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The Utilization of Ceramic Membrane for Treating of Water from Sekanak River Palembang to Produce Clean Water

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Abstract **- The aims of this research is to produce clean water from Sekanak River by using the ceramic membrane. Also, this study is to analyze the performance of ceramic membranes in terms of its ability to reduce the pollutants contained in water from Sekanak River. The ceramic membrane was tube-shaped, made from clay (87.5 %w), iron powder (2.5 %w) and activated carbon of oil palm empty bunch (10 %w). The operation condition of membrane separation was of 15 minutes, 30 minutes, 45 minutes, 60 minutes, 75 minutes, 90 minutes and the applied pressure was of 1.0 bar, 1.5 bar and 2.0 bar. The reduction pollutants (Fe, Mn, Zn, NH_3-N, NO_2^-, PO_4^{-3}, H_2S, BOD_5, and TSS) concentration increased with increasing the pressure and the operating time of membrane separation. After treating by the ceramic membrane, the average rejection of Fe, Mn, Zn, NH_3-N, NO_2^-, PO_4^{-3}, H_2S, BOD_5, and TSS are 81.22%, 95.00%, 99.00%, 85.19%, 78.85%, 73.95%, 97.78%, 87.55%, and 75.46% respectively. The pollutant concentrations in the effluent were met the Environmental Quality Standards (BML).**

Keywords: **water treatment; ceramic membrane; pressure; time operation; clean water.**

I. INTRODUCTION

The clean water demand for the world's communities increases time to time [1]. In Indonesia, it takes a high budget around four trillion rupiah per year to meet the shortage of clean water from 2000 to 2015. This is in line with the agreement of the Millennium Development Goals (MDG) and the UN General Assembly in September 2000 on the need for clean water [2]. Provision of clean water for the community is absolutely done as regulated in Article 5 of Law Number 7 Year 2004 and Law Number 11 Year 2005 regarding resources. Generally, the rural water supply system is a non-piped system because of far-flung residents, while the water supply system in urban areas already use the services of Clean Water Corporation. The river water distributed by the PDAM (clean water supplier) for clean water still does not satisfaction meet the standard of the desired quality. The river water in urban areas is contaminated by household, industrial wastes. The provision of clean water in region of the South Sumatra must meet the standards of quality standards set out in the Governor Regulation of South Sumatra Number 16 Year 2005 on Water Allotment and River Water Quality Standards.

The number of Indonesian's people which continues to grow from time to time affect the needs of clean water [3]. On the water supply side in Indonesia there are still many obstacles, especially in the contaminated riverside area. Indonesia is a maritime country with an area of 1.9 million km^2 and a sea of 5.8 million km^2 [4]. More than 100 million people in Indonesia do not have direct access to clean water and 70% take water from sources that have been contaminated by environmental pollutants. People from this group are susceptible to various diseases [3,5]. The World Water Forum in The Hague in March 2000 has predicted that clean water services for communities are still difficult to implement and Indonesia [6].

The crisis of clean water sometime occurs in Sumatera and Kalimantan especially in dry season. The river water discharge start to decrease, well water has started to dry and concentration of soluble material in surface water is higher, acidic (low pH), brownish and organic [7]. This raises concerns for water users to consume. The difficulty of clean water is also experienced by people in South Sumatera Province especially those domiciled in lowlands area. The peoples in this area generally receive clean water by collecting rainwater (rain-fed water), and some use well water and water in the form of packages sold by drinking water corporation. The availability and quality of water in the lowlands area is affected by topography and rainfall. The rain fall can affect the mineral content, thickness, level of decomposition of organic substances contained in peat soil [8]. The topography of the eastern part of South Sumatera Province is generally a swamp, while the western region is generally a highland with varying topography from flat, undulating to hilly [9].

The Sekanak River is one of the rivers located Palembang City, in the area of lowlands where most of the residents still rely on the river for the purpose of washing and sanitary. The activity of the people around the river greatly affects the quality of river water. In the Sekanak River area, home industrial growth is very fast, such as the traditional food, also business area, residents, traditional market, and others that make this river very susceptible polluted due to these activities. So, to get a source of clean water, some residents use rain-fed water for the domestic sanitation.

Many methods have been applied for river water treatment in lowlands areas such as the use of poly aluminum chloride (PAC) to minimize the color of river water in Siantan Hulu Pontianak City. By using The use of PAC at a dose of 110 mg/L can decrease the color from 624 mg/L PtCo to 15 mg/L PtCo [10]. The "One Stage Coagulation" method was able to reduce the turbidity of 97.18%, 96.79% color and 98.2% organic matter [11]. Then the river water treatment into clean water by Upflow Anaerobic Filter (UAF) and Slow Sand Filter (SSF) method can decrease the water color from 804 mg/L PtCo to 118,4 mg/L PtCo, but the result have not fulfilled the clean water standard as per Permenkes No. 416 / Menkes/PER/IX/1990 [12].

Sample river water treatment using Aerasi Pump and Sieve Matching Technique (TP2AS model) conducted in Pangkoh Central Kalimantan area, able to decrease turbidity from 10 to 1.58 mg/L, color 500 mg/L PtCo to 10,0 mg/L PtCo, Fe from 0.4 mg/ L to 0.18 mg/L [13]. Yusmaniar successfully used bentonite to decrease the Fe^{+3} ion and Cu^{+2} ion parameters in peat water of Siak Riau river [14]. The weakness of this method is the decrease in Fe and Cu ion content has not reached the permitted quality standard and the use of inefficient bentonite 1 kg/50 L of peat water. Bentonite has a good ability that is almost 95% decrease the content of arsenic (As) and copper (Cu) in wastewater [15].

One of the elements contained in tidal river water is heavy metal which is a component very harmful to the environment. Laboratory tests in animals show that severe heavy metal poisoning can lead to tumor progression. From the problems that arise above, so needed another system which more economical and practical in processing river water using ceramic membrane made of clay, iron powder and activated carbon made from empty bunch of palm oil. Ceramic membranes primarily based on Palladium have long been used in microfiltration and ultrafiltration because they are stable against the effects of heat, chemicals and solvents [16].

Some researchers have used membrane separation process to treat water to produce a clean water and treat wastewater to minimize the negative effects. Mataram et.al have published the wastewater using the nanofibre membrane. This technology can remove suspended solid, chemical oxygen demand (COD), ammonium nitrate and pathogen microorganism [17]. An ultrafiltration (UF) with ceramic membranes having a capacity of 1.44 m3/d was used to produce safe and quality drinking water. This small scale UF membrane system was constructed in two parts: one was a tubular ceramic membrane formed by a porous support (α-alumina) and the other was a tube reactor chamber 10 m long and 5 cm in diameter to generate electrocoagulation [18].

The investigation of performance efficiency of a hybrid system, consisting a membrane filtration and ozone oxidation was carried out to treat water with analysing turbidity, pH, UV_{254} absorbance and Total Organic Carbon (TOC) content. The addition of ozone to the hybrid system resulted in a substantial fouling reduction [19]. The ability of low cost ceramic membrane filtration was investigated. This ceramic membrane filtration was applied to remove three common heavy metals namely; Pb^{2+}, Cu^{2+}, and Cd^{2+} from water media. The ceramic membranes was manufactured with dimensions of 15 by 15 cm and 2 cm thickness, and were made from low cost materials of local clay mixed with different sawdust percentages of 0.5%, 2.0%, and 5.0%. According to chemical analysis results, the ceramic membrane showed high removal efficiency up to 99% for the concerned heavy metals [20]. A novel water treatment systems based on ozonation combined with ceramic membranes has been also published. This treatment system was for reducing the refractory organic compounds found in natural water sources such as groundwater. The experimental data showed the membrane contactor efficiency for oxidation of atrazine, endosulfan, and methyl tert-butyl ether (MTBE). Using this system separation, the atrazine degradation higher than 50% could not be achieved even after 60 min of reaction time. The MTBE mineralization by O_3/H_2O_2 combination increased at higher pH values and O_3/H_2O_2 molar ratio of 0.2 reaching a maximum degradation of around 65% [21].

The ultrafiltration (UF) and microfiltration (MF) ceramic membranes were combined with coagulation. This integrated separation system was studied to treat local river water located at Xinghua, Jiangsu Province, China. The evaluation on membrane fouling mechanism indicates that the cake filtration has significant influence on the pseudo-steady flux and water quality. The membrane used has a pore size of 50, 200 and 500 nm. The removal efficiency of turbidity, total organic carbon (TOC) and UV254 were higher than 99%, 45% and 48%, respectively [22]. The surface water from the River Spree in Berlin, Germany as sample water has been treated using the integrated coagulation, flocculation, induced air flotation and ceramic MF/UF membranes. Based on a 12 m^3/d pilot system was done and allowing a flux of 112 l/m^2 h with only limited and controllable fouling. Finally, using an economic analysis (net present value) it is shown that ceramic membranes are comparable in overall costs to polymeric membranes or even lower when high fluxes (150 l/m^2 h or higher) are implemented [23]. A pilot scale to study the effect of pre-treatment on the suppression of irreversible (IR) fouling of ceramic membranes has been investigated. The sample water was three UK surface waters. Tests performed using suspended ion exchange (SIX) and in-line coagulation (ILCA) has been studied. Coagulation pre-treatment provided stable membrane operation and the residual lower molecular weight (LMW) organics were not significantly retained by the membrane. Optimised ILCA pretreatment led to very low IR fouling rates of <0.3 kPa/day [24]. A ceramic membrane with 0.2 μm pore size has been applied to produce a super-hydrophilic surface on the microfiltration membrane. This membrane is capable of maintaining flux with little or no fouling under normal operating conditions. The hybrid membrane-adsorption process has been developed for the production of clean water supplies. The adsorbent was shown to reduce the heavy metals such as Cd, Hg, Ni, Co and Pb to a very high degree of recovery (>99.3% in all cases) and was easily regenerated to almost complete adsorptive capacity [25]

The advantage of the ceramic membrane is good thermal stability, resistant to chemical substances, resistant to biological or microbial degradation. These properties show a better than membranes made of polymer compounds. The ceramic membrane is relatively easy to clean with a cleaning agent. Due to resistance to chemicals causes ceramic membranes to be widely used in food processing, biotechnology and pharmaceutical products [26]. In the use of ceramic membrane as a river water treatment is expected to reduce the physical, chemical and biological parameters contained in river water in accordance with the South Sumatra Governor Regulation No. 16 of 2005 on Water Allotment and River Water Quality Standard.

Ceramic membrane performance can be measured from the value of flux and removed pollutants. The flux and removed pollutant are influenced by various factors, such as operating pressure, pollutant concentration in feed water, preliminary processing, type of filter media used and the time of operation. The main materials used in the manufacture of this ceramic membrane are clay. The clay will become a hard and rigid lump if it is dry, but will be plastic and attached if wet due to exposure to water, and will be vitreous if the clay is burned with high temperature. The use of clay in the membrane-making process serves to form and adhere the membrane mixture to a hard and rigid lump after the sintering process [27]. In addition, clay has a very low permeability (Sandra's ability to pass water). Another material used in the manufacture of ceramic membranes is activated carbon made from oil palm empty bunch as additive and iron powder. After tested using SEM-EDS, it is known that the greatest content of this additive is carbon (C) of 99.17% [28]. Oil palm empty bunch is one of good quality materials to be used as raw material of activated carbon. Preparation of activated carbon takes place in three stages: dehydration process, carbonization and activation process [29]. The iron powder used to form ceramic membrane serves as aggregate material. Besides its abundant availability in nature and easy to process, iron powder when mixed with other metals and carbon will produce very hard structures. If the composition of iron powder used for 2.5% will produce a compressive strength of 22.55 Mpa [30].

The purpose of this study is to treat water from Sekanak River by using ceramic membrane to produce clean water. Also this study is to analyze the performance of ceramic membranes in terms of its ability to reduce the pollutants contained in river water.

II. Material and Method

The ceramic membrane was tube-shaped, made from clay (87.5% w), iron powder (2.5% w) and activated carbon of oil palm empty bunch (10% w). The housing membrane was made of glass fiber with outer diameter of 9 cm, 8.5 cm of inner diameter and 30 cm in length. The water used as feed water was taken from the Sekanak River (flows to Musi River in Palembang). The pretreatment of river water sample by filtration technique used a sponge filter with 0.5 μm and 0.1 μm pore diameter, and activated carbon adsorption.

The variables were divided into two categories, namely treatment and response variables. For the treatment variables in this experience were the operating pressure, feed flow discharge and membrane separation operation time. The response variables of the study was the measurement of physical and chemical parameters. Physical parameters such as temperature, TDS and TSS, and chemical parameters of chemical parameters such as pH, iron (Fe), manganese (Mn), Zinc (Zn), sulfate ($SO4^{-2}$), BOD_5, free ammonia (NH_3¬ N), nitrite (NO_2^-), phosphates (PO_4^{-3}) and sulfides (H_2S) commonly contained in river water.

Initial concentration of the pollutants contained in the water sample of the river was measured. Sampling of river water that has passed the complete separation process was also taken every 15 minutes, 30 minutes, 45 minutes, 60 minutes, 75 minutes, and 90 minutes. The operation pressure was of 1.0 bar, 1.5 bar, and 2.0 bar.

III. Results and Discussion

A. *The effect of pressure and time operations on the flux in ceramic membrane.*

The performance of the ceramic membrane can generally be shown by permeate flux, magnitude of permeability, membrane selectivity to certain chemical pollutants and the percentage of rejection of undesirable pollutants in the feed. The augmenting of the permeability and the selectivity level of a ceramic membrane, show a better membrane performance.

The Figure 1 shows the effect of operation pressure of feed river water and the operation time of ceramic membrane separation on permeate flux. The different permeate flux was affected by the applied pressure on the membrane separation. The Increasing of operation pressure increased the permeate flux. This condition caused the increasing of flow rate of permeate. Contrary, increasing of operation time of membrane separation decreased the permeate flux, because the pore of ceramic membrane more and more will be covered by pollutant particles.

Before 30 minute of operation, the permeate flux of three different pressure decreased rapidly, but after 30 minutes of operation until 90 minutes, the permeate fluxes decreased slowly. The phenomena was caused by the pollutant time to time covering the pores of ceramic membrane. Consequently, that fluid was difficult to pass the pore. The highest permeate flux (81.53 x 10^2 L/ m^2.h) for this Sekanak river water was achieved at the pressure of 2 bar and the lowest flux value (2.29 x 10^2 L/m^2.h) was reached at 1.0 bar of pressure at 90 minute of operation.

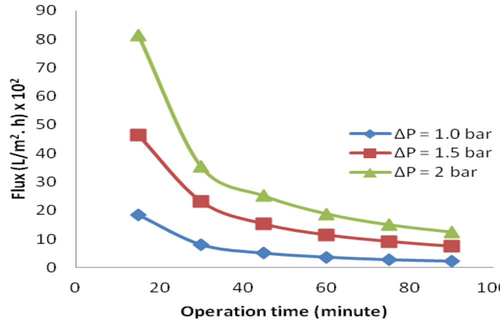

Fig. 1. The effect of applied pressure and time of separation process on permeate flux of the Sekanak river water.

B. *The effect of pressure and time operations on decreasing of Fe, Mn, Zn, NH_3-N, NO_2^-, PO_4^{-3}, BOD_5, H_2S, and TSS concentrations.*

The performance of membrane can be calculated by the ability to reduce the concentration of pollutants. The Figure 2 to Figure 10 show the decreasing concentration of Fe, Mn, Zn, NH_3-N, NO_2^-, PO_4^{-3}, BOD_5, H_2S, and TSS in the permeate until 90 minutes of operation ceramic membrane with variation pressure of 1 bar, 1.5 bar and 2 bar.

Figure 2 as following shows the effect of applied pressure and time of ceramic membrane separation process on Fe concentration of river water.

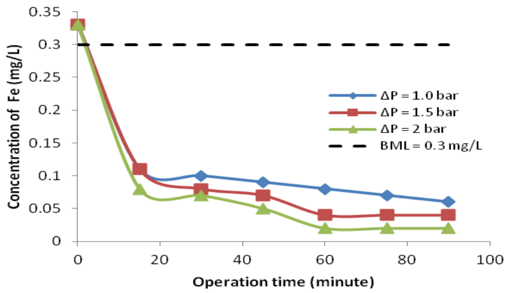

Fig.2 The effect of applied pressure and time of separation process on Fe concentration of river water.

Before treating of water of Sekanak River using the ceramic membrane, this untreated water was passed through the pretreatment process by using activated carbon. The iron concentration in the Sekanak water after adsorption was of 0.33 mg/L, while the value the Environmental Quality Standard (BML) for Fe is 0.3 mg/L. So, the concentration of Fe in the Sekanak water after adsorption was greater than the Environmental Quality Standard (BML) value. By using ceramic membrane operation, the Fe concentration was decreased to 0.11 mg/L after 15 minutes at the pressure of 1 bar operation. Based on the Figure 2 above, the highest reduction of Fe concentration in permeate was at 2 bar pressure at operating time of 60 minutes and 90 minutes reaching to 0.02 mg/L, or Fe rejection percentage is of 93.94 %. The lowest decreasing of Fe concentration was of 66.67 % at 1 bar pressure and 15 minutes operation time. This Fe concentration reached in permeate was met the Environmental Quality Standard.

In Figure 3 as following, the concentration of Mn in the feed from the Sekanak River after passing in the pretreatment process using activated carbon was of 0.22 mg/L, and this concentration of Mn was greater than the Environmental Quality Standard (BML) (0.1 mg/L). After treating in membrane operation, the concentration Mn reduced to < 0.003 - 0.03 mg/L.

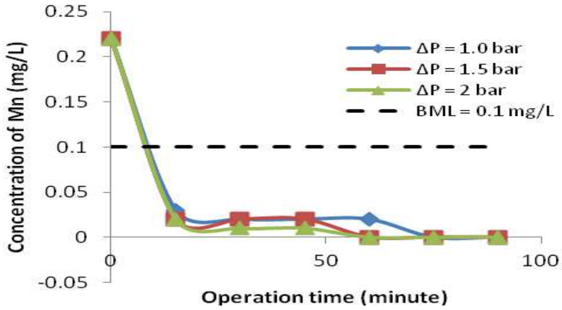

Fig. 3. The effect of applied pressure and time of separation process on Mn concentration of river water.

According to the Figure 3, the highest decreasing of concentration of Mn in permeate was occurred at 2 bar pressure and at operating time from 60 minutes to 90 minutes, and attained to < 0.003 mg/L, or the Mn rejection percentage was of 96.51 %. The lowest decreasing of concentration of Mn was of 86.36 % at the operation condition of 1 bar pressure and at the operating time of 15 minutes

Figure 4 as below shows the reduction of Zn concentration after passing ceramic membrane process. The Zn concentration was reduced from 0.1 mg/L become < 0.003 mg/L. This Zn concentration in effluent was lower than the maximum of Zn concentration according to the Environmental Quality Standard (0.05 mg/L). Based on the Figure 4, the highest permeate decreasing of concentration of Zn was occurred at the operation condition of 2 bar pressure and at operating time from 15 minutes to 90 minutes, attaining to <0.003 mg/L, or the Zn rejection percentage was of 99.00%.

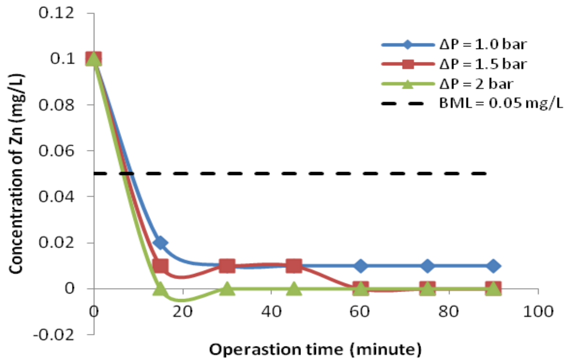

Fig. 4. The effect of applied pressure and time of separation process on Zn concentration of river water.

The Figure 5 shows the effect of the applied pressure and the time operation of membrane separation on NH_3-N concentration in river water.

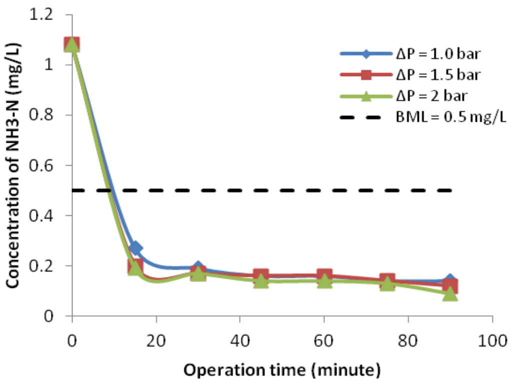

Fig. 5. The effect of applied pressure and time of separation process on NH_3-N concentration of river water.

The NH_3-N concentration in river water after pretreated by activated carbon adsorption was of 1.08 mg/L. This concentration was greater than the Environmental Quality Standard value (0.5 mg/L). Based on the Figure 5, the highest reduction of permeate NH_3-N concentration decreased at the operation condition of 2 bar pressure at operating time from 90 minutes, where the NH_3-N concentration reached 0.09 mg/L, or the NH_3-N rejection was of 98.78 %. The lowest reduction of NH_3-N concentration was of 96.35 % at the operation condition of 1 bar pressure and at 15 minutes operation time. The NH_3-N concentration in effluent was met the Environmental Quality Standards (BML).

The Figure 6 shows the effect of applied pressure and time of separation process on NO_2^- concentration of Sekanak River water. The concentration of NO_2^- in the feed of the Sekanak River that passed the process of pretreatment by using activated carbon adsorption was 0.104 mg/L.

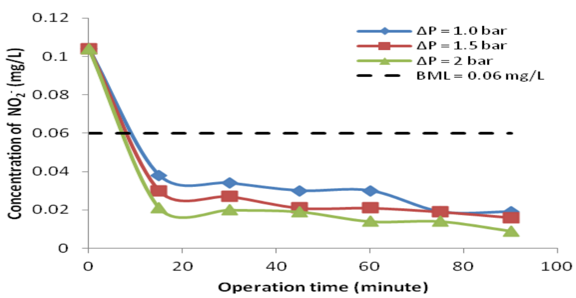

Fig. 6. The effect of applied pressure and time of separation process on NO_2^- concentration of river water.

This concentration is still higher than the Environmental Quality Standard (0.06 mg/L). After application of ceramic membrane separation, the nitrite concentration reduced to 0.009-0.038 mg/L. Based on the Figure 6, the highest reduction of NO_2^- concentration in permeate occurred at a pressure of 2 bar and at the time of 90 minutes operation, which reached 0.009 mg/L with NO_2^- rejection percentage of 91.35 %. The lowest reduction of NO_2^- concentration was 63.46 % at the condition operation of 1 bar pressure and at the operation time of 15 minutes. The NO_2^- concentration in effluent after ceramic membrane separation is met the Environmental Quality Standards (BML).

The Figure 7 shows the effect of applied pressure and time of separation process on PO_4^{-3} concentration of river water.

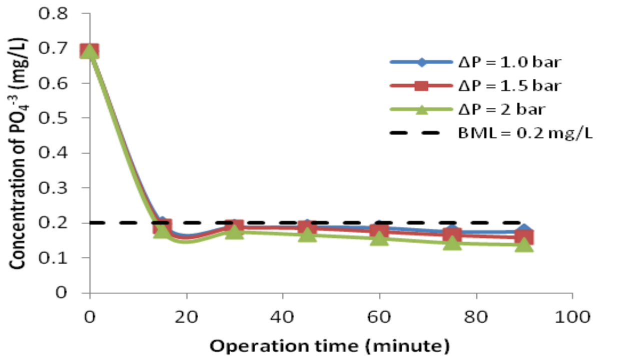

Fig. 7. The effect of applied pressure and time of separation process on PO_4^{-3} concentration of river water.

The PO_4^{-3} concentration in the water from the Sekanak River after pretreatment was of 0.691 mg/l. Thus value was greater than the Environmental Quality Standard value (0.2 mg/L). After membrane separation operation, PO_4^{-3} concentration decreased to 0.138 - 0.198 mg/L. The highest reduction of phosphate concentration in permeate was occurred at 2 bar pressure and at 90 minutes operation time, where the PO_4^{-3} concentration reached of 0.138 mg/L or the rejection percentage is of 80.03 %. The lowest of PO_4^{-3} rejection was 71.35 % at operation condition of 1 bar pressure and 15 minutes operation time. The PO_4^{-3} concentration in effluent is met the permissible Environmental Quality Standards (BML).

The Figure 8 shows the effect of applied pressure and time of separation process on BOD_5 concentration of river water.

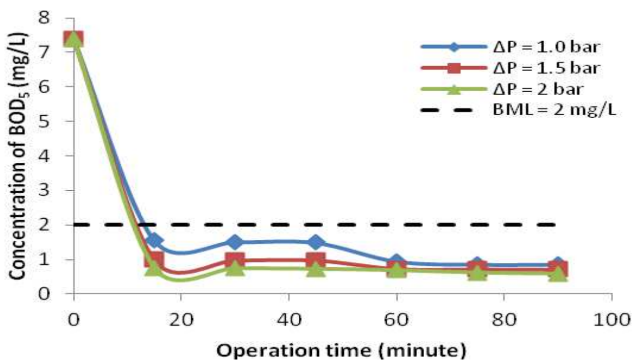

Fig. 8. The effect of applied pressure and time of separation process on BOD_5 concentration of river water.

The BOD_5 concentration in the feed water from the Sekanak River after pretreatment was of 7.39 mg/l. Thus value was greater than the Environmental Quality Standard value (2 mg/L). According to the Figure 8, the highest reduction of BOD_5concentration in permeate was occurred at 2 bar pressure and at 90 minutes operation time, where the BOD_5 concentration reached of 0.59 mg/L or the rejection percentage is of 92.02 %. The lowest of BOD_5 rejection was of 78.89 % at operation condition of 1 bar pressure and 15 minutes operation time, where BOD_5 concentration in effluent was of 1.5mg/L. The BOD_5 concentration in effluent is met the permissible Environmental Quality Standards (BML).

The effect of applied pressure and time of separation process on H_2S concentration of river water is shown on the Figure 9 as below.

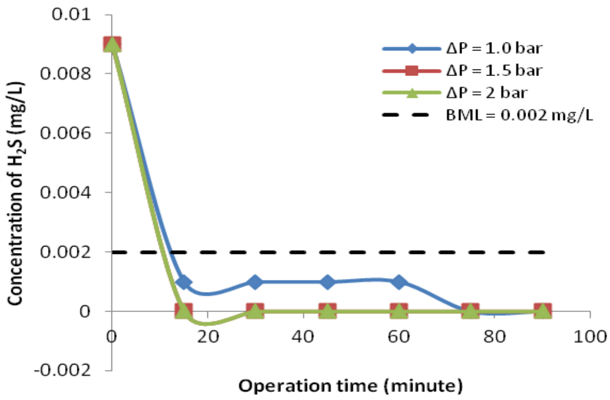

Fig. 9. The effect of applied pressure and time of separation process on H_2S concentration of river water.

Based on the Figure 9, the ceramic membrane used in this study can eliminate H_2S concentration in feed water of 0.009 mg/L become clean water. According to the Figure 9, the highest reduction of H_2S concentration in permeate was occurred at 1.5 bar pressure and at 15 minutes operation time, where the H_2S concentration rejection percentage was of 100.00 %. The lowest of H_2S rejection was 88.89 % at operation condition of 1 bar pressure and 15-60 minutes operation time, where H_2S concentration in effluent was of 0.001 mg/L. The H_2S concentration in effluent is met the permissible Environmental Quality Standards (BML).

The Figure 10 shows the effect of pressure and time of separation process on reduction of TSS concentration of river water.

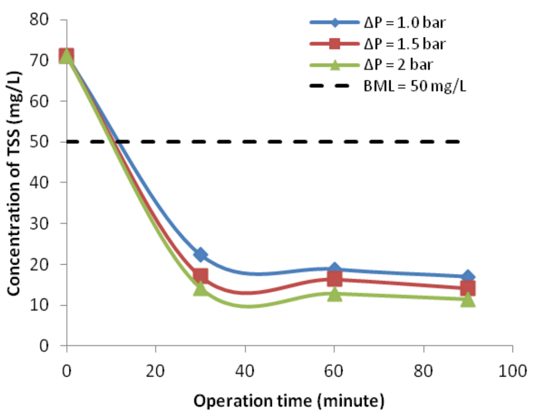

Fig.10. The effect of applied pressure and time of separation process on TSS concentration of river water.

Based on Figure 10 above shows that the membrane performance will increase with the increasing of the applied pressure. So the TSS rejection will be increased when the pressure operation is increased. The highest percentage of rejection of TSS concentration was achieved of 86.91% at 2 bar pressure and 90 minutes operation time. The smallest reduction of TSS concentration was of 11.4 mg/L. If the operating pressure applied to the membrane is too low, so the suspended particles set aside for the membrane will be slightly. Otherwise the higher the operating pressure applied to the membrane, the higher the percentage of TSS rejection in the permeate was accured. This is due to the speed of the fluid passing through the membrane will accelerate, so that suspended particles with high molecular weight or large particles can not pass through the membrane. This causes the particle deposition on the membrane surface to be more easily formed and makes it harder for the suspended particles to penetrate the membrane along with the feed, thereby reducing the permeate TSS level and finally increasing the percentage rejection of the suspended particles was carried out.

According to the Figure 2 to Figure 10, the reduction of pollutants (Fe, Mn, Zn, NH_3-N, NO_2^-, PO_4^{-3}, BOD_5, H_2S, and TSS) concentration were increased with increasing the pressure and the operating time of membrane separation. This phenomena is due to the concentration of polarization, i.e. the concentration of pollutant in the membrane wall was greater than the concentration of pollutant in the feed solution. With increasing concentrations of pollutant on ceramic membrane walls, the flow rate across the membrane was reduced.

Table I shows the results of Sekanak Rivers's water treatment to produce clean water.

According to Table 1, the pollutans concentration in water of Sekanak River that were greater than the The Environmental Quality Standard value are Fe, Mn, Zn, NH_3-N dan PO_4^{-3}, NO_2^-, BOD_5, H_2S, and TSS.

TABLE I.
THE RESULTS OF SEKANAK RIVERS'S WATER TREATMENT TO PRODUCE CLEAN WATER.

Parameter	**Unit**	**Initial**	**SF-I**	**SF-II**	**ACF**
pH	-	10.4	8,9	8,7	8,8
Temperature	^{0}C	30.8	30.7	30.4	30.7
TDS	mg/L	295	274	253	255
TSS	mg/L	87.1	71.4	71.4	71.2
Iron (Fe)	mg/L	0.36	0.33	0.33	0.33
Manganese (Mn)	mg/L	0.25	0.22	0.22	0.22
Zinc (Zn)	mg/L	0.14	0.10	0.10	0.10
Sulfate (SO_4^{-2})	mg/L	283	267	258	257
Ammonia (NH_3-N)	mg/L	1.37	1.19	1.11	1.08
Nitrite (NO_2^-)	mg/L	0.237	0.213	0.107	0.104
Sulfide (H_2S)	mg/L	0.01	0.009	0.09	0.009
Phosphate (PO_4^{-3})	mg/L	0.870	0.791	0.691	0.691
BOD_5	mg/L	7.90	7.89	7.39	7.39
Parameter	**Unit**	**Initial**	**CM**	**%R**	**Std***
pH	-	10.4	8.34	-	6 - 9
Temperature	^{0}C	30.8	30.97	-	Dev. 3
TDS	mg/L	295	195.28	23.42	1000
TSS	mg/L	87.1	17.47	75.46	50
Iron (Fe)	mg/L	0.36	0.06	81.82	0.3
Manganese (Mn)	mg/L	0.25	0.011	95.00	0,1
Zinc (Zn)	mg/L	0.14	<0.003	99.00	0.05
Sulfate	mg/L	283	17.83	93.06	400

(SO_4^{-2})					
Ammonia (NH_3-N)	mg/L	1.37	0.16	85.19	0.5
Nitrite (NO_2^-)	mg/L	0.237	0.022	78.85	0.06
Sulfide (H_2S)	mg/L	0.01	0.0002	97.78	0,002
Phosphate (PO_4^{-3})	mg/L	0.870	0.18	73.95	0,2
BOD_5	mg/L	7.90	0.92	87.55	2

Note :
SF-01 : Sponge Filter, size : 5µm
SF-02: Sponge Filter size :1 µm
ACF : Activated Carbon Filter
CM : Ceramic Membrane
R : reduction
Std* : Environmental Quality Standard (BML) based on The Governor Decree of South Sumatera Province, No. 16 Year 2005

The number of pollutans that filtered on the wall of the ceramic membrane was occurred by the increasing of pressure (*drifing force*). small size element will be rapidly passed throught the wall of ceramic membrane. Contraly, big size element will be filtered on the surface of the wall of membrane. This condition caused the pollutant concentration on the surface of the ceramic membrane will be denser than the pollutan concentration in permeate passing throught the wall of ceramic membrane. More higher pressure applied on the ceramica membrane, so more pollutants filtered on the wall of ceramic membrane. Consequently, the pollutant rejection will be increased. Based on Table I, the average rejection of Fe, Mn, Zn, NH_3-N, NO_2^-, PO_4^{-3}, H_2S, BOD_5 and TSS are 81.22% ; 95.00%; 99.00%; 85.19%, 78.85%, 73.95%, 97.78%, 87.55%, and 75.46% respectively. Generaly, the pH value of the feed water from Sekanak River was decreased from 10.4 to 8.8 after passing the activated carbon filter, and finally decreasing to 8,34 after passing to ceramic membrane. This pH decreasing was caused by filtering of the PO_4^{-3} on the wall of the ceramic membrane. The PO_4^{-3} ion has base characteristic in the feed water. The value of pH in the outlet of ceramic membrane was met to the Environmental Quality Standard (BML).

C. Characterization change of membrane ceramic

Table II shows the analysis of energy disperse spectroscopy (EDS) on ceramic membrane made from activated carbon of oil palm empty bunch.

TABLE II
ANALYSIS OF ENERGY DISPERSE SPECTROSCOPY (EDS) ON CERAMIC MEMBRANE MADE FROM ACTIVATED CARBON OF OIL PALM EMPTY BUNCH

Component	(keV)	Mass (%)	Error (%)	Atom (%)
Carbon (C)	0.277	30.37	0.24	40.70
Oxygen (O)	0.525	45.17	0.22	45.32
Aluminium (Al)	1.486	8.92	0.15	5.31
Silica (Si)	1.739	15.19	0.19	8.68
Total		100.00		100.00

In Table II above shows that there is an increasing of the mass of silica, aluminum and oxygen on the membrane. This increasing was obtained from the addition of clay to the manufacture of membranes where it is known that the compounds contained in the clay are silica, aluminum oxygen and carbon. However from Table II above also shows that there is a decreasing in carbon mass on the membrane, because when sintering, carbon compounds will bind to the oxygen to form a volatile CO2 compound.

The Table III shows the Analysis of Energy Disperse Spectroscopy (EDS) on ceramic membrane made from activated carbon of oil palm empty bunch after used for river water treatment

TABLE III
ANALYSIS OF ENERGY DISPERSE SPECTROSCOPY (EDS) ON CERAMIC MEMBRANE MADE FROM ACTIVATED CARBON OF OIL PALM EMPTY BUNCH AFTER USED FOR RIVER WATER TREATMENT

Element	% Mass				Average
	Spot-1	Spot-2	Spot-3	Spot-4	
C	13.11	55.09	30.59	21.80	30,15
O	44.10	28.67	40.04	44.26	39.27
Zn	1.53	0.29	0.49	0.53	0.71
Al	16.13	5.38	8.73	10.53	10.19
Si	21.95	8.36	16.76	19.86	16.73
Mn	1.70	0.29	0.64	0.64	0.82
Fe	1.47	1.93	2.75	2.39	2.14

Based on the Table III above, it shows that there is a new compound namely Fe, Mn and Zn on the membrane. It is considered that the heavy metals that are compounds of river water contaminants. That component can be inhibited by the membranes used in this study. This is in accordance with the theory of concentration polarization, in which the contaminant compound will be concentrated on the membrane wall. So, the resulting permeate will be less concentration of the contaminant and will increase the reduction value. This proves that by increasing the differential trans-membrane pressure acting on the filtration process will decrease the permeate concentration caused by the concentration polarization and vice versa, this will increase the percentage reduction of the contaminant compound.

IV. CONCLUSSION

According to the results of this research, the reduction pollutants (Fe, Mn, Zn, NH_3-N, and PO_4^{-3}) concentration increased with increasing the pressure and the operating time of membrane separation. After treating by the ceramic membrane, the average rejection of Fe, Mn, Zn, NH_3-N, NO_2^-, PO_4^{-3}, H_2S, BOD_5, and TSS are 81.22% ; 95.00%; 99.00%; 85.19%, 78.85%, 73.95%, 97.78%, 87.55%, and 75.46% respectively. The pollutan concentrations in the effluent were met the Environmental Quality Standards (BML).

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