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River Water Filtration with Fresh Coconut Trunk

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Abstract. Water is one of the important components that support human life. With an increase of population, there is also an increase in water consumption. In addition, improved living standards and industrial activities require improved water quality standards. However, the increase in demand is in contrast to the availability of existing water sources, and the surface water of existing rivers is strongly influenced by the tides. The flavor of surface water during the dry season is sometimes very salty. Water is not only salty but also has higher turbidity than the standard water quality. The use of rainwater as a second alternative is very limited, which could only be acquired in rainy season. To overcome chronic problems, such as lack of clean water supply, one requires appropriate water treatment technology. An appropriate water treatment system is a combination of conventional and advanced technology. Desalination, such as household scale Reverse Osmosis (RO) membrane technology has been developed to address the problem of raw and clean water availability. RO membrane technology is a water treatment by molecular filtration using a primary membrane such as reverse osmosis pressure, and one of the materials that can be utilized for the upside osmosis the coconut trunk. Coconut trunk has a fiber that serves as a filter whose mechanism of action is very similar to reverse osmosis. Therefore it can be said that coconut trunks can be used as an alternative to water treatment by reverse osmosis membrane method to obtaian clean raw water. The water quality of the filtration product with the coconut rod is temperature, the degree of acidity, dissolved oxygen, and dissolved soil which are still within the standard range of clean water. However, the electrical conductivity is still below the maximum limit of the standard water class for agriculture. Filtration with vertical fibers can reduce turbidity by 157.1 NTU. However, it is not effective to use these coconut filters for river with low-turbidity. Only the water in Barito River and Kemuning Banjarbaru meet the class of clean water class A of 5 NTU, two other rivers have decreased turbidity after going through filtration process, but the value is still > 5 NTU.

INTRODUCTION

Water is the most important substance in life after air. About three quarters of our body consists of water and no one can survive more than 4-5 days without drinking water. In addition, water is usually used for washing, bathing, cooking and cleaning dirt in our homes. Besides, water is also used for other purposes such as firefighting, Industrial, livestock, recreation, and transportation. However, today water is a problem that needs to be taken carefully. It is now expensive to obtain good water quality, in accordance with certain standards, because there is already a lot of water contaminated by various kinds of waste from human activities, both in industrial wastes and household wastes and other activities [1]. Through the provision of clean water both in terms of quality and of its strength in one area, the spread of infectious diseases in this case stomach disease, is expected to be minimized. The reduction in stomach disease is based on the consideration that water is one of the links of stomach pain. One's health is greatly influenced by the human's contact with food and drink [2].

Water is one of the important components that support human life. With the increasing population, there is an increase in water consumption. In addition, improved living standards and industrial activities also require improved water quality standards. However, the increase in demand is in contrast to the availability of existing water sources, and the surface water coming from river water is heavily influenced by the tides. The flavor of

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surface water during the dry season is sometimes very salty and the turbidity of surface water is also far above the water quality standard [3]

Improving the quality of drinking water and well water by processing water that will be needed as drinking water and daily household needs is absolutely necessary especially if the water comes from surface water [4]. One of the technologies that can be applied for water treatment is through membrane technology. Adsorption using activated carbon has been practiced to remove pollutants in wastewater, but high production costs and more difficult regeneration have led researchers to attempt using more widely available abundant natural ingredients as adsorbents. The potentials of some natural ingredients have been studied for the removal of dyes in waste [5]. Some of the ingredients include banana stems [6] peeled jackfruit waste [7], palm oil rods [8], potato plant waste [9], coconut [10], peanut shells and pineapple.

RO membrane technology is a water treatment in molecular filtration using a primary membrane which is called reverse osmosis pressure, and one of the materials that can be utilized for reverse osmosis is the coconut trunk. Coconut trunk has a cambium that serves as a filter whose mechanism is very similar to reverse osmosis. Thus, it can be said that coconut trunks can be used as an alternative to water treatment by reverse osmosis membrane method in obtaining clean raw water. Microfiltration is one of the processes by passing the feed on the microspore membrane. Microfiltration membranes can be applied in industries such as cold sterilization of beverages and pharmaceutical ingredients, fruit juice, wine and beer clarification, ultrapure water in semiconductor industry, metal recovery, sewage treatment, continuous fermentation, oil, and water emulsion separation. One of the materials can be used as a membrane is a coconut trunk.

The coconut plant (Cocos nucifera L.) is one of the most common plants in the tropics and has become an important part of the life of Indonesian people in general. Almost all of these plants can be utilized to meet their economic, social and cultural needs. In addition, the significance of this plant is reflected in the extent of the plantation area of the people that reaches 98% of the total 3.74 million ha of coconut area and involves more than 3 million farm households in the management of this plant [11]. This coconut plant is utilized almost all its parts by so that humans are considered a multipurpose plant. Coconut plant consists of stems, roots, leaves, flowers and fruit [12].

Coconut trunks include small diameter dolok, having vascular bundles that spread more densely on the outside when compared to the middle portion of the stem. The circumstances cause unequal density, in which the strength also differs both from the outside into and from the bottom up to the stem. The coconut trunk has various and striking properties ranging from the edge of the stem to the inside and from the base of the stem to the canopy. The base of the stem generally has better strength and durability properties than the inside and the end of the stem [13].

If one hectare is planted with 100 to 200 trees with an average diameter of 40 cm and a height of 10 m. then the estimated potential of hybrid coconut/ha is 125.6 -251.2 m^3. If the area of coconut plantation according to the Central Bureau of Statistics is 3.7 million ha, it will produce 929.44 million m^3 of hybrid coconut trunks. As with coconut wood that has been widely used by the community into a variety of goods such as furniture, building materials or fence posts, hybrid coconut trunks with large potentials also have the same opportunities to be utilized widely [14].

LITERATURE REVIEW

Water

Water is a substance or matter or element that is important to all life forms that are known to date on Earth, but not on other planets in the Solar System and cover almost 71% of the Earth's surface. The form can be liquid, ice (solid), and steam and/or gas. In other words because of water, the Earth becomes the only planet in the Solar System that has life.

Chemically, water is a combination of two H atoms (hydrogen) and one O atom (oxygen) with formula or H2O molecular formula. In nature, water is found in solid, liquid, and gas forms. At atmospheric pressure (76 cm-Hg) and cooled to 0°C, the water turns solid (ice). Instead, the water will turn into gas (steam) when heated to 100°C. Under normal circumstances, water is neutral and dissolves various substances, water breaks down into H and O at 2,500°C the importance of water in the human body, ranging from 50% -70% of the total weight. Human bone contains water as much as 22% of bone weight, in blood and kidneys as much as 83%. The importance of water for health can be seen from the amount of water present in the organs, 80% of the blood consists of water, the bones contain 25%, whereas in the nerves there is 75% water, the kidneys contain 80% water, in the liver 70% water, and 75% of water in our muscle. Lack of water causes kidney stones and bladder diseases, because there is crystallization of elements that exist in the body fluids [15].

Water pollution is the entry or inclusion of living organisms, substances, energies, and/or other components into water by human activities. This cause quality of water to drop to a certain level of harm, resulting in water could no longer function in accordance to its designated function [16]. Water pollution may be a regional issue or a global environment and strongly relates to air pollution as well as land use or land pollution. When the polluted air falls to earth with rain water, the water where it flows becomes polluted. Several types of chemicals for fertilizers and pesticides on agricultural land will be carried by the surrounding waters which could pollute the water on the surface of the affected location. Improper soil treatment will cause erosion so that the surface water is contaminated with sedimentary soil. Many causes of water pollution will eventually lead to marine life, causing coastal pollution and affecting the surrounding sea [17]. Heavy metals often encountered in polluted aquatic environments are mercury or mercury (Hg), Nickel (Ni), Chromium (Cr), Cadmium (Cd), Arsenic (As) and Lead (Pb). The metals can accumulate within the body of an organism and remain for long period of time as accumulated poison [18].

Pollution can have a very wide and detrimental effect so that efforts need to be done to overcome it. There are two kinds of ways to overcome pollution. One way is non-technical, which is an attempt to reduce pollution by creating laws and regulations that can plan, organize all kinds of industrial activities. The second attempt is technically tackling such as changing processes, managing waste, and adding aids [19].

Coconut

In 2002, coconut cultivation area in Indonesia was recorded at 3.7 million ha where 92.04% of coconut type was obtained from smallholder plantation. 4% was hybrid coconut plant and able to produce more than 3 million metric tons [20]. Thus Indonesia is a country that has the largest coconut plantation area in the world. Of the amount of production, the coconut processing industry needs to get attention because now we can see so much diversification of coconut products [21].

The type of coconut plant in Indonesia consists of two main varieties, namely genjah varieties (nana variety) and domestic variety in (typical variety). With the growing knowledge of tree breeding, it is known that the third group is the hybrid coconut group. Hybrid coconut is the result of a cross between genjah varieties and domestic variety, in order to produce good properties of both types of coconut origin. The glorification of coconut plants by crosses (hybridization) started in 1955 [22].

The domestic variety of coconut, which has a high and large stems, can grow to reach a height of 30 meters more and can reach the age of 100 years more. Meanwhile, the genjah coconut varieties is slim in rod shape from base to tip, stem height 5 meters or more and can be aged 50 years or more [23].

The coconut trunk has vascular bundles that spread more densely on the outside when compared to the middle portion of the stem [24]. The circumstance causes the unequal density, in which the strength also differs from both inside and from bottom to top to the trunk. Physically, coconut wood has a very wide density both from the base to the tip or from the inside edge. The base and the edge have high density and are dominated by adult vascular ties while the center and the end contain more basic tissue in the form of parenchyma and young vessel bonds with lower density. Diverse densities in one tree may be followed by variations in chemical content [25], making them suitable for use in reverse osmosis membrane technology.

Membrane Technology

The membrane is a thin layer between the two fluid phases of the feed phase and the permeate phase which serve as a barrier for particular species, which can separate substances of different sizes and restrict the transport of various species based on their physical and chemical properties. The membrane is semipermeable, meaning that the membrane can withstand certain specimens larger than the pore size of the membrane and pass on other species of smaller size. The selective properties of these membranes can be used in the separation process.

Membrane separation process has the ability to move one of the components based on the physical and chemical properties of the membrane and the separated component. The displacements that occur due to the force in the pressure differences (ΔP), the concentration difference (ΔC), the electric potential difference (ΔE), the temperature difference (ΔT), and the selectivity of the membrane is expressed by rejection. Membranes can be made from natural materials and synthetic materials, whereby natural materials are materials derived from nature such as pulp, cotton; while synthetic materials are made from chemicals such as polymers. Membranes can also be made from natural polymers (organic) and inorganic polymers.

The membrane serves to separate the material by size and shape of the molecule, holding the components of the feed larger in size than the pores of the membrane and passing the component having a smaller size. Filtration by means of membranes serves as a means of separation as well as the concentration and purification of a solution passed on the membrane.

Membrane technology has several advantages that the separation process takes place at room temperature, can be done continuously, varying properties, can be arranged as needed. Membrane separation process uses a push force of different compressive strengths, electric fields and different concentrations and can be grouped into micromembranes, ultramembranes, nanomembranes and reverse osmosis. In addition to having superior properties, membrane technology also has a weakness that is on the flux and selectivity. In the membrane process there is an inverse difference between flux and selectivity. The higher the flux results in decreased selectivity in the membrane; whereas, the most expected aspect on the membrane is to enhance the flux and selectivity of the membrane's performance [26].

Reverse osmosis is a method of obtaining pure water from salt-containing water, for example in desalination. Pure water and brine are separated by a semipermeable membrane and the pressure from the brine is raised to above the osmotic pressure, which causes water from the saline solution to flow through the membrane to pure water. This process requires a pressure of about 25 atmospheres, making it difficult to apply on a large scale [27]. Reverse osmosis membranes do not kill microorganisms but simply separate and block them [28].

RESULT AND DISCUSSION

Coconut tree (Cocos Nucifera L) is a monocot plant that has a rod structure in the form of longitudin fibers from root to leaf, this is what causes the coconut rod to be very strong despite not having a cambium. A collection of vascular fibers (red-brown spots on transverse sections) scatter over the yellowish base parenchyma tissue. This package contains a system of water transport and nutrition (xylem and phloem vessels) and thick-walled fibers [29]. The anatomy of coconut trunk results in the distribution of non-homogeneous physical properties of both cross-section and height [30].

The regular arrangement of fibers is what enables coconut trunks to filter the water that passes vertically or horizontally, since in principle the transport of water from root to leaf on coconut trunk occurs in reverse osmosis. In this research, the observation of coconut trunk's ability in filtering several kinds of river water from several sources is conducted. In the first variable, the coconut shaft is processed in such a way as to be inserted in a pipe into a filtration medium. Processing should be done carefully and accurately, given the flow of water that can flow from even a very small gap, in which there will be less chance of less filtered filth. In the second variable, the coconut rod is destroyed in such a way as to obtain the fibers of the coconut rod, then the fibers are arranged randomly into a pipe as a filter medium. Filtration media is placed in two conditions namely vertical position and horizontal position.

The object of this research using 5 rivers whose water looks murky, then the filtration process is done in laboratory using coconut trunk. Recapitulation of temperature change after filtration can be seen in Table 1.

TABLE 1. Recapitulation of temperature change

No.	River	Temperature before (° C)	Temperature after (° C)			
			Fiber vertical	Fiber horizontal	Trunk vertical	Trunk horizontal
1.	S. Martapura	27.75	27.92	28.06	27.49	27.52
2.	S. Cempaka	27.45	27.75	27.72	27.4	27.59
	S. Cempaka (2)	26.92	26.76	26.66	26.65	26.69
3.	S. Pulang Pisau	27.9	27.77	28.18	27.82	27.75
4.	S. Kemuning Banjarbaru	28.3	28.24	28.48	28.11	28.11
5.	S. Barito	27.49	27.88	28.07	27.83	28

The average temperature after filtration changes <1 °C, there is a temperature increase. but there is also a temperature decreased. The maximum temperature is 28.5 °C and the minimum 26.65 °C, which is still within the standard range of Indonesian Government Regulation no. 82 of 2001 on clean water category criteria is ± 3 °C from normal water temperature.

The recapitulation of changes in acidity after filtration can be seen in Table 2.

TABLE 2. Recapitulation of acidity change

No.	River	pH before	pH after			
			Fiber vertical	Fiber horizontal	Trunk vertical	Trunk horizontal
1.	S. Martapura	6.73	7.05	8.02	7.38	7.46
2.	S. Cempaka	5.17	6.39	6.12	6.92	6.05
	S. Cempaka (2)	7.5	6.88	6.69	6.83	7.03
3.	S. Pulang Pisau	5.31	6.31	6.41	6.21	5.38
4.	S. Kemuning Banjarbaru	5.53	6.13	6.02	6.57	6.3
5.	S. Barito	7.55	6.54	5.23	6.22	6.41

pH before ranges from 5.17 to 7.55, and after filtration ranges from 5.23 – 8.02. Almost all experience a rise in pH except for S. Cempaka (2) and S. Barito which decreases. The maximum pH is 8.02 and the minimum 5.23, only two samples whose pH < 6 of the remaining 22 samples meet the standard range of Indonesian Government Regulation no. 82 year 2001 about clean water category criteria, which is about 6-9.

The recapitulation of electrical conductivity changes after filtration can be seen Table 3.

TABLE 3. Recapitulation of elektro conductivity change

No.	River	EC before (mS/cm)	EC after (mS/cm)			
			Fiber vertical	Fiber horizontal	Trunk vertical	Trunk horizontal
1.	S. Martapura	0.220	0.197	0.183	0.231	0.224
2.	S. Cempaka	0.077	0.087	0.040	0.069	0.092
	S. Cempaka (2)	0.030	0.149	0.106	0.045	0.051
3.	S. Pulang Pisau	0.012	0.035	0.078	0.090	0.189
4.	S. Kemuning Banjarbaru	0.135	0.089	0.106	0.087	0.087
5.	S. Barito	0.355	0.061	0.031	0.078	0.071

The EC before ranges from 0.012 mS/cm to 0.355 mS/cm, and after filtration it ranges from 0.035 to 0.231. Some of the EC increased, but some also decrease. The EC maximum is 0.231 mS/cm and the minimum is 0.031 mS/cm, which is still within the standard range of Indonesian Government Regulation no. 20 of 1990 on the criteria of the class of clean water that is class D by 2.25 mS/cm.

The recapitulation of turbidity change after filtration can be seen in Table 4.

TABLE 4. Recapitulation of turbidity change

No.	River	Turbidity before (NTU)	Turbidity after (NTU)			
			Fiber vertical	Fiber horizontal	Trunk vertical	Trunk horizontal
1.	S. Martapura	19.2	18.8	18.9	19	19.1
2.	S. Cempaka	96.9	86.9	108	111	109
	S. Cempaka (2)	0	257	268	272	290
3.	S. Pulang Pisau	89.5	38.1	10	37.3	42.1
4.	S. Kemuning Banjarbaru	160	2.9	53.8	18.9	10.4
5.	S. Barito	44.1	0.2	6.6	1.8	2.3

After going through the filtration process, the turbidity of S. Cempaka actually increases from 96.9 to 111, so it was decided to take water again. The water sampling at S.Cempaka was taken on Thursday 10 August 2017. After the take-off, the turbidity from 0 has risen to 290. This requires further and deeper research into the cause because the Cempaka area is a diamond and mine replication area. From five samples only four rivers appear to decrease in turbidity. Thus, in the discussion of turbidity this research will only focus on four rivers. The highest turbidity is S. Kemuning Banjarbaru which is 160 and the lowest in S. Martapura by 19.2. After going through the filtration process with coconut trunks there is a decrease in turbidity from 1% to 99.55%. The largest percentage decrease is in filtration with vertically laid fibers of 3 rivers and 1 river present in filtration with horizontally-placed fibers. Filtration with vertical fibers can reduce turbidity to 157.1 NTU. However, it is not effective to use this coconut filter for river with low turbidity. The maximum turbidity 53.8 NTU and the minimum is 0.2 NTU, in which only S.

Barito water and S. Kemuning Banjarbaru water meets Indonesian Government Regulation no. 20 of 1990 on the criteria of clean water class A group of 5 NTU. There is also a decreased on the turbidity, other two rivers, but it has not yet meets the water standard class A.

The recapitulation of dissolved oxygen changes after filtration can be seen Table 5.

TABLE 5. Recapitulation of dissolved oxygen change

No.	River	DO before (mg/l)	DO after (mg/l)			
			Fiber vertical	Fiber horizontal	Trunk vertical	Trunk horizontal
1.	S. Martapura	4.51	4.45	4.45	4.9	4.88
2.	S. Cempaka	8.27	8.16	8.05	8.22	8.11
	S. Cempaka (2)	6.33	6.07	6.06	6.07	6.08
3.	S. Pulang Pisau	6.57	6.68	6.47	6.64	6.6
4.	S. Kemuning Banjarbaru	7.14	7.25	6.98	7.63	7.39
5.	S. Barito	8.6	8.95	8.74	8.47	8.58

The DO before ranges from 6.33 to 8.60, after filtration ranges from 4.88 to 8.95. In DO, there are some decrease, but also increase in some parts. The DO maximum of 8.95 and minimum 4.45, only S. Martapura water that dissolves oxygen < 6 mg/L of other water range meets the standard range of Indonesian Government Regulation no. 82 of 2001 on clean water category criteria.

The recapitulation of changes of total dissolved soils after filtration can be seen in Table 6.

TABLE 6. Recapitulation of total dissolved soil change

No.	River	TDS before (g/l)	TDS after (g/l)			
			Fiber vertical	Fiber horizontal	Trunk vertical	Trunk horizontal
1.	S. Martapura	0.143	0.129	0.119	0.150	0.146
2.	S. Cempaka	0.050	0.056	0.026	0.042	0.060
	S. Cempaka (2)	0.019	0.099	0.065	0.029	0.033
3.	S. Pulang Pisau	0.008	0.023	0.051	0.058	0.123
4.	S. Kemuning Banjarbaru	0.083	0.058	0.069	0.057	0.057
5.	S. Barito	0.223	0.039	0.020	0.051	0.046

The TDS before ranges from 0.008 to 0.223, and after filtration ranges from 0.020 to 0.150. TDS is down but some imcease. The maximum TDS of 0.15 g/l and minimum 0.020 g/l. all river water meets the standard range of Indonesian Government Regulation no. 82 of 2001 on clean water category criteria with TDS < 1 g/L.

Based on turbidity data and dissolved soils, the results obtained are much influenced by coconut trunk and the origin of water samples used in this study. Most of the water sampled in the study is peat water such as the water of S. Martapura, the water of S. Pulang Pisau and the water of S. Barito.

Peat is formed from the decomposition of organicmaterials such as leaves, twigs and shrubs that took place in a slow pace in an anaerobic or saturated with water. In general, the colour of peat is brown to black and with unique odor due to weathering and decomposition of organic material constituent. The organic content of the soil is high because the peat is derived from the weathering process fragments of organic materials derived from various types of plants that decompose due to the effects of weather and fossils. Areas that contain a lot of peat soil can be found in the mountains, plateaus and plains that are submerged in a long periode of time [31].

Based on the water origin of the sample then, the water containing peat water can be and easily filtered on the filter using coconut rod as the base material in the filtration process. This is because inside the coconut trunk contains fibers capable of filtering out the organic materials contained in the water sa/mple.

CONCLUSION

Temperature, degree of acidity, dissolved oxygen, and dissolved solids are still within the standard range of Indonesian Government Regulation no. 82 of 2001 on the criteria of Class 1 clean water classes. The electricity conductivity is still below the maximum limit of Indonesian Government Regulation no. 20 of 1990 on the criteria of clean water class D. Filtration with vertical fibers can reduce turbidity to 157.1 NTU. However, it is not effective to use these coconut filters for rivers with low turbididty. Maximum turbidity 53.8 NTU and minimum 0.2 NTU, only the water in S. Barito and S. Kemuning Banjarbaru comply with Indonesian Government Regulation no. 20 of 1990 on the criteria of clean water class A group of 5 NTU, two other rivers after going through filtration process turbidity is reduced but still > 5 NTU.

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