Performance of reverse osmosis membrane as a bathroom wastewater filter

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Abstract. As the population in Indonesia increases, water pollution becomes increasingly uncontrolled. people who still think that direct disposal of greywater waste does not cause serious environmental problems. Currently, liquid waste can only be used for irrigation of plants, washing cars, washing windows and flushing toilets. the concept of reuse or reuse. However, this concept can help reduce the use of available clean water. This research aims to determine the performance of reverse osmosis (RO) membrane units for treating bathroom wastewater. In this study, bathroom waste was simulated using soapy water, shampoo water, urine and salt water. Where the waste water is pumped to the RO membrane unit. pH, iron metal (Fe), manganese (Mn), fluoride (F) and organoleptic parameters (smell, taste and color) were observed before and after entering the RO membrane unit. Test results on the shampoo showed that after going through the RO unit, the water became slightly more acidic while other parameters met clean water quality standards. The same test results also occurred in soapy water and salt water. Test results on filtered urine show that there is a reduction in acidity but the smell of urine is still present. Testing these parameters shows that the RO membrane unit has succeeded in maintaining the quality standards for Fe, Mn and F metal content in water even though there is a decrease in pH in soapy water, shampoo water and salt water. Based on these results, additional processing is still needed to return the pH of the water to the pH range of clean water and eliminate the urine Odor that still exists.

1 Introduction

Because of the growing scarcity of water in many parts of the world, new water sources have evolved, including saltwater desalination and expanded use of surface water and deeper groundwater sources. However, operations such as Saltwater desalination cause increased

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CO_2 emissions and other pollutants to be released into the atmosphere, disrupting the marine environment. Another option is to utilize wastewater for toilet flushing (if done), which can cut water use and urban water demand by 10-25% [1].

The term "grey water" refers to the wastewater produced by cities, which includes water from hand basins, kitchen sinks, washing machines, dishwashers, and bathtubs but does not include toilet streams [2]. Reusing greywater on-site in cities can reduce water use and promote sustainable practices. Meanwhile, bathroom wastewater, such as waste in the form of water used for bathing, washing clothes and kitchen activities, is a type of greywater waste. The problem of greywater waste pollution in river water bodies can be solved by treating liquid waste before it is discharged into the water. Recent research indicates that processing greywater liquid waste can be used as a new alternative to access clean water sources, namely through the notion of reuse [3]. This concept's use is still limited; it cannot be utilized to manufacture ready-to-drink water or even for basic needs because the water quality remains low. Currently, liquid waste can only be utilized to water plants, wash automobiles, clean windows, and flush toilets. However, this approach can help minimize the usage of available clean water, so that the availability of clean water will persist even when it is damaged by extreme climate change [4, 5].

The most prevalent urban wastewater treatment system is based on the conventional activated sludge (CAS) process, which requires a lot of energy for aeration and depletes the organic load's potential energy content. Recently, it was predicted that wastewater contains more chemical energy (in the form of organic pollutant load) than is required for CAS treatment. However, the low organic content (1 to 2 g/L) is the most significant impediment to utilizing this energy [6]. Membrane bioreactors can treat wastewater by combining activated sludge processes for BOD and nitrogen removal, as well as anaerobic processes for methane synthesis. Compact systems achieve significant organic carbon removal, while membrane bioreactors can retain a greater biomass content [7]. Currently, no single technology can adequately treat industrial effluents due to their complexity. Various strategies are often employed to attain desired water quality in the most cost-effective manner [8].

One approach for managing bathroom wastewater is to employ Reverse Osmosis (RO) membrane technology. Previous research suggests that using this technique can improve water quality and efficiency [9, 10]. This technology is primarily utilized for saltwater desalination, commercial drinking water production, and wastewater treatment [11, 10]. However, there is a little issue with this technology: fouling (blockages) in the membrane, which reduces membrane function. As a result, energy consumption, membrane cleaning frequency, and membrane replacement rates rise [12, 13].

Water quality is measured by taste, odor, color, and organic/inorganic matter concentration. Water contamination can have a negative impact on human health. A portion of inorganics are in the mineral form of heavy metals. Heavy metals accumulate in human organs and neural systems, interfering with normal processes [14].

The aim of this study is to investigate the efficacy of Reverse Osmosis membrane technology, which uses bathroom wastewater samples to produce quality water that may be reused. Given the risks, efforts are needed to prevent a drastic decline in our groundwater supply. One way to prevent this decline is to use reverse osmosis technology for wastewater treatment to provide sanitation and clean water. This move is in line with sustainable development goal number 6, clean water and sanitation which aims to ensure equitable and sustainable access to clean water and sanitation for all.

2 Material and Methods

This research was conducted in one of the houses located in Sleman, Yogyakarta. In the experiment, domestic wastewater originating from bathroom toilets will be processed using a Reverse Osmosis membrane to re-purify the domestic water.The tool used in this research was an RO membrane unit obtained from the Pison Water shop which was tested using three samples, namely urine water, soap water with the Lifebouy brand, and clear brand shampoo water. All components in the RO membrane unit, such as CTP tubes, PP tubes, GAC tubes, skid frames, measuring instruments, piping systems, electrical resources and control panels, collaborate to produce water that is suitable for consumption.

The first stage begins by filtering the water through a clear vertical tube, which functions to remove large particles or more than 5 microns. Then the next stage is Granular Activated Carbon (GAC) with a vertical white tube in the middle, where the water that has gone through the first stage is filtered to remove chemicals such as detergent and chlorine. In the third stage, the white vertical tube on the left is used to remove other chemicals as well as carry out neutralization of taste, odor, and remove particles with a size of more than 10 microns. Entering the fourth stage, the water flows into a large white horizontal tube containing a Reverse Osmosis (RO) membrane. At this stage, there are two channels: first, RO drinking water which has passed through a filter with pores the size of 0.0001 microns, and second, waste water or waste water which contains chemical, physical, bacterial and viral pollution. After the RO stage, the water that has passed through the membrane enters a small horizontal tube above the membrane, called Post Carbon, to remove any chemicals that may remain, improving taste and odor. Ultimately, a diaphragm pump is used to maintain water flow throughout the process. This process allows domestic wastewater containing urine, soapy water and shampoo water to be processed through a series of stages to produce water that is cleaner and safer to use, by removing various contaminants and unwanted substances.

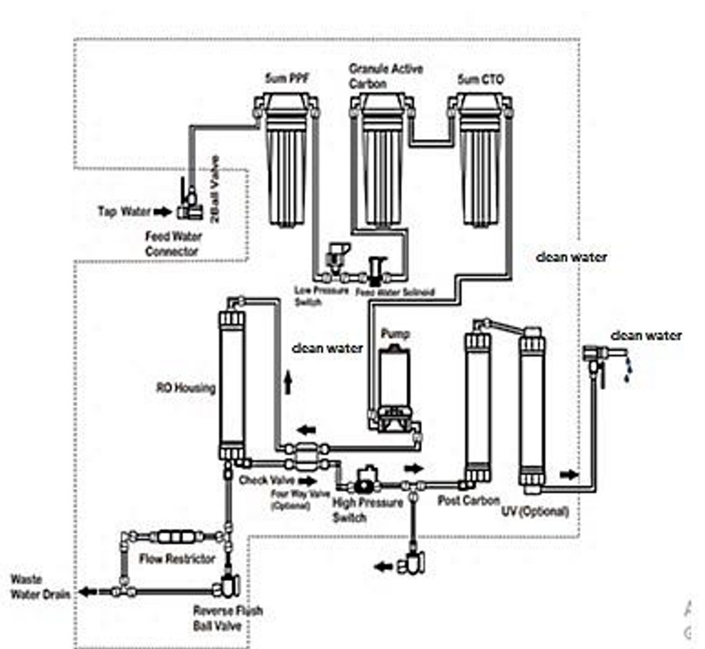

Fig. 1. Reverse Osmosis Membrane Unit for Treating Bathroom Waste Water.

Based on Figure 1 pH, iron (Fe), manganese, fluoride (F) levels, and organoleptic properties such as smell, taste, and color will all be analyzed. Testing was conducted out at the Yogyakarta City Health Laboratory UPT, which is located at Jl Sisingamangaraja No. 23 Brontokusuman, Mergangsan, Yogyakarta. The determination of pH was used using the potentiometric method, while the determination of the metal content Fe, Mn and F respectively used the Indonesian national standards (SNI) 69894-2009, 6989 5-2009 and 06-6989 29-2005. Organoleptic testing is used to test smell, taste and color.

3 Result and Discussion

In this study, the parameters observed were pH, iron, manganese and fluoride content as well as organoleptics such as smell, taste and color. These parameters will be compared before and after passing through the RO membrane. PH is a key air quality metric. Acidic water can corrode metal pipes and plumbing systems. Meanwhile, alkaline air provides apparent disinfecting [14] The usual pH range for drinking water according to WHO is 6.5-8.5, however for Indonesian National Standart (SNI) SNI it is 6.5-9.0. Excess iron (Fe) doses during intrauterine life may affect the genetic structure of the phenotypic, increasing susceptibility to a variety of common disorders [15]. Indonesian government requirements require that the quantity of iron in pure water not exceed 1.0. Fluoride (F) is very important in small ways amount for bone mineralization. However, excessive use may result in the gradual, cumulative disabling diSaltse known as fluorosis [16]. In this case, the World Health Organization (WHO) and the Indonesian national standard (SNI) set a safe limit for fluoride at 1.5 milligrams per liter. Manganese is an important nutrient involved in the metabolism of amino acids, proteins and lipids, but in excess it can be a strong neurotoxicant. In addition, manganese exposure from water consumption is not too much of a concern, because manganese intake from water consumption is less than food intake, except in infants [17]. The established standards for organoleptic parameters exclude the effects of toxic substances and do not pose a danger to human health. However, if the organoleptic properties of the water do not meet hygienic standards, this is very likely due to the presence of toxins that can pose a real health hazard to the population. Changes in the smell, taste and color of the water, the formation of a layer or foam on the surface, can indicate the effects of chemicals in the water that can have a negative impact on health [18]

Fig. 2. Soap and shampoo samples that will be tested with RO

In this research, based on Figure 2, three experiments were carried out using different samples, namely clear shampoo water, Lifebuoy soap water and urine samples. Next, testing was carried out for the three samples. The test was carried out twice, namely before and after recycling in order to compare the effectiveness of the Reverse Osmosis Membrane. The results of the analysis of the Clear Shampoo Water sample can be seen in Table 1. Based on

Table 1, the results of the analysis of Clear Shampoo Water before recycling apparently still meet quality standards. The pH level value can also be said to be neutral. However, the Manganese (Mn) test results are close to the established quality standards. Based on research results [19], it is proven that synthetic shampoo water contains more Mn metal than herbal shampoo water. Metals such as manganese (Mn), iron (Fe) and fluoride are carcinogenic and can damage the central nervous system [20]. Filtration of the sample water using a Reverse Osmosis Membrane turned out to have an effect on reducing the substances contained in the sample. The pH test results, iron (Fe), Manganese (Mn), after recycling decreased. Moreover, the test results for Manganese (Mn) decreased very drastically. This proves that filtration using a Reverse Osmosis Membrane can be an option for getting clean water from bathroom waste in the form of clear shampoo water.

Table 1. Results of Physical and Chemical Examination of Clear Shampoo Water Samples Before and After Recycling

Parameter	**Test results (Mg/L)**		**Quality Standarts**
	before	**after**	
pH	7.0	6.2*	6.5-9.0
Iron (Fe)	0.155	<0.009	1.0
Manganese (Mn)	0.214	0.005	0.5
Flourida (F)	<0.001	<0.001	1.5
Smell	Fragrance	Odorless	Odorless
Taste	tastes bitter	tasteless	tasteless
Color	720*	0	50

Table 2. Results of Physical and Chemical Examination of Lifebouy Soap Water Samples Before and After Recycling

Parameter	**Test results (Mg/L)**		**Quality standarts**
	before	**after**	
pH	7.2	6.1*	6.5-9.0
iron (Fe)	<0.009	0.011	1.0
Manganese (Mn)	<0.001	0.021	0.5
Flouride (F)	<0.001	0.001	1.5
smell	Fragrance	odorless	Odorless
taste	bitter,	tasteless	Tasteless
Color	6600*	15	50

Based on Table 2 the physical and chemical examination of the Lifebuoy soap water samples before recycling, it turns out that the test results for pH, Iron (Fe), Manganese (Mn), and Fluoride (F) were very good, where for the test the iron content was less than 0.1, and the test for the Mn and F was even close to 0. However, after recycling using a reverse osmosis membrane, the test results for metals increased. This is because there is a possibility that the Lifebuoy soap water sample was mixed with the previous sample which remains in the Reverse Osmosis device.

Table 3. Results of Physical and Chemical Examination of Urine Samples Before and After Recycling

Parameter	Test results (Mg/L)		Quality standarts
	before	after	
pH	6.3*	7.2	6.5-9.0
iron (Fe)	<0.009	<0.009	1.0
Manganese (Mn)	<0.001	<0.001	0.5
Flouride (F)	2.139*	0.05	1.5
Smell	Urine smell	Urine smell	Odorless
Taste	tasteless	tasteless	
Color	710*	10*	50

Based on Table 3 Physical and chemical examinations did not obtain significant results between before and after recycling. The smell of this urine sample didn't even change. However, at least the smell of the sample can change so that the water can be reused. The Fluoride (F) test results were too high and exceeded the quality standards based on SNI 06-6989.29-2005. However, for the pH level test, which could initially be said to be acidic, after being recycled it becomes neutral and for the metal test, Flour (F) also decreases after the recycling process. According to the organoleptic test results, the odor of urine remains after passing through the RO, however the color is significantly lowered from 710 to 10, meeting clean water quality criteria.

Table 4. Result of physical and Chemical Salt water as representative kitchen liquid waste

Parameter	Test Results		Quality Standarts
	before	After	
pH	8.0	6.3	6.5 – 9.0
Iron (Fe)	< 0.009	< 0.009	1.0
Manganese (Mn)	< 0.001	< 0.001	0.5
Fluoride (F)	1,760	< 0.018	1.5
Smell	Odorless	Odorless	Odorless
Taste	Salty	Tasteless	Tasteless
Color	0	0	50

Table 4 shows the pH value becomes increasingly acidic after being passed through the RO membrane unit. Meanwhile, the content of metals such as Mn and F has decreased so that it has reached the set standards. The salt water used is a simulation of kitchen waste water. In some Indonesian communities, kitchen waste is usually mixed with bathroom waste. So, in this research kitchen wastewater was simulated with salt water.

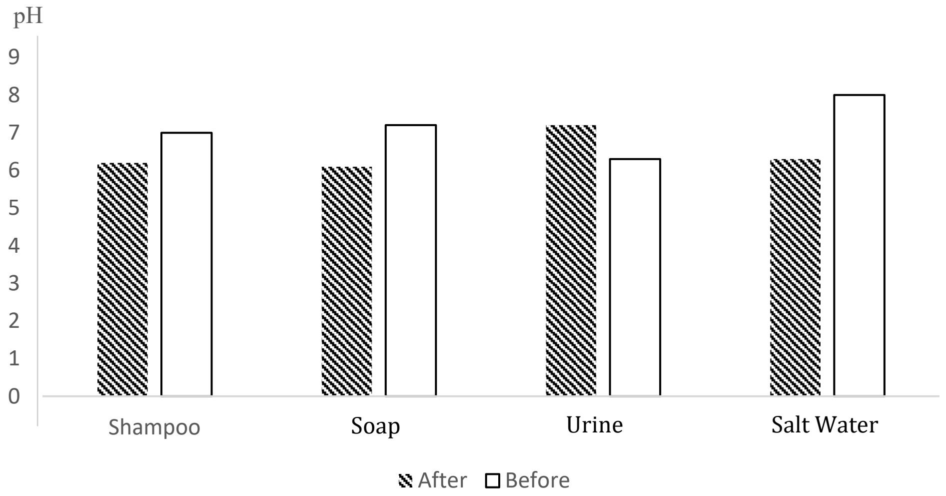

Fig. 3. PH of Soap Water, Shampoo Water, Urine and Salt Water

pH or power of hydrogen is a value or measurement used to assess the degree of acidity or alkalinity of a solution. More precisely, the pH of drinking water is used to measure the relative levels of free hydrogen ions and hydroxyl ions in the water. If the free hydrogen ions are high, the water means it has acidic properties, and vice versa. This pH value uses numbers on a scale of 1 to 14. Water that is acidic will have a low pH, namely below 7, and indicates that the water has been contaminated by pollutants. Meanwhile, water that is basic or alkaline will have a pH value above. Figure 3 shows the pH of soap, shampoo and salt water. However, the pH in this final result is not in accordance with the required quality standards. therefore, the use of this Reverse osmosis membrane still requires another unit

4 Conclusion

In this study there were four samples, namely shampoo water, shampoo water, urine water and salt water which were recycled using a Reverse Osmosis Membrane. After the examination, it turned out that the metal levels in all samples had decreased, only the urine samples still had a smell. Meanwhile, the pH of the fourth sample can be said to still meet clean water quality standards. Water that passes all stages can be used as clean water, while water that does not pass will be thrown away. The air produced from the Reverse Osmosis Membrane is of a quality that is safe for consumption and free of contamination because the device is effective in filtering small to microscopic particles. However, RO membrane units still require additional processing processes such as adjusting pH levels and removing urine odor.

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