KINETIC STUDY OF ADSORPTION PROCESS USING CHITOSAN, ACTIVATED CARBON, AND RICE HUSK FOR MONOETHANOLAMINE (MEA) WASTEWATER TREATMENT VIA BATCH PROCESS.

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ABSTRACT

In petrochemical industry, monoethanolamine (MEA) is a common solvent used as absorption medium to remove carbon dioxide (CO_2) from the gaseous stream. In the absorber, the reaction between CO_2 and MEA will generate some salt and increased the amount of the suspended solids in an absorber due to direct contact between gas and liquid (two fluid phases). This phenomenon can cause a sudden foaming where will decreasing the absorption efficiency, increasing amine loses, reduced quality of product gas, and the MEA sometimes is not appropriate to feed back into the stripper because of the properties deterioration and gives difficulties in optimizing the absorption processes and it has been removed as wastewater. This study had been conducted to examine the best method of treating the MEA wastewater. Adsorption method had been chosen in this treatment with here different adsorbents that are activated carbon, chitosan and rice husk. Three different variables that are adsorbent dosage, mixing time and mixing speed were varied to examine the effect of residue oil and MEA concentration. Then, the kinetic model of adsorption of residue oil had been obtained. The analysis of the oil and grease and amine concentration was followed by APHA methods. The result showed activated carbon which is showed the highest adsorption value of residue oil in absorbent dosage (32.14%), mixing time (62.32%), and mixing speed (64.29%) compared to chitosan adsorption value of residue oil in absorbent dosage (28.13%), mixing time (46.43%), and mixing speed (53.57%) and rice husk adsorption value of residue oil in absorbent dosage (21.43%), mixing time (37.71%), and mixing speed (44.64%). The MEA concentration in all adsorbent used in this study does not affected by the adsorption treatment based on three parameter that was been tested. The kinetic model of activated carbon and rice husks followed first order pseudo (normally expressed in the range of reaction only) while chitosan followed second order pseudo (obtain a two step linear relationship) and this model agree with chemisorptions being rate controlling. As conclusion, the adsorption technique using activated carbon (powder), chitosan (powder), and rice husk (powder) can be of the selected adsorbents because they do not affected with MEA concentration.

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ABSTRAK

Dalam industri petrokimia, monoethanolamine (MEA) adalah salah satu bahan pelarut yang biasa digunakan di dalam proses penyerapan untuk pembuangan karbon dioxide (CO2) dari dalam aliran gas. Di dalam “absorber”, tindak balas yang berlaku diantara CO2 and MEA akan menhasilkan sebatian garam yang boleh meyebabkan peningkatan jumlah pepejal terampai di dalam “absorber” disebab kan pertemuan secara lansung diantara gas dan cecair (dua fasa cecair). Fenomena ini akan meyebabkan terhasilnya buih secara tiba-tiba di mana akan mengurangkan kecekapan proses penyerapan, kehilangan amine akan meningkat, mengurangkan kualiti produk, dan akan menyebabkan MEA tidak dapat diguna kembali di dalam “striper” disebabkan tidak memenuhi cirri-ciri untuk digunakan kembali sebagai “feed”, dan akan menyukarkan proses pengoptimum didalm peyerapan dan secara langsung akan dikeluarkan sebagai sisa air. Kajian ini telah dijalankan untuk mengkaji kaedah terbaik dalam merawat air sisa MEA. Kaedah “Adsorption” telah dipilih dalam merawat sisa air MEA dengan mengunakan bahan penjerap (adsorben) yang berbeza iaitu karbon diaktif, chitosan dan sekam padi. Tiga pembolehubah yang berbeza yang dos bahan penjerap , pencampuran masa dan pencampuran kelajuan telah diubah untuk mengkaji kesan pengurangan minyak sisa dan kepekatan MEA. Kemudian, model kinetik bagi proses penjerapan minyak sisa telah diperolehi. Analisis kepekatan minyak dan gris dan amine mengunakan kaedah APHA . Hasil daripada kajian menunjukkan karbon teraktif menunjukkan nilai serapan yang tinggi minyak sisa dalam dos yang boleh menyerap (32.14 %), masa pencampuran (62.32 %), dan kelajuan (64,29 %) berbanding dengan mencampurkan nilai penjerapan chitosan bagi minyak sisa dalam dos yang boleh menyerap (28.13 %), masa pencampuran (46.43 %) , dan kelajuan (53.57 %) dan sekam padi nilai penjerapan minyak sisa dalam dos yang boleh menyerap (21.43 %) pencampuran, masa pencampuran (37.71 %), dan kelajuan (44,64 %). Kepekatan MEA dalam semua bahan penjerap yang digunakan dalam kajian ini tidak terjejas oleh proses penjerapan berdasarkan tiga pemboleh ubah yang diuji. Model kinetik untuk karbon diaktifkan dan sekam padi mengikut “pseudo-first order”(biasanya dinyatakan dalam lingkungan reaksi sahaja) manakala kinetic model untuk chitosan adalah “pseudo-second order” (mendapatkan dua langkah hubungan linear) dan model ini bersetuju dengan “chemisorption” menjadi kadar mengawal. Kesimpulannya , teknik penjerapan menggunakan karbon diaktifkan (serbuk) , chitosan (serbuk), dan sekam padi (serbuk) boleh digunakan dalam merawat sisa air MEA kerana tidak menjejaskan dengan kepekatan MEA.

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C_e	Residue oil concentration at equilibrium concentration, mg/L
C_o	initial concentration of residue oil, mg/L
k_1	rate constant of pseudo first order adsorption, mg/mg.min
k_2	rate constant of pseudo second order adsorption, min^{-1}
q_e	Adsorption density at equilibrium solute concentration, C_e , mg/mg
q_t	Amount adsorption at time t, min
R^2	Correlation coefficient
t	Time taken for adsorption, min
V	Sample volume, L
W	Mass of adsorbent, g

LIST OF ABBREVIATIONS

CO_2	Carbon Dioxide
H_2S	Hydrogen Sulphide
MEA	Monoethanolamine
DDA	Degree of deacetylation
˚C	Degree of Celsius
mL	Millilitre
L	Litre
Rpm	Revolution per minutes
wt%	weight percent
mg/L	Concentration

CHAPTER I

INTRODUCTION

1.1 Research Background

Carbon dioxide (CO_2) is one of the major greenhouse gases and it is main contributor factor of increasing the earth's surface temperature which tends to cause global warming (Sedghi S. M. et al, 2011; Chunbo YE et al, 2012). Large amounts of CO_2 are produced annually in various industries due to burning of fossil fuels (Mortaheb H. R. et al, 2012) such as in industrial processes for example oil refineries, cement works, and steel and iron production (IPCC, 2005). Due to reduce and control the emission of CO_2 to avoid greenhouse effect, several technologies of CO_2 capture had been researched and developed. There are many technology option had been suggested for CO_2 captured such as pre-combustion capture, post-combustion capture, and oxyfuel process (Nuchitprasittichai A., Cremaschi S.,2013).

In petrochemical industry, generally in natural gas processing plant, raw natural gas which contains carbon dioxide needs to be treated by removing the CO_2 prior to further processing activities (Razali M. N. et al, 2010). The present of CO_2 pose as interference in the processing activities and will cause the failure of the product quality (Razali M. N. et al, 2010). There are various type of separation processes for CO_2 removal have been developed such as absorption, adsorption membrane and cryogenics (Rao A. B. et al, 2002). Among of those separation methods, absorption by using amine-based absorbents is the most common industrial process due to its highest CO_2 removal efficiency (Yang H. et al, 2008). The CO_2 will be captured from flue gas with low CO_2 concentration (Mofarahi M. et al, 2008; Razali M. N. et al, 2010), and it can be used for dilute system, and can be retrofitted to any plant (Razali M. N. et al, 2010). The solvent is regenerated at elevated temperature, so it requires thermals energy for the regeneration (Abu Zahra et al, 2005). Currently, aqueous monoethanolamine (MEA) is a widely used solvent for this technique due to its high reaction rate with CO_2 (Han C, 2011) and for removing CO_2 and hydrogen sulphate (H_2S) from flue gas stream (Harold et al, 2004). Other than high reactivity, MEA solvent also a low solvent cost, low molecular mass and thus high absorption capacity on a mass basis, reasonable thermal stability, and others (McCann N. et al, 2008).

Scrubbing with aqueous monoethanolamine (MEA) is a mature technology in capturing carbon dioxide in coal fired power plant flue gas and other lower pressure process stream (Kohl A. et al, 1998). The process flow of capturing CO_2 as shown in figure 1.1, the flue gas containing CO_2 will enter the absorber and will contacts with a aqueous solution of MEA where the solution flowing counter currently to the flue gas stream. The reaction process between CO_2 and MEA is exothermic. This process will form water soluble salt due to weak base react with weak acid respectively. The rich amine solution leaving the absorber at the bottom of the column is then heated by exchanger with the lean amine solution where come from the regenerator unit (Mores P.et al, 2011). In the stripper, the chemical solvent is generated at 100-140 ˚C (elevated temperature) and pressure must less than atmospheric. In the reboiler, heat is supply using low pressure steam to maintain regeneration conditions. Due to removal of the chemical bound of CO_2, the solvent has to be heated which provide required desorption heat where lead to energy penalty. This also for production of steam, this acts as stripping gas. At the condenser, the steam is recovered and return back as feed to stripper after CO_2 gas produced and leave the condenser. The lean MEA then will be recycling back to the absorber (Alie et al., 2005).

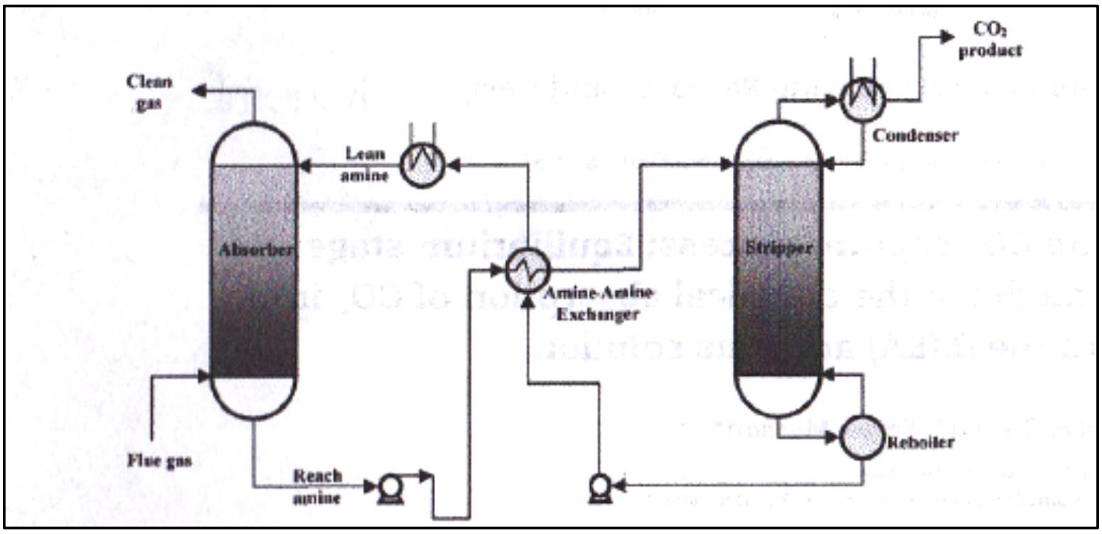

Figure 1-1: Flow diagram of the conventional CO_2 post-combustion process (Mores P. et al., 2011)

1.2 Problem Statement and Motivation

Monoethanolamine (MEA) is an organic compound consisting two functional groups which are primary amine (amino group in its molecule) and primary alcohol (a hydroxyl group). It also widely use in the manufacture of cosmetics, surface active agents, emulsifiers, pharmaceuticals, and plasticizing agents for agents of absorption and removal of H_2S and CO_2 from refinery and natural gas streams, and carbon dioxide and ammonia manufacturing (Chunbo YE et al, 2012). MEA is weak base which have several characteristics such as toxic, flammable, colorless, viscous liquid with an odor alike to ammonia. The reactions occur between ethylene oxide and ammonia producing ammonia. In aqueous solution, the bond between MEA and CO_2 will be break by heating it and at gaseous state CO_2 will be release (Han C, 2011; Harold et al, 2004). Due to ion mobilization in the solution, any treatment methods would be apply as the MEA left in aqueous solution (Razali M. N. et al, 2010).

Usually, the gas absorption process is carried by in different units such as bubble columns, sieve tray or packed tower (Sedghi S. M. et al, 2011). Due to direct contact between gas and liquid (two fluid phases), lead several technical problems such as foaming, channeling, unloading and flooding (Sedghi S. M. et al, 2011). In absorption process of CO_2, hydrocarbon component may well be carried out over to the absorber with the feed gas which cause unexpected foaming in the absorber (Razali M. N. et al, 2010). This is because of the reaction between CO_2 and MEA will generate some salt and increased the amount of the suspended solids in an absorber which is contributing to the foaming problem.

Foam is a mass of bubbles created when certain type of gases are dispersed into liquid. It consist a strong of liquid than surround the bubbles and causing the large volume of foaming of non productive foam. Several problems occur by this foaming phenomenon can causes decreasing the absorption efficiency, increasing amine loses, reduced quality of product gas, and the MEA sometimes is not appropriate to feed back into the stripper because of the properties deterioration and gives difficulties in optimizing the absorption processes and it has been removed as wastewater (Razali M. N. et al, 2010). Due to high financial impact on the purchase of new MEA solution and the disposal cost of MEA wastewater initiative in finding effective solution which can save this expenditure and at the same time protect the environment (Razali M. N. et al, 2010).

Based on the previous literatures, there are several researches on treatment of wastewater from petrochemical plants which sufficiently conducted especially for recycle purposed. The treatment of MEA wastewater by using chitosan and activated carbon has been done previously but no work has been in the literature using rice husk regarding treatment of MEA wastewater. In addition, this research also evaluated the potential of recycling of the treated MEA wastewater and reused it in the CO_2 removal unit. Due to simple, easy, shorter time, economically viable to commercialized and widely used in the treatment of wastewater plant, the physical treatment methods will be chosen.

There are three common adsorbents used in the treatment wastewater in industries which are chitosan, activated carbon, and rice husk based on adsorption methods. These methods will be selected due to employed and explored for examine the feasibility to remove oil concentration in the MEA wastewater and at the same time to maintaining the amine concentration level at acceptable limit.

1.3 Research Objectives

The following are the objectives of this research:

i) To identify the kinetic model of adsorption treatment of MEA wastewater using chitosan, activated carbon, and rice husk wastewater via batch process.

1.4 Research Scopes

The following are the scope of this research:

i) To treat the MEA wastewater via batch adsorption method.
ii) To determine the best absorbent between chitosan, activated carbon, and rice husk in the adsorption of the MEA wastewater.
iii) To determine and suggest the kinetic model of the adsorption of MEA wastewater.

1.5 Research Contribution

The contribution of this research is to reduce heat regeneration at stripper column of amine absorption process for CO_2 removal from natural gas processing plant. Several process parameters i.e. amine concentration, reboiler temperature and stripper pressure that effect the heat consumption for solvent regeneration in stripper column are varies in this study. The optimum process operating conditions with minimum heat regeneration are proposed in this work. Thus, CO_2 removal process from natural gas can be improved

1.6 Chapter Organisation

The structure of the reminder of the thesis is outlined as follow:

Chapter 2 provides several handy guide and solid background to a particular topic provided from the literature review. More explores in the subtopic of introduction of wastewater treatment, monoethanolamine (MEA) wastewater, adsorption theory, types of adsorbents, and kinetic equilibrium model. This discussion concerns the works of the previous researches that linked to this research.

Chapter 3 gives the materials, equipment, and methods followed to solve the problem of this study. To achieve the objectives and scopes of this research, this study had been carried out by conducting adsorption treatment batch process. The experimental methods involved the procedure for preparation of monoethanolamine (MEA) wastewater, experimental set up for adsorption batch treatment, oil content, monoethanolamine (MEA) concentration, kinetic and isotherm analysis. Detail of the experimental will be discussed as below.

Chapter 4 is about the results that have been obtained from experiments regarding this research along with brief discussion by comparing it with previous study. Besides that, expected results for this research, also will be discusses and briefly explain based on results that have been obtained.

Chapter 5 is about the conclusion regarding the based on results that have been obtained. Besides that, in this chapter also provides a brief recommendation that can be suggested to improve this research.

CHAPTER II

LITERATURE REVIEW

2.1 Overview

In this chapter, there are several handy guide and solid background to a particular topic provided from the literature review. More explores in the subtopic of introduction of wastewater treatment, monoethanolamine (MEA) wastewater, adsorption theory, types of adsorbents, and kinetic equilibrium model. This discussion concerns the works of the previous researches that linked to this research.

2.2 Introduction To Wastewater Treatment

Water is one of the most abundant compounds found in nature, covering approximately three-fourth of the surface of the earth. Due to human activities such as liquid waste discharged from domestic houses, industrial activities, and agriculture or commercial processes can decreasing the quality of water. To treat the water that had been polluted, many researchers come out with several methods. Generally, there are three methods used in water and wastewater treatment;

1. Physical methods

2. Chemical methods

3. Biological methods

2.2.1 Physical Methods

Physical methods of wastewater treatment is used to remove substance by use of naturally occurring forces such as gravity, electrical attraction, and van der wall's forces as well as by use of physical barriers. The physical methods involve of sedimentation, screening, aeration, filtration, flotation, degasification, and equalization.

2.2.1.1 Sedimentations

Sedimentation is the process on allowing the particles in suspension in water to resolve out of the suspension in the consequence of gravity. Sludge is the particles that resolve out from the suspension become sediment and in the water treatment. Consolidation is happen when a thick layer of the sediment continues to resolve. When consolidation of sediment or sludge is assist by mechanical means then this is known as thickening. In water treatment sedimentation might be used to reduce the concentration of particles in suspension before the application of coagulation, to reduce the amount of coagulating chemicals needed, or after coagulation and, possibly, flocculation. When sedimentation is applied after coagulation, its purpose is usually to reduce the concentration of solids in suspension so that the subsequent filtration can function most effectively. Sedimentation is one of several methods for application prior to filtration: other options include dissolved air flotation and some methods of filtration. Generally, solids-liquid separation processes are occasionally referred to as clarification processes (Gregory R. and Edzwald J. 2010).

2.2.1.2 Screening

Screening is the first operation at any wastewater treatment works. This process essentially involves the removal of large non-biodegradable and floating solids that frequently enter a wastewater works, such as rags, papers, plastics, tins, containers and wood. Efficient removal of these constituents will protect the downstream plant and equipment from any possible damage, unnecessary wear & tear, pipe blockages and the accumulation of unwanted material that will interfere with the required wastewater treatment processes. Wastewater screening is generally classified into either coarse screening or fine screening. Screens may be manually or mechanically cleaned, with only the older and smaller treatment facilities using manually cleaned screens as their primary or only screening device. Coarse screens are typically used as primary protection devices, and usually have openings of 10mm or larger. Fine screens are used to remove material that may cause operation & maintenance problems in downstream processes, particularly in systems that lack primary treatment. Typical opening sizes for fine screens are 3 to 10mm. With advances in screening technology, fine screens with openings of less than 3mm are now utilized to reduce suspended solids to levels near those achieved by primary clarification. Most modern wastewater treatment plants will utilize a combination of coarse and fine screening (i.e. upstream coarse screens providing protection to downstream fine screens) (Cooke R. L., 2000).

2.2.1.3 Aeration

Aeration is the processes of transport air into close contact with water for the uses of trade certain components between the two phases. Oxygenation is one of the purposes of aeration. Others are removal of volatile organic substances, hydrogen sulfide, ammonia, and volatile organic compounds. A gas or substance dissolved in water may further react with water. Such a reaction is called hydration. Ionic substance dissolves due to hydration, for example (Cooke R. L., 2000):

$$HCl(g) + x\,H_2O = H(H_2O)_x^{+} + Cl_{(aq)}^{-}$$

$$H_2S = H_{(aq)}^{+} + HS_{(aq)}^{-}$$

These reactions are reversible, and aeration may also causes dehydration resulting in releasing the gas from water. Henry's law is applicable to this type of equilibrium for consideration. There are several methods in aeration process such as (Cooke R. L., 2000):

1. Diffused aeration function is to make the air bubbles through water.
2. Spray aeration is a placed where water is sprayed through air.
3. Multiple-tray aeration will be allowed the water to flow through several trays for mixed with the air.
4. Cascade aeration can be defined as water flows downwards over many steps in the form of thin water falls.

5. Air stripping is a mixture of multiple tray and cascade technique plus casual packed blocks causes the water to mix systematically with air.

2.2.1.4 Filtration

Filtration is the process to remove suspended particles from water by fleeting the water through a medium such as sand. As the water pass throughout the filter, floc and impurities get trapped in the sand and clean water will flow through. The filtered water collects in the clear well, where it is disinfected and then sent to the customers. This processes generally, the final step in the solids elimination process which begins with coagulation and advanced through flocculation and sedimentation. In the filter, up to 99.5% of the suspended solids in the water can be removed, including minerals, floc, and microorganisms (Cooke R. L., 2000).

2.2.1.5 Flotation

Floatation is one of separation methods. It is widely used in the wastewater treatment and mineral processing industries. In the flotation concentration minerals is transferred will be transferred to the froth leaving the gangue in the pulp which called as direct flotation. In reverse flotation, the gangue will separated into the froth fraction where the air bubbles only can stick to the mineral particles if they are displace water from the mineral surface which meant the mineral has to be hydrophobic. The air bubbles will continue support the mineral particles at the surface if a stable froth which is achieve by used floatation reagents can be formed. There are various flotation processes including dissolved air flotation, induced gas flotation, and froth flotation where typically used in mineral processing industry (Booth, 1971).

2.2.1.6 Degasification

Degasification or gas stripping is acted as prevention or delays of the time for the production of rising sludge as a certain gas production is going to take place after the degasification before the water is sufficiently super saturated for the gas bubbles to be formed again. This process might take place in mechanically/ hydraulically, or by means of vacuum. The refrigeration will stops the biological process temporarily and consequently prevents the formation of the news gas bubbles for a period time (Henze, 2002)

2.2.1.7 Equalization

Equalization in industrial treatment facilities is used as dampening of organic fluctuations for prevents shock loading of biological systems. Other than that, to control the pH for minimize the chemical requirements for neutralization. It also used as minimized flow surges to physical and chemical treatment which permit chemical feed rates compatible with feeding equipments. In biological system it provides continuous feed even when the factory is not operating. It will also control the discharges of the waste municipal system and will distribute waste loads evenly. Lastly, equalization purpose is to prevent high concentration of the toxic material from entering the biological treatment plant (Dr. Aslıhan Kerc., 2013).

2.2.2 Chemical Methods

Chemical methods of wastewater treatment are applied to be more efficiency in treatment of water and wastewater in settling, flotation, and filtration. The chemical methods involve of pH control, coagulation and flocculation, oxidation and reduction, adsorption, and ion exchange.

2.2.2.1 pH Control

There some pH changes in the solubility of some substance in water. As example the solubility of ferric ion or aluminium ion is sufficiently will reduced to formed the precipitate of hydroxide in a specific range. This method frequently used in separated of metallic ions from the water and wastewater. The pH controls of water are important measures to carry out the coagulant, flocculation, oxidation, reduction treatments and the efficiency (Razali M. N. et al, 2010).

2.2.2.2 Coagulant and Flocculation

Coagulant and flocculation treatment one of method to aggregate fine particles and colloids dispersed stably in water and to make their large flocs which are easy to separate from water through settling, flotating processes and others. Usually the Ferric salts and aluminium salts as coagulants. Flocculant is used for high molecular weight synthesis polymer. The coagulants will neutralized the surface electrical charges of particles and break their stable dispersion in the water. When the flocculants combine with neutralized particle, the large will be form. For separating of those flocs from water, the thickeners, flotators, and filter will be used (Razali M. N. et al, 2010).

2.2.2.3 Oxidation and reduction

To decomposed cyanides, nitride and various organic substances, the oxidation treatment will be applied to harmless the substances. It is also used for oxidizing of ferrous ion in the underground water, where the ferric ions will easily precipitate as the ferric hydroxide. The temperature and pH of water should be adjusted within the suitable ranges for proceeding the oxidation and reduction (Razali M. N. et al, 2010).

2.2.2.4 Adsorption

Recently, special adsorbents which selectively adsorb specified heavy metals ions and others substances are also used for water and wastewater treatment. Usually the adsorbents are filled in fixed bed or fluidized bed, and water to be treated passes through the bed. In batch treatment, the adsorbents are added into the water and will be separate by settling or filtration after the completion of adsorption. Then, after treatment the adsorbents are regenerated or disposed after making them harmless by solidification (Razali M. N. et al, 2010).

2.2.2.5 Ion Exchange

In this process the ions in the solution will exchanged with ion exchanger such as ion exchange resins. The ions exchanger approaching the full capacity is regenerated and reused. In water treatment, ion exchangers are large used in water treatment for utilized for removing hardness from water which are softening and producing demineralised water. In wastewater treatment, for the treatment of removing toxic substances and for recovering valuable materials from wastewater, the ion exchange usually applied. The toxic substance usually used in the wastewater heavy metals (Razali M. N. et al, 2010).

2.2.3 Biological Methods

Biological method is applied to decomposing organic substances wastewater by using utilizing of microorganism. It is important in any of wastewater treatment plant whether in municipal or industry that having soluble organic impurities or mixer of two types of wastewater sources. This method usually economical in terms of capital investment and the operating costs. The process has cemented its place in any of integrated of wastewater treatment plant. Usually it consist two treatments which are aerobic and anaerobic (Mittal A., 2011).

2.2.3.1 Aerobic Treatment

Aerobic treatment is meaning by the presence of air which is oxygen. This treatment is related to the type of bacteria or microorganisms which is involved in degration of organic impurities in certain wastewater and the operating conditions of the bioreactor. In this treatment, there are two process principle which are the microbial reactions will take place in the presence of molecular/ free of oxygen and the reaction products must be carbon dioxide, water and excess biomass. The reaction kinetic of this treatment is relatively fast. The net sludge yield of this treatment usually is high. For the post treatment in this process typically direct discharge or filtration or disinfection. The foot- prints relatively large in this treatment. Usually the capital cost investment in this treatment relatively high. The examples of technologies for this treatment are activated sludge (e.g. Extended Aeration, Oxidation Ditch, and MBR), The Fixed Film Processes (e.g. Trikling Filter or Biotower and BAF), and MBBR or Hybrid Processes (e.g. IFAS). The applications of this treatment in wastewater are to make the wastewater with low to medium organic impurities (COD < 1000 ppm) and for wastewater that are difficult to biodegradable such as municipal sewage, and refinery wastewater (Mittal A., 2011).

The suitable operation conditions activated sludge systems in this treatment are generally at pH (6-8), temperature (15-30˚C), the dissolved oxygen (more than 0.5 mg/L), and BOD load (0.2-0.6 kg BOD/ kg MLSS.day) (Razali M. N. et al, 2010).

2.2.3.2 Anaerobic Treatment

Anaerobic treatment is meaning by the absence of air which is oxygen.. In this treatment, there are two process principle which are the microbial reactions will take place in the absence of molecular/ free of oxygen and the reaction products must be carbon dioxide, methane and excess biomass. The reaction kinetic of this treatment is relatively slow. The net sludge yield of this treatment usually is also slow usually one fifth to the tenth of aerobic treatment process. For the post treatment in this process is invariably followed by aerobic treatment. The foot- prints relatively small and compact in this treatment. Usually the capital cost investment in this treatment relatively low with the pay back payment. The examples of technologies for this treatment are continuous stirred tank reactor or digester, Upflow Anaerobic sludge Blanket (UASB), and Ultra High Rate Fluidized Bed Reactor (e.g. EGSBTM, and ICTM). The applications of this treatment in wastewater are to make the wastewater with high from medium organic impurities (COD > 1000 ppm) and easily biodegradable wastewater such as food and beverage wastewater which is rich in starch or sugar or alcohol (Mittal A., 2011).

2.2.4 Effect of Wastewater to the Environment

In a clearer environmental there is a widespread awareness to the mankind’s. The major sources of the pollution can be formed from the water and the air. Organics and inorganic waste can be classified by the substance of the waste such as toxic chemicals, harmful bacteria, and unwanted waste. In the stream, when an organic waste enter the feed stream, the bacteria growth that affects aquatic life forms will be encourage by depleting the quantity of the oxygen level in the water. The stream will be septic due to the bacteria undergoing anaerobic metabolism, producing the odor, and will darkening the water appearance (Razali M. N. et al, 2010).

The inorganic waste such as copper, nickel, and lead, are basically toxic substances which are cannot be further break it down by the bacteria and these waste sometimes can be poisonous to the human health and aquatic life forms. There are some others common type of pollution that effected by the wastewater as shown table below.