Formulating an Anorganic Membrane Using Clay, Activated Carbon and Micro Zeolite as Filter Media for Peat Water Purification

N Nahar, S Saifuddin, Muhammad Sami
Chemical Engineering Department, Politeknik Negeri Lhokseumawe
Jl. Medan-Banda Aceh, Buketrata, Lhokseumawe
E-mail: nahar@gmail.com

Abstract. Peat water is surface water in swampy or lowland areas that has a high color intensity, low pH (3-5) and strongly metals' bonded. In proper treatment, the existence of peat water can meet the needs of the surrounding community. Additionally, keeping clean water or drinking water can be helped by the alternative treatment of peat water. Peat inorganic ceramic membrane which can be in accordance with water quality based on the Regulation of the Minister of Health of the Republic of Indonesia Number: 492 / Menkes / Per / IV / 2010. Ceramic membrane made from clay and modified with activated carbon and zeolite in such way turned out to be able to produce drinking water in accordance with drinkable water standards. This study aims to determine the membrane's ability to treat peat water and determine the magnitude of turbidity reduction, total dissolved solid (TDS), pH, Fe and Mn and E. coli bacteria. This research was carried out by filtering peat water through the membrane. Membranes was made of tubes with specifications used are 7 cm high and 6.8 cm in diameter and 0.8 cm wide with various mixture of clays, activated carbon and zeolites. The compositions are 80; 10; 10; 70; 20; 10; 60; 30; 10, 50; 40; 10, respectively, and 140 mesh active carbon size variations. After the investigation, it turns out that all of the composition 80; 10; 10 (clay: activated carbon: zeolite) with a combustion temperature of 800°C is the best membrane removal result that produces standards drinkable water content with clear color intensity.

1. Introduction
Well water and river water are peat water sources in Indonesia that can be processed into water consumption. Since these waters generally do not meet the requirements of clean water so further processing is needed.

The development of clean water treatment technology with membrane technology is a promising treatment process with good quality and also suitable for drinking water treatment in developing countries because membranes have many advantages. The common filter used is the ceramic membrane as one of the appropriate technologies. Among the advantages of membrane technology are producing quality water, using less chemicals, ease of operation (automatic), being able to set aside pollutants in a large range so that it does not require a large place and a ceramic water filter then produce water that is free from dirt or microorganisms.

In reference [1], the authors have made ceramic membranes to improve the quality of swamp water. The results of this study show that the performance of ceramic filters made from a mixture of clay, coal fly ash and iron powder is relatively effective in producing good quality permeate. This is reflected in
the reduction in the content of heavy metal iron (Fe) ions in swamp water to reach 91.54% and the content of organic matter (KmnO4) reached 84.83% followed by a reduction in total dissolved solid (TDS) approximately 60.2% [2] and [3].

Porous carbon, or better known as activated carbon, is used as an adsorbent for color removal, waste treatment, water purification. Activated carbon is charcoal that has changed its physical and chemical properties due to the activation treatment carried out with activators of chemicals or by heating at high temperatures. Activated carbon then forms amorphous which consists mainly of free carbon and has a hollow inner surface, black color, odorless, tasteless, and has a far greater absorption compared to carbon that has not undergone the activation process [4] and [5].

Zeolites are a group of non-metal natural minerals which have a chemical structure of aluminum-silicate framework found in nature with high cation exchange capacity, high adsorption and hydration-dehydration properties. The color of the zeolite itself is white-grayish, white-greenish, and yellowish-white. The size of the zeolite ranges from no more than 10-15 microns.

In this research, a ceramic membrane was made using clay, activated carbon nanoparticles and zeolite nanoparticles as drinking water filter media. Nanoparticles are currently used for the developments in science and technology. Nano-scale material that can enhance the physical, mechanical and chemical properties of a material without having to damage the atomic structure.

Additionally, this research aims to find alternative water treatment. Basically, ceramic material has sufficient porosity to separate impurities, is relatively durable and has sufficient mechanical strength and is not reactive to water.

2. Method

2.1. Materials and Tools

The tools used are Digital Scales, Turbidimeters, TDS meters, pH meters, Sieve size 140, planetary ball milling Fritsch pulverisette, PSA and AAS. Materials used are Clay, Zeolite, Activated Carbon, HCl 2M and Aquadest.

2.2. Substance Activation

The used chemical substances such as zeolite, activated carbon and zeolite particles must activate in a chemical process before being used as filter media for the peat water treatment. The making of ceramic membrane as the mixture of clays and those mentioned substances also put into account.

2.2.1. Zeolite Activation. This activation is proceeded by grinding zeolite as much as 2 kg then soaked with 2.2 litters of 2M HCl solution for 1 hour, filtered, washed with distilled water until the pH of the zeolite is neutral and roasted at 130°C for 4 hours.

2.2.2. The making of Activated Carbon Particles and Zeolite Particles. Zeolites are sieved with 140 mesh sieves. The making of zeolite particles and activated carbon particles was carried out using the top down method using the planetary ball milling Fritsch pulverisette by grinding the starting material (zeolite and activated carbon) into the milling device. Every milling time, 80 grams of zeolite is utilized by using a ball mill with a speed of 350 rpm lasts for 6 hours.

2.2.3. The making of Ceramic Membranes. Mixing clay with activated carbon and zeolite particles in a ratio 80%; 10%; 10%, 70%; 20%; 10%, 60%; 30%; 10% and 50%; 40%; 10%. Then added water and stirred evenly. After that the material is printed manually shaped tube. The printed material is dried at room temperature for 4 days. The printed material is burned with a combustion temperature of 600°C, 700°C and 800°C so that a complete dehydration (drying) and vitrification (change of chemical elements from clay to ceramic) forms a ceramic filter.
3. Results and Discussion
Based on the peat water test results obtained from the analysis of the initial characteristics of several parameters listed in table 1.

In reference to the standard of drinking water quality in the Republic of Indonesia Ministry of Public Health Regulation No. 492 / MECHANISM / PER / IV / 2010 [6] and thus the peat water has exceeded the threshold for use as drinking water. Therefore, peat water should be treated first before being used as drinking water.

Table 1. Considered parameters

| Parameter | Units | Value |
|-----------|-------|-------|
| TDS       | mg/L  | 550   |
| Turbidity | NTU   | 2.99  |
| pH        |       | 5.5   |
| Fe        | mg/L  | 1.2143|
| Mn        | mg/L  | 7.1294|

However, in this paper the considered parameter that put into the discussion is turbidity. As illustrated in Figure 1.

Figure 1. Effect of burning temperature of membranes on the efficiency of allowance for turbidity content

The highest efficiency of turbidity reduction is a membrane with a composition of 60%: 30%: 10% at a temperature of 600°C of 94.64%. in addition, the lowest turbidity reduction efficiency is membrane with a composition of 80%: 10%: 10% at a temperature of 800°C that is equal to 38.46%. The amount of turbidity removal efficiency in peat water is influenced by the combustion temperature that is not too high as well as the large amount of activated carbon that varies with the clay and zeolites in the membrane. While the value of turbidity removal efficiency is small which is influenced by high combustion temperatures, causing large pores and cracks in the membrane that make the turbidity in peat water not filtered properly.

4. Conclusion
Based on the results, it can be concluded that clay-based earthenware filters with a mixture of activated carbon and zeolite can reduce turbidity. The best decrease in turbidity is at a temperature of 600°C with a composition of clay: active carbon: zeolite (50%: 40%: 10%). The more activated carbon used in the
making of membranes, the more pores are formed and also form a larger surface area so that more particles are retained and conversely the less active carbon is used the smaller the surface area so that the particles are retained less.

References

[1] Agmalini, S., Lingga, N.N and Nasir, S. 2013. Improving Swamp Water Quality Using Ceramic Membranes Made from Clay and Coal Fly Ash. Journal of Chemical Engineering. Vol.19 (2), p. 59-68.

[2] Anggriawan, A., Saputra, E and Olivia, M. 2015. Allowance for Fe and Mn Metal Content in Peat Water by the Utilization of Kaolin Geopolymers as Adsorbents. Jom FTEKNIK. 2 (1), p. 1-6.

[3] Baker, W.R. 2004. Membrane technology and Applications., 2nd edition., California: Jon Willey & Sons.

[4] Asip, F and Okta, T. 2013. H2s Adsorption on Natural Gas Using Ceramic Membranes with Iodometric Titration Method. Journal of Chemical Engineering. 19 (4), p. 22-28.

[5] Nurhayati, C and Susanto, T. 2015. Utilization of Fly Ash Coal as a Ceramic Membrane Material in the Peat Water Treatment Unit. Journal of Industrial Research Dynamics. 26 (2), p. 95-105.

[6] Indonesia Ministry of Public Health, 2010. Regulation of the Minister of Health of the Republic of Indonesia. No. 492 / MENKES / PER / IV / 2010 concerning Drinking Water Quality Requirements. Jakarta: Ministry of Health.