A STUDY ON WATER QUALITY AT SUNGAI PANDAN

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AT SUNGAI PANDAN

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ABSTRAK

Sungai mempunyai banyak kegunaan yang penting, adalah sangat penting untuk kualitinya dipantau dan dikaji secara berterusan. Justeru itu, objektif kajian ini adalah untuk menentukan Indeks Kualiti Air (WQI) Sungai Pandan berdasarkan enam parameter dalam skop Water Quality Index WQI, dan untuk melihat keberkesanan kaedah merawat air sungai dengan menggunakan dua jenis penggumpalan iaitu Aluminium Sulphat dan Iron Sulphate atau lebih dikenali sebagai Ferric Sulphate. Berdasarkan keputusan kajian, nilai WQI untuk Sungai Pandan adalah diantara 88.96 (hiliran) sehingga 97.62(hulu). Nilai ini diperoleh setelah mengambil kira sub-indeks enam parameter WQI iaitu Oksigen Terlarut (DO), Permintaan Oksigen Biokimia (BOD), Permintaan Oksigen Kimia (COD), Pepejal Terampai (TSS), Nitrogen Ammonia (AN) dan pH. Bagi penentuan klasifikasi Sungai Pandan, nilai WQI yang telah diperoleh menunjukkan Sungai Pandan berada di bawah Kelas I sehingga Kelas II. Untuk perbandingan kedua-dua penggumpalan, Aluminium Sulphate lebih bagus untuk penyingkiran kekeruhan and pepejal terampai. Peratus penyingkiran kekeruhan bagi Aluminium Sulphate di setiap stesen diantara 38.76% sehingga 60.98% manakala bagi Ferric Sulphate hanya diantara 21.14% sehingga 36.41% sahaja. Secara keseluruhan bagi penyingkiran kekeruhan dan pepejal terampai, Aluminium Sulphate lebih bagus berbanding Ferric Sulphate. Bagi penyingkiran pepejal terampai pula, untuk di setiap stesen peratus penyingkiran oleh Aluminium Sulphate adalah diantara 30.77% sehingga 48.48% dan ia adalah lebih tinggi berbanding Ferric Sulphate yang hanya diantara 12.5% sehingga 33.33% sahaja. Jelas kelihatan bahawa Aluminium Sulphate lebih bagus untuk menyingkirkan pepejal terampai berbanding Ferric Sulphate. Bagi penyingkiran logam-lagam berat, Ferric Sulphate lebih menyerlah berbanding Aluminium Sulphate. Untuk logam Copper, Aluminium Sulphate telah menyingkirkan peratus logam diantara 5.88% sehingga 25% sahaja disetiap stesen manakala Ferric Sulphate bermula dari 17.65% sehingga 33.33%. Untuk logam Chromium, Aluminium Sulphate menyingkirkan sebanyak 10.34% sehingga 29.63% manakala Ferric Sulphate dapat menyingkirkan sebanyak 11.11% sehingga 37.63%. Untuk logam Zinc, 3.57% sehingga 56.25% bagi Aluminium Sulphate manakala 6.06% sehingga 59.38% dapat disingkirkan oleh Ferric Sulphate. Jelas ternyata bagi penyingkiran logam-logam berat Ferric Sulphate lebih bagus berbanding Aluminium Sulphate.

ABSTRACT

The river has many important uses, it is very important for its quality to be monitored and reviewed continuously. Therefore, the objective of this study is to determine the Water Quality Index (WQI) of Sungai Pandan based on the six parameters in the scope of the WQI Water Quality Index, and to see the effectiveness of the river water treatment method using two types of coagulants Aluminium Sulphate and Iron Sulphate or better known as Ferric Sulphate. Based on the results of the study, the WQI value for Sungai Pandan is between 88.96 (downstream) up to 97.62 (upstream). This value was obtained after taking into account the six sub-indexes of the WQI parameters: Dilute Oxygen (DO), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Suspended Solids (TSS), Nitrogen Ammonia (AN) and pH. For the determination of the Pandan River classification, the WQI value has been shown to indicate that Pandan River is under Class I until Class II. For comparison of both coagulant, Aluminium Sulphate was better for removal of turbidity and suspended solids. The percentage of turbidity removal for Aluminium Sulphate at each station is between 38.76% and 60.98%, while for Ferric Sulphate is only between 21.14% and 36.41%. In general for the removal of turbidity and suspended solids, Aluminium Sulphate is better than Ferric Sulphate. For the removal of suspended solids, for each station the percentage of removal by Aluminium Sulphate is between 30.77% and 48.48% and it is higher than Ferric Sulphate which is only between 12.5% and 33.33%. It is clear that Aluminium Sulphate is better to remove suspended solids than Ferric Sulphate. For the removal of heavy metals, Ferric Sulphate is much superior to Aluminium Sulphate. For Copper, Aluminium Sulphate has removed metal percent between 5.88% and up to 25% at each station while Ferric Sulphate ranges from 17.65% to 33.33%. For Chromium metal, Aluminium Sulphate eliminates 10.34% up to 29.63% while Ferric Sulphate can get rid of 11.11% up to 37.63%. For Zinc metal, 3.57% to 56.25% for Aluminium Sulphate while 6.06% to 59.38% can be removed by Ferric Sulphate. Clearly, the removal of heavy metals Ferric Sulphate is better than Aluminium Sulphate.

TABLE OF CONTENTS

LIST OF TABLE

LIST OF FIGURES

LIST OF ABBREVIATIONS

WQI	Water Quality Index
NQWS	National Quality Water Standard
DO	Dissolve Oxygen
BOD	Biochemical Oxygen Demand
COD	Chemical Oxygen Demand
AN	Ammonia Nitrogen
TSS	Total Suspended Solids
pH	Acidity/Alkalinity

CHAPTER 1

INTRODUCTION

1.1 Background study

'Water Planet' also other name for the Earth. By far most of water on the Earth surface is more than 96 percent, is saline water in the seas. The freshwater assets, for example, water tumbling from the skies and moving into streams, waterways, lakes, and groundwater, give individuals the water they require each day to live. Water sitting on the surface of the Earth is anything but difficult to imagine, and your perspective of the water cycle may be that precipitation tops off the waterways and lakes.

Surface water assets, for example, streams, lakes, repositories, estuaries, and beach front waters, are fundamental for sea-going biological communities, water supply, fisheries, and recreational and shipping exercises. For quite a long time, they have been viewed as the premise of improvement for urban zones, industry, and farming far and wide. Consequently, fitting preservation and the board of surface water assets is vital.

Waterways as a rule of a wide range of qualities to various individuals. For instance, waterways symbolize associations, since they contact everybody, and everyone on a fundamental level lives downstream. Streams additionally symbolize human well-being, since crisp water from waterways is fundamental to our networks and ourselves. Another esteem exemplified in a waterway is that of living space, featuring the significance of securing freshwater biological communities for fish and untamed life both in the stream, and along the river banks.

Deforestation in watershed area can prompt soil disintegration, which expands the danger of flooding and avalanches, and in addition making the soil unusable for farming or family unit purposes. Along a streams course, networks living along the river banks are in charge of an alternate arrangement of issues that further influence water quality and amount - over use, dumping of strong waste, depleting of sewage and dark water, and urban trash that dirties water run-off that streams into waterways. Ventures add to these issues by releasing waste water, synthetic compounds and so forth specifically into waterways, without being securely treated heretofore. At the point when dirtied waterways deplete into seas, the issues are intensified, contamination influences angle stocks, wrecks coral-reef living spaces that further exhausts angle stocks, and builds marine squanders, especially plastics, entering the natural way of life and in the end influencing human when animals devour the plastics. Waterways are in reality confronting various natural issues. This is in spite of the way that the greater part of consumable water for human utilization originates from waterways. In some outrageous cases, waterways, lakes and estuaries are unsatisfactory for such essential uses as angling and swimming.

Waterways convey water and supplements to regions all around the earth. Stream have a significant impact in the water cycle, going about as seepage channels for surface water. Rivers give fantastic environment and sustenance to a significant number of the world organisms. Many uncommon plants and trees develop by waterways. Ducks, voles, otters and beavers make a homes on the stream banks. Reeds and different plants like bulrushes develop along the stream banks. Other creatures utilize the waterway for sustenance and drink. Fowls, for example, kingfishers eat little fish from the waterway. In Africa, creatures, for example, elands, lions and elephants go to waterways for water to drink. Different creatures, for example, bears get fish from rivers. River deltas have various types of natural life. Creepy crawlies, warm blooded animals and feathered creatures utilize the delta for homes and for food. Rivers give venture out courses to investigation, business and recreation. River valleys and fields give ripe soils. Ranchers in dry locales inundate their cropland utilizing water conveyed by water system trench from adjacent rivers. Rivers are a significant vitality source. Amid the early mechanical period, plants, shops, and manufacturing plants were worked close quick streaming waterways where water could be utilized to control machines. Today steep waterways are as yet used to control hydroelectric plants and water turbines.

With an end goal to build up a framework to think about water quality in different parts of the nation, more than 100 water quality specialists were called upon to help make a standard Water Quality Index (WQI). The record is fundamentally a scientific method for ascertaining a solitary incentive from numerous test outcomes. The file result speaks to the dimension of water quality in a given water bowl, for example, a lake, waterway, or stream. The important is imperative to screen water quality over some undefined time frame so as to distinguish changes in the water biological system. The Water Quality Index, which was produced in the mid-1970s, can give a sign of the soundness of the watershed at different indicates and can be utilized monitor and examine changes after some time. The WQI can be utilized to screen water quality changes in a specific water supply after some time, or WQI very well may be utilized to contrast a water supply quality and other water supplies in the locale or from around the globe.

The Water Quality Index utilizes a scale from 0 to 100 to rate the nature of the water, with 100 being the most noteworthy conceivable score. When the general WQI score is known, WQI very well may be contrasted against the accompanying scale with decide how solid the water is on a given day.

Table 1.1 National Water Quality Standards (NWQS) Malaysia

Parameter	**Unit**	**Class I**	**Class II**	**Class III**	**Class IV**	**Class V**
Nitrogen Ammonia	mg/L	<0.1	0.1-0.3	0.3-0.9	0.9-2.7	>2.7
Biochemical Oxgen Demand	mg/L	<1	1-3	3-6	6-12	>12
Chemical Oxygen Demand	mg/L	<10	10-25	25-50	50-100	>100
Dissolved Oxygen	mg/L	>7	5-7	3-5	1-3	<1
pH	-	>7	6-7	5-6	<5	>5
Suspended solids	mg/L	<25	25-50	50-150	150-300	>300
Water Quality Index	-	<92.5	76.5-92.7	51.9-76.5	31.0-51.9	>31.0

Table 1.2 Water Quality Classification

Class	Usage
I	Nature conservation Water Supply I - Almost no treatment required Fishing I - Aquatic species is very sensitive
II	Water Supply II - Conventional Treatment Fisheries II - Sensitive aquatic species
III	Water Supply III - Extensive treatment required Fisheries III – Livestock
IV	Irrigation
V	None of the above

Table 1.3 WQI Table

Water Quality index (WQI)	River Classification
More than 92.7	I
76.5-92.7	II
51.9-76.5	III
23.0-51.9	IV
Less than 31.0	V

Table 1 above shows Malaysia's National Water Quality Standards (NWQS) for rivers in Malaysia while Table 2 shows the water class and what can the water used for and Table 3 is a resource WQI schedule from the Department of Environment.

1.2 Problem statement

Water assets, both surface water and groundwater are generally misused characteristic assets and thus at present water assets are confronting genuine contamination and deficiencies issues far and wide. Water need consequently fundamental to give careful consideration to the enhancement and support of water quality and amount. Consequently, emerges the need to create viable philosophies for assessment of groundwater and surface water assets for manageable advancement and wellbeing of human wellbeing. Use of groundwater is by and large unmetered not at all like surface water and this has prompted groundwater outrageous misuse. Though, surface water then again is progressively vulnerable to contamination from different sources and water supply is by and large metered. Notwithstanding, tainting of the two types of water assets is extremely basic because of a few reasons, for example, agriculture runoff, household and modern contamination.

Water crisis are one of the main issues in Malaysia. According to World Wide Fund Malaysia (WWF-Malaysia), rates of water wastage in household, modern and agrarian utilize are high and this is unsustainable in the long haul. Contrasted with different nations, Malaysia uses and wastes excessively water.

Humans can survive without food for a few weeks, but humans cannot survive without water for so long. The maximum duration that human can withstand without water is only predicted for only several days.

1.3 Objective study

Among the objectives of the study that are included in the outcomes of this study are:

i. To determine and classify the Water Quality Index (WQI) at each checkpoint.
ii. To determine the optimum dosage for each coagulant, aluminium sulphate and iron/ferric sulphate.
iii. To compare the coagulants in terms of dosage, total suspended solid (TSS) and heavy metals such as copper, chromium and zinc.

1.4 Scope of study

This study take place at Sungai Pandan, three checkpoint were determined and at each checkpoint three samples were collected, in total nine samples were collected and analysed. This study focuses on six parameters to determine the Water Quality Index (WQI), which are Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Nitrogen Ammonia (AN), Suspended Solids (TSS) and Index alkalinity or acidity (pH). Two commonly used coagulant in treatment of water and wastewater were selected and jar test will be undergo to obtain the optimum dosage for each coagulant such as Aluminium Sulphate and Iron Sulphate or usually called as Ferric Sulphate. Then, after the optimum dosage obtained, the result of turbidity, TSS and heavy metals such as chromium, copper and zinc were compared for each coagulant at each optimum dosage samples. All the data were tabulated and compared to each other to observe which coagulant better to remove turbidity, TSS and in addition, heavy metals.

1.5 Significant of study

Waterway water quality is a significant angle in deciding the tidiness of the stream. Water quality evaluation completed by characterizing water based National Water Quality Standards (NWQS) as a rule. Through this characterization, the dimension of water quality can be resolved. Furthermore, the consequence of the exploration directed is relied upon to bring issues to light to a specific gathering in pushing ahead protection or waterways that is in basic. Moreover, the outcomes of this investigation can be utilized as a one of the sources of comparison in the future. The coagulants kill the negative electrical charge on particles, which destabilizes the powers keeping colloids separated. Water treatment coagulants are contained emphatically charged atoms that, when added to the water and blended, achieve this charge balance. Inorganic coagulants, natural coagulants, or a mix of both are commonly used to treat water for suspended solids evacuation. In this study, Aluminium Sulphate and Ferric Sulphate were used as a coagulant.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The waterway is a significant wellspring of water to people in regular use. It cannot be denied that the waterway is the backbone of human lives. Nonetheless, in accordance with the progress of time, the issue of water contamination is deteriorating. The contamination has brought about the catchment zone being wrecked. This has additionally given a great deal of suggestions to people and other living things, particularly amphibian life. Refuse transfer and dangerous waste into the stream have prompted waterway contamination. The dirtied waterway will wind up shallower and less working. After some time, the world will likewise confront the emergency of clean water supply.

In accordance with waterway contamination issues, the checking of stream water quality is additionally significant before it is taken for water use. Every stream should be tried already for the water quality dimension before being utilized for suitable use as recommended by the Department of Environment (DOE). Waterway water quality can be estimated utilizing the Water Quality Index (WQI). WQI is a standard that has been utilized all around to gauge the nature of stream water. There are numerous parameters used to survey water quality. These incorporate physical parameters (pH and broke down oxygen), supplements (smelling salts and phosphates) and metals (cadmium and iron). Because of that, the Department of Environment Malaysia has utilized six key parameters to survey the nature of the stream waters, ie Dilute Oxygen (DO), Acidity or Alkalinity Index (pH), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Suspended Solids (TSS) and Ammonia Nitrogen (AN). These six parameters have been given a specific weight or incentive in the computation to get a WQI esteem for a waterway.

The fundamental reason for the WQI determination is to decide the water quality and to group the waterway Class I, Class II, Class III, Class IV or Class V. Classification of water quality is significant in light of the fact that each class has a manual for utilize the stream. For instance, waterway classes I and II can be utilized for drinking water supply and different uses that require clean water supply. The streams that fall in evaluation III and underneath are not appropriate for clean water supply.

2.2 Water Quality Index (WQI)

Seaside water quality factors, for example, pH, dissolved oxygen, biological oxygen demand, total suspended solids, ammonia, nitrate, phosphorous, chlorophyll-an and fecal coliform are the well-being indicators of beach front condition. All things considered, the huge datasets made are frequently perplexing to get the values. Therefore, trying to display the complex datasets in an increasingly far reaching approach, a solitary pointer of Coastal Water Quality Index (CWQI) was endeavored. The CWQI is a dimensionless number that joins different water quality factors into a solitary number by normalizing esteems to emotional rating bends (Horton, 1965; Brown et al., 1970; Miller et al., 1986). Water quality index (WQI) has been widely used to indicate a water quality class for drinking use (Rabeiy, 2017).

To compute WQI, assigning of a weight for each groundwater meters (wi), computing of relative weight (Wi) and quality rating scale (qi) are needed. Thus, wi were assigned for pH, TDS, EC, Ca^{2+},Mg^{2+},Na^{+}, K^{+}, HCO_3^{-},Cl^{-},SO_4^{2-},PO_4^{3-},NO_3^{-} and F^{-} and Wi is computed using eq. (1) (Brown et al., 1972; Tiwari and manzoor, 1988; Babiker et al., 2006; Gebrehiwot et al., 2011; Singh and Khan, 2011; Selvam et al., 2013; Boateng et al., 2016; Jhariya et al., 2017; Rabeiy, 2017; RamyaPriya and Elango, 2018)

To survey water nature of stores in lower compasses of Yellow River utilizing the water quality index (WQI) strategy and endeavor to think about water quality and fundamental defilements of mountain and Yellow River supplies, water tests were completed more than 6 years. Nine water factors were chosen to take part WQI computation by Principal Component Analysis (PCA). WQI values went from 17.8 to

77.8 in five repositories, which specified "great" to "exceptionally poor" water nature of supplies. No huge contrasts in WQIs were found among mountain and Yellow River supplies. A noteworthy finding from the investigation is that mercury was the primary tainting in 5 supplies, while TP (add up to phosphorus) and SO4 were another fundamental pollutions in mountain and Yellow River stores, separately. Use of the WQI is recommended to be a useful instrument that empowers people in general and chiefs to assess water nature of savouring supplies bring down compasses of Yellow River (Hou et al., 2016).

The use of water quality index (WQI) is a basic practice that defeats a large number of the recently referenced issues. Moreover, WQI enables all partners to get data on water quality. WQI grants to survey changes in the water quality and to recognize water patterns. A quality list is a unitless number that attributes a quality incentive to a total arrangement of estimated parameters. Water quality lists by and large comprise of sub-list scores doled out to every parameter by contrasting the estimation and a parameter-explicit rating bend, alternatively weighted, and joined into the last record. Such WQI gives a number that can be related with a quality rate, WQI is straightforward, and depends on logical criteria for water quality (Tomas, Čurlin, & Marić, 2017).

Water Quality Index (WQI) is a standout amongst the most generally utilized ideas for portrayal of the nature of a water asset. This idea has wide acknowledgment among strategy creators and different partners as this gives a reasonable and extensive image of the status of the contamination of a water body. The standard advance of improvement of a WQI are parameter determination, task of loads, advancement of sub-record capacities and last collection of weighted sub-list esteems. Out of these, the present investigation focusses on the initial step, i.e. parameter choice. The aftereffects of this examination will assume an essential job in the improvement of Ganga Water Quality Index later on. For the present investigation, at first accessible information has been exposed to Principal Component Analysis (PCA) and this prompted decrease of number of parameters from 28 to 9. This has been done to make the procedure progressively achievable and monetary as this would definitely decrease the time, exertion and cost required to screen tests for countless. The at long last shortlisted 9 parameters were-Dissolved Oxygen (DO), pH, Conductivity, Biological Oxygen Demand (BOD), Total Coliform (TC), Chlorides, Magnesium, Sulphate, Total Dissolved Solids (TDS). PCA uses the fluctuation in the whole informational index and tasks in new measurements, along these lines diminishing the quantity of parameters however holding most extreme difference. The utilization of factual methods in WQI improvement makes the quality data not so much one-sided but rather more target in nature and structures the premise of advancement of a Ganga Water Quality Index (GWQI) in future (Tripathi & Singal, 2019).

Drinking Water Quality Index is a numerical apparatus used to change huge amounts of water quality information into a solitary number and the got single number speaks to the general drinking water quality status. For the most part, Water Quality Indices are determined in two stages. The initial step is crude scientific outcomes for chosen water quality parameters, having diverse units of estimation, are changed into unit less sub list esteems. The second step is the gotten sub-records are then collected utilizing some sort of conglomeration capacity to deliver a WQI esteem (Ponsadailakshmi, Sankari, Prasanna, & Madhurambal, 2018)

River are one of the principle water assets for rural, drinking, ecological and modern use. Water quality index can and have been utilized to distinguish dangers to water quality along a stream and add to all the more likely water assets the board. There are many water quality records for the appraisal and use of surface water for drinking purposes. Notwithstanding, there is no settled list for the appraisal and direct utilization of waterway water for water system purposes. The point of this examination was to receive the system of the National Sanitation Foundation Water Quality Index (NSFWQI) and, with changes, apply the data in a way which will fit in with water system water quality prerequisites. To achieve this, the NSFWQI parameters for drinking water use were amended to incorporate water quality parameters appropriate for water system. For each chosen parameter, an individual weighting graph was produced by the FAO 29 rule. The NSFWQI recipe was then used to ascertain a last list esteem, and for every parameter a worthy range in this esteem was resolved. The new file was then connected to the Ghezel Ozan River in Iran as a contextual investigation. A forty multi-year record of water quality information (1966 to 2010) was gathered from four hydrometery stations along the river. Water quality parameters including Na^+, Cl^-, pH, HCO_3^-, EC, SAR and TDS were utilized for water quality examination utilizing the adjusted NSFWQI formula. The aftereffects of this contextual investigation indicated variety in water quality from the upstream to downstream closures of the waterway. Consistent monitoring of the river-water quality and the foundation of a long-term management plan were prescribed for the security of this important water asset (Misaghi, Delgosha, Razzaghmanesh, & Myers, 2017)

Lake Taihu Basin, a standout amongst the most created areas in China, has gotten significant consideration because of lake in severe contamination. From the investigation gives a reasonable comprehension of the water quality in the streams of Lake Taihu Basin dependent on bowl scale checking and a water quality index (WQI) strategy. From September 2014 to January 2016, four samplings crosswise over four seasons were led at 96 destinations along primary waterways. Fifteen parameters, including water temperature, pH, dissolved oxygen (DO), conductivity, turbidity (tur), permanganate file (CODMn), total nitrogen, total phosphorus, ammonium (NH4-N), nitrite, nitrate (NO3-N), calcium, magnesium, chloride, and sulphate, were estimated to figure the WQI (Wu, Wang, Chen, Cai, & Deng, 2018).

The Water Quality Index has been created numerically to assess the water nature of Al-Gharraf River, the primary part of the Tigris River in the south of Iraq. Water tests were gathered month to month from five examining stations amid 2015– 2016, and 11 parameters were dissolved organic oxygen demand, total dissolved solids, the grouping of hydrogen particles, dissolved oxygen, turbidity, phosphates, nitrates, chlorides, and in addition turbidity, total hardness, electrical conductivity and alkalinity (Ewaid & Abed, 2017).

The NSFWQI was created to provide a standardized strategy for looking at the water nature of different water sources dependent on nine water quality parameters, i.e., temperature, pH, broke down oxygen, turbidity, fecal coliform, biochemical oxygen request, absolute phosphates, nitrates and all out solids. The water quality reaches have been characterized as superb, great, medium, awful and exceptionally terrible as per NSF WQI technique (Chaturvedi and Bassin, 2009).

Then, many different methods for the calculation of WQI have been developed by several authors (Debels et al., 2005; Saeedi et al., 2009; Tsegaye et al., 2006).

2.3 Coagulant (Aluminium and Iron Sulphate or Ferric Sulphate)

In coagulation, expansion of synthetic, for example, alum which produces positive charges to kill the negative charges on the particles. At that point the particles can stick together, shaping bigger particles which are all the more effectively evacuated. The coagulation procedure includes the expansion of the concoction (for example alum) and afterward a quick blending to break down the compound and accordingly all through the water.

In both water and wastewater treatment plants, aluminium sulphate (AS) and poly-aluminium chloride (PACl) are considered as two run of the mill and broadly utilized inorganic metal or pre-hydrolysed metal-particle coagulants, (He, Xie, Lu, Huang, & Ma, 2019).

This examination showed the estimation of coagulation approaches for control of species in coal crease gas (CSG) related water, which can bring about scaling of downstream films and gear amid desalination. The theory was that coagulation can be viable at expelling turbidity causing species, antacid earth particles and broke up silicates from CSG related water structures. Both reproduced and genuine CSG related water tests were dealt with utilizing a container analyser and expansion of either aluminium chlorohydrate (ACH), aluminium sulphate (alum) or ferric chloride. All coagulants diminished turbidity (> 95%) and furthermore evacuated soluble earth particles and broke down silicates (ca. 29% for calcium; 0% for magnesium; 60% for barium; 21% for strontium; 33% for silica), (Nishat, Rajapakse, Dawes, & Millar, 2018).

Harsh coal crease water delivered from the coal seam gas (CSG) industry is frequently treated by invert assimilation to make the water reasonable for helpful reuse. All things considered, pre-treatment advances are required so as to limit layer fouling. Some speculation has been made that coagulants might almost certainly expel tricky broke up particles, for example, basic earth particles and solvent silicate species which are in charge of scaling of films and gear. Subsequently, this examination assessed the execution of aluminium chlorohydrate and aluminium sulphate coagulants for both re-enacted coal crease water and water gathered from working CSG wells. For reproduced coal crease water tests the level of broke down silica expulsion was commonly high (>85%) and advanced by expanding water saltiness. Aluminium sulphate was better at evacuating silica (c.f. 94– 92%), barium (c.f. 87– 20%), strontium (c.f. 66– 15%) and magnesium (c.f. 16– 7.5%) and more regrettable at expelling calcium (44– 65%) contrasted with aluminium chlorohydrate from simulated coal seam water, respectively, (Lin, Couperthwaite, & Millar, 2017).

The coagulation-flocculation strategy is utilized to expel numerous sorts of natural and inorganic materials, for example, oils, fats, metals, phosphorus, and matter in suspension. This strategy is generally utilized in water treatment methods and probably the most utilized coagulants are aluminium or iron salts. The aluminium particle has a solid capacity of complexation with natural atoms and neutralization of molecule charges, advancing the development of totals (Zouhri et al., 2015).

Coagulant is essential to the effectiveness of coagulation process. Customary coagulants, for example, aluminium and ferric salts have just been generally utilized in water treatment and their coagulation instruments have been contemplated for quite a long time, (Guo et al., 2015).

Coagulation is a normally utilized procedure in water and wastewater treatment in which mixes, for example, aluminium salts are added to effluents so as to destabilize the colloidal material and cause that little particles agglomerate into bigger and set-tleable flocs. The adequacy of this procedure will rely upon the coagulating specialist utilized, the dose, the arrangement pH, the concentration and nature of the natural mixes present in the water, (Dom, Gonz, Garc, & Francisco, 2007).

A coagulation– flocculation treatment has been connected to a slaughterhouse fluid profluent, utilizing ferric sulphate as coagulant and actuated silica, powdered initiated carbon, cationic polyacrylamide, polyvinyl liquor, polyacrylic corrosive and anionic polyacrylamide as coagulant helps so as to improve the settling time. When the ideal conditions had been set up (speed and time of blending amid flocculation step, pH, coagulant furthermore, coagulant help dosages), the productivity of the coagulation–flocculation process was contemplated by contrasting the molecule estimate dispersion when the expansion of the coagulant. At the point when ferric sulphate was utilized without the coagulant helps, molecule expulsion effectiveness differed with size, despite the fact that by and large proficiency was very generous (87%). The utilization of coagulant helps improved the evacuation proficiency, with the exception of on account of enacted silica, when the percentage tumbled to 78%. In every single other case evacuation proficiency esteems between 93% (for polyvinyl liquor) and 99% (for anionic polyacrylamide) were reached, (Llor, Soler, & Ortu, 2003).

Coagulation or filtration utilizing iron (Fe) or aluminium (Al) salts is the most powerful innovation for groundwater Arsenic evacuation (Davis and Edwards, 2014; Du et al., 2014; US EPA, 2003). Coagulated As evacuation for the most part utilizes Fe salts instead of Al salts, as Fe salts have been shown to have better As expulsion execution because of their higher adsorption site thickness (Fan et al., 2003). As of late, a prehydrolyzed polyferric sulphate was created by improving multinuclear hydroxyl edifices with different charges, which showed better coagulation productivity thought about than ferric salts (Cheng, 2002; Liang et al., 2009).

Coagulation utilizing two aluminium (alum and aluminium chlorohydrate (ACH)) and two ferric-based coagulants (ferric chloride and ferric sulphate) was examined as a pre-treatment for the UVC/H2O2 treatment of a high saltiness civil wastewater turn around assimilation concentrate (ROC). The ferric-based coagulants were commonly superior to alum, (Umar, Roddick, & Fan, 2018).

Coagulation and flocculation broadly utilized in mechanical wastewater because of its straightforwardness and viability. The primary motivation behind coagulation or flocculation is to lessen turbidity of wastewater, which is for the most part because of the nearness of suspended particles, called colloids, (A. Aidan et al, 2017)

In the study comparing efficiency between tannin-based coagulants (Tanfloc, Acquapol C1 and S5T) and aluminium sulphate at concentration of 160 mg L−1, (Beltrán-Heredia et al, 2012)

The stock solutions of each of Tanfloc SL, Tanfloc SG and aluminium sulphate (Al2(SO4)3) coagulants, marketed in powder form, were prepared by dissolving 2 g of coagulant in distilled water, and filling volume to 50 mL. The chemical coagulant solution (Al2(SO4)3) was prepared weekly and maintained at 4 °C, (N. Graham et al, 2008)

The commercial inorganic coagulant used was aluminium sulphate (Al2(SO4)3.(14–18)H2O) of Cinética Química brand with operating pH in the range of 5.5 to 8, (N.M.G Fernandes et al 2010)

CHAPTER 3

METHODOLOGY

3.1 Introduction

Methodology is a lot of systems or techniques used to lead explore. The approach can be either the investigation of the rule strategies, principles and hypothesizes utilized by a control or the deliberate investigation of techniques that are, can be, or have been connected inside an order. This section portrays on the techniques utilized primary expectation of doing this examination.

This research has been developing in order to achieve three objectives of this study, to determine and classify the Water Quality Index (WQI) at each checkpoint, to determine the optimum dosage for each coagulant, aluminium sulphate and iron sulphate or mostly known as ferric sulphate and to compare the coagulants in terms of dosage, total suspended solid (TSS) and heavy metals such as copper, chromium and zinc. So as to pick up the goals, data assembled beginning from literature review, information accumulation, information investigation and the discourse of the outcomes, suppositions and conclusion. This sort of strategy system is to ensure all the data picked up for this investigation is connected for assessment.

3.2 Overall methodology process

In order to reach or get through all the objectives as mention in Chapter 1, this experiment were divided into a few phases which are phase one, phase two and lastly phase three.

3.2.1 Phase One

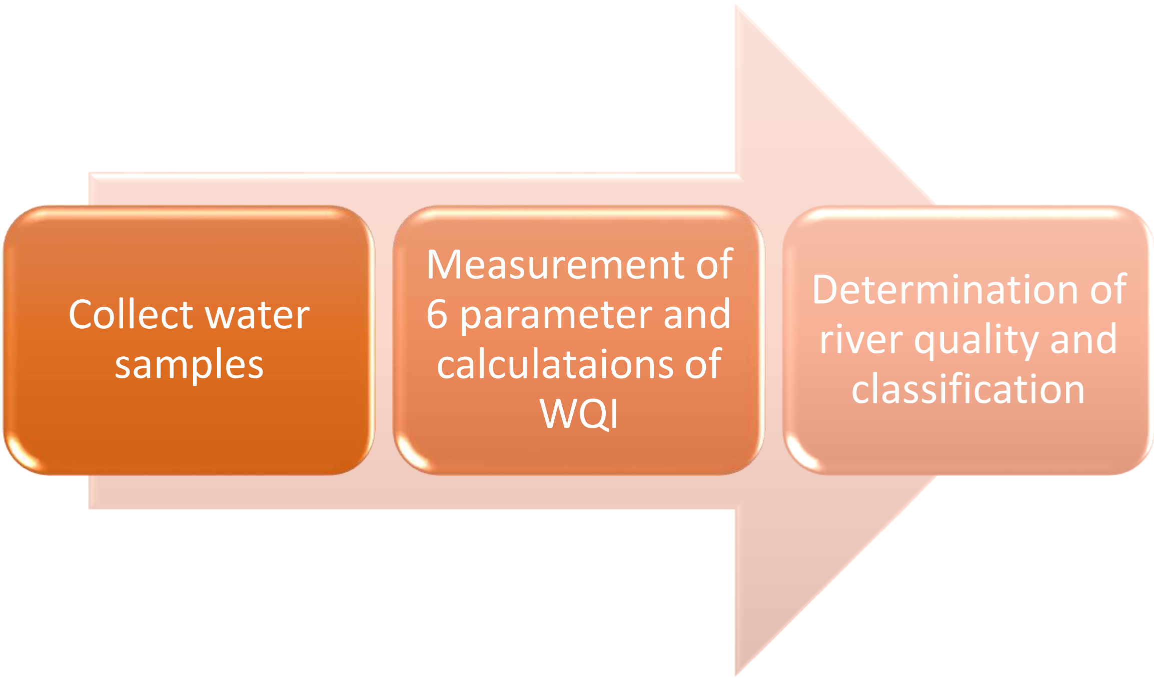

Figure 3.1. Phase One

Based on the Figure 1 above, all nine samples were collected and brought to the laboratory to conduct all the necessary test to obtain all the data for each parameter for calculation of Water Quality Index (WQI) which are Dissolve Oxygen (DO), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Ammonia Nitrogen (AN), Total Suspended Solid (TSS) and Acidity and Alkalinity (pH). WQI for each samples were determined and classify based on the National Water Quality Index Malaysia (NWQS) that have been mention in Table 1 in chapter 1 previously.

3.2.2 Phase Two

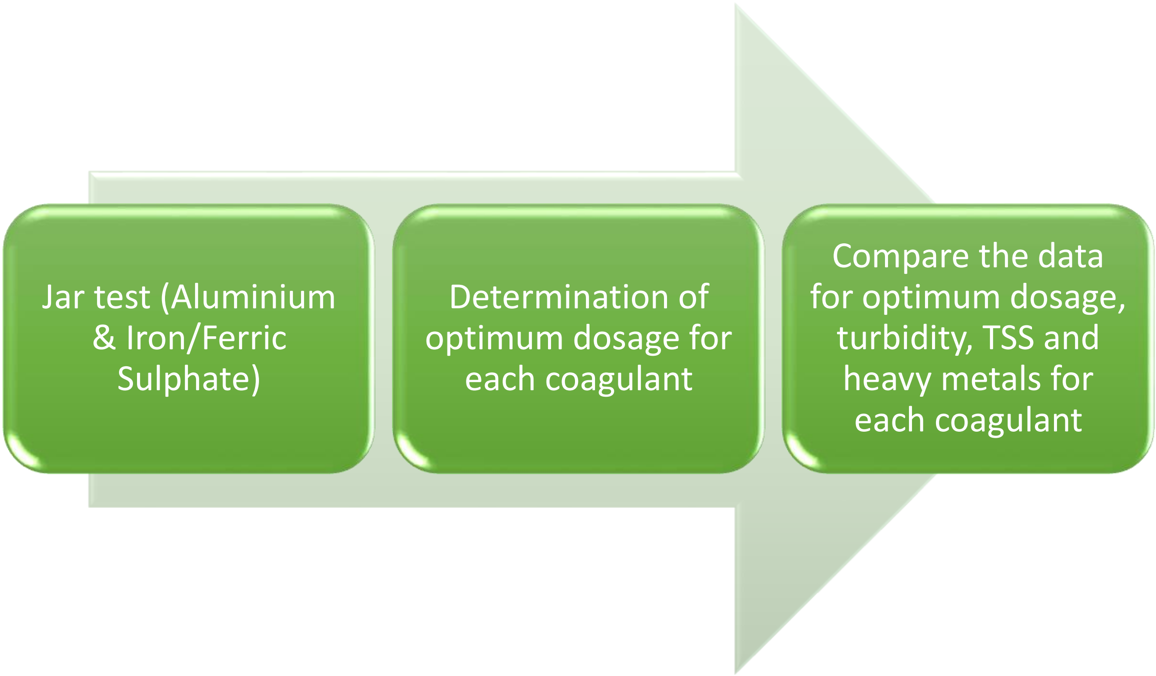

Figure 3.2 Phase Two

Based on the Figure 2 above, next procedure was jar test. Jar test were conducted using two most common coagulant in water and wastewater treatment such as Aluminium Sulphate and Iron Sulphate or commonly called as Ferric Sulphate. Optimum dosage for both coagulant were determined. Based on the optimum dosage, value for turbidity, total suspended solids and heavy metals such as copper, chromium and zinc were compare between two coagulants.

3.2.3 Phase Three

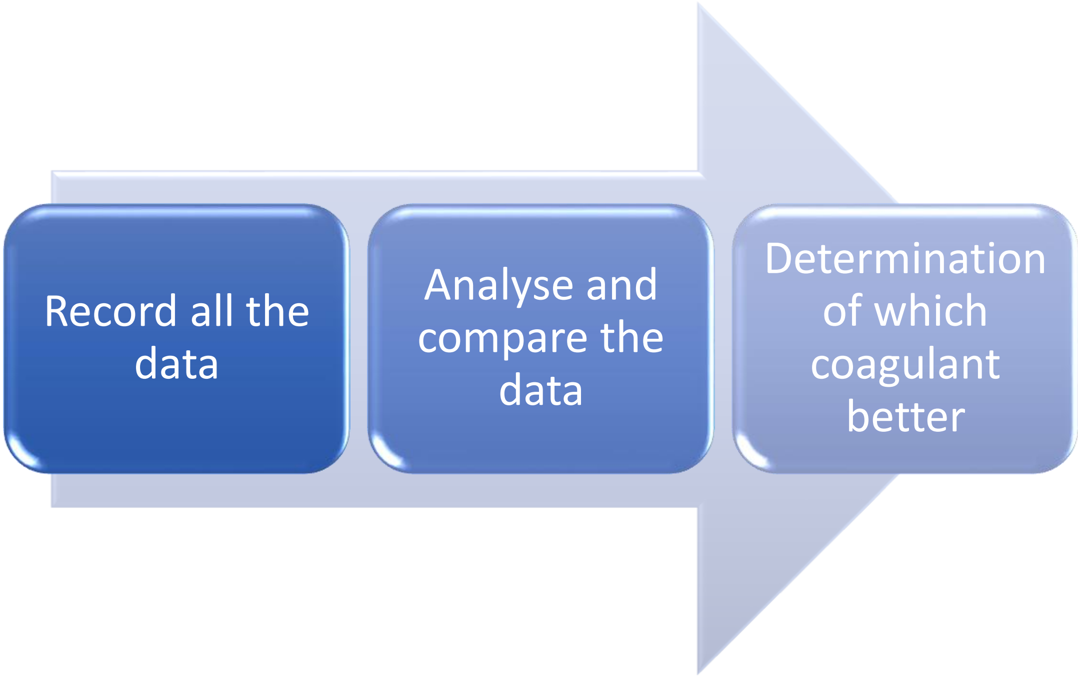

Figure 3.3 Phase Three

For last phase, based on the Figure 3.3 above, after all the experiment that will be needed in order to get the data for achieving all the objectives that were mention in chapter 1 were done, whole data were recorded. Then, based on the data, overall analyse and comparison the data for both the coagulants were conducted. Lastly, between the two coagulant that were chosen, determination of which coagulant was superior than the other was made.

3.3 Sampling water surface

The samples were collected from three different locations (A,B and C) at Sungai Pandan, as shown in the Figure 3.4 below. All the containers were labelled before going to the site location. Conservations have been done on the site promptly at the season of test gathering. Gathered samples were put into the cooler with temperature around 4°C amid transportation to lower or retard the digestion of the creature on the sample. Every one of the samples were put away in the icebox at the temperature under 6°C with secured layer to keep up dull condition. The general research facility investigation was finished around 14 days from the date of sample collections. Table 3.1 below shows the location for each checkpoints.

Figure 3.4 Location of each checkpoint

Table 3.1 Coordinate for each station

STATION	COORDINATE
Up-stream (A)	3°47'29.3"N 103°08'55.2"E
Middle-stream (B)	3°46'39.8"N 103°11'12.1"E
Down-stream (C)	3°48'08.6"N 103°14'19.5"E

3.4 In-situ measurements

The in-situ parameters incorporate pH, temperature and dissolved oxygen (DO) were conducted at site location.

3.5 Ex-situ measurements

Laboratory analysis was conducted at the Environmental Laboratory, Faculty of Civil Engineering, University Malaysia Pahang, Gambang. All the sample preparation and preservations conducted were following on the standard procedures provided by American Public Health Association (APHA) and United States Environmental Protection Agency (USEPA) Methods.

3.4.1 Biological Oxygen Demand (BOD)

All the samples water from each station were filled the BOD bottle and marked by each station. Each jug is thumped gradually to expel the air bubbles that can influence the values of the BOD. The BOD bottle that has been marked and set in the hatchery at 20 ° C as shown in Figure 3.6 for 5 days. Following 5 days, BOD5 esteem can be gotten by utilizing YSI 5000 as shown in Figure 3.5.

Figure 3.5 Dissolve Oxygen Meter Apparatus

Figure 3.6 Incubator

3.4.2 Chemical Oxygen Demand (COD)

2 mL of water samples from each station and 3 ml COD digestive fluid inserted embedded in COD test tubes and marked for each station. At that point all test tubes were warmed at the same time at 150 ° C for 2 hours utilizing COD reactor. Following 2 hours of warmed, the cylinders will be left at room temperature and COD readings are accessible utilizing the HACH DR6000 spectrophotometer as shown in Figure 3.7.

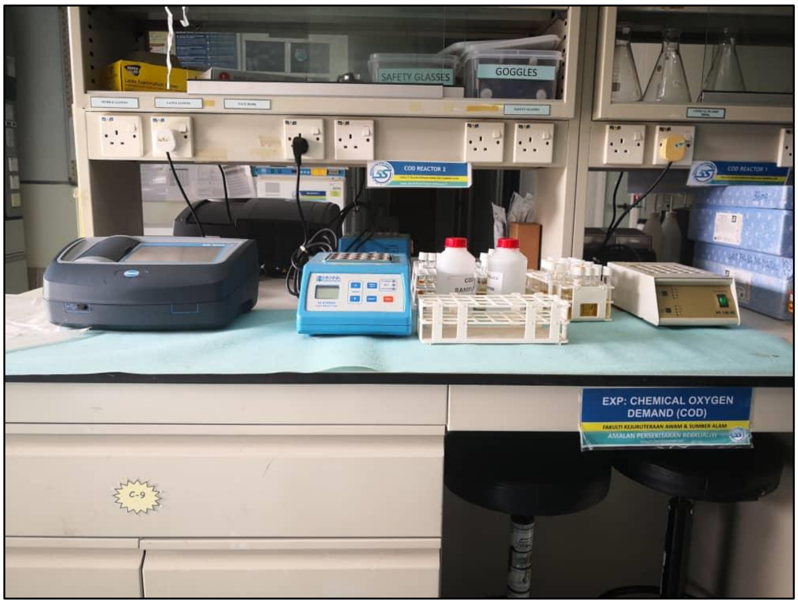

Figure 3.7 DR6000 Spectrophotometer

3.4.3 Ammonia Nitrogen (AN)

Before conducted this test, the machine or tool called DR5000 Spectrophotometer was setup the system to Ammonia, Salic program number 385 N. After the setup process, two sample were prepare (10mL) for each checkpoints, one for blank, one for sample. Next, ammonia salicylate powder was added to each sample. Both sample were shaken and left for about three minutes to let the reaction occurred. After the times up, ammonia cyanurate powder were added and shaken to dissolve the reagent and left around fifteen minutes. When the times was ended, clean the bottle and inserted the blank first into the instrument and ‘zero’ button was pressed. The other sample also been clean before inserted in the instrument and the instrument will scan the samples.

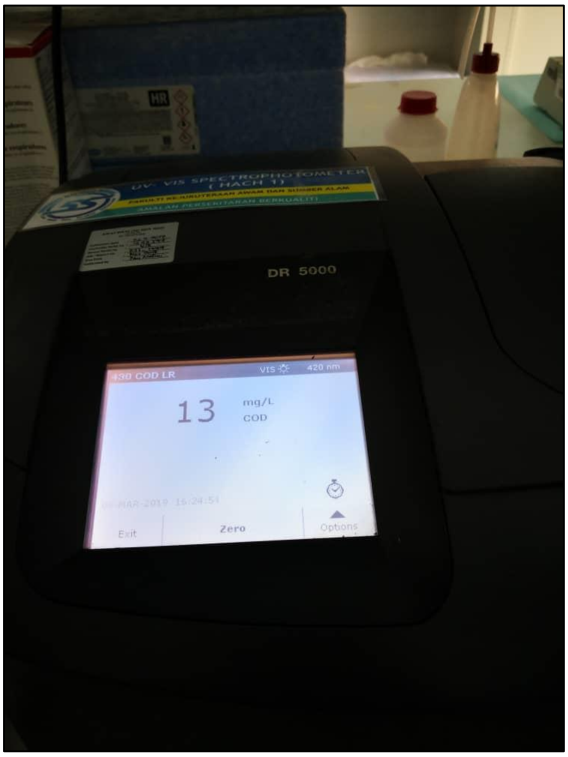

Figure 3.8 Result of AN obtain by using DR5000 spectrophotometer

3.4.4 Total Suspended Solid (TSS)

The filter paper was weighed when the TSS investigation was finished. Diagnostic Balance GR200 as shown in Figure 3.10 below was utilized to gauge the genuine load of each filter paper. The gauging entryway will be shut amid the weighting procedure to keep away from any blunders in perusing. The filter paper was put on a flagon of sauce consolidated with 100 ml of water test of the waterway. The gas vacuum siphon as shown in Figure 3.9 below was utilized to breathe in the water from the filter paper so the remaining channel paper is just suspended solids. The channel paper then warmed in a broiler as shown in Figure 3.11 for an hour prior being reused to get suspended solids.

Figure 3.9 TSS apparatus

Figure 3.10 Result of weight of filter paper by using Balance GR200

Figure 3.11 Universal oven

3.6 Jar test

The reason for the laboratory jar test is to choose and evaluate a treatment program for expulsion of suspended solids or oil from crude water or a weaken procedure or waste stream. Container tests are led on a four-or six-place group stirrer as shown in Figure 3.12 below, which can be used to mimic blending and settling conditions in a clarifier. Containers (recepticles) with various treatment programs or a similar item at various measurements are run one next to the other, and the outcomes contrasted with an untreated container, or one treated with the present program. Before proceed with the Jar test, preparation of coagulant were made. For each coagulant, Aluminium Sulphate and Iron Sulphate or Ferric Sulphate, one gram each were weighed and put inside 1000ml beaker. Then 1000ml of distilled water were added and mixed together in the same beaker. After that, six beakers of 600ml were used in this jar test per coagulant. Each beaker were filled with 500ml of samples water. Pipette were used to add the coagulant in increasing amount of 10ml, 20ml, 30ml, etc. to each successive beaker except one as a reference. For one minute, the stirred were begun rapidly at speed 60-80 rpm. After one minute, the speed were reduced to 10-30 rpm for 15 minutes. When the stirred period finished, stirrer were stopped and allows the flocs to settle for 10 minutes. 10ml from each beaker were taken and the turbidity were measured using turbidity meter. Graph of turbidity versus coagulant dose were plotted and the optimum dosage were determined.

Figure 3.12 Jar test apparatus

3.7 Heavy Metals

From the jar test, the optimum dosage water samples were test for heavy metals such as copper, chromium and zinc. The instrument used for this experiment was same in the Ammonia Nitrogen test which is Hach DR 6000 Spectrophotometer.

3.7.1 Copper

The program was setting to number 135 Copper, Bicin. Two 10mL sample was prepared, one for blank and one for reagent. CuVer 1 Copper Reagents Powder Pillow as shown in Figure 3.13 below was added to the sample and was swirled. The sample were left for two minutes for the reaction to occurred. The blank sample was cleaned before inserted into the instrument. After put the blank, the ‘zero’ button was pressed and the other samples were cleaned first before being put into the instrument after the blank sample was removed and pressed the ‘read’ button, the result will appeared accordingly.

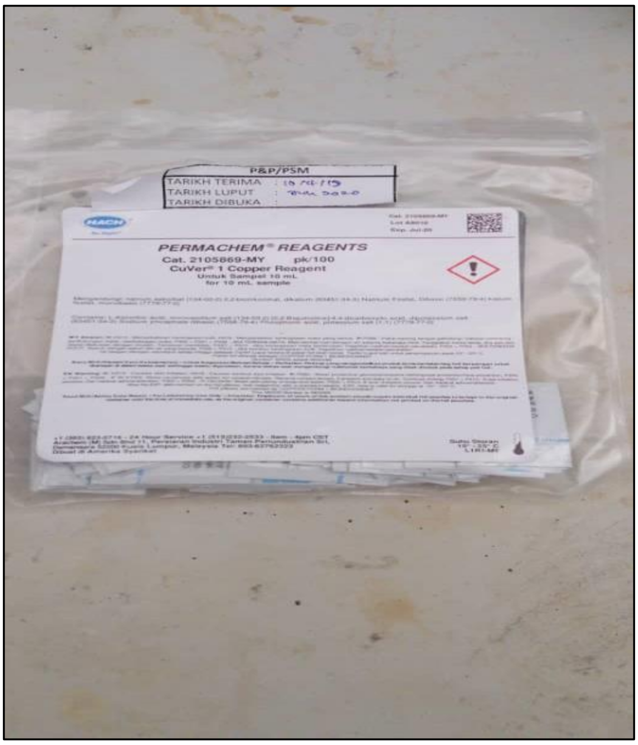

Figure 3.13 CuVer 1 Copper Reagents Powder Pillow

3.7.2 Chromium

The program was setting to number 90 Chromium, Hex. Two 10mL sample was prepared, one for blank and one for reagent. ChromaVer3 Reagents Powder Pillow as shown as Figure 3.14 below was added to the sample and was swirled, appearance of purple colour indicates the existence of chromium. The sample were left for five minutes for the reaction to occurred. The blank sample was cleaned before inserted into the instrument. After put the blank, the 'zero' button was pressed and the other samples were cleaned first before being put into the instrument after removed the blank sample and pressed the 'read' button, the result will appeared accordingly.

Figure 3.14 ChromaVer3 Reagents Powder Pillow

3.7.3 Zinc

The instrument program was setup to 780 Zinc. 20mL of water samples were measured by using pipette and being put into 25mL mixing cylinder. ZincoVer 5 Reagent Powder Pillow were added to the mixing cylinder and closed. The cylinder was shaken vigorously in order to dissolve the reagent. The colour of the sample should be orange. 10mL of samples were put into sample cell and marked as blank sample. The rest 10mL were mix with 0.5mL of cyclohexanone and the sample were left for thirty seconds. In the meantime, the mixing cylinder were shake vigorously. The colour might be change if there is an existence of zinc in the water. Three minutes time for the mixture to let the reaction occurred according to the manual. The solution in the mixing cylinder was pour into sample cell. After the timer was up, the blank sample was cleaned before inserted into the instrument. After put the blank, the ‘zero’ button was pressed and the other samples were cleaned first before being put into the instrument after removed the blank sample and pressed the ‘read’ button, the result will appeared accordingly.

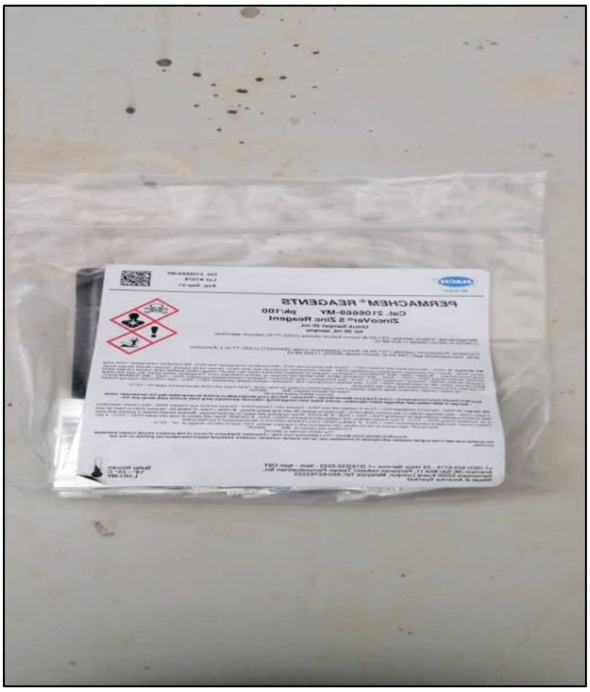

Figure 3.15 ZincoVer 5 Reagent Powder Pillow

CHAPTER 4

DATA ANALYSIS AND DISCUSSION

4.1 Introduction

Every one of the consequences of the investigation completed at the water examining and lab examination will be talked about in this part in detail. An examination of the information acquired is critical to encourage the count of Water Quality Index (WQI) for Pandan River. Examination performed at the inspecting site is for parameters, for example, Dissolved Oxygen (DO), Temperature and Index of Alkali or Acidity (pH). Though the investigates done in the lab are for parameters, for example, Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Suspended Solids (TSS), Nitrogen Ammonia (AN). This is on the grounds that these parameters should be dissected utilizing certain devices and synthetic concoctions.

4.2 Water Quality Index (WQI)

In order to calculate the WQI, all six parameters need to be determined first. Table 4.1 shows for upstream parameters :

Table 4.1 Up-stream parameter

PARAMETER	STATION UPSTREAM			AVERAGE
	A	B	C	
pH	6.51	6.44	6.56	6.50
DO (mg/L) @ % saturation	7.48 @ 90.53	7.36 @ 89.08	7.55 @ 91.38	7.46 @ 90.29
BOD (mg/L)	5.3	5.1	5.4	5.3
COD (mg/L)	< range (3-150), take 2	< range (3-150), take 2	< range (3-150), take 2	< range (3-150), take 2
TSS (mg/L)	0.033	0.028	0.037	0.033
AN (mg/L)	< range (0.01), take 0.009	< range (0.01), take 0.009	< range (0.01), take 0.009	< range (0.01), take 0.009

From the Table 4.1 above, at upstream station three samples were taken and the average value was calculated to increase the accuracy of data. Based on the Table 1 in Chapter 1 for pH parameter, pH falls into Class I because pH in the range of 6.5-8.5. For Dissolve Oxygen (DO), also falls into Class I because in range (greater than 7). For Biochemical Oxygen Demand (BOD), BOD in Class III because the value was closed to value in Class III which is 6. For Chemical Oxygen Demand (COD), COD falls into Class I because the value was less than the value in Class I which is 10. For Total Suspended Solids (TSS), TSS falls into Class I also, due to the value of TSS was lower than the value in the Class I. Lastly, for Ammonia Nitrogen (AN), AN falls into Class I because the value was lower than the value in Class I.

Table 4.2 Middle-stream parameter

PARAMETER	STATION MIDDLE-STREAM			AVERAGE
	A	B	C	
pH	5.80	5.77	5.91	5.83
DO (mg/L) @ % saturation	7.81 @ 94.53	7.76 @ 93.92	7.93 @ 95.98	7.83 @ 94.77
BOD (mg/L)	2.85	2.74	2.89	2.83
COD (mg/L)	13	10	15	12.67
TSS (mg/L)	0.012	0.008	0.018	0.013
AN (mg/L)	0.01	0.01	0.03	0.02

From the Table 4.2 above, at middle-stream station three samples were taken and the average value was calculated to increase the accuracy of data. Based on the Table 1 in Chapter 1 for pH parameter, pH falls into Class III because pH in the range of 5-9. For Dissolve Oxygen (DO), falls into Class I because in range (greater than 7). For Biochemical Oxygen Demand (BOD), BOD in Class II because the value was closed to value in Class II which is 3. For Chemical Oxygen Demand (COD), COD falls into Class I because the value was closed to the value in Class I which is 10. For Total Suspended Solids (TSS), TSS falls into Class I also, due to the value of TSS was lower than the value in the Class I. Lastly, for Ammonia Nitrogen (AN), AN falls into Class I because the value was lower than the value in Class I.

Table 4.3 Down-stream parameter

PARAMETER	STATION DOWN-STREAM			AVERAGE
	A	B	C	
pH	5.81	5.78	5.93	5.84
DO (mg/L) @ % saturation	7.26 @ 87.87	7.22 @ 87.38	7.34 @ 88.84	7.27 @ 87.99
BOD (mg/L)	3.65	3.61	3.70	3.65
COD (mg/L)	9	7	13	9.67
TSS (mg/L)	0.008	0.006	0.011	0.008
AN (mg/L)	0.20	0.17	0.21	0.19

From the Table 4.3 above, at downstream station three samples were taken and the average value was calculated to increase the accuracy of data. Based on the Table 1 in Chapter 1 for pH parameter, pH falls into Class III because pH in the range of 5-9. For Dissolve Oxygen (DO), falls into Class I because in range (greater than 7). For Biochemical Oxygen Demand (BOD), BOD in Class II because the value was closed to value in Class II which is 3. For Chemical Oxygen Demand (COD), COD falls into Class I because the value was closed to the value in Class I which is 10. For Total Suspended Solids (TSS), TSS falls into Class I also, due to the value of TSS was lower than the value in the Class I. Lastly, for Ammonia Nitrogen (AN), AN falls into Class I because the value was closer to the value in Class I.

Before all the data can be used to calculate the WQI, the data need to be converted to its own sub-index as Table 4.4 below. The formulae of conversion for sub-index was tabulated as Table 4.4 below.

Table 4.4 Formulae of conversion for sub-index

PARAMETER	SUB-INDEX	RANGE
DO (%saturation)	SIDO = 0 SIDO = 100 SIDO = $-0.395 + 0.030x^2 – 0.00020x^3$	For x ≤ 8 For x ≤ 92 For 8 < 92
BOD	SIBOD = 100.4 – 4.23x SIBOD = 108*exp(-0.055x) – 0.1x	For x ≤ 5 For x > 5
COD	SICOD = -1.33x + 99.1 SICOD = 103*exp(-0.0157x) - 0.04x	For x ≤ 20 For x > 20
AN	SIAN = 100.5 -10.5x SIAN = 94*exp(-0.573x) – 0.04x SIAN = 0	For x ≤ 0.3 For 0.3 < x < 4 For x ≥ 4
TSS	SISS = 97.5*exp(-0.00676x) + 0.05x SISS = 71*exp(-0.0061x) + 0.015x SISS = 0	For x ≤ 100 For 100 < x < 1000 For x ≥ 1000
pH	SIpH = $17.02 – 17.2x + 5.02x^2$ SIpH = $-242 + 95.5x – 6.67x^2$ SIpH = $-181 + 82.4x – 6.05x^2$ SIpH = $536 – 77.0x + 2.76x^2$	For x < 5.5 For 5.5 ≤ x < 7 For 7 ≤ x < 8.75 For x ≥ 8.75

After all the data of all parameter has been converted into the sun-index respectively, the data was tabulated as Table 4.5 shown below.

Table 4.5 Sub-index

PARAMETER	SUBINDEX		
	Up-stream	**Middle-stream**	**Down-stream**
pH	96.94	88.06	88.24
DO	96.96	100	95.62
BOD	98.85	88.43	84.96
COD	96.44	82.25	86.24
TSS	95.68	95.69	95.69
AN	99.56	98.4	80.55

After the conversion of all the parameters to the sub-index respectively, water quality index were determined by using the Equation 1 below. Based on the calculation, water quality index for Sungai Pandan getting worse from upstream (97.42) which in Class I to middle-stream (92.60) which in Class II and downstream (88.96) which in Class II.

$$WQI = 0.22SIDO + 0.19SIBOD + 0.161SICOD + 0.15SIAN + 0.16SISS + 0.12SIpH \quad \text{(Eq. 1)}$$

Table 4.6 Classification of WQI

PARAMETER	Up-stream	Middle-stream	Down-stream
WQI	97.42	92.60	88.96
CLASS	I	II	II

4.3 Jar Test

Table 4.7 Jar test up-stream A

JAR TEST					
Aluminium Sulphate (mL)	**Aluminium Sulphate (mg/L)**	**Turbidity (NTU)**	**Iron/Ferric Sulphate (mL)**	**Iron/Ferric Sulphate (mg/L)**	**Turbidity (NTU)**
0	0	15.3	0	0	15.3
10	20	15.2	10	20	15.8
20	40	15.8	20	40	18.6
30	60	13.9	30	60	17.9
40	80	9.37	40	80	16.9
50	100	11	50	100	16.5
			60	120	16
			70	140	13.9
			80	160	12.1
			90	180	9.73
			100	200	11.1

Roughly based on the Table 4.7 above, clearly Aluminium Sulphate is better than Ferric Sulphate, this is because the Aluminium Sulphate used less amount to achieve the optimum dosage which is 80mg/L compare to Ferric sulphate that used up to twice amount of Aluminium Sulphate which is 180 mg/L.

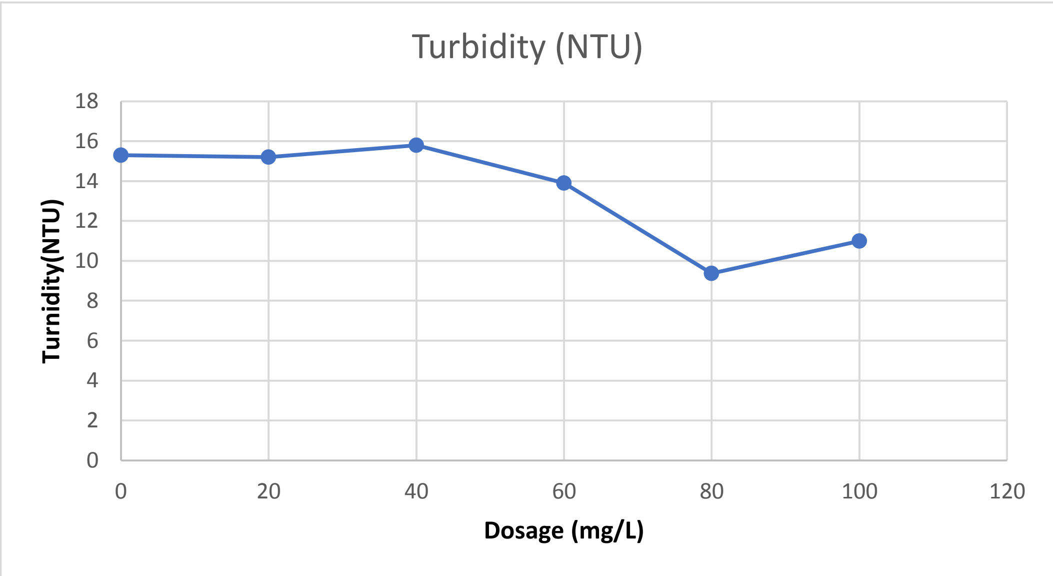

Figure 4.1 Upstream A Turbidity vs Dosage (mg/L) for Aluminium Sulphate

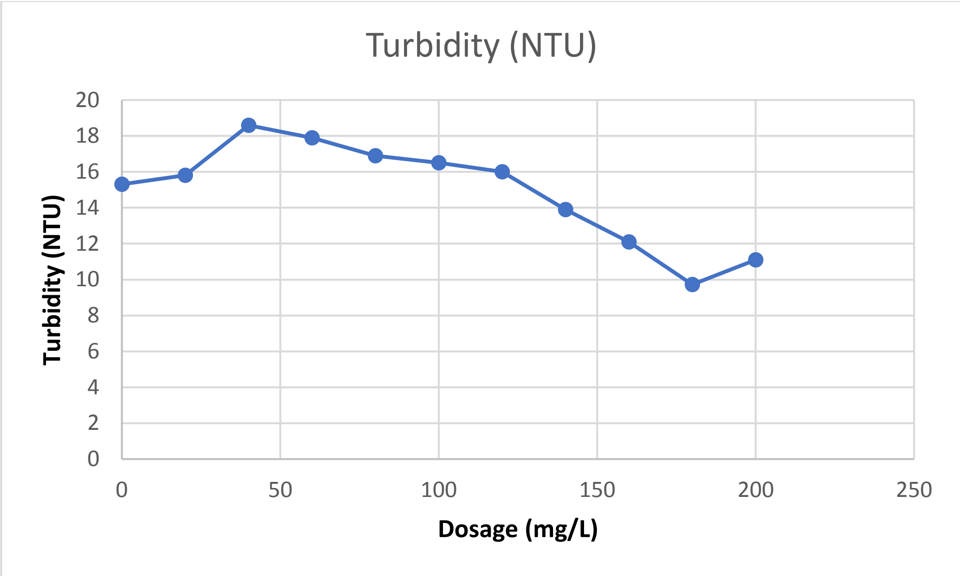

Figure 4.2 Upstream A Turbidity vs Dosage (mg/L) for Ferric Sulphate

Based on the result on both Figure 4.1 and Figure 4.2, if both of the coagulants used the same amount dosage for an example, 20mg/L, the turbidity for Aluminium Sulphate getting decreases and that was great compare to Ferric Sulphate, when using the same dosage, the turbidity will increase and that is not a good sign. In addition, for upstream test for turbidity as overall comparison, Aluminium Sulphate far better than Ferric Sulphate in order to remove turbidity.

Table 4.8 Jar test upstream B

Aluminium Sulphate (mL)	**Aluminium Sulphate (mg/L)**	**Turbidity (NTU)**	**Iron/Ferric Sulphate (mL)**	**Iron/Ferric Sulphate (mg/L)**	**Turbidity (NTU)**
0	0	15.1	0	0	15.1
10	20	14.9	10	20	15.5
20	40	14.4	20	40	19
30	60	13.8	30	60	17.7
40	80	9.12	40	80	16.6
50	100	10.88	50	100	16.1
			60	120	15.5
			70	140	13.7
			80	160	12
			90	180	9.89
			100	200	11.4

Roughly based on the Table 4.8 above, clearly Aluminium Sulphate is better than Ferric Sulphate, this is because the Aluminium Sulphate used less amount to achieve the optimum dosage which is 80mg/L compare to Ferric sulphate that used up to twice amount of Aluminium Sulphate which is 180 mg/L.

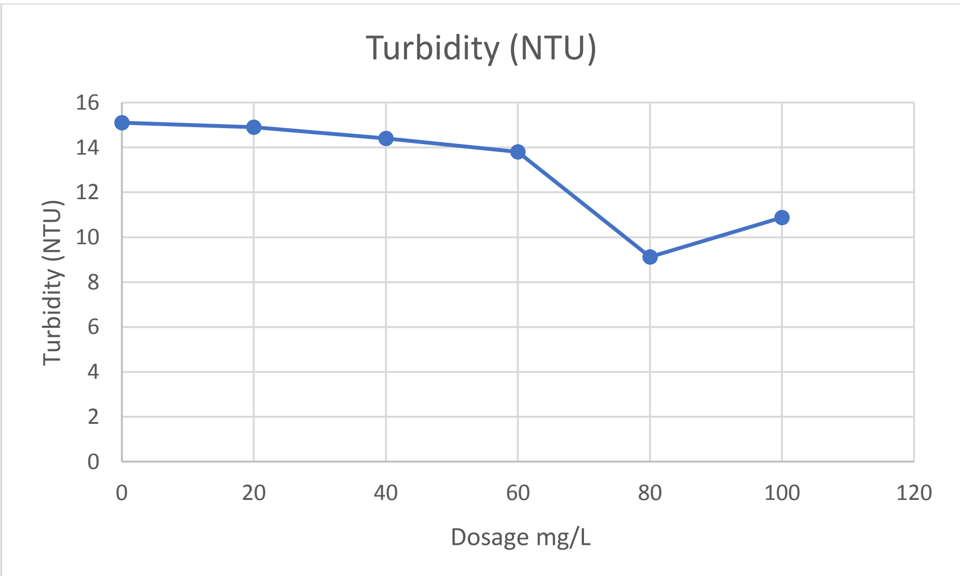

Figure 4.3 Upstream B Turbidity vs Dosage for Aluminium Sulphate

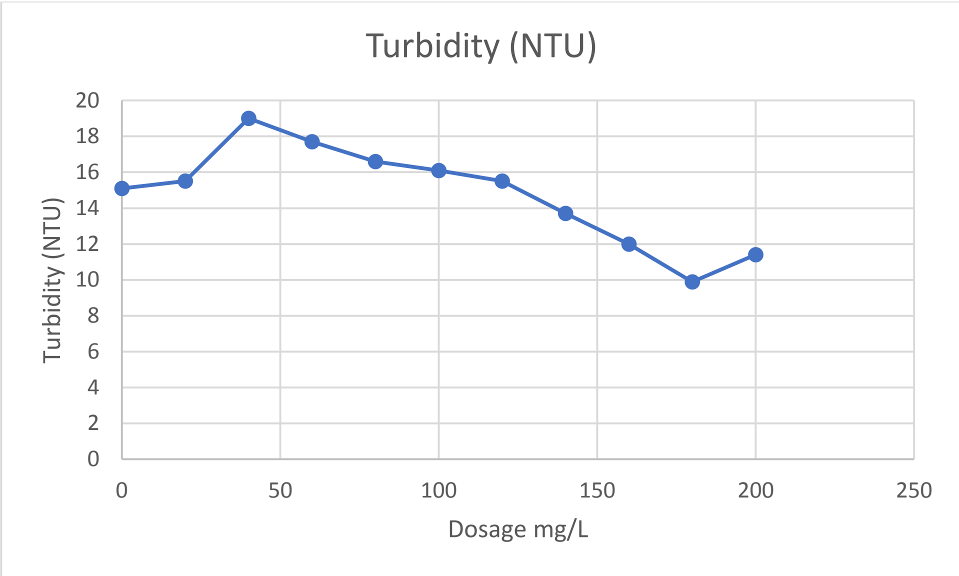

Figure 4.4 Upstream B Turbidity vs Dosage for Ferric Sulphate

Based on the result on both Figure 4.3 and Figure 4.4, if both of the coagulants used the same amount dosage for an example, 20mg/L, the turbidity for Aluminium Sulphate getting decreases and that was great compare to Ferric Sulphate, when using the same dosage, the turbidity will increase and that is not a good sign. In addition, for upstream test for turbidity as overall comparison, Aluminium Sulphate far better than Ferric Sulphate in order to remove turbidity.

Table 4.9 Jar test upstream C

Aluminium Sulphate (mL)	Aluminium Sulphate (mg/L)	Turbidity (NTU)	Iron/Ferric Sulphate (mL)	Iron/Ferric Sulphate (mg/L)	Turbidity (NTU)
0	0	15.4	0	0	15.4
10	20	14.5	10	20	15.9
20	40	14.2	20	40	17
30	60	12.3	30	60	16.3
40	80	8.1	40	80	16.2
50	100	11.9	50	100	16
			60	120	15.3
			70	140	12.9
			80	160	11.8
			90	180	9.5
			100	200	11.7

Roughly based on the Table 4.9 above, clearly Aluminium Sulphate is better than Ferric Sulphate, this is because the Aluminium Sulphate used less amount to achieve the optimum dosage which is 80mg/L compare to Ferric sulphate that used up to twice amount of Aluminium Sulphate which is 180 mg/L.

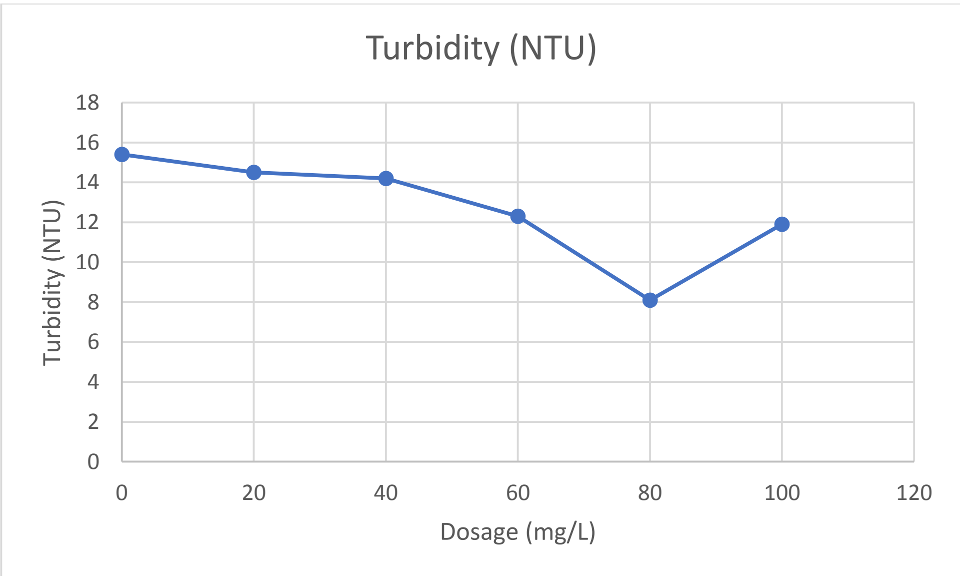

Figure 4.5 Upstream C Turbidity vs Dosage for Aluminium Sulphate

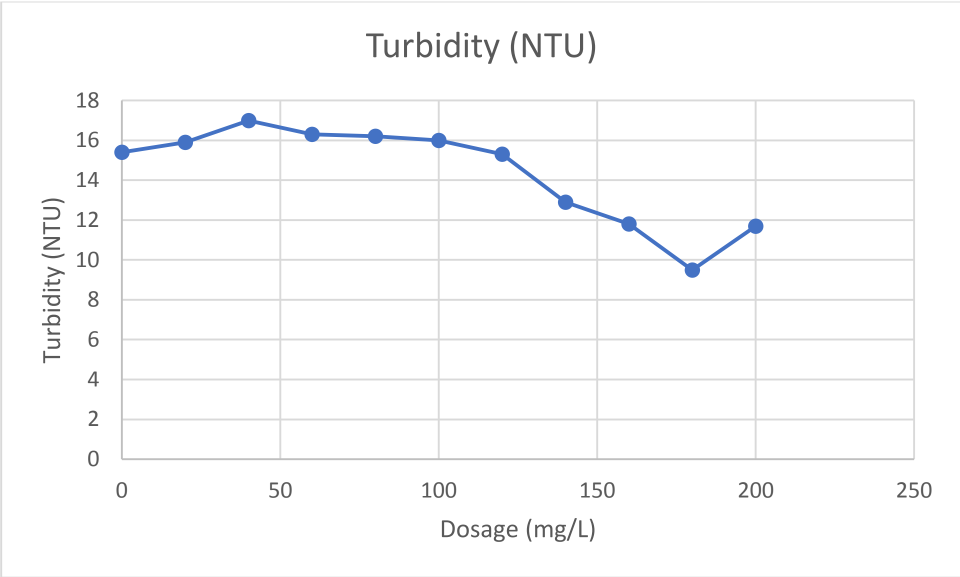

Figure 4.6 Upstream C Turbidity vs Dosage for Ferric Sulphate

Based on the result on both Figure 4.5 and Figure 4.6, if both of the coagulants used the same amount dosage for an example, 20mg/L, the turbidity for Aluminium Sulphate getting decreases and that was great compare to Ferric Sulphate, when using the same dosage, the turbidity will increase and that is not a good sign. In addition, for upstream test for turbidity as overall comparison, Aluminium Sulphate far better than Ferric Sulphate in order to remove turbidity.

Table 4.10 Jar test middle-stream A

JAR TEST					
Aluminium Sulphate (mL)	**Aluminium Sulphate (mg/L)**	**Turbidity (NTU)**	**Iron/Ferric Sulphate (mL)**	**Iron/Ferric Sulphate (mg/L)**	**Turbidity (NTU)**
0	0	12.3	0	0	12.3
10	20	10.3	10	20	13.4
20	40	9.8	20	40	14.1
30	60	6.5	30	60	16.5
40	80	4.8	40	80	15.7
50	100	7.7	50	100	14.3
			60	120	13.8
			70	140	12.9
			80	160	10.8
			90	180	9.7
			100	200	11.8

Roughly based on the Table 4.10 above, clearly Aluminium Sulphate is better than Ferric Sulphate, this is because the Aluminium Sulphate used less amount to achieve the optimum dosage which is 80mg/L compare to Ferric sulphate that used up to twice amount of Aluminium Sulphate which is 180 mg/L.

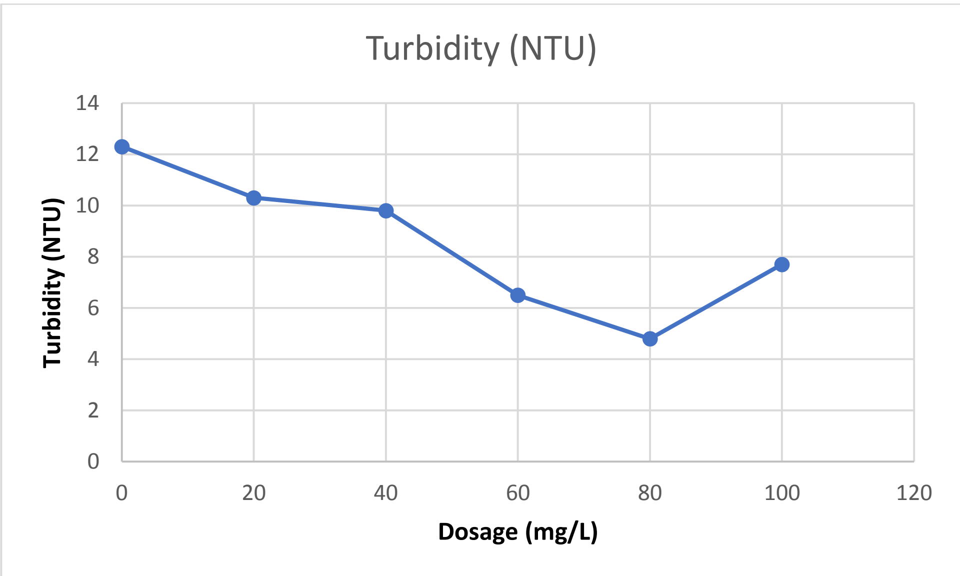

Figure 4.7 Middle-stream A Turbidity vs Dosage (mg/L) for Aluminium Sulphate

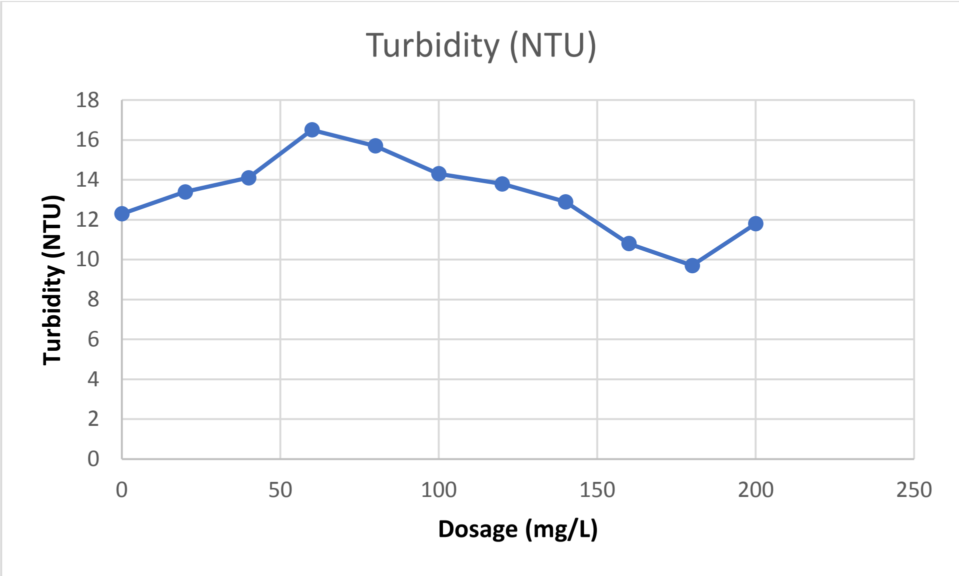

Figure 4.8 Middle-stream A Turbidity vs Dosage (mg/L) for Ferric Sulphate

Based on the result on both Figure 4.7 and Figure 4.8, if both of the coagulants used the same amount dosage for an example, 20mg/L, the turbidity for Aluminium Sulphate getting decreases and that was great compare to Ferric Sulphate, when using the same dosage, the turbidity will increase and that is not a good sign. In addition, for middle-stream test for turbidity as overall comparison, Aluminium Sulphate far better than Ferric Sulphate in order to remove turbidity.

Table 4.11 Jar test middle-stream B

Aluminium Sulphate (mL)	Aluminium Sulphate (mg/L)	Turbidity (NTU)	Iron/Ferric Sulphate (mL)	Iron/Ferric Sulphate (mg/L)	Turbidity (NTU)
0	0	12.2	0	0	12.2
10	20	10.4	10	20	13.1
20	40	9.7	20	40	14.4
30	60	6.2	30	60	16.7
40	80	5	40	80	15.7
50	100	8.1	50	100	14.8
			60	120	13.3
			70	140	12.1
			80	160	10.5
			90	180	9.2
			100	200	11.3

Roughly based on the Table 4.11 above, clearly Aluminium Sulphate is better than Ferric Sulphate, this is because the Aluminium Sulphate used less amount to achieve the optimum dosage which is 80mg/L compare to Ferric sulphate that used up to twice amount of Aluminium Sulphate which is 180 mg/L.

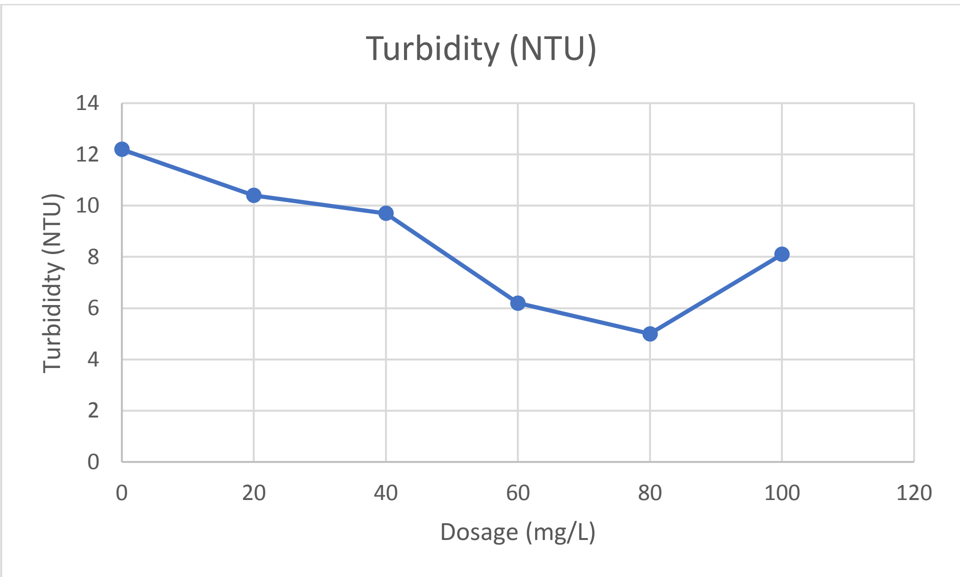

Figure 4.9 Middle-stream B Turbidity vs Dosage for Aluminium Sulphate

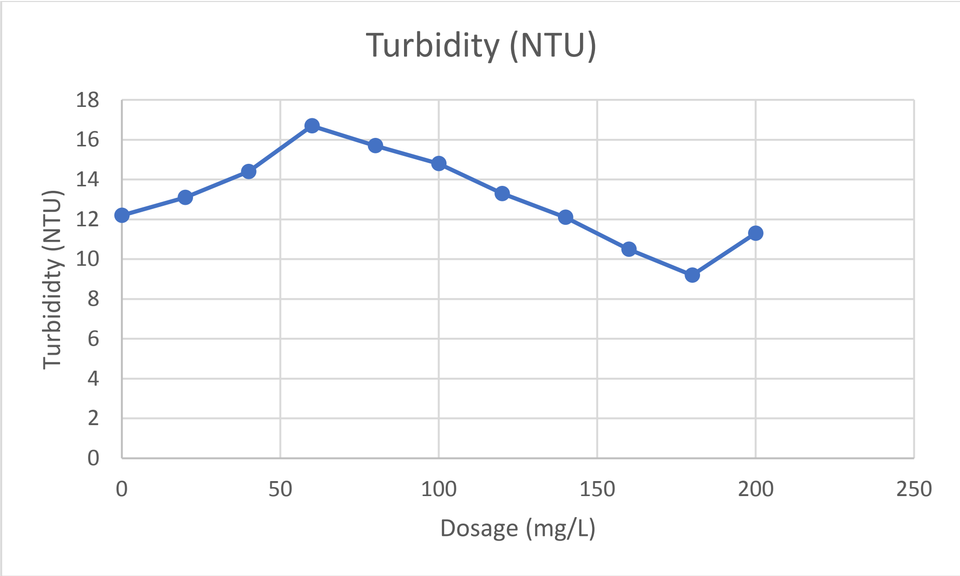

Figure 4.10 Middle-stream B Turbidity vs Dosage for Ferric Sulphate

Based on the result on both Figure 4.9 and Figure 4.10, if both of the coagulants used the same amount dosage for an example, 20mg/L, the turbidity for Aluminium Sulphate getting decreases and that was great compare to Ferric Sulphate, when using the same dosage, the turbidity will increase and that is not a good sign. In addition, for middle-stream test for turbidity as overall comparison, Aluminium Sulphate far better than Ferric Sulphate in order to remove turbidity.

Table 4.12 Jar test middle-stream C

Aluminium Sulphate (mL)	Aluminium Sulphate (mg/L)	Turbidity (NTU)	Iron/Ferric Sulphate (mL)	Iron/Ferric Sulphate (mg/L)	Turbidity (NTU)
0	0	11.9	0	0	11.9
10	20	10.1	10	20	13.4
20	40	9.9	20	40	14.7
30	60	6.1	30	60	16.1
40	80	5.2	40	80	15.8
50	100	8.7	50	100	14.5
			60	120	13.1
			70	140	12.6
			80	160	10.8
			90	180	9.1
			100	200	11.7

Roughly based on the Table 4.12 above, clearly Aluminium Sulphate is better than Ferric Sulphate, this is because the Aluminium Sulphate used less amount to achieve the optimum dosage which is 80mg/L compare to Ferric sulphate that used up to twice amount of Aluminium Sulphate which is 180 mg/L.

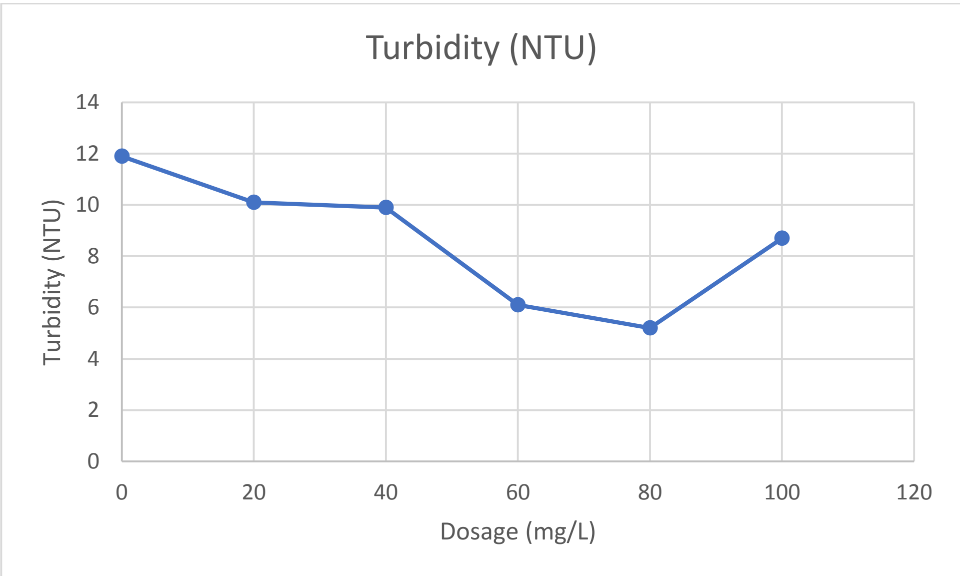

Figure 4.11 Middle-stream C Turbidity vs Dosage for Aluminium Sulphate

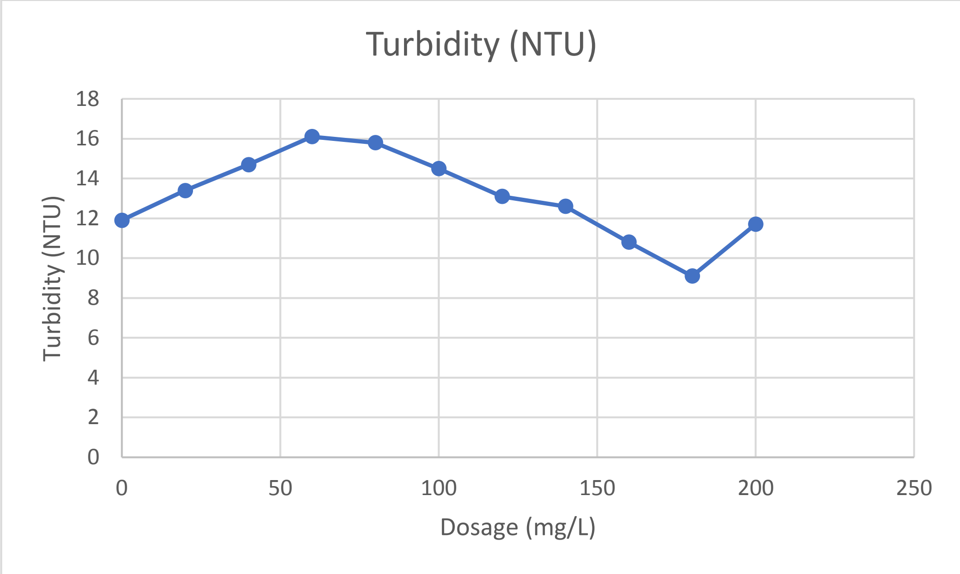

Figure 4.12 Middle-stream C Turbidity vs Dosage for Ferric Sulphate

Based on the result on both Figure 4.11 and Figure 4.12, if both of the coagulants used the same amount dosage for an example, 20mg/L, the turbidity for Aluminium Sulphate getting decreases and that was great compare to Ferric Sulphate, when using the same dosage, the turbidity will increase and that is not a good sign. In addition, for middle-stream test for turbidity as overall comparison, Aluminium Sulphate far better than Ferric Sulphate in order to remove turbidity.

Table 4.13 Jar test down-stream A

JAR TEST					
Aluminium Sulphate (mL)	**Aluminium Sulphate (mg/L)**	**Turbidity (NTU)**	**Iron/Ferric Sulphate (mL)**	**Iron/Ferric Sulphate (mg/L)**	**Turbidity (NTU)**
0	0	10.91	0	0	10.91
10	20	4.55	10	20	10.1
20	40	4.52	20	40	9.99
30	60	4.47	30	60	10.4
40	80	5.15	40	80	8.11
50	100	5.24	50	100	7.97
			60	120	7.69
			70	140	7.40
			80	160	7.01
			90	180	7.17
			100	200	7.88

Roughly based on the Table 4.13 above, clearly Aluminium Sulphate is better than Ferric Sulphate, this is because the Aluminium Sulphate used less amount to achieve the optimum dosage which is 60mg/L compare to Ferric sulphate that used up to more than twice amount of Aluminium Sulphate which is 160 mg/L.

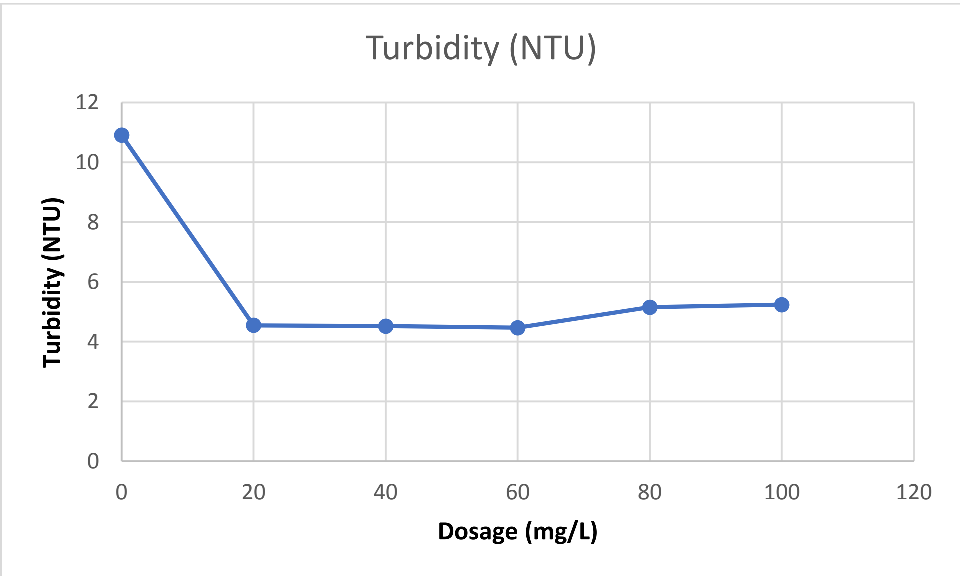

Figure 4.13 Down-stream A Turbidity vs Dosage (mg/L) for Aluminium Sulphate

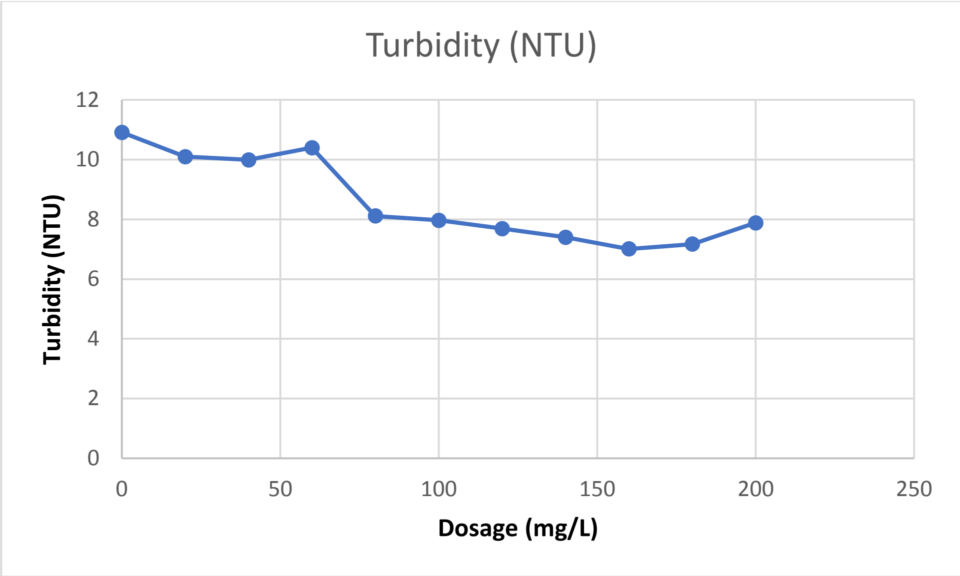

Figure 4.14 Down-stream A Turbidity vs Dosage (mg/L) for Iron/Ferric Sulphate

Based on the result on both Figure 4.14 and Figure 4.15, if both of the coagulants used the same amount dosage for an example, 20mg/L, the turbidity for Aluminium Sulphate getting more decreases and that was great compare to Ferric Sulphate, when using the same dosage, the turbidity will decreases too but least than Aluminium Sulphate. In addition, for down-stream test for turbidity as overall comparison, Aluminium Sulphate far better than Ferric Sulphate in order to remove turbidity.

Table 4.14 Jar test downstream B

Aluminium Sulphate (mL)	Aluminium Sulphate (mg/L)	Turbidity (NTU)	Iron/Ferric Sulphate (mL)	Iron/Ferric Sulphate (mg/L)	Turbidity (NTU)
0	0	10.8	0	0	10.8
10	20	4.6	10	20	10.1
20	40	4.33	20	40	9.81
30	60	4.13	30	60	10.3
40	80	5.16	40	80	8.9
50	100	5.69	50	100	7.55
			60	120	7.13
			70	140	7.11
			80	160	7.01
			90	180	7.45
			100	200	7.98

Roughly based on the Table 4.14 above, clearly Aluminium Sulphate is better than Ferric Sulphate, this is because the Aluminium Sulphate used less amount to achieve the optimum dosage which is 60mg/L compare to Ferric sulphate that used up to more than twice amount of Aluminium Sulphate which is 160 mg/L.

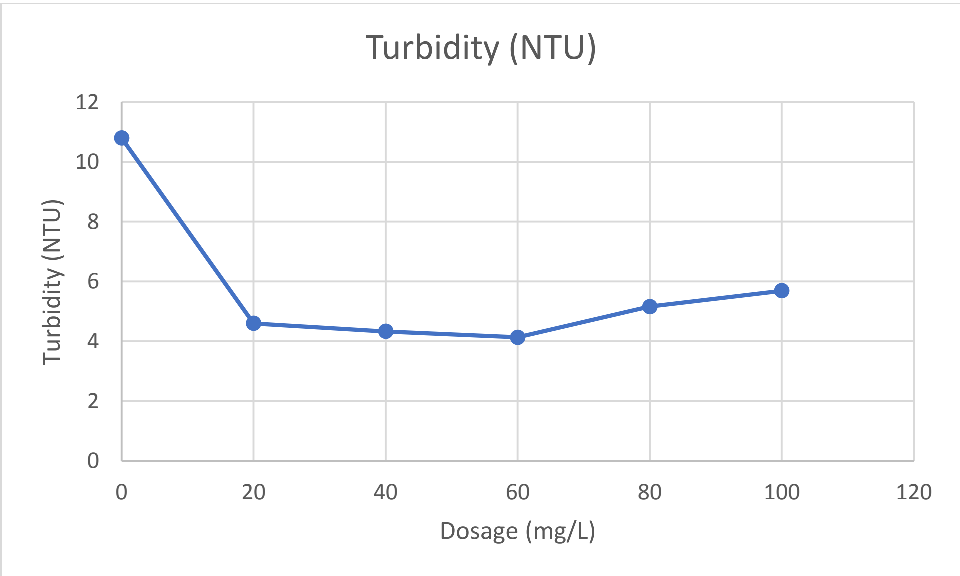

Figure 4.15 Downstream B Turbidity vs Dosage for Aluminium Sulphate

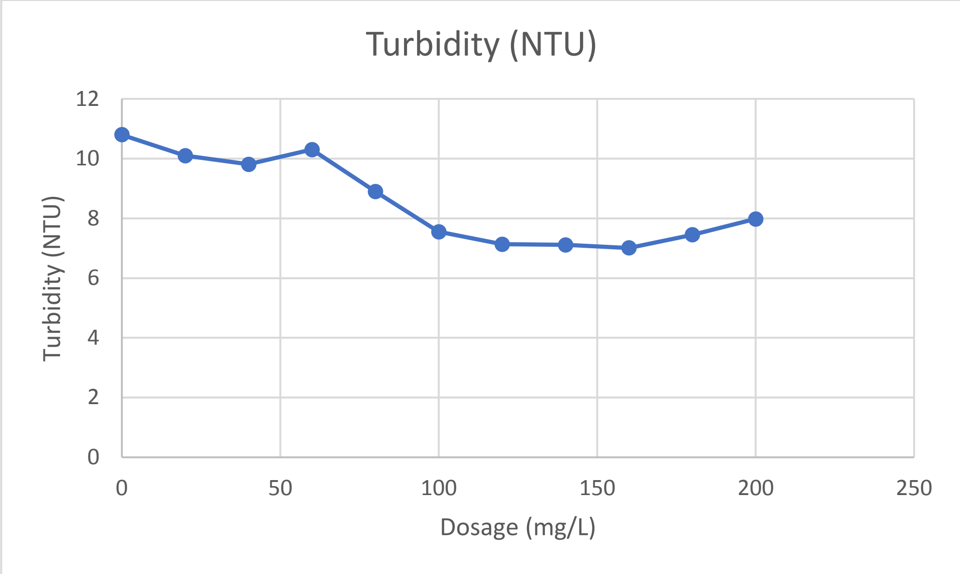

Figure 4.16 Downstream B Turbidity vs Dosage for Ferric Sulphate

Based on the result on both Figure 4.15 and Figure 4.16, if both of the coagulants used the same amount dosage for an example, 20mg/L, the turbidity for Aluminium Sulphate getting more decreases and that was great compare to Ferric Sulphate, when using the same dosage, the turbidity will decreases too but least than Aluminium Sulphate. In addition, for downstream test for turbidity as overall comparison, Aluminium Sulphate far better than Ferric Sulphate in order to remove turbidity.

Table 4.15 Jar test downstream C

Aluminium Sulphate (mL)	Aluminium Sulphate (mg/L)	Turbidity (NTU)	Iron/Ferric Sulphate (mL)	Iron/Ferric Sulphate (mg/L)	Turbidity (NTU)
0	0	11	0	0	11
10	20	4.8	10	20	10.1
20	40	4.31	20	40	9.31
30	60	4.04	30	60	10.1
40	80	5.36	40	80	9.8
50	100	5.98	50	100	7.65
			60	120	7.43
			70	140	7.41
			80	160	7.01
			90	180	7.66
			100	200	7.9

Roughly based on the Table 4.14 above, clearly Aluminium Sulphate is better than Ferric Sulphate, this is because the Aluminium Sulphate used less amount to achieve the optimum dosage which is 60mg/L compare to Ferric sulphate that used up to more than twice amount of Aluminium Sulphate which is 160 mg/L.

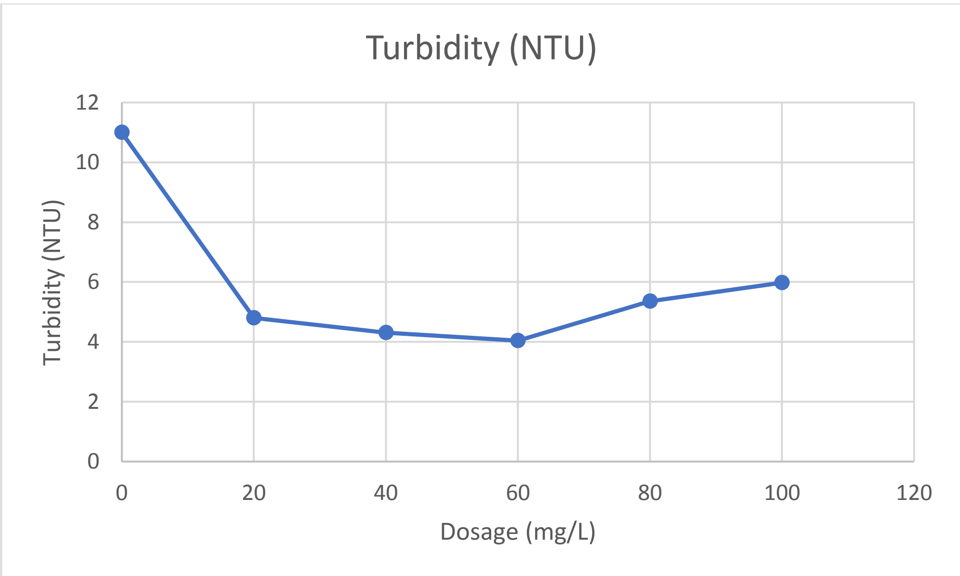

Figure 4.17 Downstream C Turbidity vs Dosage for Aluminium Sulphate

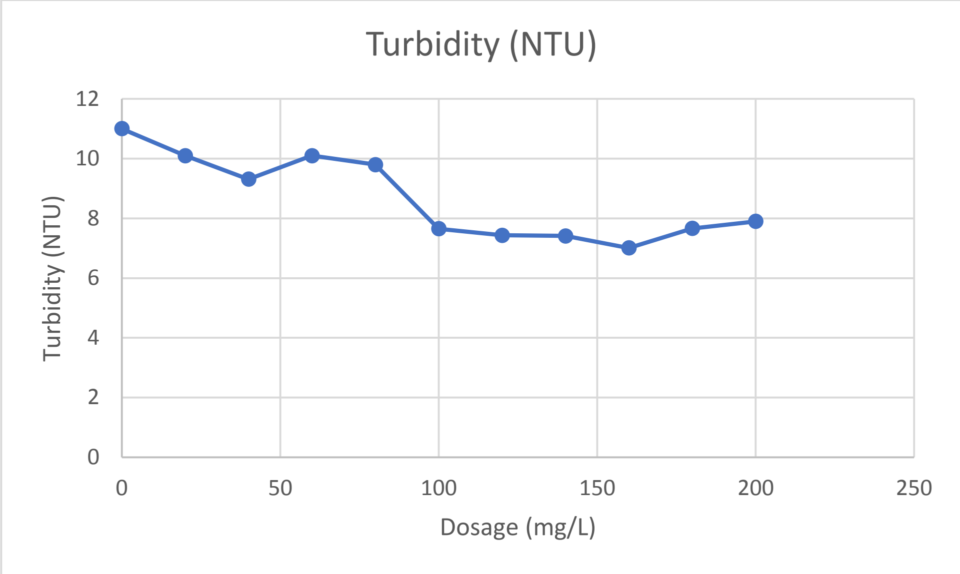

Figure 4.18 Downstream C Turbidity vs Dosage for Ferric Sulphate

Based on the result on both Figure 4.17 and Figure 4.18, if both of the coagulants used the same amount dosage for an example, 20mg/L, the turbidity for Aluminium Sulphate getting more decreases and that was great compare to Ferric Sulphate, when using the same dosage, the turbidity will decreases too but least than Aluminium Sulphate. In addition, for downstream test for turbidity as overall comparison, Aluminium Sulphate far better than Ferric Sulphate in order to remove turbidity.

4.4 Total Suspended Solids

Table 4.16 TSS result for up-stream

PARAMETER	**STATION**			**AVERAGE**
	A	**B**	**C**	
TSS (mg/L)	0.033	0.028	0.037	0.033

For the Total Suspended Solid (TSS) at up-stream, three samples were collected and the average value was calculate to increase the accuracy of the data as shown in Table 4.10 above.

Table 4.17 TSS result up-stream after using Aluminium Sulphate

PARAMETER	**STATION**			**AVERAGE**
	A	**B**	**C**	
TSS (mg/L)	0.017	0.015	0.019	0.017

For the Total Suspended Solid (TSS) at up-stream, three samples were collected and by using the data from optimum dosage for Aluminium Sulphate in the Table 4.7, the average value was calculate to increase the accuracy of the data as shown in Table 4.11 above.

Table 4.18 TSS result up-stream after using Ferric Sulphate

PARAMETER	**STATION**			**AVERAGE**
	A	**B**	**C**	
TSS (mg/L)	0.022	0.018	0.025	0.022

For the Total Suspended Solid (TSS) at up-stream, three samples were collected and by using the data from optimum dosage for Ferric Sulphate in the Table 4.7, the average value was calculate to increase the accuracy of the data as shown in Table 4.12 above.

Table 4.19 TSS result for middle-stream

PARAMETER	STATION			AVERAGE
	A	B	C	
TSS (mg/L)	0.012	0.008	0.018	0.012

For the Total Suspended Solid (TSS) at middle-stream, three samples were collected and the average value was calculate to increase the accuracy of the data as shown in Table 4.13 above.

Table 4.20 TSS result middle-stream after using Aluminium Sulphate

PARAMETER	STATION			AVERAGE
	A	B	C	
TSS (mg/L)	0.009	0.007	0.011	0.009

For the Total Suspended Solid (TSS) at middle-stream, three samples were collected and by using the data from optimum dosage for Aluminium Sulphate in the Table 4.8, the average value was calculate to increase the accuracy of the data as shown in Table 4.14 above.

Table 4.21 TSS result middle-stream after using Ferric Sulphate

PARAMETER	STATION			AVERAGE
	A	B	C	
TSS (mg/L)	0.011	0.008	0.013	0.011

For the Total Suspended Solid (TSS) at middle-stream, three samples were collected and by using the data from optimum dosage for Ferric Sulphate in the Table 4.8, the average value was calculate to increase the accuracy of the data as shown in Table 4.15 above.

Table 4.22 TSS result for down-stream

PARAMETER	**STATION**			**AVERAGE**
	A	**B**	**C**	
TSS (mg/L)	0.008	0.006	0.011	0.008

For the Total Suspended Solid (TSS) at down-stream, three samples were collected and the average value was calculate to increase the accuracy of the data as shown in Table 4.16 above.

Table 4.23 TSS result down-stream after using Aluminium Sulphate

PARAMETER	**STATION**			**AVERAGE**
	A	**B**	**C**	
TSS (mg/L)	0.005	0.003	0.008	0.005

For the Total Suspended Solid (TSS) at down-stream, three samples were collected and by using the data from optimum dosage for Aluminium Sulphate in the Table 4.9, the average value was calculate to increase the accuracy of the data as shown in Table 4.17 above.

Table 4.24 TSS result down-stream after using Ferric Sulphate

PARAMETER	**STATION**			**AVERAGE**
	A	**B**	**C**	
TSS (mg/L)	0.007	0.005	0.010	0.007

For the Total Suspended Solid (TSS) at down-stream, three samples were collected and by using the data from optimum dosage for Ferric Sulphate in the Table 4.9, the average value was calculate to increase the accuracy of the data as shown in Table 4.18 above.

Table 4.25 Average comparison

STATION	BEFORE (mg/L)	AFTER (mg/L)	
		Alum	Ferric
Upstream	0.033	0.017	0.022
Middle-stream	0.013	0.009	0.011
Down-stream	0.008	0.005	0.007

Table 4.26 Percentage of removal (%)

STATION	**PERCENTAGE REMOVAL** (%)	
	Aluminium Sulphate	**Ferric Sulphate**
Up-stream	48.48	33.33
Middle-stream	30.77	15.38
Down-stream	37.5	12.5

Based on the total suspended solids in Table 4.19 and percentage of removal in Table 4.20, obviously that Aluminium Sulphate far superior compare to Ferric Sulphate. To prove that, at the up-stream, before the coagulant process for both, the value is 0.033mg/L and after both of the coagulants process, Aluminium Sulphate decrease more than by using Ferric Sulphate which is 0.017mg/L while Ferric Sulphate only decrease to 0.022mg/L. If convert into percentage as in Table 4.20, Aluminium Sulphate remove the TSS by 48.48% while Ferric Sulphate only 33.33%. Same goes to the middle-stream and down-stream, Aluminium Sulphate decreases TSS more than Ferric Sulphate.

4.5 Heavy Metals

Table 4.27 Heavy metals results for up-stream

HEAVY METAL	BEFORE (mg/L)	AFTER (mg/L)	
		Aluminium Sulphate	Ferric Sulphate
Copper	0.17	0.16	0.14
Chromium	0.027	0.019	0.017
Zinc	0.32	0.14	0.13

Based on the Table 4.21 above, heavy metals such as copper, chromium and zinc were detected and by using the optimum dosage from Table 4.7, clearly there were differences of values for both coagulant. To put an example, for copper before the coagulant process, the value was 0.17mg/L and after both coagulants process, for Aluminium Sulphate the value decrease to 0.16mg/L while for Ferric Sulphate the value decrease to 0.14mg/L. By comparing all the data before and after both coagulant, Ferric Sulphate give significant difference in removing heavy metals than Aluminium Sulphate.

Table 4.28 Heavy metals results for middle-stream

HEAVY METAL	BEFORE (mg/L)	AFTER (mg/L)	
		Aluminium Sulphate	Iron/Ferric Sulphate
Copper	0.23	0.19	0.17
Chromium	0.029	0.026	0.024
Zinc	0.33	0.33	0.31

Based on the Table 4.22 above, heavy metals such as copper, chromium and zinc were detected and by using the optimum dosage from Table 4.8, clearly there were differences of values for both coagulant. To put an example, for chromium before the coagulant process, the value was 0.029mg/L and after both coagulants process, for Aluminium Sulphate the value decrease to 0.026mg/L while for Ferric Sulphate the value decrease to 0.024mg/L. By comparing all the data before and after both coagulant, Ferric Sulphate give significant difference in removing heavy metals than Aluminium Sulphate.

Table 4.29 Heavy metals results for down-stream

HEAVY METAL	**BEFORE (mg/L)**	**AFTER (mg/L)**	
		Aluminium Sulphate	Iron/Ferric Sulphate
Copper	0.24	0.18	0.16
Chromium	0.018	0.015	0.016
Zinc	0.28	0.27	0.24

Based on the Table 4.23 above, heavy metals such as copper, chromium and zinc were detected and by using the optimum dosage from Table 4.9, clearly there were differences of values for both coagulant. To put an example, for copper before the coagulant process, the value was 0.24mg/L and after both coagulants process, for Aluminium Sulphate the value decrease to 0.18mg/L while for Ferric Sulphate the value decrease to 0.16mg/L. By comparing all the data before and after both coagulant, Ferric Sulphate give significant difference in removing heavy metals than Aluminium Sulphate.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

Based on the Water Quality Index (WQI) conducted on Sungai Pandan, there are several conclusions that can make. As for overall, water quality of Sungai Pandan can be said that along the river it getting worse from upstream to downstream, Class I (97.42) to Class II(88.96) respectively. This data was obtained by considering all the parameter that needed to calculate the Water Quality Index (WQI) which were Dissolve Oxygen (DO), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Ammonia Nitrogen (AN), Total Suspended Solids (TSS) and Alkalinity or Acidity (pH).

1. For the Water Quality Index (WQI) determination and classification on Sungai Pandan, the WQI value shows that the water quality getting worse along the stream, from Class I (97.42 index value at up-stream) to Class II (88.96 index value at down-stream)
2. Both the coagulants which are Aluminium Sulphate and Iron Sulphate or commonly knew as Ferric Sulphate have been compared in terms of optimum dosage, turbidity and total suspended solids. As can be seen in previous chapter, Aluminium Sulphate performs better than Ferric Sulphate. To put an example, for optimum dosage, Aluminium only used 80mg/L compare to Ferric Sulphate, 180mg/L. As for total suspended solid, Aluminium Sulphate also gave better results compare to Ferric Sulphate. To put an example, at upstream Aluminium can remove up to 48.48% of removal of TSS while Ferric Sulphate only 33.33%.

3. After the coagulants process, the heavy metals such as chromium, copper and zinc also have being effected. As shown in Chapter 4 previously, for the removal heavy metals, Ferric Sulphate outclass Aluminium Sulphate. To put an example, based on Table 4.22, Ferric Sulphate can remove heavy metals more than Aluminium Sulphate, before coagulant amount of copper in the water was 0.17mg/L and after coagulants process, for Ferric Sulphate the value decrease to 0.14mg/L while for Aluminium Sulphate only decrease to 0.16mg/L.

5.2 Recommendation

Sungai Pandan is one of the tributaries streaming into the fundamental basin of the Kuantan River. Despite the fact that this waterway is a little stream, the water quality ought to be kept up for the reason and significance of every living thing. Albeit now Sungai Pandan is under Class II, advance to improve the quality should be taken. Among the proposed improvement recommendations that can be considered to improve the data in this study are as per the following.

1. For the determination and classification of water quality index of Sungai Pandan, the samples need to be taken more to increase the accuracy of data.
2. For the preparation of coagulants, should varies more to see clearly how the effect of coagulants. To put an example, as in this study, one gram per litre has been used, so to varies more, use two gram and so on
3. Add another parameter such as acidity or alkalinity (pH) to observe the difference between coagulants performance under respective pH.
4. For the heavy metals, use a proper glass bottle for the UV-VIS Spectrophotometer test for better results obtained.

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