Modification of Surface Hollow Fiber Membrane Ultrafiltration for Processing Produced Water

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Abstract: Produced water classified in the wastewater would require water treatment before being discharged into water bodies. One of the alternative technologies that could be used for the processing of produced water is a membrane technology that can be used as a source of new water well for irrigation agriculture, industrial water, and water Therefore, studies for treating produced water using hollow fiber membrane ultrafiltration has. Making the surface modification of hollow fiber ultrafiltration membrane can increase the viscosity and concentration as well as in the coagulation process is a hybrid joining hollow fiber ultrafiltration membrane allows for better elimination of contaminants present in raw water, which is very important for the quality.

1 INTRODUCTION

1.1 Research Background

Produced water is a byproduct of water brought to the surface during oil and gas collection, which includes formation water, injection water, and chemicals are added to the drilling or oil or water separation process. The produced water can pollute the environment if not handled properly (Hidayat, 2007) produced water contains organic and inorganic materials potentially B3 (Toxic Substances and Hazardous) that affect the environment and human health. The rapid development of industry demand for improved technology towards better, which minimizes the weaknesses that can degrade performance ultrafiltration membranes, Ultrafiltration has been applied in water treatment systems, among the available membrane module, hollow fiber membranes are compact and self-sufficient has been widely used as ultrafiltration membrane configurations (Ramli et al. 2014) hollow fiber ultrafiltration membrane has been recognized as one of the most important processes applied in water treatment systems because it uses low pressure process that requires less energy and have a very economic cost. Therefore, to identify the filtration performance of the process is concentrated on hollow fiber membrane applications, it is best to understand and analyze the factors that can affect the performance of hollow fiber ultrafiltration membrane.

1.2 Problem Statement

Produced water classified in the wastewater would require water treatment before being discharged into water bodies. One of the alternative technologies that could be used for the processing of produced water is a membrane technology that can be used as a source of new water well for irrigation agriculture, industrial water and drinking water (Saputra et al. 2013), therefore, various studies to treat water be produced using hollow fiber membrane ultrafiltration was performed (Yang et al. 2006) examines the creation and characterization of poly Phthalazines ether sulfone ketone (PPESK) ultrafiltration membrane hollow fiber with thermal stability where the thermal stability of high PPESK ultrafiltration membrane hollow fibers with different morphologies and the show has been prepared by dry / wet phase inversion spinning method successfully. In addition, the viscosity of the casting solution is highly dependent on the content PPESK, who said, with the increase in concentration viskositasdan content PPESK greatly improve and become dependent shear-level.

(Konieczny *et al.,* 2006) Researching on Efficiency of the hybrid coagulation-ultrafiltration water treatment process with the use of immersed hollow-fiber membranes which Process hybrid joining the coagulation membrane hollow fiber

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ultrafiltration, such as UF, allowing for the elimination of the better of contaminants present in the raw water, which is very important for the quality. Use of Fe2 (SO4) 3 coagulant determined as COD and oxygen consumption of the use of FeCl3. In the case of FeCl3, Improved Content chloride was observed. Use of Fe2 (SO4) 3. This increase is not significant for the quality of the treated water.

(Nabe et al. 1997) examines the polysulfone ultrafiltration membrane surface modification and fouling by BSA solution in which the surface energy of the membrane, as measured by the contact angle, used to characterize the different membranes. Streaming-potential measurements were obtained to investigate the membrane surface. Surface roughness of each membrane is also determined by the power of the atom. (Prince et al. 2014) studied the synthesis and characterization of PEG-Ag move PES hollow fiber membrane ultrafiltration with antifouling properties durable where modification of functional PES hollow fiber membrane that has been done by incorporating hydrophilic polyethylene glycol (PEG) and nanoparticles of silver (Ag) through thermal grafting. Poly (acrylonitrile-comaleic acid) (PANCMA) is used as a chemical linker to attach PEG and silver for the PES hollow fiber membrane. Functional modifications using different analytical techniques such as Fourier transform infrared (FTIR) spectroscopy, energy-dispersive X-ray (EDX) study, the water contact angle (CA), Fourier Emission Scanning Electron Microscopy (FESEM), and porometer. Subsequently, the membrane was tested for purewater flux and antifouling property. The contact angle of the data, it was identified that the new surface modification can improve the hydrophilicity of the membrane. Based on experimental data generated less so maximum it is necessary to further study if there are additional UF membrane.

(Chung et al. 2000) Researching on the Influence of the shear rate in the spinnerets morphology, separation performance and mechanical properties of the hollow fiber membrane ultrafiltration polyethersulfone.Where the hollow fiber UF membranes are made of drug-containing solution polyethersulfone (PES) / N-methyl-2-pyrrolidone (NMP) / Diethylene Glycol (DG) with a weight ratio of 13/45/42. Wet-spinning process was deliberately chosen to make the hollow fibers without attracting and water is used as an external coagulant. Therefore, in the belief that the effects of gravity and elongation at formation of stress fibers can be significantly reduced and the orientation caused by shear stress in a spinner which can be frozen into the wet-spun fibers. The results showed that the high shear rate in the spinner apparently resulting hollow fiber UF membrane with a thicker and / or denser skin due to greater molecular orientation. As a consequence, when the shear rate increases, pure water flux, the coefficient of thermal expansion (CTE) and the end of the fiber elongation decreases, but the storage modulus, tensile strength and Young's modulus increases. For the first time, it was found that there was a certain critical value of the shear rate under the clear separation performance fiber increased while the flux decreased dramatically with increased shear rate but above the flux separation slightly decreased while there was no change. (Ramli et al. 2014) Researching about the factors that influence the hollow fiber membrane ultrafiltration water treatment in operational performance which the initial processing as well as the transmembrane pressure (TMP) can penetrate flux. These factors are important as a reference point when evaluating the operating performance of hollow fiber ultrafiltration membranes. Thus, allowing a proper assessment and better in choosing a water treatment system. (Gholami et al. 2003) Researching on Effect of heat treatment on the performance of hollow fiber membrane ultrafiltration polyethersulfone (PES) in which the hollow fiber membrane Polyethersulfone (PES) prepared by the method of spinning the dry-wet and then heated in an oven at different temperatures to determine the effect of treatment Hot on the performance of their ultrafiltration. Found that the hollow-fiber membranes shrink by heat treatment, as evidenced by a decrease in flux and increase the separation of solutes, though no visible changes in hollow-fiber dimensions.

Selection of the appropriate type of membrane for produced water treatment is done by (Safitri et al. 2013) ultrafiltration technology for produced water treatment wherein In this research, the processing of produced water using ultrafiltration membranes. which aims to determine the characteristics of the beginning of produced water and the membrane (functional groups on the membrane), knowing the performance of the membrane represented by flux and rejection, and assess the effect of ultrafiltration on the characteristics of the end produced water Therefore more research is needed on waste water refining petroleum to know whether ultrafiltration technology can be utilized for the processing of petroleum refinery waste.

1.3 Research Objective

Research conducted aims are as follows:

a. Reviewing the process of making hollow ultrafiltration membrane made of Polyamide.
b. Making assess Phthalazines poly ether sulfone ketone (PPESK) hollow fiber ultrafiltration membranes with thermal stability.
c. Analyzing the performance of non-fouling membranes Polyamide modified for produced water treatment
d. Assessing the performance of the membrane represented by flux and rejection, and assess the effect of hollow ultrafiltration membranes for water characteristics terproduksi

2 LITERATURE REVIEW

2.1 Membrane Ultrafiltration (UF) Technology

Today, ultrafiltration (UF) technology is recognized by the water industry as a very attrac- tive process for producing drinking water, UF membranes are physical barriers which are able to efficiently remove suspended particles, turbidity, bacteria, colloids, algae, parasites and viruses for clarification and disinfection purposes. In comparison with conventional processes such as coagulation, flocculation, sedimentation and/or flotation, rapid and slow sand filtration, UF tech- nology has many advantages such as (1) superior quality of treated water, (2) a much more compact system, (3) easier control of operation and main- tenance, (4) fewer chemicals, and (5) less pro- duction of sludge.

2.2 Membran

Membrane has several advantages, namely The process of speciation can be either continuous or batch, Low energy consumption, The process of separation can take place at room temperature, Easy to scale up, The nature of the membrane varies, and easy to set, Does not require any additives and Equipment is compact.

2.3 Classification of Membrane

According to Mulder (1996), the membrane is classified into several categories as follows:

1. The type of membrane based on the manufacture
   a. Biological membranes eg skin cells, kidneys, heart, etc. (Wenten, 1999).
   b. The membrane synthesis into two types, namely
   - Organic membrane is a membrane which as its main composition of polymers and macromolecules, for example: cellulose acetate membrane (CA), polyacrylonitrile (PAN), polyamide (PA) and others.
   - Inorganic membrane is composed of inorganic compounds, eg ceramic membranes (such as $ZrO2$ and γ-$Al2O3$), membrane glass (like $SiO2$¬).
2. The type of membrane based on morphology is divided into two types, namely:
   a. Symmetric membrane is a membrane having a pore size that is homogeneous,
   b. An asymmetric membrane is a membrane with a pore size outer side more tightly with a thickness of between 0.1-0.5 µm
3. The type of membrane based on the principle of separation. Based on the principle of the separation, the membrane is divided into three types, namely:
   a. Porous Membrane: The membrane of this type is applied to microfiltration, ultrafitrasi, and nanofiltration.
   b. The non-porous membrane with the membrane of this type can separate molecules that have more or less similar size to one another.
   c. The membrane carrier molecule is determined by a very specific carrier that facilitates transport specific.
4. Type membrane by function
   a. Microfiltration, 0.05 to 10 µm<2 bar : Separating suspensions and colloids
   b. Ultrafiltration, 1-100 nm 1-10 bar : Separating macromolecules
   c. Nanofiltration, <2 nm 10-25 : Separating bars soluble components having a low molecular weight
   d. Reverse osmosis, <2 nm , Brackish water: 15-25 bar, Sea water: 40-80 bar Separating dissolved components with low molecular weight

2.4 Membrane Preparation Method

Membranes can be made from organic materials and inorganic polymers such as ceramic, metal, and glass. Several techniques can be used to make membranes that sintering, stretching, track-etching, template leaching and phase inversion (Mulder, 1996).

2.5 Membrane Fouling

Adsorption or accumulation of certain components in produced water on the membrane surface or in the pores of the membrane which can result in decreased efficiency of flux. Fouling is a limiting survival of a membrane in the economic value of produced water treatment (Ahmadun *et al*. 2009).

Fouling of the membranes can be classified into:

2.6 Irradiation with UV Rays

UV light on the membrane used to make membranes become susceptible to the reaction, then the polymer chain must contain a double bond, hydroxyl group, or a benzene ring (Nunes and Peinemann, 2001). UV light causes polymerization of the membrane. However, in the presence of polymerization will reduce pore size that will cause a reduction in permeability (Susanto, 2007). Polymerization speed depends on operating conditions such as the type of UV light (wavelength and energy), the concentration of monomer, the distance between the source of UV and membrane, and the exposure time (Homayoonfal, 2010).

2.7 Membrane Characterization Modified

The analysis used to determine the performance of the membrane can be seen from the parameter flux (permeability), rejection (selectivity), and the structure of membrane morphology (Mulder, 1996).

2.8 Hollow Fiber Membrane

Hollow Fiber Membrane (HFM) is a membrane that can be used to transfer gas and steam hydrophobic (ie volatile and semivolatile organic compounds) between two liquids, usually gas (air) and water (liquid).Membranes are often used in the industry is an asymmetric membrane.

2.8.1 Advantages of Hollow Fiber

Hollow fiber membrane is one of the most popularly used in the industry. This is due to several useful features that make it attractive for the industry. Among others are:

a. Energy needs: In the filtration process no phase change involed. Consequently, it is not necessary latent heat. This makes hollow fiber membranes have the potential to replace several operating units which consume heat, such as distillation or evaporation column.
b. There is no product waste: Since the principal base is hollow fiber filtration, do not generate waste from operation unless the unwanted components in the feed stream. This can help to reduce operating costs for dealing with garbage.
c. large surface per unit volume: Hollow fiber membrane surfaces have large volumes per module. Therefore, the smaller the size of the hollow fiber membranes than other types but can provide higher performance.
d. Flexible: Hollow fiber membranes are flexible, able to perform filtering in 2 ways, both are "inside-out" or "outside-in".
e. Low operating costs: hollow fiber requires lower operating costs compared to other types of operating unit.
f. However, it also has some drawbacks that cause application problems. Among the drawbacks are:
g. Membrane fouling: Hollow fiber membrane fouling more often than other membranes because of the configuration. contaminated feed would increase the rate of membrane fouling, esapecially for hollow fibers.

2.8.2 Asymmetric Hollow Fiber Membrane Applications

Asymmetric Hollow Fiber Membranes can be applied for CO2 Separation of Hydrocarbons and Fluorocarbons. High-pressure carbon dioxide separation of fluorocarbons is essential in the production of fluoropolymers such as poly (tetrafluoroethylene). Plasticize typical polymeric membranes under high pressure CO2 partial conditions. Based on the measured performance of the separation of CO2 / C2H2F2 and CO2 / C2H4 mixture, the selectivity of CO2 / C2 F4 mixture is greater than 100. The long-term stability studies show that membranes provide separation stable for 5 days at 1250 psi partial pressure of CO2, thus making the membrane approaches interesting.

2.9 Polyimide

Aromatic polyimides are typically used for applications in high temperature, because the material can maintain high strength in continuous use at temperatures above 300 ° C for short periods. Continuous film, foil, sheet, fabric or laminate is particularly desirable for use in high temperature electrical insulation for thermal stability and durability of the resin. While the resin substrate imide can be used for circuit boards fireproof, radomes, etc., the use of the most major, namely in the manufacture of thin film to wrap the electric motor or the like, where these materials can withstand high temperatures long term without loss of mechanical or electrical properties. Thermosetting polyimides are very valuable as films, with fused-ring aromatic groups contributes to high thermal stability. High tensile strength in a wide temperature range, dimensional stability, wear resistance, high dielectric strength, chemical resistance, and radiation resistance properties is desirable to use a lot of polyimides. Polyimide films, such as "Kapton", has been found to be used in electric motors are compact, in which the high dielectric strength, and toughness are important, as well as in insulation for aircraft wiring and missiles, etc. In wrapping insulation film, flexibility and elongation of the film is important for allowing polyimide to conform to the shape of the substrate. The film is made by casting can be solution-oriented after removing at least part of the solvent, as the evaporation of the film. Molecular orientation can be done by stretching the film in the machine direction orientation (MDO) and / or transverse direction orientation (TDO) at a temperature of orientation. Typical previous films made by this process can have 10% to 25% elongation before breaking under tensile stress.

2.10 Ultrafiltration Membrane

Operating membrane separation process can be defined as two or more components of the fluid flow through a membrane. The membrane serves as a barrier (Barrier) is a highly selective thin between the two phases, it can only skip certain components and hold the other components of a fluid flow that passed through the membrane (Mulder, 1996). Membrane process involves feed (liquid and gas), dangaya thrust (drivingforce) due to the pressure difference (ΔP), the concentration difference (ΔC) and the energy difference (AE). Ultrafiltration membrane process (UF) is an effort that uses the membrane separation with different thrust force of pressure is strongly influenced by the size and distribution of pore membranes (Malleviale., 1996). The separation process occurs in particles of colloidal size range. The membrane operates at a pressure antara1-5bar and permeability limits ARE1 0-50l / m2.jam.bar. Applied Membrane Technology is to generate clean water with your water quality requirements. The raw water is inserted kebejana containing a semi-permeable membrane, with a tekanan.Ini gave the physical process of separating solute from solvent. The membrane only traversed solvent, while dissolved, either electrolytes or organic, will be rejected (rejection), also prakits to remove organic substances. Other contaminants such as colloidal right retained by the pore structure that acts as a filter (sieve) nominal BM molecule used for ultrafiltration membrane has a porous membrane structure and asymmetric. Membrane advantages compared with conventional treatment in drinking water treatment, among others (Wenten.1996) Requiring lower energy for operation and maintenance, design and construction of small-scale system, the equipment is modular so easy in-scaleup and do not need extreme conditions (temperature and pH). However, membranes have limitations such as the occurrence of the phenomenon of concentration polarization, fouling, which is a barrier for water volumeprocessed generated and also the limitations of the age of the membrane.

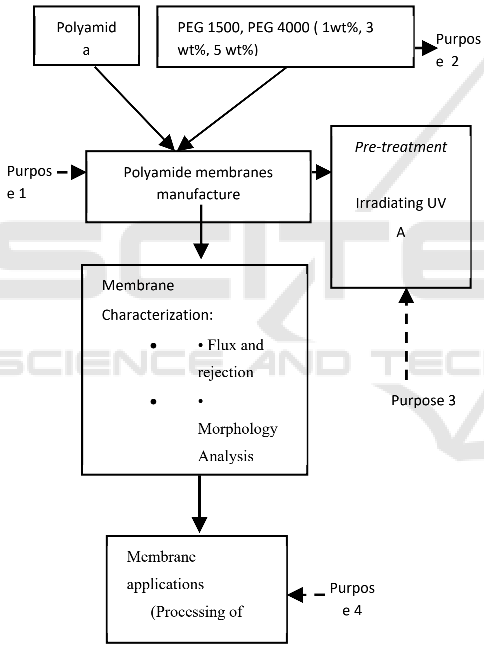
2.11 Produced Water Treatment

Produced water is water from underground rock structure on the source of the oil has been dragged to the ground along with the gas and oil in the exploration and production of fossil fuels. Produced water can be derived from the exploration and production of oil well offshore (offshore) or on land (on-shore). During this time produced water is a byproduct of the largest and regarded as waste in the process of exploration and production of oil and gas. The average ratio of the amount of produced water with oil in oil wells in the world reached 3: 1. The amount of produced water will increase as the old age of exploration and production of oil wells. The content of produced water depends on the geographical location of oil wells, the type of rock structures under the ground, the type of hydrocarbon that is produced, as well as various additive compounds that are used during the exploration and production takes place.

2.12 Future Direction

The research to be undertaken to achieve the goal of the research is expected. The research is divided into three stages, namely the manufacture of Polyamide membranes, characterization stage, and the stage of membrane application for processing produced water. Polyamide membranes at the stage of manufacture begins by making a print solution that consists of Polyamide polymer with composition 18 wt%; additives PEG 1500 and 4000, each with a concentration of 1 wt%, 3 wt%, 5 wt%; and acetone as the solvent. Printing membranes using phase inversion methods. This method is done by printing the membrane on the glass plate using a casting knife, and then the membrane is irradiated with UV light by varying the time for 10, 20, 30 minutes. Furthermore, the membrane is inserted into the coagulation bath with distilled water as non-solvent for 1 hour, followed by immersion in a different coagulation bath for 24 hours. The membranes were dried in an oven at a temperature of 40-50 ° C for 24 hours. The next stages were characterized by determination of flux and rejection, Scanning Electron Microscopy (SEM) and Fourier Transform Infrared (FTIR). After that tested the application of membranes for water treatment produced.

Research Design Diagram:



3 CONCLUSION

Based on literature study that has been described above, To Modify and analyze the factors that can affect the performance of hollow fiber ultrafiltration membrane is one of the processes are applied in water treatment systems because it uses low pressure process that requires less energy and have a very economic cost. Use of the membrane can be formed in a variety of configurations and sizes, Configuration hollow fiber membrane has the advantage of a compact design with a surface area of the membrane is very high, therefore, produce better productivity with support mechanisms that can be returned to the separation of produced water provides good flexibility as well as easy handling during module fabrication operation

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