# THE PERFORMANCE OF REVERSE OSMOSIS MEMBRANE IN WATER TREATMENT

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*Abstract*

*Membrane technology has led to a new focus on water and wastewater treatment. This is due to several drawback of the conventional water treatment i.e release the toxic and carcinogenic materials. In this research, the use Reverse Osmosis (RO) membrane for treating river and well water to obtain clean and drinking water was studied. The variables studied were effect of pressure and operation time to the membrane flux. The pressure was varied from 1 to 7 bar and the operation time was varied from 15 to 60 minutes. The content of Total Dissolved Solid (TDS) in the permeate product was analyzed. The results shown that the increase of pressure would increase the membrane flux and decrease TDS. The increase of the operation time would decrease membrane flux and TDS. The reverse osmosis membrane was successfully applied to treat the river and well water. The product fulfill national standard quality of drinking water by viewpoint of the TDS content.*

Keywords: *Membrane Reverse Osmosis, TDS, flux*

## Introduction

The conventional water and wastewater treatment, especially chemical treatment, has several disadvantages, such as the production of chemical sludge as well as toxic and carcinogenic materials. The by product of carcinogenic materials, such as three halo methane (THM), were found inherent with chlorination process in water treatment. In addition, the conventional water treatment requires large surface areas. All of the drawback of these technology could be covered by membrane technology. The membrane technology has main characteristics as follows : energy saving, modular, environmental friendly, easy to be combined with conventional processes, and small surface area are required. Therefore, the membrane technology has led to a new focus on water treatment.

The performance of Reverse Osmosis Membrane for water treatment depends on the kind of membrane, membrane size, pressure, temperature and quality of water entering the system. In general, Reverse Osmosis Membranes are made from cellulose acetate, cellulose triacetate, and aromatic polyamide resin. At the beginning, RO was used to prepare fresh water from sea water. Recently, RO is used to treat not only sea water but also fresh water. RO can be used to lessen organic and inorganic components, bacterium and detectable particulate in impure drinking water. Therefore, the use of membrane reverse osmosis for supplying drinking water doesn't need the desinfection process (http://www.rci.rutgers.edu). In this research, the use Reverse Osmosis (RO) membrane for treating river and well water to obtain clean and drinking water was studied.

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## Materials And Methods

A schematic diagram of the reverses osmosis membrane employed in this study is shown in Fig 1.

The main unit consists of feed tank, cartridge filter, and reverse osmosis membrane. The 20 L feed and product tanks were made of plexy glass. Membrane reverse osmosis with 1.5 $m^2$ filtering area was made of cellulose acetat. The river and well water used in this experiment was taken from Tembalang and Kaligarang, both located in Semarang.

The variables studied are effect of pressure and operation time to the membrane flux. The pressure was varied from 1, 3, 5, to 7 bar and the operation time was varied from 15, 30, 45, to 60 minutes. The content of Total Dissolved Solid (TDS) in the permeate product was analyzed according to APHA Standard Methods for Water and Wastewater Treatment 1992.

## Results And Discussion

### The influence of pressure to permeate flux, TDS, and % rejection

The influence of pressure to permeate flux, TDS, and % rejection was studied by varying operating pressure from 1, 3, 5, to 7 bar. The operating time wes set to be one hour. The results are presented in Figure 2.

Figure 2 shows the increase of pressure will improve quantity of permeate flux. This is due to the driving force of Reverse Osmosis membrane is transmembrane pressure. All of the water fed to membrane resulted in a similar trend. The results presented in figure 2 indicate that Tembalang River results highest permeate flux, followed by Sampangan, Tembalang well and Kaligarang river.

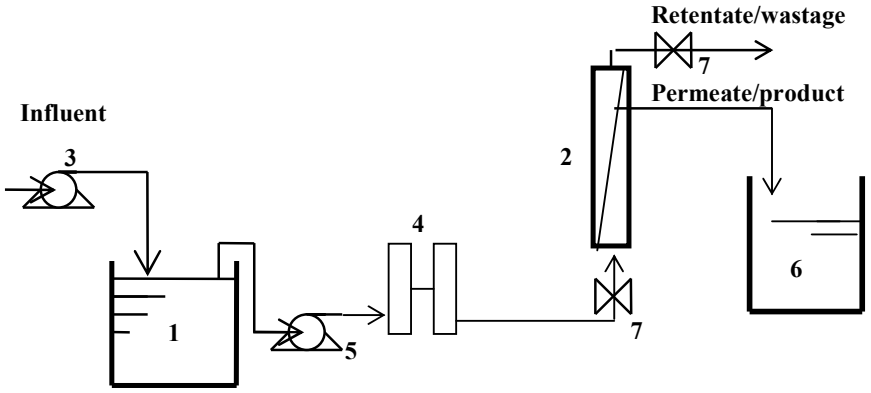
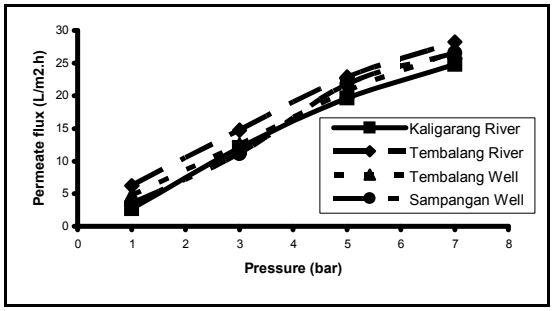
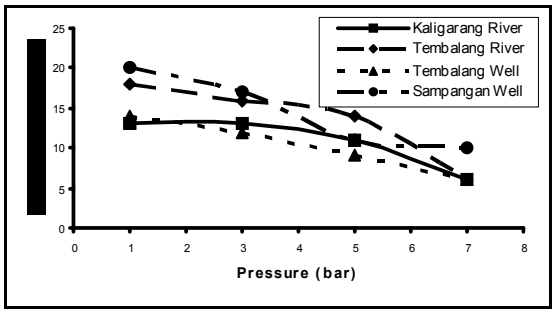


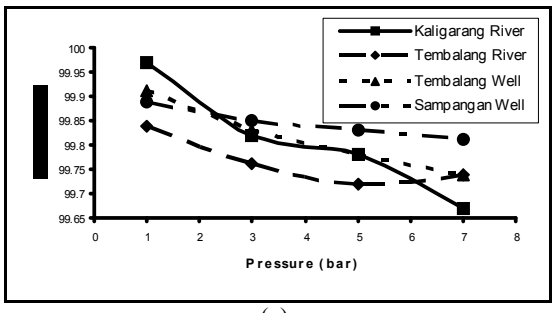

Fig.1. Schematic diagram of the reverse osmosis membrane system for water treatment; 1. Feed tank; 2. Reverse osmosis membran; 3. feeding pump; 4. cartridge filter; 5. Feed membrane pump; 6. Product tank; 7. Valve




(a)




(b)




(c)

Figure 2. The influence of pressure to (a) permeate flux; (b) TDS; and (c) % rejection

The next study, the influence of pressure to permeate TDS content is presented in Figure 2 (b). Total Dissolved Solid (TDS) is one of parameter of water quality can be used to show the quality of drinking and surface water. In general, TDS consists of the carbonate, bicarbonate, chloride, sulfate, phosphate, nitrate, calcium, magnesium, sodium, potassium, iron, manganese and other ions. Figure 2 (b) shows that greater of the pressure used the lower the permeate TDS content. All kind of water fed to membrane give the similar trend. Water with initial TDS about 300 ppm will give TDS permeate about 5 to 20 ppm. The national standard quality of drinking water requires that TDS is not higher than 1000 ppm.

Actually, the TDS content of all feed was not higher than 1000 ppm. However, TDS content about 5 – 20 ppm in the drinking water is very small to the newest trend in the world that requires very little TDS in drinking water. RO can fulfill this requirement. The next study is directed to asses the influence of pressure to percent rejection.

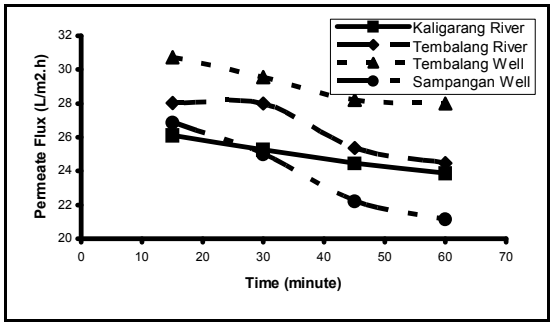
Percent rejection is the ability of membrane to retain unwelcome component, i.e. the solute retained in membrane. The % rejection will be in the range from 0 % to 100 %. The percent rejection 100 % indicates that membrane is perfectly able to retain solute, and the membrane is referred as ideal membrane. Rejection 0 % indicates that solute and solvent freely pass the membrane (Mulder, 1996).

The result depicted in figure 2 (c) indicates that high operating pressure will tend to decrease percent rejection. During membrane operation, membrane will retain solid molecule at its surface, and the solid will accumulate at membrane surface (Mulder, 1996). With existence of pressure increase operates for,

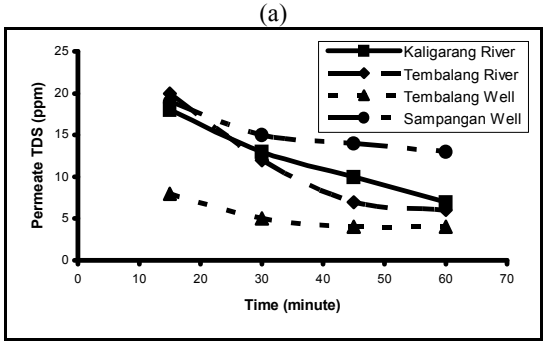
hence bait which can penetrate membrane layer more and more so that sum up solid which retained at membrane surfaces also more and more. This matter will result membrane ability to retain solid component will on the wane. Descend of this membrane ability expressed in % rejection tend to downhill along with pressure increase.

**The influence of operating time to permeate flux, TDS, and % rejection**

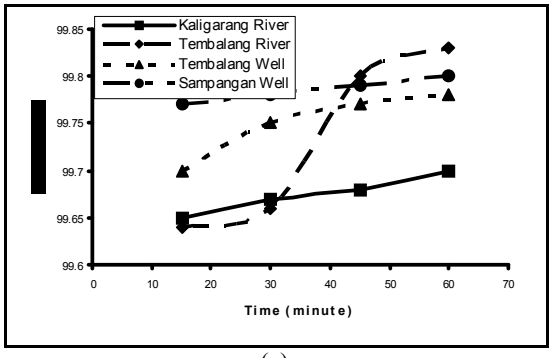
The influence of operating time to flux, TDS, and % rejection were studied by varying operating time from 15, 30, 45, to 60 minutes with operating pressure fixed at 7 bar. The dynamics of flux, TDS, and % rejection at the several operating time are presented in Figure 3.




(a)




(b)




(c)

Figure 3. The effect of time to (a) permeate, (b) TDS, and (c) % rejection

Figure 3 (a) and (b) show that the increase of operating time will tend to decrease permeate flux and TDS content. This matter caused progressively increase the time operated, hence increasingly amount of solid molecule which retained at membrane surface. The existence of solid accumulated on the membrane surface will result concentration polarization. Furthermore, these can promote the membrane fouling. Consequently, it will tend to decrease of permeate flux. The same reason will also occur with the TDS content.

Figure 3 (b) also shows that the progressive increase of operating time will tend to decrease permeate TDS. With increasing the operating time, the accumulation of solid at the membrane surface also more and more. Therefore, by increasing the time operate for hence the possibility of concentration polarization will also increase. Polarization existence earns to result the happening of fouling which can cause membrane ability to retain unwelcome component will become to decrease. This matter will result ions existence which get away and dissolve in permeate so that will cause increase TDS. However, in this research, TDS permeate smaller along with increase the time operated. This matter because variable of operating time which still relatively short so that the membrane ability to retain unwelcome component still be big enough. As a result, membrane still is selective enough to retain solid molecule at its surface. However, in the real field applied of RO, the TDS content in permeate will be homogeneously at all variation of operating time.

Figure 3(c) shows that longer the operating time will also increase % rejection. These matters goes together to descend of rate TDS in permeate. As mentioned been studied at figure 3 (b), operating time is still relatively short to operate for membrane, so that the possibility of the concentration polarization and fouling not yet there is so that the membrane ability to retain unwelcome component and selectivity still be big enough.

**Conclusions**

The increasing of pressure would increase the membrane flux and decrease TDS. The increasing of the operation time would decrease membrane flux and TDS. The reverse osmosis membrane was successfully applied to treat the river and well water. The product fulfill national standard quality of drinking water by viewpoint of the TDS content.

**Refferences**


1. APHA, 1992, "*Standar Methods for Water and Wastewater Analysis*"
2. Mulder, M,1996, *"Basic Principle of Technology Membran"*, second edition, Netherland
3. *http;//www.jbptitbpp-gdl-s2-2004-robertjuna/ ITB Central Library*, "Nanofiltration Membrane For High Valence Ions And Organic Compound Separation"
4. *http://www.oznet.ksu.edu/library/H2OQL2/ MF884.pdf*, Powell, G. Morgan, and Richard D. Black, "Water Quality"
5. *http://www.msue.msu.edu/msue/iac/disasterresp/ HomeImprovment/wq24.pdf,* "Reverse Osmosis For Home Treatment of Drinking Water"
6. *htttp://www.rci.rutgers.edu*, "U. S. Filter, Deionized (Reverse Osmosis) Water Treatment System"
7. *http://www.GEwater.com*, "What Is Reverse Osmosis (RO) Process?"
8. *http://www.epa.gou/safewater/consumer/hist.pdf*, "History of Water Treatment"