 25 L bottles and two 900 mL bottles has been taken from IPASA laboratory and were used to collect wastewater sample. At the first sight, the sample collected manually by hand without the helps from connecting tube. Normally, there will be connecting tube to ensure that wastewater will run out directly into the bottle without touching the hands. This is because untreated water needs to be handled with protection since it contains harmful bacteria and microbes that are not removed yet. Usually, sampling process will take 2 hours from understanding the whole sewage system till the water collecting session. By using proper personal protective equipment such as rubber clinical glove, safety helmet, and safety shoes helps smoothen the whole process. Aftermath, the bottles will be carried into vehicle while all crew will wash over their body with clean purified water before going back to IPASA.

(i)

(ii)

(iii)



(iv) (v)

(vi) (vii)

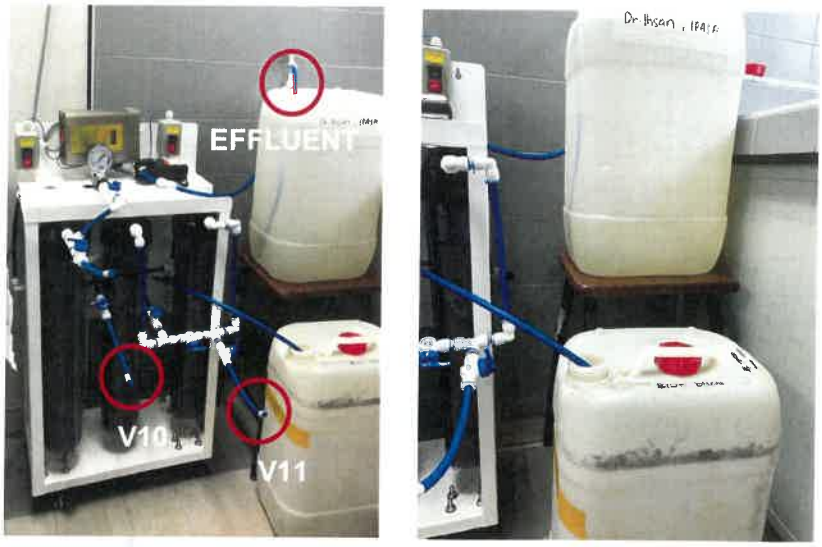
Figure 4.4: (i); (ii); (iii); (iv); (v); (vi); (vii) Collecting Wastewater at Sewage Treatment Plant

Next, when the effluent sample had already been collected safely it will be stored and chilled in IPASA. The effluent sample will be **stored in cooling room** before continue using them. The cooling room of negative degree will preserve the bottles since experimental and laboratory system will run at the next day. After storing for 24 hours, there will be sediment of large particles at the bottom of the bottle base. Therefore, before continuing with running the system it is very compulsory to shake the effluent bottle back and forth. This is to ensure that all particles are mixed together and does not disturb the concentration.

(i) (ii)

Figure 4.5: (i); (ii) Cooling Room

Moving on to the next project flow which is by **Running the system**. Since effluent collected had already been chilled, it is the moment for the system start up. The system begins when wastewater effluent flow down through the sand bed in each column. There were three different columns connected with each other as well as three different outputs. Three valves were valves V10, V11, and effluent. Each valves collect sample for each column to observed the filtration rate and the whole system efficiency. The system runs for 10 hours from 8.00 am until 4.00 pm while each sample from all valves will be taken after every 2 hours.



(i) (ii)

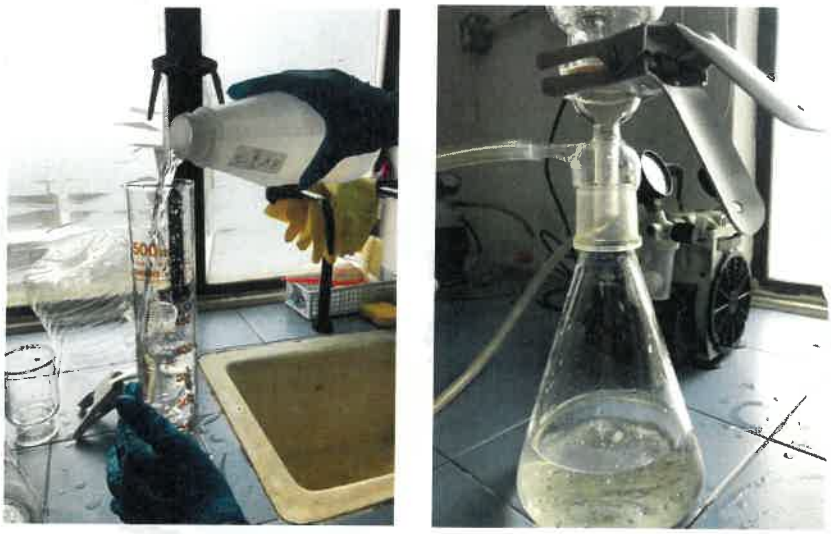
Figure 4.6: (i); (ii) Sand Filtration System Running

(i) (ii)

Figure 4.7: (i); (ii) Effluent Sample Collected from Each Valves (V10, V11, Effluent)

Last but not least, the major important process after collecting water sample from the system is **Lab Testing**. Although the filtration had been done during the system running, another filtration process needs to be carried out by experimental works. Basically, the experiment begins by flowing effluent through a thin rounded filter paper to filter again all access of small particle left in the wastewater effluent. The process had been repeated 12 times each sample collected from the system. Then, when the effluent had been filtered the paper will be removed and separated by each aluminium disk for the next Total Suspended Solid Experiment.

Plus, each sample gives different colour since the sample taken from a different valve and columns. The statement illustrates that darker colour highly taken from the first column which is output located at V10. This is because wastewater flow started through first column and did not completely filtered before moving to the next sand bed column. Meanwhile in third column which is valve located at the end of system consist cleaner and purified water since it has been through three sand bed to be compared with. Therefore, the filter paper colour would be much lighter. Hence, the more water flow undergoes many sands bed, the lighter the colour it should be providing an observation that water being filtered time to time. Also, the amount of large and small particle decreases throughout each column until the end of the system output. When wastewater effluent had already been filtered, the remaining amount of effluent will be stored back inside the bottle and chilled in refrigerator.



(i) (ii)

Figure 4.8: (i); (ii) Filtration Experiment

Last but not least, after the filtration process had been done the next crucial step to gain data and result is by **Experimenting**. The experiments conducted to investigate the efficiency and rate of filtration of the sand bed in the system. Therefore, the value for each experiment is very important to gain which possible material would be a great filtration media in treating wastewater. One of the experiments conducted is **Total Suspended Solid (TSS) Experiments**. The purpose of this experiment is to determine the operational behaviour of waste treatment system. This is also to observe the water clarity and the portion of fine particulate matter remains in wastewater.

In order to test the total suspended solid, effluent sample need to be filtered through a weighed standard glass-fiber filters. The residue left on the filter paper will be dried whereas the temperature needs to be above 100°C. Thus, there will be increase in weight of the filter which responded to be total suspended solids of the effluent sample. The high total suspended solid values influenced by excessive solid generations due to and increase of biochemical oxygen demand (BOD). Apart from that, the experiment continues by testing the effluent **pH**. This experiment is to identify the acidity of the solution by measuring physically using litmus paper or quantitatively using a pH meter.

Next, the experiment continues with **Chemical Oxygen Demand (COD) Experiments** where it measures water and wastewater quality by monitoring their efficiencies. The test is based on strong oxidizing agent, under acidic conditions, and fully oxidize all organic compound into carbon dioxide. Theoretically, a higher COD levels demonstrates a greater amount of oxidizable organic material which may reduce dissolved oxygen levels. If the dissolved oxygen levels can lead to anaerobic conditions resulting dangerous forms to aquatic life. Another experiment that had been carried out is **Biochemical Oxygen Demand (BOD) Experiments**. The experiment purpose is to determine the amount of dissolved oxygen needed by aerobic biological organisms to break down organic material in the particular wastewater. Basically, the greater the BOD will require rapid oxygen depleted in the stream. By that means less oxygen available to higher forms of aquatic life.

Other than that, the **Turbidity Experiments** is based on the comparison of intensity of light scattered under a condition. Turbidity can be important indicator of the sediment in wastewater which can lead to negative effect to aquatic life. The suspended sediments will cause the light to be blocked and may carry contaminants and harmful pathogens. As for the final experiments will carried out by conducting **Nitrogen Experiments**. Nitrogen value is inspected since high amount nitrogen will cause overstimulation of aquatic plant growth and algae exist in water. In turn, it can clog water intakes and use up dissolved oxygen that may block light to deeper water. To deduce, all of the experiment carried out different terms and specific research but with the same objectives which is to find the cleanliness of water and identify rate of filtration towards wastewater effluent. The experiment needs to be handled with specific procedure given with the help by mentor to achieved accurate result.

(i)

(ii)

(iii)

(iv)

Figure 4.9: (i); (ii) COD Experiments (iii) TSS Experiments (iv) BOD Experiments

4.2.4 Overall Project

Wastewater treatment is very important since it is interconnected with the use of water especially by homes, industries, and businesses. The wastewater needs to be treated before it is release back to the environment by reducing pollutant and removing harmful pathogen using technologies. In this project, wastewater is a fundamental to protect health of many different ecosystem. This is why sand bed filtration is introduced to helps remove harmful particles biologically. Also, sand is a material that is easy to found and handle since it covered most of natural ecosystem have. Thus, by using sand helps lower down the cost and its estimated value during building the system. Moreover, during the progress of this project it widen knowledge regarding how sewage treatment plant works. Not only that, a better understanding achieved regarding the water flow and how contaminants would bring harms towards local user. The project also acknowledged specific research in improving filtration rate as well as their efficiency for a better quality in result. The whole project determined to illustrate scientific implementation in wastewater treatment through observing and running system. The sand filtration system had been introduced since the first day of industrial training and it helps building physical skills and experimental skills during the process. Many inputs had been received within the project itself by understanding the importance of filtration media, the harmful effect of having high COD and low BOD levels, and also the mechanism of all system based on their process flow.

5.0 CONCLUSIONS AND RECOMMENDATIONS

As for the summary, industrial training had been beneficial especially towards the student and company itself. There are many lessons can be learned from the task and project assigned by supervisor to fulfil the requirement of being an internship student. Centre for Environmental Sustainability and Water Security (IPASA) had been very delightful in accepting diploma students in pursuing the journey to finish their program. As for myself, I experienced various knowledge and new material that had been delivered not only from supervisor but also all working staff. This huge professional experience manages to sharpen my soft skills and boost confident in communicating with other people. The most fun part was the idea of having various kind of graduates from international despite their country and ethnicity, I manage to prove better on my communication skills by using English as the first priority language when discussing with mentors.

Apart from the skills and knowledge, I experience other opportunity to observe a real working industry and wastewater treatment plant to understand more regarding on what I already learned in environment subjects during my fifth semester of diploma. This visit to multiple sewage plant had widen and brighten my eyes on the real working equipment to treat wastewater before it been disposed back to the environment. All of the experience proves directly on what I already learned and it was a very delight moment to apply my basic diploma knowledge in working life. Not only that, the experiments conducted in IPASA also links with what had been though in university. I manage to get hands on the equipment and understand the methodology and standard procedure correctly. Plus, the mentors introduced me to various scientific notation and principal during conducting the experiments.

I believe that in future, this company manage to excel on their vision and mission to be the top among the others in sustain the environment. As for recommendation, I am hoping that would be more upcoming project can be done despite the pandemic COVID-19 that had been the barrier physically for people. The company manages to improve from time to time and develop successful research among the staff and graduates. Through out the industrial training period, it was an easy experience since there are a lot of helping hands willing to share as much possible knowledge they have. But due to some turbulence, ups and downs during the project and Covid had already been the difficulties especially in experiencing both industrial working and work-from-home style of working. To deduce, it was a good learning process and exposure in preparing myself for future as well as to helps build critical thinking skills. As environment are a very important key issue, it should had been taken seriously especially in treating wastewater to sustain environment for the future generations.

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