REVERSE OSMOSIS SYSTEM FOR READY-CONSUMPTION WATER DESALINATION

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REVERSE OSMOSIS SYSTEM FOR DRINKING WATER DESALINATION PROCESS

Abstract:*Water is a compound that is very important for all living things. But along with the times and several other factors, the level of water pollution is increased. The purpose of this study is to process contaminated water into clean water and ready for consumption using a reverse osmosis membrane equipped with a solar cell installation by making solar power as an alternative energy source so that an effective and efficient system achieved. This study uses experimental methods to obtain water quality based on TDS, pH, salinity, and turbidity that meet the requirements. The variables used in this study are discharge (Q) : ml/minute and pressure i (P) : bar. From the filtration process using reverse osmosis with an operational pressure of 4 bar and a discharge of 300 ml/minute, it is found that there is a decrease in TDS levels to 346 Mg/l and decrease of turbidity to 1.72 NTU. With a decrease in salinity from 1100 Mg/l to 187 Mg/l, the low-pressure reverse osmosis process can't be able to reduce salinity optimally.*

Keywords: reverse osmosis, desalination, clean water, TDS, salinity

Abstrak: *Air merupakan suatu senyawa yang sangat penting bagi seluruh makhluk hidup . Namun seiring perkembangan zaman dan beberapa faktor lainnya, tingkat pencemaran air semakin meningkat. Tujuan penelitian ini adalah untuk mengolah air terkontaminasi menjadi air bersih dan siap untuk konsumsi menggunakan membran reverse osmosis yang dilengkapi instalasi solar cell dengan menjadikan tenaga surya sebagai sumber energi alternatif agar terjadi suatu sistem efektif dan efisien. Penelitian ini menggunakan metode eksperimen agar didapat kualitas air berdasarkan TDS,pH,Salinitas,dan Kekeruhan yang memenuhi syarat. Variabel yang digunakan dalam penelitian ini adalah debit (Q) : ml/menit dan tekanan i (P) : bar . Dari proses filtrasi dengan menggunakan reverse osmosis dengan tekanan operasional 4 bar dan debit 300 ml/menit didapatkan bahwa terjadi penurunan kadar TDS menjadi 346 Mg/l dan juga penurunan kekeruhan menjadi 1,72 NTU. Dengan penurunan kadar garam (salinity) dari 1100 Mg/l menjadi 187 Mg/l proses reverse osmosis bertekanan rendah belum mampu menurunkan kadar garam (salinity) dengan optimal.*

Kata kunci: Osmosis terbalik, desalinasi,air bersih,TDS,Salinitas

INTRODUCTION

Water is a very important compound for all living things on this earth. Water covers almost 71% of the earth's surface. The availability of water on earth is 97% in the form of salt water and 3% in the form of fresh water which more than two thirds of its part is in the form of glaciers and polar ice. On land, most of the fresh water comes from rivers and lakes where the life of living things depends on rivers and lakes. The problem of clean water always occurs in Indonesia's watersheds, which is increasing with the increase in population, as well as the rise of industries that dispose industrial waste into rivers. The want of clean water will continue to worsen with population growth, climate change and up investment. so long as every population grows, so will water consumption, both in agriculture, industry and households. Climate change will cause long-lasting droughts, heat waves, and storm events, indirectly impactful the availability of water on Earth (Castell-Exner and Petry, 2014).

There are several ways that are often done to obtain clean water(Adhitya Putra, 2018), one of which is water purification technology using Reverse Osmosis (RO) membrane technology. Reverse Osmosis is a filtering method through a semi-permeable membrane(Shahid, 2019). In the process using a membrane, the decomposition of water and impurities is based on the osmotic pressure where the water goes through a reverse osmosis process from a segment that has a high concentration of water to a segment that has a low concentration of water. During this process, dissolved substances and hazardous materials will be disposed of as water (waste).

Based on the problems above, this study aims to find out how to design a ready-to-consumption water filtration device using solar energy to meet the needs of remote communities and to analyze the influence of RO on the water filtration.

In the filtration process using a reverse osmosis membrane, there are several interrelated factors that will affect the quality of the filtered water. These factors
is as follows :

1) Pressure

Pressure affects the flow rate of the solvent through the membrane. The flow rate increases with increasing pressure, and the quality of the treated water (permeate) also increases. Pressure plays an important role in the permeate rate that occurs in the membrane process. The higher the pressure

of a membrane, the greater the flux produced by the permeate

When viewed from the operating pressure on the membrane, the following equation applies:

$$\Delta P = [\frac{Pf+Pc}{2}] - P_p$$

The operating pressure on the membrane (ΔP) is affected by the absorption flow pressure (Pp). To get a large hydrostatic pressure, the inflow pressure (Pf) and the flow pressure in the solute flow (Pc) must be large, while the absorption flow pressure (Pp) must be small because the operating pressure (ΔP) is directly proportional to the absorption pressure (Pp). .

2) Temperature

The standard temperature used is 70ºF (21ºC), but generally used starts from 85ºF (29ºC)

3) Density of membrane

The tighter the membrane, the better the treated water produced

4) Flux (flux)

Continuous movement of water. To determine the flux can be obtained by calculating the permeate flow rate per unit area of the membrane

5) Recovery Factor

The higher the acquisition factor, the better the salt concentration in the brackish water treatment process obtained. Generally, the recovery factor has a range of 75-95%.

6) Salt Rejection (rejection of salts)

Rejection salts depend on the type and characteristics of the selected membrane. However, it also depends on the operating conditions, the concentration of the feed solution and the flow rate. The rejection value is an absolute number. Generally the rejection value is from 85 – 99.5% with 95% being used more often

7) Membrane Resistance

The membrane can only last a short time (will be damaged quickly) if too many unwanted components enter the feed water, such as bacteria, fungi, phenol.

RESEARCH METHODS

Data collection methods generally includes survey, guestionnaires, direct observation, focus groups, etc:

a. Study of literature. Studying the material related to the proposed idea by taking into account the capabilities of the 5-step RO machine, the analysis is used based on the experimental literature that has been carried out
b. The experimental method is to carry out a water purification process using a reverse osmosis system where the purification process is carried out on several water samples which are then tested on several water samples that

have not been processed and water samples that have been processed by paying attention to several water parameters where variations in operational pressure ie 1-4 bar with a discharge of 300 ml/minute.

c. The variables used in this study are:
   1) Independent variable : Operational pressure used
      a) 1 bar.
      b) 2 bars.
      c) 3 bars.
      d) 4 bars.
   2) The dependent variable used is:
      a) *Total Dissolve Solid (TDS)*
      b) *Turbidity*
      c) *Salinity*
      d) pH

System description

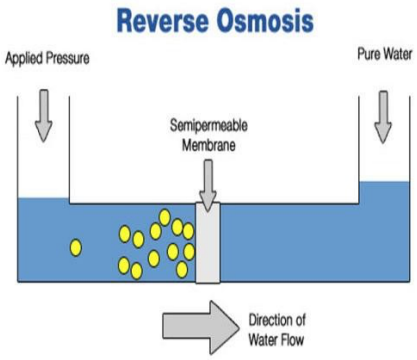

Figure 1. Schematic of reverse osmosis process

The working principle of the Reverse Osmosis filter is based on osmosis events that occur in nature. Water passes through a semi-permeable membrane from a solution with a lower concentration to one with a higher concentration until the equilibrium is reached. The Reverse Osmosis process is the opposite of the osmosis process, which is to provide back pressure with a greater osmotic pressure on the surface of a thicker liquid, so the purer liquid will penetrate the membrane surface into a purer liquid.

Figure 2. Application of Desalination using an RO system with solar cells

Here is a water filtration system using reverse osmosis by utilizing sunlight as an environmentally friendly resource.

Work principle

In order for a liquid with a high concentration to pass through the membrane and into a liquid with a lower concentration, reverse osmosis must produce back pressure with a higher osmotic pressure (Yusuf ,2009). Reverse osmosis membrane technique has the benefit of requiring very less energy (Sefentry & Masriatini, 2020)

The stages of reverse osmosis water desalination are explained as follows:

1) The reservoir is used to keep contaminated water with high concentrations of other substances

like Na, Cl, Mg, and other contaminants.

2) Next, set the Digital Pressure Switch to the specific operating pressure of 1-4 bars so that it is higher than the osmotic pressure.

3) The water will pass through the sediment tube in the first stage, which will be filtered to minimize big particles.

4) The water is then inserted in a tube containing granular activated carbon (GAC), which eliminates the chemicals from the water.

5) After that, the water goes through the CTO Carbon block treatment, which works to remove the taste, smell, and further tricomethane.

6) The water then flows through the RO membrane to filter out all the substances that are still allowed to pass.

7) The water will next move into the UV room, where the ultraviolet rays will eliminate any residual microbes before it is consumed.

The Republic of Indonesia's Minister of Health's Regulation No. 492/MENKES/PER/IV/2010 specifies the drinking water quality standards.

Table 1. MoH standard water data

No.	Parameter	Unit	Ministry of Health Standard
1.	TDS	Mg/L	500
2.	Turbidity	NTU	5
3.	Salinity	Mg/L	250
4.	PH		6.5-8.5

EXPERIMENTAL SETUP.

Research using experimental methods with samples of contaminated brackish water where this measurement aims to observe and obtain measurement results from raw water and water that has undergone a reverse osmosis process. This study has four variable, namely the operational pressure used is 1-4 bar and the flow rate is 300 ml/minute. However, in a seawater filtration system with reverse osmosis, a pressure of 55-80 bar . is required(Yoshi & Widiasa, 2016)so that the energy required is low and the membrane is not damaged quickly. In this experiment the water that enters the reverse osmosis machine is first carried out with an initial treatment process, namely by natural filtration in the form of filtering with (silica sand and activated carbon). This study has several parameters, including TDS (Total Dissolve Solid), PH (acidity level), Salinity (salt content in water), Turbidity (turbidity). Measurements were carried out in two experiments, namely on raw

water and also on water that has been processed. In this measurement process using measuring instruments (*TDS meter, Turbidty meter , pH meter*)that have been calibrated and have also received standards from the Ministry of Health.

RESULT AND DISCUSSION

Tests and measurements carried out on raw water and also water that has been processed by a reverse osmosis machine in order to get water that is ready for consumption is processed with an operational pressure of 1-4 bar and a flow rate of 300 ml/minute so the energy required is low and the membrane is not fast. damaged so that it can last for a long time.

The following is measurement data from raw water obtained from contaminated brackish water.

Table 2. Initial water data before processing

No.	Parameter	Unit	Contaminant Water
1.	TDS	Mg/L	3300
2.	Turbidity	NTU	3.9
3.	Salinity	Mg/L	1100
4.	PH		8

This is the results obtained water that has been processed with a reverse osmosis machine with an operational pressure of 1-4 bar and a water flow rate of 300 ml/minute.

Table 3. Water data after processing

Operating Pressure (bar)	*TDS* (Mg/l)	*Turbidity* (NTU)	*Salinity (Mg/l)*
1	673	3.21	407
2	589	2.84	311
3	489	2.21	214
4	346	1.72	187

Based on this information, reverse osmosis filtration at pressures between 3 and 4 bar has been successful in changing the water content to meet the standards set by the MoH for drinking water.

CONCLUSIONS AND FUTURE WORK

Conclusion:

Based on the results of several studies and experimental results obtained from the filtration process with an RO machine:

a. Based on the results of water measurements from the RO process, it was found that the operational pressure of 1 and 2 bar did not meet the water requirements according to the standards of the Ministry of Health.

b. Based on the results of water measurements from the RO process, it was found that with operational pressures of 3 and 2 bar, the water requirements were met

according to the standards of the Ministry of Health

c. The ability of reverse osmosis membranes using low pressure has not been able to eliminate salinity and TDS levels optimally. This is because if the operating pressure is low, the flow rate is also low which causes a low flux value.

Suggestion:

a. It is hoped that in future technological developments using reverse osmosis with a larger capacity to increase effectiveness.

b. For RO machines, it is expected to use sensors to measure water quality parameters.

c. It is necessary to add a more sophisticated filtration system to get water that is ready for consumption.

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