HYBRID MEMBRANE TO REMOVE IMPURITIES IN WASTE WATER

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ABSTRACT

Hybrid membrane is for remove all contaminated inside the waste water. Nowadays, water pollution is becoming dangerous and sometimes not safe to use. The waste water actually comprise from liquid waste discharged by domestic residences, commercial properties, industry and agriculture. Main components of oil and gas industries waste water are acid gases, grease and lead. The research for waste water treatment has conducted by using hybrid membrane process. This method can remove the contaminants inside waste water and lowering the percentage of Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), pH, Turbidity and also carbon dioxide inside the waste water. This process is used sand silica column, activated carbon column and membrane column. The percentage removal based on amount of BOD, COD, pH and Turbidity of waste water before and after for each column. The purpose of this study is not only to remove carbon dioxide in waste water but also to remove all the contaminated inside the waste water. The difference compositions of membrane give difference percentage of removal. The additives are added about 1wt%, 3%wt and 5%wt of Monosodium Glutamate (MSG) to investigate the effect of MSG to the membrane performance. The overall process was started at first column which is sand silica column, then activated carbon column and the last is membrane column. The process gives lower amount of BOD, COD, pH and Turbidity. From the result shows that MSG based membrane with 3wt% MSG, achieve the best clearance about 80%.

ABSTRAK

Proses membrane hybrid adalah **untuk menyingkirkan segala bahan yang tercemar di dalam sisa air. Pada hari ini,pencemaran air adalah sangat merbahaya dan kandangkala ia tidak selamat digunakan. Sisa air adalah terbentuk daripda cecair terbuang yang atang dari kawasan perumahan.bahan komersil, industry dan agrikultur. Komponen utama di dalam sisa air minyak dan gas industry adalah gas berasid, gris dan plumbum. Kajian ini adalah mengenai rawatan air menggunakan proses membrane hybrid. Kajian ini adalah untuk menyingkirkan sisa bahan di dalam air dan mengurangkan peratus Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), pH, kekeruhan dan juga karbon dioksida untuk sebelum dan selepas proses. Perbezaan komposisi membrane menunjukkan perbezaan jumlah peratus penyingkiran di dalam sisa air. Aditis ditambah sebanyak 1w%, 3w% dan 5w% Monosodium Glutamat(MSG) untuk menguji kesan MSG terhadap prestasi membrane. Proses dimulai dengan pasir silica, karbon dan membrane. Proses ini dapat mengurangkan nilai BOD,COD,pH, kekeruhan dan karbon dioksida di dalam air. Daripada keputusan menunjukkan MSG bagi membrane dengan 3%w MSG, adalah sangat baik dan peratus penyingkiran sisa di dalam air adalah sebanyak 80 peratus.**

TABLE OF CONTENT

LIST OF TABLE

LIST OF FIGURES

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Introduction

As we all know, water is essential for all living things. The sufficient supply of good quality water is fundamental to economic and social development society. Waste water is any water that has been adversely affected in quality by athropogenic influence. It comprises liquid waste discharged by domestic residences, commercial properties, industry or agriculture and can encompass a wide range of potential contaminants and concentrations. Urban waste water is usually a combination of one or more of the following which makes it polluted water which are domestic effluent consisting blackwater and greywater, water from commercial establishment and institutions including hospitals, industrial effluent, stormwater and other urban run-off (Pay Drechsel *et* al., 2010). Waste water from industrial processes are varied complex often containing compounds not found in nature. Industrial waste water are often highly discoloured, turbid, alkaline or acid and unique to the industry in question (E.B Welch *et* al., 2003).These method are based on removal all impurities inside the waste water. There are three stages to complete the treatment which are sand silica column, activated carbon column and lastly membrane. There are also many researchers used physical treatment, biological treatment and advanced treatment (tertiary) for removal all impurities inside the waste water. In this study, the physical treatment is used by adsorption process for removal all particles and gas to get higher percentage removal of BOD, COD, turbidity, pH and Carbon Dioxide in waste water.

1.2 Research Background

1.2.1 Impurities

The most important pollutants in the oil processing waste waters are conventional pollutants such as oil and grease, suspended solids and pH, and non conventional pollutants such as phenolic compounds, sulfide and ammonia (Chong Heo Rhee et al., 2008). For the total suspended solid include all particles suspended in water which not pass through a filter. Suspended solid are present in sanitary waste water and many types of industrial waste water. There are also nonpoint sources of suspended solid such as soil erosion from agricultural and construction sites.

Hydrogen sulfide is colourless, flammable gas with a characteristics odour of rotten eggs. It is produced naturally and as a result of human activity. It also come from natural resources include non-specific or anaerobic bacterial reduction of sulfates and sulfur containing organic compounds. Hydrogen sulfide is found naturally in crude petroleum, natural gas, volcanic gases and hot springs. It also found in ground water. It is released from stagnant or polluted waters and marine or coal pits (Dr C-H Sclene J.Chou, 2003). Moreover hydrogen sulphide is also toxic and great care must be taken in presence. High concentrations can overwhelm olfactory glands, resulting in loss smell (Metcalf *etc* al., 2003).

Carbon dioxide is poisonous gas. A molecule of CO_2 is made of 1 part carbon and 2 parts O_2. Therefore, its chemical formula is CO_2. CO_2 is found in solution, mixed in the water of lakes, ponds, streams and oceans. If high levels of CO_2 will make the pH more acidic. A high level of CO_2 usually indicates that there is a lot of dead material undergoing decomposition. This may occur naturally but could be the result of difficult types of water pollution or water treatment. Grease is a liquid or solid material composed primarily of fats and oils from animal or vegetables sources.

Table 1.1: Limitation for concentration need be considered in the water (W. Wesley Eckenfelder *etc* al., 1995).

Pollutant or System Condition	Limiting Concentration
Suspended solids	<50 to 125 mg/L
Oil and grease	<35 to 50 mg/L
Toxic ions	
Pb	≤0.1 mg/L
Cu + Ni + CN	≤1 mg/L
pH	6 to 9
Alkalinity	0.5 lb alkalinity as $CaCO_3$/lb BOD Removed
Acidity	Free mineral acidity
Sulfides	<100 mg/L
Phenols	<70 to 300 mg/L
Ammonia	<500 mg/L (as N)
Organic load variation	<10 to 16 g/L

Limitation for concentration need be considered in the water. If the limitation achieve more than limitation the water become waste water. Figure 1.1 shows pollutant in water and the range of consideration for concentration for each pollutant.

1.2.2 Membrane

Membrane used for treatment of water and waste water typically consists of a thin skin having a thickness of about 0.20 to 0.20 micrometer supported by a more porous structure of about 100 micrometer in thickness. Membrane can made from number of different organic and inorganic materials. The membrane are usually used for wastewater treatment are typically organic (Metcalf *etc* al., 2003).

Permselective membranes can be classified according to different criteria as mechanisms of separation, physical morphology, and chemical nature. There are essentially three mechanisms of separation which depend on one specific property of the components to be selectively removed or retained by the membrane. There are essentially three mechanism of separation which depends on one specific property of the components to be selectively removed or retained by the membrane (Joel Mallevialle etc al., 1996).

Firstly is separation based on large differences in the size (sieve effect). Main operations are MF, UF, DIA. Secondly separation based on the differences in solubility and diffusivity of materials in the membrane (solution-diffusion mechanism). This is typically the case with GP, PV, and RO. For the third is separation based on differences in the charges of the species to be separated(electrochemical effect) as in ED and in Doman dialysis (Joel Mallevialle etc al., 1996).

For pressure driven and permeation membrane operations, the flux of permeate is inversely proportional to the thickness of the membrane. In fact, it was development of anisotropic membrane which led to the breakthrough in industrial applications. These membranes consist of a very thin top layer, called the skin, supported by a thicker and more porous supporting sublayer. The skin has the main functions of the membrane, since the overall flux and selectivity are depend only on the structure of the skin (Joel Mallevialle etc al., 1996).

1.2.3 Waste water Treatment Process

In the industrialized countries the first water treatment techniques involved processes of a purely physical and mechanical nature to reduce the solid content. Originally the initial stage in these systems aimed at reducing substances in suspension by using chemo-physical methods. Continental natural waters are the classical source for supplies of drinking water. Spring water is the best drinking water because of the natural conditions which guarantee hygiene standard and generally preclude any specific treatment (G.Boari *et* al., 1997).

It is impossible to specify a precise method for treating surface waters because of the various qualities of water that exist. Nevertheless, a series of conventional processes can be identified such as screening, straining, oxidation, clariflocculation and filtration. These can be followed by specific stages for the removal of particular pollutants. One of the most common and efficient method for removing micropollutants is the process of absorption on activated carbon. This is often combined with an ozonization process. Stripping processes are use to remove volatile micro-pollutants such as solvents, chloride, ammonia and sulphide (G.Boari *et* al., 1997).

1.3 Problem Statement

Effluent discharge from industries into water bodies and waste water treatment systems is currently causing significant health concerns. The pollution of the aquatic environment is a serious and growing problem (Sasaki *et* al., 1997). Increasing number and amount of industrial, agricultural and commercial chemicals discharged into aquatic environment having led to various deleterious effects on the aquatic organism (Mc Glashan and Hughies 2001). Aquatic organism such as fish, accumulate pollutants, directly from contaminated water and indirectly via the food and in (Sasaki *et* al., 2001). Heavy metals toxicity has been extensively studied in fish (Chan et al., 1999). Application of chemical fertilizers containing trace of heavy metals causes contamination of fish with these metals (Chalsemartin, 1983).

The impact of toxic materials on the integrity and functioning of DNA has been investigated in many organisms under field conditions (Bombail *et* al., 2001). Several biomarks have been utilized as tools for detection of exposure to genotoxic pollutants. Such biomarks include presence of DNA adducts, chromosomal aberrations, DNA stand breaks and micronuclei measurements. In fish, erythrocytes are mainly used as sentinel markers of exposure to genotoxic compounds (Mitchelmore and Chipman *et* al., 1998).

Researchers have found connection between quality and acute water-borne diseases such as thyroid (Cutler and Miller 2005) and diarrhea and access to clearer water may low infant mortality. The connection between water quality and cancer, however has not been fully explored.

The useful of hybrid membrane is simple way to remove all impurities such as particle and pathogen, suspended solid, carbon dioxide, hydrogen sulphide and many more. It is more effectively and can low energy utilization, low capital costs, low maintenance and superior removal ability.

1.4 Objectives

The proposed research was studied to achieve the following objectives:

(i) To describe the technique used for waste water treatment.
(ii) To remove impurities using high performance membrane.
(iii) To increase the percentage removal of pH, Chemical Oxygen Demand(COD), Biological Oxygen Demand (BOD), and turbidity of waste water.

1.5 Scopes of Study

In order to achieve the objectives, the following scopes have been identified.

(i) Set up equipment for Treatment Process by used silica sand, activated carbon and membrane

(ii) Fabrication of membrane by added monosodium glutamate (MSG) to increase the membrane performance.

(iii) Remove impurities included carbon dioxide in waste water.

1.6 Research Contributions

Hybrid membrane treatment process are more useful, save and beneficial to the environment and society. There are several benefits which are:

(i) Contribute to the society in preventing the community from any harm and danger chemical for instance water.

(ii) Preserving and protecting environment.

(iii) Reduce the cost and energy consumption needed to degrade the dyes effluent.

CHAPTER 2

LITERATURE REVIEW

2.1 Description of Impurities

Impurities in waste water consist of suspended solids, carbon dioxide, oil and grease, hydrogen sulphide and many more. For total suspended solid concentration less than 20mg/L to be clear, Water with total suspended solid levels between 40-80 mg/L tends to appear cloudy, while water with concentration over 150mg/L usually appears dirty. The nature of the particles that comprise the suspended solid may cause these numbers to vary.

The carbon cycles begin with organics carbon that is in the waste stream. Bacteria decompose the organic carbon as they eat it and release. Most of the BOD in waste water treatment is made up of carbon based organics.

The sources of oil and grease in waste water are come from petroleum refining, used oil refining and crude oil producing facilities. Virtually every refinery used oil and refining operation from primary distillation through final from primary distillation through final treatment, contains various fraction of oils and organosulfur compound in waste water. For crude oil producing facilities, waste water may contain drilling mud, brine, free and emulsified oil, tank bottom sludge and natural gas. Many oil-bearing strata have brine-bearing formations. Oil and gas must then be separated from the waste water. This waste water is typically a brine waste containing some oil contamination and must be disposed (Choong Hee Ree etc al., 2005).

Table 2.1: Typical Pollutant concentrations in a variety of industrial wastewaters

Pollutant	units	Petroleum Refinery	Textile Mills	Starch Production
BOD5	mg/L	100-500	75-6300	1500-8000
COD	mg/L	50-600	220-31300	1500-10000
TSS	mg/L	10-300	25-24500	100-160
VSS	mg/L		100-400	-
TDS	mg/L	1500-3000	500-300	-
Sulfates/ Sulfides	mg/L	Non detect-400	-	-
Oil and Grease	mg/L	10-700	-	-

2.2 Physical Characteristics of Waste water

The physical characteristics of wastewater include those items that can be detected using the physical senses. They are temperature, color, odor, and solids. For the temperature, the temperature of wastewater varies greatly, depending upon the type of operations being conducted at your installation. Wide variation in the wastewater temperature indicates heated or cooled discharges, often of substantial volume. They have any one of a number of sources. For example, decreased temperatures after a snowmelt or rainfall may indicate serious infiltration. Changes in wastewater temperatures affect the settling rates, dissolved oxygen levels, and biological action. The temperature of wastewater becomes extremely important in certain wastewater unit operations such as sedimentation tanks and recirculating filters.

The color of wastewater containing dissolved oxygen (DO) is normally gray. Black-colored wastewater usually accompanied by foul odors, containing little or no DO, is said to be septic. For the odour the domestic sewage should have a musty odor. Bubbling gas and/or foul odor may indicate industrial wastes, anaerobic (septic) conditions, and operational problems. Wastewater is normally 99.9 percent water and 0.1 percent solids. If a wastewater sample is evaporated, the solids remaining are called total solids. The amount of solids in the drinking water system has a significant effect on the total solids concentration in the raw sewage. Industrial and domestic discharges also add solids to the plant influent. There are many different ways to classify solids. The most common types are dissolved, suspended, settleable, floatable, colloidal, organic, and inorganic solids.

Part of the total solids is dissolved in wastewater. Much like sugar dissolves in coffee, many solids dissolve in water. Dissolved solids pass through a fine mesh filter. Normal wastewater processes using settling or flotation are designed to remove solids but cannot remove dissolved solids. Biological treatment units such as trickling filters and activated sludge plants convert some of these dissolved solids into settleable solids that are then removed by sedimentation tanks.

2.3 Membrane Technology

While membranes were initially applied in specialized situations such as seawater desalination, membrane technology has grown into a multibillion-dollar international business expanding at around 15 percent per year. Water purification is a major segment of the membrane market, but the other areas in which membranes are employed include effluent treatment, bioreactors, metal recovery, solvent dewatering, and paint recovery (Chris A. Buckley and Quentin E.Hurt, 1996).

Membrane processes do not generally require the addition of aggressive chemicals, can be operated at ambient temperatures, form an absolute barrier to the flow of contaminants, and are space efficient-features that make them both economically and environmentally attractive.

Membrane process encompass a wide range of applications in fluid separation and are now considered as a new and emerging separation technology for industrial application. For several important separation processes, membrane technology has now reached its initial stage of maturity (Ismail, 1997). There are 8 major membrane process applications in table 2.2.

Table 2.2: Major Membrane Application

Membrane Process	Application
Microfiltration-Cross	Sterile solution/water purification
Flow Filtration	Beverage filtration effluents Cell Harvesting
Ultrafiltration	Dairy(whey recovery, precheese concentration) Electrocoat colloids Effluent (oil-water, pulp and paper, dye-stuffs, tannery)
Reverse Osmosis	Water desalination, ultra pure water, dairy industry, effluent treatment (metal-finishing, photographic, chemical processes), biomedical applications, and pharmaceuticals industries.
Gas Separation	Hydrogen recovery/removal, CO2 removal O2 enrichment, helium recovery, N2 enriched air, pollution control, sour gas treating, H2 recovery, natural gas dehydration, air dehydration.
Electrodialysis	Water desalination, acidity reduction in citrus juice, deionization of whey.

Dialysis	Hemodialysis (artificial kidney).
Pervaporation	Dehydration of organic solvents.

2.4 Advantage of Membrane Technology

Membrane separation process enjoys numerous industrial applications with the following advantages.

a) Membrane separation processes offered more capital and energy efficiency compared to conventional separation processes in some application.
b) No additional waste product, it is a clean technology with operational ease. Other than the unwanted components of their feed, membrane processes produce no waste in that they provide a mean for recovering value from previously discarded effluents.
c) Equipment is modular. Scale up from pilot to commercial size is easy compare to the other separation techniques such as distillation, absorption and stripping. It has greater flexibility in designing systems.
d) The process requires simple, easy to operate and compact equipment. The process has acquired a significant industrial role in industrial scenario in term of economic consideration (Pandey an Chauhan, 2001)

2.5 Preparations of Membrane

There are number of different techniques used to prepare organic membranes: sintering, stretching, track etching, coating, and phase inversion. Coating techniques are used to make the composite dense membranes; sintering, stretching, a track etching can make only microfiltration membranes. Phase Inversion is a far more general technique.

2.5.1 Asymmetric Membranes Prepared by Phase Inversion

The most important commercial membranes are asymmetric or asymmetric-based composite membranes. They are generally prepared by the so-called phase inversion process, in which a polymer is dissolved in an appropriate solvent and cast as a 0.1 to 1-mm-thick film. A nonsolvent is then added to this liquid film, causing phase separation and precipitation. At the interface between the polymer solution and the nonsolvent (figure 2.1), the solvent and the nonsolvent exchange by diffusion. The solvent diffuses into the coagulation bath with a flux J_s whereas the nonslovent will diffuse into the case film (J_{ns}).

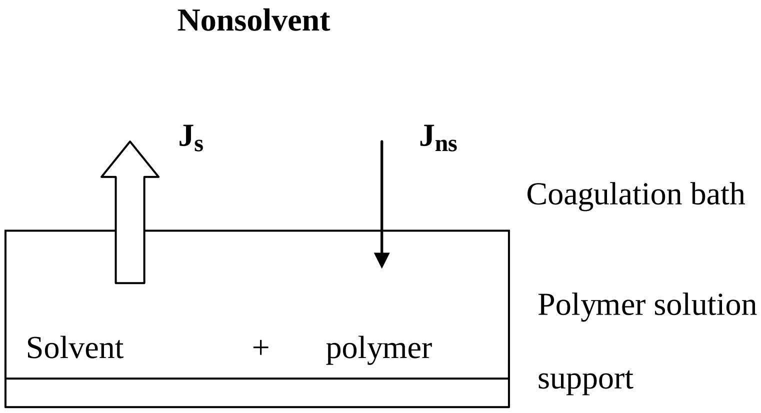

Figure 2.1 Principle of the formation of a membrane by phase inversion

Due to the concentration profile which exists in the cast film, the first layer which precipitates is on the top of the cast film and its composition is richer in polymer than the deeper layers. As a consequence, the successive layers which precipitate are less and less concentrated in polymer (or more and more porous). In summary, it is useful to remember that the anisotropic structure of the membrane depends on thermodynamic and kinetic factors which can be estimated knowing the following data such as nature polymer, nature of solvent and nonsolvent, composition of casting solution, composition of coagulating bath, gelation and crystallization behavior of the polymer, location of the liquid-liquid demixing gap, temperature of the casting solution and the coagulation bath and evaporation time (Joel mallevialle *etc* al., 1996).

2.5.2 Dry/Wet Phase Inversion

This process has been used form ultrathin skinned and defect free easy asymmetric membranes from variety of glassy polymer (Pesek and Koros, 1993) Multi component casting solution containing solvents comprised of halogenated of hydrocarbon and nonslovent comprised of aliphatic alcohol allowed dry interfacial phase separation in nascent membrane prior to the “wet” coagulation of the rest of the nascent membrane immersion in methanol (Pesel and Koros, 1993).

The dry/wet phase inversion technique requires multi component casting solution of polymer at least or volatile solvent and or less volatile nonsolvent which bring the solution to phase separation by means of solvent outflow and nonsolvent in flow.

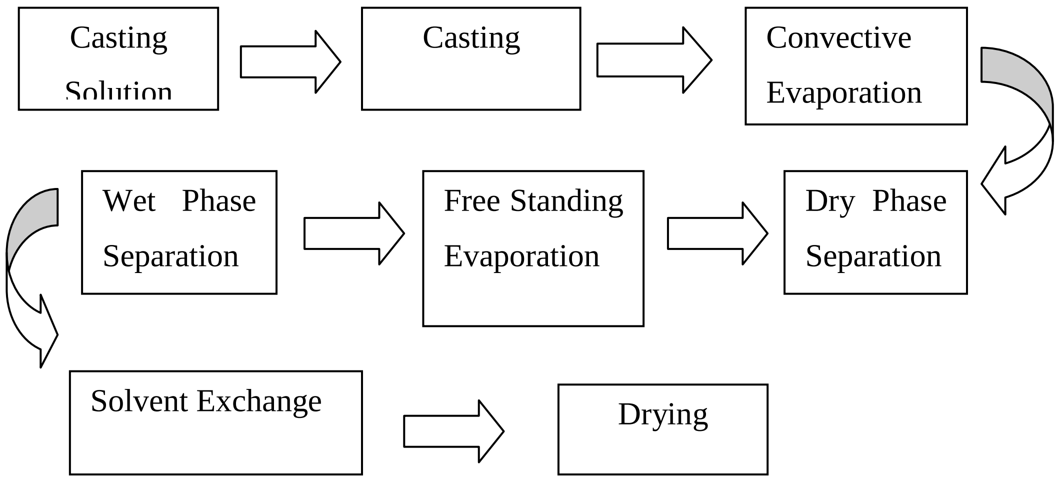

Figure 2.2 Steps involved in the preparation of integrally-skinned asymmetric phase separation membrane by using dry/wet process (Pesek and Koros, 1993).

2.6 Waste Water Effluent Treatment Method

Hybrid membrane is a process to remove impurities in waste water such as pathogens, viruses, organic particles, bacteria, carbon dioxide and sulphide.

2.6.1 Sand Silica

Silica is the name given to a group of minerals composed of silicon and oxygen, the two most abundant elements in the earth's crust. Silica is found commonly in the crystalline state and rarely in an amorphous state. It is composed of one atom of silicon and two atoms of oxygen resulting in the chemical formula SiO_2 . Sand consists of small grains or particles of mineral and rock fragments. Although these grains may be of any mineral composition, the dominant component of sand is the mineral quartz, which is composed of silica (silicon dioxide) (Dr Kamal Shah Ariffin, 2004).

Other components may include aluminium, feldspar and iron-bearing minerals. Sand with particularly high silica levels that is used for purposes other than construction is referred to as silica sand or industrial sand. For a particular source of sand to be suitable for glassmaking, it must not only contain a very high proportion of silica but also should not contain more than strictly limited amounts of certain metallic elements. Silica sand is also normally required to be well-sorted to have grains of an approximately uniform size.

Most sources of sand used by the construction industry do not satisfy these requirements and are not, therefore, suitable for glassmaking. Industrial uses of silica sand depend on its purity and physical characteristics. Some of the more important physical properties are: grain size and distribution, grain shape, sphericity, grain strength and refractoriness (Dr Kamal Shah Ariffin, 2004).

For filtration and water production the industrial sand is used in the filtration of drinking water, the processing of wastewater and the production of water from wells. Uniform grain shapesand grain size distributions produce efficient filtration bed operation in removal of contaminants in both potable water and wastewater. Chemically inert, silica will not degrade or react when it comes in contact with acids, contaminants, volatile organics or solvents. Silica gravel is used as packing material in deep-water wells to increase yield from the aquifer by expanding the permeable zone around the well screen and preventing the infiltration of fine particles from the formation (Dr Kamal Shah Ariffin, 2004).

2.6.2 Activated Carbon

Granular activated carbon is commonly used for removing organic constituents and residual disinfectants in water supplies. This is not only improves taste and minimizes health hazards, it is also to protects other water treatment units such as reverse osmosis membranes and ion exchange resin from possible damage due to oxidation or organic fouling. Activated carbon is a favored water treatment technique because of its multifunctional nature and the fact that it adds nothing detrimental to the treated water (Frank Desilva, 2000).

Typical surface area for activated carbon is approximately 1000 square meters per gram (m2/gm). However, different raw materials produce different types of activated carbon varying in hardness, density, pore and particle sizes, surface area, extractable, ash and pH. These differences in properties make certain carbons preferable over others in different applications.

Generally, the lower the flow rate, the more time the contaminant will have to diffuse into a pore and be absorbed. Adsorption by activated carbon is almost always improved by a longer contact time. Again, in general terms, a carbon bed of 20 by 50 mesh can be run at twice the flow rate of a bed of 12 by 40 mesh, and a carbon bed of 12 by 40 mesh can be run at twice the flow rate of a bed of 8 by 30 mesh. Whenever considering higher flow rates with finer mesh carbons, watch for an increased pressure drop.

Organic material in public water supplies comes from decaying plant in life, which becomes more soluble in water over time and exists as large, high molecular weight organic acids (non-polar weak acids). Eventually, smaller molecular weight acids for varying sizes form. Typical organic acid molecules range in molecular weight from a few hundred to tens of thousands (Frank Desilva, 2000).

The size, number and chemical structure of organic acid molecules depend on a large number of factors, including water pH and temperature. Accordingly, there exist an almost infinite number of organic acids. As a result, removing organics can be difficult and is always site-specific. Activated carbon’s adsorptive properties are used to remove organics. Generally, adsorption takes place because all molecules exert forces to adhere to each other. Activated carbon adsorbs organic material because the attractive forces between the carbon surface (non-polar) and the contaminant (non-polar) are stronger than the forces keeping the contaminant dissolved in water (polar).