Portable Drinking Water Processing Equipment using Membrane Innovation of Palm Oil Fuel Ash (POFA) Activated Orange Peel Powder (OPP) for Peat Water

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Abstract

Water is a natural resource that has a very important role in human life. 14% of Jambi Province is peatland, making water sources dominated by peat water. Peat water is not suitable for drinking and requires further processing for consumption. Membranes are a technology with low energy consumption and simple designs that can be used to treat high quality drinking water. Membranes can be made from natural materials, one of which is using Palm Oil Fuel Ash (POFA). POFA is dominated by SiO_2 content up to 60% which can be used as an adsorbent membrane for peat water treatment. POFA's membrane can be activated by Orange Peel Powder (OPP) from its citric acid content. The membrane is made with variable POFA - OPP mixture ratios of 5:5, 7:3, and 9:1. The membrane has a particle size of 100 mesh and a large porous surface, so it can inhibit particles in water. POFA - OPP membrane technology can be applied as a portable equipment for processing drinking water from peat water. This innovation can be used as an environmentally friendly and economical technology and also can be easily used by the public to having drinking water standards.

Keywords: *membrane, drinking water, peat water, palm oil fuel ash (POFA), orange peel*

1. Introduction

Water is a natural resource that has a very important role in human life[1]. Water treatment is needed as the first step in using water for human needs, especially for consumption needs as drinking water[2]. Jambi is a province that has the 3rd largest peatland on Sumatra's island. The area of peatlands in Jambi Province reaches 736,227.20 ha or around 14% of the area of Jambi Province (Jambi Provincial Forestry Service, 2018). The large area of peat land in Jambi Province means that the water sources in this province are dominated by peat water. Peat water is a form of ground water or surface water found in swampy and lowland areas[3]. Peat water must go through processing first to be suitable for drinking water.

Drinking water processing technology continues to develop. One technology that has recently been widely used for drinking water treatment is membrane technology. In the process of drinking water treatment, membrane technology is able to produce high quality drinking water. Membrane technology offers several advantages, such as low energy consumption, simple operating system, smaller land requirements due to the modular design of the membrane system, and is environmentally friendly[4]. Filtration membranes can be used as a drinking water treatment technology. This membrane can be applied using the adsorption method, so that it becomes a combination of water treatment technology that has quite high quality. However, membranes have one drawback, namely that they are more expensive than other processing technologies, so innovation is needed in making membranes to reduce the costs required[5]. One solution that can be used is to make membranes from natural materials, making them more economical and affordable.

Based on BPS data (2021), palm oil production in Jambi Province reached 3,022,600 tons in 2020 and produced waste around 70% of the total production. One of the wastes produced is Palm Oil Fuel Ash (POFA), which is the residual ash from boiler combustion at a temperature of 700 ^{o}C – 1000 ^{o}C[6]. POFA is a problem for the palm oil industry. Waste management that is not yet optimal will threaten the surrounding environment, such as soil contamination, groundwater pollution, air pollution, and even threaten human health. Besides the negative impacts it produces, POFA can also have a positive impact if handled well. The main chemical components that make up POFA are metal oxides, especially SiO_2 which reaches up to 64%. Silica or SiO_2 can be used as an adsorbent because of its active nature, porosity, reactive surface, and high selectivity[7]. The high silica content in POFA can be used in various adsorption applications, one of which is for processing peat water. Based on this, POFA can also be used as a natural material for making absorption membranes for processing peat water into drinking water.

In making membranes from POFA, an activator is needed that can activated carbon for the absorbent that will be produced. To reduce costs in making membranes, activators from natural ingredients can be used. One natural material that can be used is orange peel waste. Orange peel contains Citric Acid ($C_6H_8O_7$) which can contribute to its acidity[8]. The high citric acid content in orange peel can be used as an acid activator in making adsorbent membranes from POFA.

From previous research, a portable water treatment tool has been created that can be used to meet clean water needs. However, there is no portable tool that can be used to process water into drinking water. Based on these problems, researchers will conduct research "Portable Drinking Water Processing Equipment using Membrane Innovation of Palm Oil Fuel Ash (POFA) Activated Orange Peel Powder (OPP) for Peat Water". This is needed to answer the problem of drinking water needs with cheaper and easier processing costs.

2. Materials and Methods

2.1 Pre-treatment of Palm Oil Fuel Ash (POFA)

The material used in this research is POFA which is obtained from burning palm oil waste in boilers. Before POFA is used and processed into membrane making material, POFA is first cleaned and sifted using a 100 mesh sieve. Sifting is done so that the POFA used is clean and uses the same particle size. After sieving, the POFA is then washed. The washing process is carried out repeatedly until the washing water used is clean. POFA washing is done with a

sieve and filter paper because the POFA particle size is quite small. After completion of the washing process, POFA can be used to make membranes.

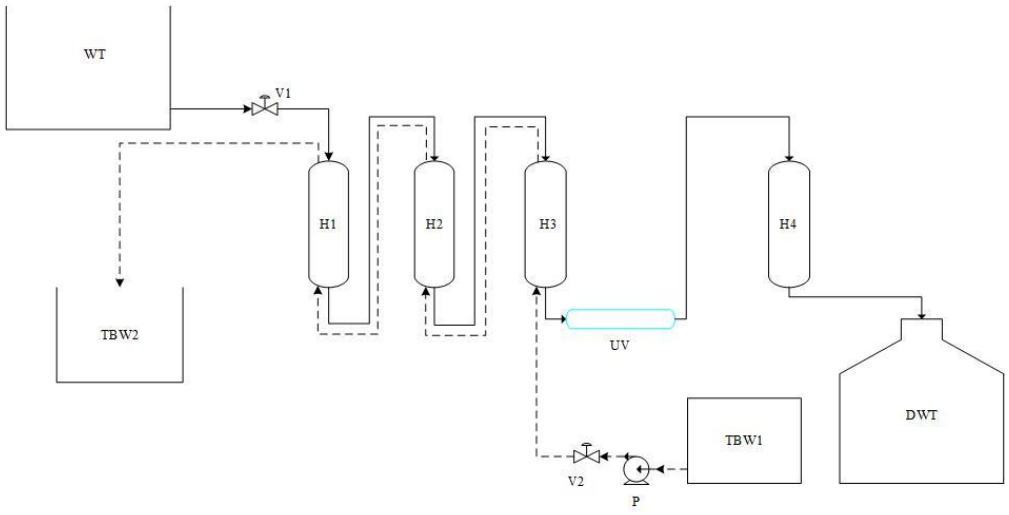
2.2 Synthesis of Orange Peel Powder (OPP) Activator from Orange Peel

Orange peel will be synthesized and produce Orange Peel Powder (OPP). The initial process carried out is to cut the orange peel into 1 cm^2 size, then wash it using water before drying. The orange peel is roasted using an oven at a temperature of 250 ^oC for 6 hours, then crushed or crushed using a crusher. After that, the sieving process was carried out using a 100 mesh sieve. This process is carried out to adjust the size of the adsorbent and expand the adsorption surface so that there are more active sites on the adsorbent. In this process, Orange Peel Powder (OPP) will be produced which will be used as an acid activator in making membrane active carbon from POFA.

2.3 Process of Making Activated Carbon from Palm Oil Fuel Ash (POFA) Using Orange Peel Powder (OPP) Activator

The initial process carried out is to mix POFA and OPP according to a predetermined ratio, namely 50:50, 70:30 and 90:10, then add 20% water from the total solids as a binding agent. The homogeneous mixture was put into a closed cup. After that, the mixture was burned using an oven at a temperature of 250 ^oC for 2 hours. The mixture that has gone through the combustion process is then cooled. Then wash the mixture until the washing water is clear. In this process, POFA carbon activated OPP will be produced, which will be used as a filter membrane in drinking water treatment.

2.4 Installation of Portable Drinking Water Treatment Equipment with Membrane POFA Activated OPP



In making this portable drinking water treatment tool, a tank is used as a water storage area before processing. The water storage tank is placed at a higher place to utilize gravity in the process of flowing water to the water treatment equipment. In the processing process, researchers assembled 4 house filters and also ultraviolet. The first filter house contains previously made POFA carbon activated OPP, the second filter house contains silica sand, and the third filter house contains manganese sand. After that, the researchers used ultraviolet for the next series of tools, and continued with the fourth house filter which contained a pH stabilizer. The next series of tools is a drinking water storage tank that has been processed. Researchers also designed a backwash process which functions as a reverse washing system.

Backwash aims to wash the filter material and remove dirt particles that are blocked on the surface of the filter.

3. Result and Discussion

POFA - OPP membranes can be used as materials for processing peat water into drinking water. The silica content in POFA can inhibit particles in water. Peat water which is acidic around pH 3 – 4.5, when filtered using a POFA membrane produces water that tends to be neutral. It is known that the POFA – OPP membrane has a fairly high pH value, reaching pH 10.

The very small particle size of the POFA - OPP membrane, which is 100 mesh, can produce a wider pore surface. The more active pores, the greater the surface area of the membrane which can be an absorption medium. These pores will absorb unwanted components in drinking water treatment.

However, the very small particle size of the POFA membrane makes it difficult to apply this water treatment. POFA particles can be included in the water if the process is not carried out correctly, and will result in a high Total Dissolve Solid (TDS) in the water. This is undesirable and must be avoided in order to produce drinking water according to the parameters that have been accepted, which is the permitted Total Dissolve Solid (TDS) content is < 300 mg/L.

The application of POFA-OPP membranes as portable drinking water treatment equipment is a viable solution. The application of the POFA-OPP membrane can be designed so that POFA particles do not dissolve in water.

4. Conclusion

This portable drinking water treatment equipment using membrane innovation of POFA activated OPP can be applied as a technology for treating peat water. This innovation could be a solution to drinking water problems in Jambi Province, which is dominated by peat water. Besides that, this innovation is also another solution to processing POFA waste which has not been utilized and is a problem for the palm oil industry in Jambi Province.

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