Synthesis Cellulose Acetate Membranes for Water Treatment in the Coastal Region

Jhon Armedi Pinem* and Vany Silvia
Chemical Engineering Department, Faculty of Engineering Riau University
Bina Widya Campus KM 12.5 Panam-Pekanbaru
Telp./Fax. 0761-566937; Email: jhonarmedi@yahoo.com

ABSTRACT

Indonesia especially Riau Province have several coastal areas. Availability of fresh
water in coastal areas Riau very minimal so that the necessary technology that can
process water at the coast into clean water. Suitable technology used is cellulose acetate membrane technology. In this research is made of cellulose acetate membranes using phase inversion technique by precipitation by immersion. Ethanol is used as a coagulant (non - solvent) with the composition of the casting solution consists of cellulose acetate 17 % w/w , acetone 56 % w/w , and formamide 56 % w/w . Advantages of cellulose acetate as the membrane material is hydrophilic and have durability resistance of fouling, especially protein and fat. Cellulose acetate membranes also possess high flux, a combination that is rare in other membrane materials. Cellulose acetate membranes are relatively easy to manufacture and raw materials are renewable resources. Selection of acetone because acetone capable of dissolving cellulose acetate. Cellulose acetate and formamide are not mutually dissolve (having different polarity characteristics) so it is necessary to dissolve the cellulose acetate phase using acetone. The purpose of the addition of formamide is additive to improve the properties of the membrane surface. With the additives may affect the morphology and structure of membrane performance. The third raw material is capable of producing a white sheet-shaped membrane. To maintain the quality of the cellulose acetate membrane, the membrane is kept in a solution of sodium azide 0.1%.

Keyword: *coastal , cellulose acetate, phase inversion , membranes*

1. Introduction

Indonesia is the largest archipelago in the world and have 17,508 islands with a coastline of 81,000 km. About 60% of Indonesia's population (approximately 185 million people) lives in coastal areas (Anonymous, 2008). For Riau Province are 19.89% of the total area (107,932.71 km2) is an ocean (CPM, 2008). A region bordering the sea is coastal areas. One of the problems faced by the community in the area is difficult to meet the needs of clean water that meets health

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standards. Existing water is generally brackish water (brackish water). Existing watersources is generally brackish water (brackish water). Brackish water (BW) desalination is the main street that is effective to obtain water that is increasingly difficult to obtain (Zhang, 2013).

Brackish water is a mixture of fresh water and sea water (salt water). Brackish water is difficult to be processed into clean water because the salt content is high enough, that is 2000 to 5000 mg/L (Jaber, 2004). The conventional method is used for this difficult to treat brackish water because the salt content is too high. Modern
desalination technologies are thermal distillation and evaporation that is widely used today is indeed capable of doing well brackish water desalination to produce drinking water. However, this technology requires large energy, high investment costs, the structure of complex equipment, requires a fairly large space and maintenance costs led to this technology less competitive (Zhang, 2013). Desalination technology with cellulose acetate membrane is the most economical process for treating brackish water and sea water because of its low cost and energy efficiency (Rahardianto, 2007).

Membrane is generally defined as a selective layer that sits between the two phases, namely phase feed and phase permeate (Mulder, 1996). Membrane processes can also be interpreted as a thin layer of semi-permeable that the inside porous, can pass certain species and species-species withstand larger than the pore size of the membrane (Setiasih, 2009). Separation process in the membrane caused by the driving force (thrust) is given, can be a pressure gradient (ΔP), the

concentration gradient (ΔC), the electrical potential gradient (AE), or the temperature gradient (ΔT) (Mulder, 1996). All kinds of synthesis material can be used to make membranes. The material can be inorganic, organic or a combination of both ingredients. Material modifications can be done with a particular technique to obtain a membrane structure with morphology suitable for the specific separation. According Mulder (1996) there are several techniques available to make the synthetic membrane deposition techniques one of which is through immersion. Deposition technique by immersion is done by casting solution on a glass plate and then immersed in the coagulation bath containing a nonsolvent. At the time of immersion will occur diffusion of the solvent (solvent) in the casting solution to a non-solvent (non-solvent), and of the non-solvent for the polymer. Diffusion that occurs will lead to instability on the polymer solution so happen separation (mixing) that produces an asymmetric membrane. In this technique, the

membranes come through partial evaporation of the solvent in the upper layer, in order to obtain pores with small size. While at the bottom of the membrane will

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experience a rapid loss of solvent due to the diffusion of nonsolvent, so that the resulting pores with a larger size. In the manufacture of cellulose acetate membranes needed polymer cellulose acetate, acetone, and additives formamide. Solvents and additives must be soluble either with a polymer (Setiasih, 2009). Membrane characterization needed to determine the properties of the resulting membrane. Characterization of membrane associated with the structure of the membrane is chemical properties, crystallinity, pore statistics, and thickness, while dealing with membrane function is the permeability and selectivity.

2. Material and Method

Materials. Materials used are cellulose acetate, polyamide, ethanol, benzene, nitrogen gas (N2), HCl, NaOH, H2SO4, NaCl, MgSO4, MgCl2, dextran with various molecular weight and demineralized water .

Preparation of Cellulose Acetate Membrane. Membranes were prepared from a mixture of 17% cellulose acetate, 27% formamide and 56% acetone (Wijoyo, 2002).

Having obtained a homogeneous casting solution mixture, stirring was stopped and the casting solution allowed 13 hours to eliminate air bubbles contained in the solution casting. Casting solution was printed on a glass plate, which at the edges has been given a tape. Casting solution was poured to taste, leveled using a rod stirrer, and allowed to stand in the open air for 30 seconds to evaporate most of the solvent. Furthermore, a glass plate is immersed in the coagulation bath contains ethanol temperature of 4 °C until the film (membrane) in spite of itself.

The membrane produced in this experiment is a flat membrane that is transparent. Membrane allowed for 1 in cold coagulant, then the water flowed for 2,5 hours to remove excess solvent. The membrane was cut a circle with a diameter of 5.5 cm, and then stored in a sodium azide solution 0.1%.

Results and discussion

Cellulose acetate membrane prepared by phase inversion method. The raw materials which used in the synthesis of this membrane are cellulose acetate (17%), acetone (56%) and formamide (27%). The advantage of cellulose acetate as the membrane material is hydrophilic which has good resistance to fouling, especially protein and fat. Cellulose acetate membrane also has high flux rejection ability. This combination is rare in other membrane materials. Cellulose acetate membrane is relatively easy to synthesis and renewable resources.

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The solvent which used in this research is acetone because acetone is able to dissolve cellulose acetate well. Cellulose acetat and formamide are not mutually dissolve (having different characteristic of polarity), so it need process to dissolve the cellulose acetate using acetone. Besides that, acetone can also form pores in the membrane. If composition of acetone which added to synthetis membrane increase, there will be more pores generated.

Raw material which used besides cellulose acetate and acetone is formamide. Formamide used as additive. The purpose of addition of formamide is to improve the characteristics of surface membrane. It may affect the morphology and membrane performance.

The raw materials are inserted into the erlenmeyer gradually while stirring using a magnetic stirrer. Stirring performed in relatively long period in order to make the casting solution becomes homogeneous. After that, stirring is stopped and the casting solution allowed to stand for 13 hours to remove air bubbles which contained in the casting solution. Casting solution was printed on a glass plate, the edges of glass plate have been given the masking tape with a thickness of 120 µm.

Casting solution is poured onto the glass plate, and then flattened using a rod stirrer, and allowed to stand in the open air for 30 seconds to evaporate most of the solvent. Solvent evaporation process affects the resulting of flux, where the flux
becomes lower in the membrane that has a longer evaporation time. When the processing of evaporation, there is an exchange place between molecules of acetone and air. The empty space which left by acetone molecules will be occupied by air molecules. Long evaporation process enables the empty space that formed during the evaporation re-closed thus forming a membrane with a smaller pore size, which can determine the flux generated by the membrane.

Furthermore, a glass plate was soaked in the coagulation bath which containing 1 liter of ethanol with a temperature of 4 °C until the film (membrane) separated by itself (Richa, 2011). Then, the membrane allowed to stand for 1 day in 1 liter of distilled water. After that, the membrane was washed with water for 2.5 hours to remove excess solvent. Then the membrane was cut into 5.5 cm diameter circular shape, and then stored in a solution of 0.1% sodium azide (Richa, 2011). The processing scheme of synthesis membrane can be shown below.

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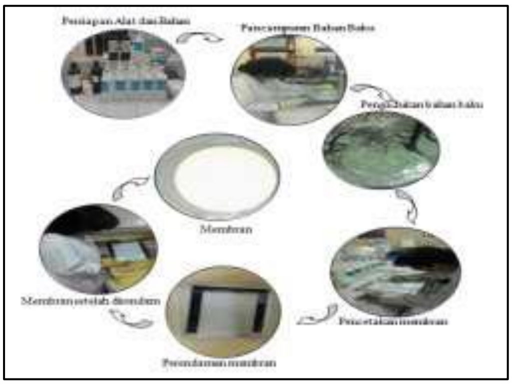

Figure 4.1 The processing scheme of synthesis membrane

Conclusion

Based on the results of this research, we can conclude that by using cellulose acetate as the primary main raw, ethanol and formamide as secondary main raw, we can produce sheet-shaped membrane.

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