



# CONFERENCE PROGRAMS AND ABSTRACT

**The 3<sup>rd</sup> FIRST 2019 INTERNATIONAL CONFERENCE  
FORUM IN RESEARCH, SCIENCE, AND TECHNOLOGY  
OCTOBER 09-10, 2019  
*Palembang, Province of South Sumatera  
Indonesia***

**Organized by :**



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## **PREFACE**

The 3rd FIRST 2019 (Forum in Research, Science, and Technology) International Conference was initiated and organized by State Polytechnic of Sriwijaya in collaboration with Management and Science, University (MSU), Malaysia and National Chin-Yi University of Technology, Taiwan. The theme of the conference was “Integration of Advanced Technology to Enhance Social Welfare”. The 3rd FIRST 2019 International Conference facilitated the participants from all over the world to meet face to face to open chances in establishing connection and collaboration among them. It was not only for the researchers in academics, but also in industries and governments. This conference became an effective media to link the researchers from many parts of the world conference, for exchanging, sharing, following up and discussing the results of the latest research, industry’s needs, and government regulatory policies. The 3rd FIRST 2019 International Conference became worthwhile platform for researchers to present their finding in the areas on multidisciplinary of Engineering and Science (Track 1), Computer Science and ICT (Track 2), and Social Science (Track 3). It has also provided an opportunity for the professionals and researchers to learn and share about the latest development and research in those 3 tracks.

The 3rd FIRST 2019 International Conference attracted so many authors not only from Indonesia but also from other countries, such as Japan, Taiwan, and Malaysia. There were 180 papers were accepted in the 3rd FIRST 2019 International Conference, including 89 papers for Track 1 (Engineering and Science), 46 papers for Track 2 (Computer Science and ICT), and 45 papers for Track 3 (Social Science). In The 3rd FIRST 2019 International Conference, there were 4 keynote speakers and 2 invited speakers. As the keynote speakers, there were Prof. Yasushi Kiyoki, Ph. D from KEIO University, Japan, Prof. Nurul Taufiqu Rochman, M. Eng, Ph. D, From LIPI, Indonesia, Prof. Tjiptohadi Sawarjuwono, M. Ec., Ph. D., Ak, from Universitas Airlangga, Indonesia, and Prof. Win-Jet Luo, from National Chin-Yi University of Technology, Taiwan. As the invited speakers, there were Dr. R. Wisnu Nurcahyo, DVM from Universitas Gadjah Mada, Indonesia, and Assoc. Prof. Dr. Intan Zaurah binti Mat Darus from Universiti Teknologi, Malaysia. The 3rd FIRST 2019 International Conference committee would like to say thank you very much for all the participants and their respected institutions that have supported for the success of the 3rd FIRST 2019 International Conference, and also for all of the guess and sponsors of the 3rd FIRST 2019 International Conference.

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## The Performance of Reverse Osmosis (RO) Membrane in Producing Pure Water

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**Abstract.** This research was conducted to determine the performance of Reverse Osmosis (RO) membranes in producing pure water, pure water known as mineral-free water or water with zero dissolved solids (TDS = 0 ppm). PDAM (Regional Drinking Water Company) Tirta Musi in Palembang, South Sumatra and water from the Micro Filtration (MF) and Ultrafiltration (UF) processes are fed to the RO process using two feeding methods, namely a single pass and a circulation feed. In a single pass feed, the operating pressure is set at 20 - 50 Psig, where an increase in the product rate and the rejection rate so that the flux increases.

Rejection of TDS obtained increased from 96.6% - 97.5%. Furthermore, the circulating feed system with a constant pressure of 50 Psig decreases TDS and Conductivity. Rejection of TDS 96.1% for PDAM water feed and Rejection of TDS for feed water from MF&UF 97.3% in subsequent feedings there was a decrease in TDS and conductivity but not significantly. The purified water produced has a TDS content of 0.16 - 0.48 ppm, a conductivity of 0.17 - 0.49  $\mu\text{s} / \text{cm}$ , a pH of 6.99 - 7.2 and a resistivity of 177 - 185  $\text{k}\Omega$ , the characteristics of this pure water are according to the standard pure water in ASTM D1193 - 99e1 and NCCLS.

**Key words :** Pure water, Reverse osmosis, Rejection, single pass and circulation feed

### 1. Introduction.

Pure water is water that is processed so that it is free of ions or minerals contained in it. Pure water is known as Aquadest and Aquabidest also known as demineralized water, deion water, or distillate water according to the method of its manufacture. Pure water is often called TDS 0 water, which is widely recommended for cosmetic factories, food industries, hospitals and laboratory purposes. Pure water / Aquadest is often used as a thinner or solvent for chemicals, as a reagent, cleaning glassware / laboratory equipment. In the steel processing industry: Aquades are widely used as coolants for steel cutting machines, such as Wire Cut, and others that require water for cooling, with Aquadest / pure water it will inhibit scale and lichens. Aquades can also be used as battery water [1].



The process to remove minerals in water can be done in several ways, namely with ion exchange resins (IE), electrodialysis, membrane transfer distillation, flash evaporation, and reverse osmosis (RO) [2-3], the process can be done individually; Ion Exchange [4] and also with combined processes such as a combination of Microfiltration (MF) and IE [5], heat process and RO process [4]. RO is able to reduce conductivity and TDS reaches 81% and 82%, even the conductivity and TDS of water produced can reach  $0 \mu\text{S} / \text{cm}$ ,  $0 \text{ mg} / \text{l TDS}$  [5].

The application of RO in the water treatment and desalination process is very widely used today [6]. RO process can be used to overcome the problem of water in areas where the source of water is sea water or brackish water [7-9], processing brackish water into clean water using a reverse osmosis membrane [10], taking back water from wastewater [11] Reverse Osmosis for reduce the salinity of raw water [12]. RO processes are preferred over thermal processes [8]. The advantage of reverse osmosis membrane technology is its speed in producing water [9], RO method can reduce costs [13].

In the research process the RO is applied to obtain pure water, the water used is sourced from PDAM Tirta Musi Palembang South Sumatra water and water from MF and UF products. RO performance can be seen from the method of feeding, the water feed is processed one way (single pass) and the feed process is in circulation.

## 2. Material and Methods

There are two types of feed water in the RO process; firstly the water sourced from the PDAM taken at the Posri Chemical Engineering Laboratory, secondly the water produced from the MF and UF processes. The MF membrane of the Watertech product used is  $0.1 \mu\text{m}$ ,  $0.3 \mu\text{m}$ ,  $0.5 \mu\text{m}$ , while UF is  $0.01 \mu\text{m}$  and CSM type RO membrane is  $0,0001 \mu\text{m}$ .

Feed water used in the form of PDAM water and water produced by MF and UF, both of which are fed to the RO membrane with two types of feed, the first feed is processed once through a single pass at a pressure of 20-50 psi, the second type of feed is by The method of repetitive circulation is the result of a single pass being re-fed three times. Feed water and products produced from each process are analyzed using Waterproof Instruments. The parameters measured are conductivity, TDS, pH, and resistivity.

## 3. Results and Discussion

Table 1 data is the result of parameter analysis on RO feed for single pass feed type, this water contains TDS of 8.15 ppm, pH of 6.98, conductivity of  $8.16 \mu\text{S} / \text{cm}$ , and Resistivity of  $6.143 \text{ k}\Omega$ . Whereas in Table 2 the water results from microfiltration (MF) and ultrafiltration (UF) processes.

Table 1. Feed Water Analysis for a single pass Process

TDS (ppm)	Conductivity ( $\mu\text{S}/\text{cm}$ )	Resistivity ( $\text{k}\Omega$ )	pH
8,15	8,16	6,143	6,98

Water that is fed by circulation can be seen in Table 2. There are two types of water, namely PDAM water and water produced by the MF and UF process which are fed by recirculation. PDAM water content of TDS is 12.33 ppm and the conductivity is  $12.3 \mu\text{S} / \text{cm}$ , while the results of MF and UF of TDS and Conductivity are 8.21 ppm and  $8.2 \mu\text{S} / \text{cm}$ , and the pH of the two is almost the same 7.01 and 7, 04.

Table 2. Feed Water Analysis for the circulation process

Feed Water	TDS (ppm)	Conductivity ( $\mu\text{S/cm}$ )	Resistivity ( $\text{k}\Omega$ )	pH
MF&UF	8,21	8,2	6,094	7,04
PDAM	12,33	12.3	4,407	7,01

The performance of the RO process is determined by the ability of this membrane to reduce TDS, namely the concentration of dissolved solids and their conductivity which also shows the number of ions dissolved in water. Furthermore, the ability of the membrane is also determined from the rate of product produced by the unity of membrane area known as Flux.

In a one-way or single pass feed process with TDS and Conductivity as shown in Table 1, the resulting flux and rejection rates can be seen as shown in Figure 1. The product rate, rejection rate and flux will increase with increasing operating pressure, the product rate rises from 7.837 L / h at a pressure of 20 psig to 19,011 L / h at a pressure of 50 psig. Flux is obtained by dividing the rate of product by area of membrane.

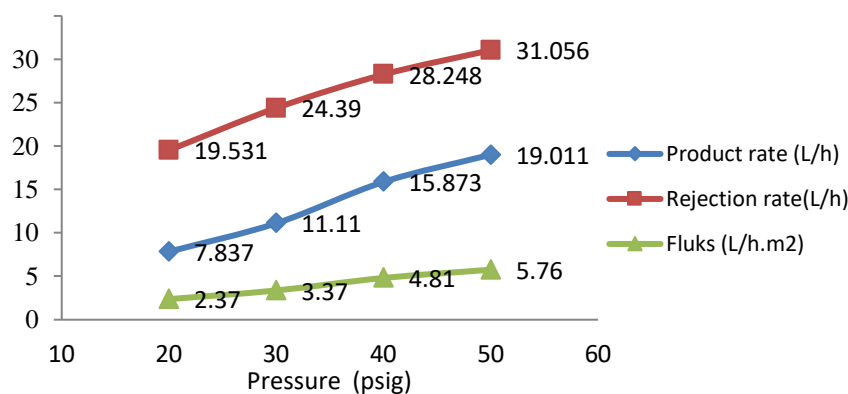


Figure 1. Fluxes and Rejection data on Reverse Osmosis (RO)

Rejection rate is greater when compared to the product rate, this is due to the compacting and polarization that occurs on the membrane surface [10-12]. Meanwhile Rejection to TDS increases with increasing operating pressure [10] starting from 96.6% at a pressure of 20 Psig and rising to 97.5% at a pressure of 50 Psig as shown in Figure 2.

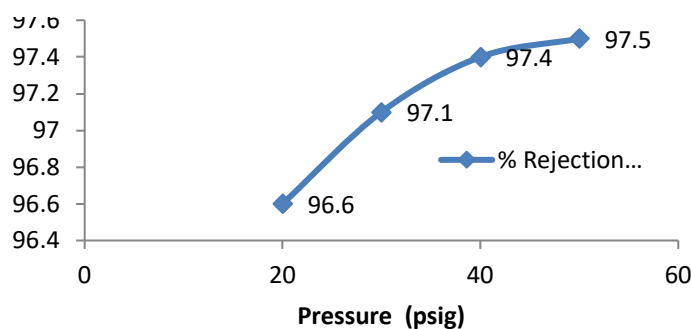


Figure 2. The Effects of Pressure on Rejection



In Table 3, it can be seen that the rate of pure water production rises with increasing pressure as well as in Table 4 the rejection rate increases with increasing pressure, TDS and conductivity also increases while resistivity decreases with increasing pressure due to increasing ions in the rejection flow [10-11].

**Table 3. Product characteristics Analisis on RO**

Pressure (psig)	Product rate (L/h)	TDS (ppm)	Conductivity ( $\mu\text{S/cm}$ )	Resistivity ( $\text{k}\Omega$ )	pH
20	7,837	0,28	0,28	161,5	7,01
30	11,11	0,24	0,24	185,3	7,01
40	15,873	0,22	0,23	194	7
50	19,011	0,21	0,22	201,1	7

In Table 3 above the quality of pure water produced is good enough with an average TDS content of 0.2375 ppm, with an average conductivity of 0.2325  $\mu\text{S/cm}$  of pH 7.0 and a resistivity of 185.475  $\text{k}\Omega$  is in accordance with the requirements ASTM and NCCLS standards [14].

**Table 4. Rejection Analisis on Reverse Osmosis Procces**

Pressure (psig)	Rejection rate (L/h)	TDS (ppm)	Conductivity ( $\mu\text{S/cm}$ )	Resistivity ( $\text{k}\Omega$ )	pH
20	19,531	11,42	11,44	4,37	7,01
30	24,39	12,01	11,9	4,164	7
40	28,248	12,77	12,68	3,915	6,99
50	31,056	13,1	13,11	3,832	7,01

The following Table 5 shows the characteristics of the products produced from two types of feed water and two types of feed systems on RO membranes. Rejection of TDS for PDAM water feed and water resulting from MF and UF of 96.10% and 97.31% on a single pass, then if the pure water is fed back to RO repeatedly (in circulation up to 3 times) the TDS content for both feed water continues to decrease until its TDS of 0.18 ppm for PDAM water feed and 0.16 ppm for MF&UF product water.

**Table 5. Product characteristics and method of Feeding on Reverse Osmosis (RO)**

Parameter	Unit	PDAM Water Feed					MF&UF Water Feed				
		Before	After	Circulated Product			Before	After	Circulated Product		
		Process	Single pass	1 time	2 time	3 time	Process	Single pass	1 time	2 time	3 time
Conductivity	$\mu\text{S/cm}$	12,3	0,49	0,39	0,23	0,18	8,21	0,22	0,22	0,17	0,17
TDS	ppm	12,33	0,48	0,4	0,22	0,19	8,2	0,22	0,21	0,17	0,16
Resistivity	$\text{k}\Omega$	4,047	86,81	109,8	192,8	234,3	6,094	200	217,7	267,9	278,9
pH	pH	7,01	7,2	7,03	7,03	7,01	7,04	7,04	7,03	7	7,01
NaCl	ppm	121,5	15,86	15,05	13,85	13,67	82,45	13,83	13,71	13,64	13,56

The quality of the pure water product produced is also getting better if the RO product produced continuously in circulation will reduce TDS and conductivity and likewise the salt content is equivalent to NaCl down, while the resistivity rises and the average pH 7.

Pure water / Aquadest is water that is free of impurities, water with zero clear TDS, is odorless, and has no taste, has the ability to dissolve many substances, so it is known as a universal solvent. From the Table of pure water produced from this study has a TDS of 0.16 - 0.48 ppm, a conductivity of 0.17 - 0.49  $\mu\text{S/cm}$ , a pH of 6.99 - 7.2 and a resistivity of 177-185  $\text{k}\Omega$ , characteristic of pure water This meets ASTM D1193 - 99e1 and NCCLS standards.

**Tabel 6.** ASTM D1193-91e1 *Standard Specification for Reagent Water*

Parameter	Type	Type	Type	Type
	I	II	III	IV
Electrical Conducti.. Max. ( $\mu\text{S/cm}$ at 25°C)	0,056	1,0	4,0	5,0
Electrical Resistivity ( $\text{M}\Omega\cdot\text{cm}$ at 25°C)	18,2	1,0	0,25	0,2
pH at 25°C	-	-	-	5,0 - 8,0
TOC max. ( $\mu\text{g/L}$ )	10	50	200	n/a
Sodium max. ( $\mu\text{g/L}$ )	1	5	10	50
Total Silica max. ( $\mu\text{g/L}$ )	3	3	500	n/a
Chlorides max. ( $\mu\text{g/L}$ )	1	5	10	50
Endotoxins IU/ml	< 0.03	< 0.25	-	-

<https://puretecwater.com/downloads/water-quality-standards.pdf> 27 /08/2019

**Tabel 7.** *National Committee for Clinical Laboratory Standards (NCCLS)*

Parameter	Type I	Type II	Type III
Bacteria (CFU/ml)	< 10	< 1000	NA
Ph	NA	NA	5,0 - 8,0
Resistivity ( $\text{M}\Omega\cdot\text{cm}$ @ 25°C)	> 10*	> 1	> 0,1
Silica (mg/L)	< 0,05	< 0,1	< 1
Total Solids (mg/L)	0,1	1	5
Total Oxidisable Organic Carbon (mg/L)	< 0,05	< 0,2	< 1
Particulate matter	< 0.2 $\mu\text{m}$		

<https://puretecwater.com/downloads/water-quality-standards.pdf> 27 /08/2019

#### 4. Conclusion

Reverse Osmosis provides rejection of TDS and a large Conductivity value above 96% with a product rate of 7-19 L / h. The method of feeding with circulation can reduce even smaller TDS to even reach

zero TDS if the RO product is continuously fed back to the RO. Pure water produced from RO products meets ASTM D1193-91e1 and NCCLS standards.

## 5. Acknowledgements

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