1st APTIK International Conference on Poverty and Environment:

RESILIENCE IN POVERTY ALLEVIATION AND ENVIRONMENTAL MITIGATION

BOOK OF ABSTRACTS

Hosted by

APTIK
ASOSIASI PERGURUAN TINGGI KATOLIK

UNIVERSITAS ATMA JAYA YOGYAKARTA

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AUDITORIUM GEDUNG KAMPUS III
UNIVERSITAS ATMA JAYA YOGYAKARTA (UAJY)
Jl. BABARSARI NO.43

YOGYAKARTA, 21 - 23 SEPTEMBER 2018

Greetings,

I would like to thank God and everyone who had contributed their time to make this conference happen. I am pleased to welcome our distinguished keynote speakers, invited speakers, presenters, and participants at the "1st APTIK International Conference on Poverty and Enviroment: Resilience in Poverty Alleviation and Environmental Mitigation" in Yogyakarta, Indonesia.

Higher education institutions play significant role in improving our society. In the world where inequality and environmental disasters still exist, these become the challenges that great thinkers such as academia, experts, and researchers need to work together to find solutions for those problems. I would also like to use this occasion to mention that this initial conference is held in our beloved university, Universitas Atma Jaya Yogyakarta (UAJY). Community service and engagement are two important elements in our academia culture.

For decades, this university, together with the Association of Catholic Institutes of Higher Learning, have worked together to help the improvement of the life of the community in need. This conference is set up to connect these great thinkers to collaborate, create new ideas, and contribute more to the society in the spirit of serviens in lumine veritatis or as we call it as to serve in the light of the truth.

We would like to extend our deep gratitude to the Rector of Universitas Atma Jaya Yogyakarta (UAJY), Head and the people of the Association of Catholic Institutes of Higher Learning (APTIK) that have supported this event. Our co-host universities that have encouraged their researchers and lecturers to participate in this event. We also would like to thank the steering and organising committees, and all the parties that have helped this event from the beginning until the end.

Final words, I sincerely wish this conference will be fruitful and an impactful platform for the development of ideas to contribute to these challenging issues of poverty and environmental disasters. Once again, I wish you will have a good time and welcome to Yogyakarta, Indonesia.

Head of Institute Research and Community Service

Universitas Atma Jaya Yogyakarta

Dr. I Putu Sugiartha Sanjaya, SE., M.Si., Ak. CA

TIME SCHEDULE

"1st APTIK International Conference on Poverty and Enviroment: Resilience in Poverty Alleviation and Environmental Mitigation"

Yogyakarta, 21-23 September 2018 | Auditorium Campus III, UAJY

21 September 2018 (Day 1)

Venue : St. Bonaventura Auditorium

TIME	SCHEDULE	PLACE
08.00-08.30	**Registration**	**St. Bonaventura Auditorium**
08.30-09.00	Opening speech by: • Head of the conference committe: Dr. I Putu Sugiartha Sanjaya, SE., M.Si., Ak., C.A • Chairman of the Association of Catholic Institutes of Higher Learning (APTIK) (Dr. Ir. Paulus Wiryono Priyotamtama, S.J., M.Sc) • Rector of the Universitas Atma Jaya Yogyakarta (Dr. Gregorius Sri Nurhartanto, SH., LL.M	
09.00-09.45	Keynote Session Dr. Ir. Paulus Wiryono Priyotamtama, S.J., M.Sc (The Spirituality in the Poverty Alleviation and the Environmental Mitigation in the Indonesian context)	
09.45-10.00	Coffee Break	
10.00-10.30	Panel Session 1 Dr. Gregorius Sri Nurhartanto, SH., LL.M Rector of UAJY (The Leadership of Atma Jaya Yogyakarta in the Poverty Reduction in Yogyakarta through Community Service and Engagement Programs)	
10.30-11.00	Panel Session 2 Drs. Bambang Ismawan, MS (Bina Swadaya) (Community Involvement in Poverty Reduction through Environmental Approach in Indonesia)	
11.00-11.30	Panel Session 3 Dr. Agustinus Prasetyantoko Head of Jaringan Penelitian dan Pengabdian kepada Masyarakat APTIK (JLPMA) (Progression in climate change policy: how far Indonesia has considered environmental factors in the economic policy)	
11.30-13.30	Lunch	
13.30-15.30	Parallel Session 1	**Classroom 411-414**
	Parallel Session 2	
	Parallel Session 3	
	Parallel Session 4	

TIME	SCHEDULE	PLACE
15.30-16.30	Coffee Break	St. Bonaventura Auditorium
16.30- 18.00	Journal Writing Clinic Dr. Jonatan Lassa Charles Darwin University (Australia)	Room III/ 4
18.00-20.00	Welcome Dinner	St. Bonaventura Auditorium

22 September 2018 (day 2)
Venue : St. Bonaventura Auditorium

TIME	SCHEDULE	PLACE
15.30-16.30	Opening	St. Bonaventura Auditorium
15.30-16.30	Keynote Session Gerald Potutan, Ph. D. Recovery expert, International Recovery Platform (Japan) (Recovery as Opportunity for Resilience Cases of Poverty Alleviation and Environmental Mitigation following a Disaster)	
15.30-16.30	Coffee Break	
15.30-16.30	Panel session 1 Br. Armin Luistro FSC Rector De La Salle Philippines University (The Philippines) (The Role of the Catholic Universities in South East Asia in Reducing Poverty)	
15.30-16.30	Panel session 2 Prof. Shibata Yu, Ph.D. Kumamoto Prefecture University (Japan) (Perspectives on cultural and environmental/agricultural recovery post the 2016 Kumamoto Earthquake)	
15.30-16.30	Panel session 3 Dr. Jonatan Lassa Charles Darwin University (Australia) (Disaster risk management ecosystem: Australia and Indonesia)	
15.30-16.30	Lunch	
15.30-16.30	Parallel Session 1	Room 411- 413
15.30-16.30	Parallel Session 2	
15.30-16.30	Parallel Session 3	
15.30-16.30	Coffee Break	St. Bonaventura Auditorium
15.30-16.30	Closing ceremony	

THE APPLICATION OF PILOT PLANT HYBRID MEMBRANE IN THE HOSPITAL WASTEWATER TREATMENT TO OVERCOME THE ANTIBIOTIC RESISTANCE PROBLEMS IN THE URBAN WATER

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ABSTRACT

The clean water crisis is a world and Indonesia issue.The hospital is a place of public service that plays an important role for maintaining the survival of human life.Consumption of antibiotics in hospitals causes potential contamination of residual antibiotics that will be mixed with wastewater.Regulations on hospital wastewater in Indonesia have not regulated the content of antibiotics.Antibiotics are resistant and persistent if they are in aquatic environments even in small concentrations. Hospital wastewater treatment system has not been designed process the antibiotics, so it needs to be developed alternative technology and solve the problem.This research was conducted for 1.5 years, sample using hospital wastewater type B in Palembang City used grab and composite sampling. Research design used a laboratory-scale design experiment to analyze the performance of Hybrid membrane (NF-RO) in treating antibiotics in hospital wastewater. Membrane performance calculation variables are rejection.Quantitative analysis showed a Ciprofloxacin level of 4.7 ppm and exceeded the prevailing standard quality in Europe (EC50<1 ppm).These results proved there is a correlation between the quantity of antibiotics with hospital wastewater become the potential pollutant agent in the water.The results of the study showed Hybrid membrane (NF-RO) performance reducing the levels of Ciprofloxacin antibiotics. The highest hybrid membrane (NF-RO) rejection was 98,31% (80 psi and 1,5 h) with Ciprofloxacin levels at retentate of 0,06 ppm and Rejection system was 98,56%. This result showed Hyrid membrane process is possible appliction in hospital to overcome the antibiotics resistance problems.

Keywords : Hybrid membrane,Antibiotic, Ciprofloxacin, Hospital Wastewater, Resistance

RESILIENCE BASED ON DIALOGUE BETWEEN SCIENCE AND FAITH

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Submitted for presentation at the First APTIK International Conference on Poverty and the Environment:
"Resilience in Poverty Alleviation and Environmental Mitigation",
Universitas Atma Jaya Yogyakarta, 21-23 September 2018

Abstract

Resilience as a way of life would be well-grounded when the actor has an integrated personality, meaning that his/her world view has more or less integrated the physical and spiritual dimension of the human person. The Republic of Indonesia has done that since its proclamation of independence in year 1945, by establishing the Pancasila principles. Parahyangan Catholic University (usually acronymed "Unpar") has formulated further this integration in its so-called SINDU-based (Spirituality and Basic Values of Unpar) way of life in year 2015. This way of life has been incorporated into the welcoming activities for new students, strategically involving around 70 lecturers, both senior and junior, as an immersion activity. What remains is the difficult task of realizing this way of life, of being resilient in paying attention towards "the other", opting preferentially for the poor or weaker persons. A supporting condition for this resilience would be a practised personal dialogue between science and faith. This is also seen as proper for a practising professional, including a lecturer at a catholic university, even when having different faiths, especially in this era of a so-called 4th industrial revolution, encompassing integration and automation of services, and the role of artificial intelligence. Some simple examples of incorporating this dialogue in lectures and daily life are presented.

Keywords: Resilience, poverty, dialogue, science, faith

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ABSTRACT

The clean water crisis is a world and Indonesia issue.The hospital is a place of public service that plays an important role for maintaining the survival of human life.Consumption of antibiotics in hospitals causes potential contamination of residual antibiotics that will be mixed with wastewater.Regulations on hospital wastewater in Indonesia have not regulated the content of antibiotics.Antibiotics are resistant and persistent if they are in aquatic environments even in small concentrations. Hospital wastewater treatment system has not been designed process the antibiotics, so it needs to be developed alternative technology and solve the problem.This research was conducted for 1.5 years, sample using hospital wastewater type B in Palembang City used grab and composite sampling. Research design used a laboratory-scale design experiment to analyze the performance of Hybrid membrane (NF-RO) in treating antibiotics in hospital wastewater. Membrane performance calculation variables are rejection.Quantitative analysis showed a Ciprofloxacin level of 4.7 ppm and exceeded the prevailing standard quality in Europe (EC_{50}<1 ppm).These results proved there is a correlation between the quantity of antibiotics with hospital wastewater become the potential pollutant agent in the water.The results of the study showed Hybrid membrane (NF-RO) performance reducing the levels of Ciprofloxacin antibiotics. The highest hybrid membrane (NF-RO) rejection was 98,31% (80 psi and 1,5 h) with Ciprofloxacin levels at retentate of 0,06 ppm and Rejection system was 98,56%. This result showed Hyrid membrane process is possible appliction in hospital to overcome the antibiotics resistance problems.

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BACKGROUND

The data which are released by the WWF world organization in the annual toxic chemical reports between 1930 to 2000 reveals that the production of chemicals as the causing of human activities increased from 1 million to 400 millions per year. Statical data which are published by Euro Statin 2013 showed that in the years of 2002 to 2011, more than 50% of the total production of chemicals produced the harmful compounds and 70% of the chemical had the significant environmental impacts. In addition, the human activities have resulted in the contamination of water sources with the highly toxic biological micropollutants such as viruses and bacteria (Xie, 2012; Periasamy and Sundaram, 2013; Sui et al., 2015).

Verlicchi et al. (2015) and Tran et al. (2013) reported that some contaminant pollutants require the further attention and treatment due to the limited regulation and have typical waste characteristics of Pharmaceuticals and personal care products (PPCPs). PPCPs is categorized as the chemical substances used by humans and animals in the preventing of diseases, disinfectants, perfumes, lotions, and other personal needs. The study which was conducted by

Bu et al. (2013) in China and Lea et al. (2012) in South Carolina explained the potential, sources, and impacts which were generated by PPCPs on the environment. PPCPs have the persistent and bioaccumulative properties as the residue in the environment and potentially affects the health and ecological impacts (Brausch dan Rand, 2011; Brausch et al., 2012; Daugton, 2013; Vasquez et al., 2014).

Some residue which was detected including Analgesics/anti-inflammatories, Antibiotic, Cardiovascular pharmaceuticals(b-blockers/diuretics), Estrogens dan hormonal compounds, Psycho-stimulants, and Antiepileptic drug (Li et al., 2015). Evgenidou et al., (2015) found that the Pharmaceuticals and personal care products (PPCPs) and prohibit drugs provided the negative impacts as the biotic and abiotic environmental through the derivative products of the transformation which was generated by the lack of knowledge, technology, and efficiency in the reducing of drugs.

In general, the hospital activities obviously produce some residues of medicines including antibiotics. Currently, Antibiotics become the most important part of the treatment due to treating the human infection, Vasquez et al. (2015) reported the potential pollution of the biological wastes of hospital affects either direct and indirect effects on the human health. Hospital wastewater which is containing the chemicals and drugs is carcinogenic and genotoxic that can initiate the growth of cancer and genetic disorders (Cuong et al., 2013; Escher et al., 2010; Orias and Perrodin, 2013; Sharma et al., 2015; Bayer et al., 2014).

Hospitals as the one form of health services to the community in a variety of activities produce the wastewater that can be processed to minimize the impact before discharged into the water body. The ministry of health reported that in 2014 there were 2.410 hopitals in Indonesia. Furthermore, in South Sumatera, there were 55 hospitals where 27 hospitals were located in Palembang. Moreover, from the number of hospitals, it was estimated that the hospital could produce 376.089 tons per day and 48.985,70 tons per day of the solid waste and wastewater, respectively (Dhani and Yulinah, 2011).

Bebianno and Rey (2015) concluded that the exposing of hospital wastewater in large quantities have a wide impact on the aquatic environment. Hamjinda et al. (2015) observed the characteristics of hospital wastewater with the research subjects of antibiotics compounds at seven hospitals in Bangkok and found several antibiotic compounds (Kuinolon, Ofloxacin, Levofloxacin, Norfloksasin, Siprofloksasin, Sulfametoksazol, and Norfloksasin) which have toxicity impacts to some microorganisms such as Chlorella vulgaris and Scenedesmus quadricauda), and Microcrustacean (Moina macrocopa). Kurniawan et al. (2017) found 5 types of antibiotics (Ciprofloxacin, Lincomycin, Metronidazole, Netilmicin, Ofloxacin/Levofloxacin) in the hospital wastewater in Palembang, Indonesia.

Kyzas et al. (2015) and Verlicchi et al. (2012b) found that the wastewater containing medicinal residues was very dangerous and toxic to humans and the environment. Furthermore, the trace number of micropollutant in parts per billion (ppb) or parts per trillion (ppt) in the drinking water have a detrimental effect on human health due to chronic properties (Huerta-Fontela et al., 2010, Ratola et al., 2012, Nam et al., 2014).

Hospital waste is all waste produced by hospital activities in solid, liquid, and gas forms. Hospital wastewater is all wastewater including stool derived from hospital activities that may contain microorganisms, toxic chemicals, and radioactive substances harmful to health (Kepmenkes RI No:1204/Menkes/SK/X/2004 about Hospital health environment requirements). Hospitals include the producers of hazardous and toxic waste from a specific source with D.277 codes (PP No.85,1999). Hospital activities produce solid, liquid, and gas wastes with distinctive characteristics with high organic content, suspended materials, relatively high amounts of fat and volume (Taylor and Senac, 2014).

Wastewater treatment is a contaminant processing technology as a strategy to reduce the burden of upstream environmental pollution through wastewater treatment system. Wastewater treatment plant is an instrument that is generally a combination of three wastewater treatment processes including physical, mechanical-biological, and chemical process. The physical-mechanical and chemical process is basically similar with the wastewater treatment to get the clean water in which the active sludge process is commonly used in the biological wastewater treatment (Jiang et al., 2013)

In fact in the environment, WWTP still leaves a lot of problems and obstacles. The extent of the location of the instrumentation, and also the cost required for the installation or maintenance increase the cost of the hospital wastewater treatment process. furthermore, the generated effluent requires the further treatment thus consuming high energy and cost. Some studies were conducted by (Zorita et al., 2009; Kosma et al., 2010; Behera et al., 2011; Deegan et al., 2011; Jelic et al., 2011; Gracia-Lor et al., 2012 reported that the sewage treatment plant owned by the hospital does not have the ability to reduce the content of medicines in wastewater.

SOLUTION

Chonova et al. (2016) reported that commonly the WWTP of the hospital was not designed to remediate the wastewater containing the drugs which most of the wastewater could release as the wastewater contained the drugs. It was shown by the specific characteristics which reported by Gracia-Lor et al. (2012) who conducted a research in Valencia, Spanyol. The results presented that the WWTP of hospital needs a specific plan to include some efforts to minimize the waste and wastewater treatment through the wastewater treatment plant. The characteristics of hospital wastewater containing the Pharmaceuticals and personal care products (PPCPs) is difficult to be reduced by common hospital wastewater treatment system (Rivera-utrilla et al., 2013).

Membrane technology as one of the installations of sewage treatment unit has the promising development and progress. Membrane technology is mostly done in the process of separation and purification of drinking water (Bodzek et al., 2012). Membranes have several advantages compared the conventional methods such as providing the continuous running process with low energy consumption, requiring no additional chemical and can run at low temperature, easy to scale up, requiring no extreme condition, varying of membrane material which easily adaptable and combined with other separation and treatment. (Kusumawatidan Tania, 2012).

The use of membrane technology in the wastewater treatment process is relatively expensive compared to the active sludge because it requires some additional handling such as routine membrane cleaning, and replacing of membranes. If we use the long-term perspective with twenty-year wastewater treatment needs with the optimum wastewater effluent quality requirements, the cost required in the membrane technology is equal with the conventional activated sludge (Young et al., 2012).

Madaeni, et al. (2015) explained that the membrane process offers the significant advantages due to operational simplicity, flexibility, cost-effectiveness, reliability, low energy consumption, good stability, environmental compatibility, easy to control, handling, and scale up with the operating conditions such as temperature, pressure, and pH. Furthermore, nano-filtration and technology which use the pressure principle on the membrane called reverse osmosis are relatively new technology in the wastewater treatment system (Shon et al., 2013). Although the process uses relatively high operational and consumption costs, the process is the latest technology of filtration process to reduce the contaminant with high concentrations and has the challenge to be made on the contaminants with distinctive characteristics (Oller et al., 2014).

The membrane process using nanofiltration (nF) and reverse osmosis (RO) is increasingly used to produce high-quality water. Numerous studies have demonstrated the ability of nF-RO to remove the organic and inorganic contaminants including pharmaceutical wastewater (Kim et al., 2007; Radjenovic et al., 2008; Yangali and Quintanilla, 2008; Dolar et al., 2013: Kurniawan et al. 2016). Frederic and Yves (2014) and Alzahrani and Wahab (2014) reported that the new technology should be implemented in the hospital wastewater treatment because there were several micropollutants found in the treated wastewater.

In the literature reviews, most of the hospital wastewater treatment in Indonesia use the activated sludge which is combined with the aerobic and anaerobic pond to remove the contaminant. However, the treatment does not have a pre-analysis and post-analysis to identification thepharmaceutical compounds releasing as the WWTP effluent because it was not necessary and the quality standard managed by the government does not regulate in detail which compound should be removed during the treatment. Prayitno et al. (2012) conducted a research about the quality of hospital wastewater in Malang and some study reports about the quality of wastewater in some hospitals in Indonesia (RSUD KeletJepara, RSUD Dr. Muhammad ZeinPainanSumbar, RS Permadi, RSU Prov. NTB, RSUP Dr.WahidinSudirohusodoSulsel, RS PKT Bontang, RSUP Persahabatan). The results showed that operator of wastewater only monitored the physics, chemistry, biology, and radioactivity aspects according to the hospital wastewater quality standard.

Membrane technology might be a solution in hospital wastewater treatment and the development of membrane process can be combined (hybrid membrane) with the membrane method of nanofiltration and reverse osmosis (Singh, 2015). The nanofiltration process combined with reverse osmosis can separate the impurity components having characteristics containing the medicinal residue of 94% -100% (Dolar et al., 2012). The hybrid nF-RO is the latest technology which is not widely applied in hospital wastewater treatment.

The sense of the process membrane through hybrid or integrated system is assembling a membrane processing process in an installation by combining one or more membrane process with or without conventional processes to improve the performance of treatment depending on the feed characteristics and products (Greenle et al., 2009). The hybrid system might reduce the operational costs and environmental pollution and enhance the efficiency of the treatment. U.S. Department of Energy (2016) showed that some economic advantages of hybrid membrane usage in clean wastewater treatment process shown below.

a. Reduce the electricity cost through combining the hybrid process with more than 90 % of an advanced process of wastewater treatment
b. Reduce 20% or more of the wastewater treatment cost
c. Reduce 90% of carbon emission
d. Reduce 94% of the contaminant in the wastewater

Zakrzewska-Trznadel (2013) have conducted the advanced technologies through incorporate two membrane process using UF and RO membranes to treat radioactive wastewater from actinide partition.Plakas et al. (2012) reported that the hybrid nF-RO process could reduce pesticide wastewater. Abid et al. (2012) also performed the nF-RO process to remove the pollutant from the textile industry wastewater in Iraq and the results showed that the nF-RO could effectively remove 92.2%, 99.58, and 99.9% of the color, black, and blue dyes, respectively with the optimum condition of 65 mg/L of concentration, 39oC of feed temperature, and 8 bar of pressure. The results showed that the membrane technology had a higher reducing capacity with a lower effective cost. In addition, the study showed that the use of nF membranes in the removal of color waste from Iraq possessed the promising technology.

METHOD OF IMPLEMENTATION

Sampling

In this study, the hospital wastewater was taken from the wastewater treatment plant in the first pond (primary pond) where all the hospital activities that produce the wastewater are flowed and collected in this pond. The first pond shaped beam with a size of 2.4 m x 1.9 m x 4.0 with a capacity of 18.2 m3. The wastewater was taken using Vandorn Sampler (Fig.1) with a specific depth. The wastewater sampler should comply with the requirements which made of a material which does not affect and contaminate the sample, easy to clean, carry, and move the sample into the container bottle without any residual suspended material in it.

Figure 1.*Vandorn Sampler*

The sampling process is conducted into 3 steps which is preparation sampling, taking grab and composite, and packing. The sampling process refers to SNI 6989.59:2008 (water and wastewater-chapter 59: Wastewater sampling method). The sampling process was taken on Monday (26th – 31st of October 2016) at 10.00-11.00Western Indonesian Timezone at peak load capacity of wastewater treatment volume. The sampling process is taken at a time of moment at one particular location and a mixture of wastewater sample which is taken from different points over time with the same volumes (composite).

The sample analysis was conducted by collecting the wastewater into the polyethylene bottle (Figure 2), and homogenized and divided into two or more parts of the sample. The sample was treated equally and analyzed in PT. Angler Bio Chem Laboratory, Surabaya (Akreditasi KAN LP-514-IDN, SNI ISO/IEC 17025:2008). The sample containers (bottle) should comply the requirements of glass or polyethylene (PE) or polypropylene (PP) or ethylene (PTFE) or polyurethane or polytetrafluoroethylene (PTFE) which easily to be sealed, clean and free of contaminant, quite strong, and high stability.

Figure 2.*Polyetilen bottle*

Membrane design the hybrid process (NF-RO)

The advanced process after the pretreatment process is a membrane block which is the producing of a membrane hybrid process (nF-RO). RO is commonly used in the post-treatment process due to the capacity to remove the dissolved ions, solids, and organic matters (Pandey et al., 2012).

The design of the research process has 17 L/h of capacity with a commercial nF membrane (F11028, British Portacle-Water Quality USA) and RO (CSM Korea Model RO 2012-100) equipped with housing membrane. The pipe is polyurethane tube with the pipe size on membrane block of 3/8 mm and block RO ¾ mm with the maximum working scale of 230 psi and temperature 150oF. The process uses the RO pump with the maximum inlet pressure of 60 psi and outlet pressure of 110 psi with the normal flow rate of 1.8 LPM. In this step, the advanced pretreatment process is conducted. Figure 3 showed the design of hybrid membrane technology process.

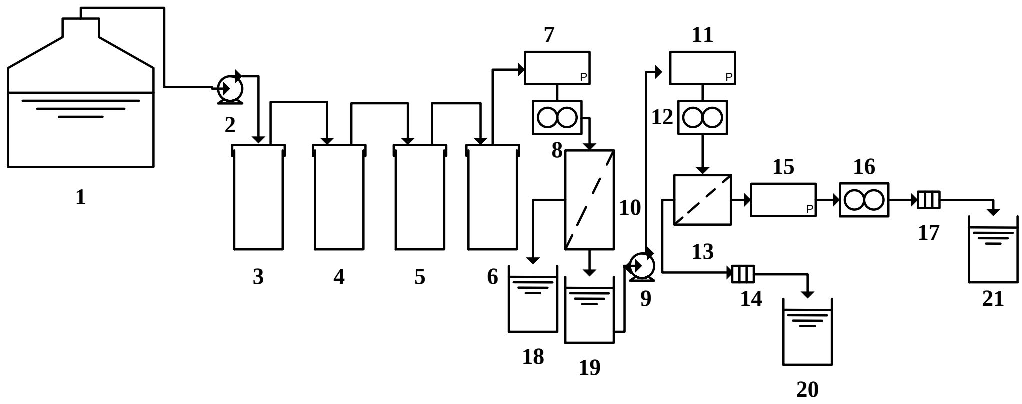

Figure 3. the design of hybrid membrane technology process

Description:

1. **Inlet tank**
   Made of plastic material with a capacity of 300 L. The inlet tank is used as the membrane feed wastewater.
2. **Pomp 2**
   It serves to drain the feed to the membrane hybrid process block.
3. **Filter of 10" 5 micron**
4. **Filter of 10" 1 micron**
   The 5 micron (DAI-05) and 1 micron (DAI-01) filter catridge serves to filter out the particles and other contaminants which still present in the feed. Temperature: 5-60 ^{o}C, *Water Quality, USA Design.*
5. **Granular Activated Carbon (GAC)**
   Model GAC 933 RO *Coconut Activated Carbon USA Technology*, *Degree of Nominal Filtration* 5 micron, *Design flow rate max* : 1.5 GPM, *Maximum temperature* : 100 ^{0}F (38 ^{0}C), *Maximum pressure* : 125 psi (8,6 bar), *Minimum Pressure* : 20 psi (1,4 bar).
6. **CTO Carbon Blok Filter**
   Reduction of*Giardia, Cryptosporidium, Certsin, VOCs, Chlorine, Extra fine* sediment, smell and taste. *Pressure*: 2 psi 1 GPM. *Maximum operating temperature* : 38 ^{0}C
7. **Pressure Gauge**
   It serves to see the pressure of the water rate flow before entering the nF.
8. **Flow Meter**
   It serves to see the process flow rate entering the nF.

9. **Booster Pump RO**
   It serves as a water booster on RO with pressure of 60 psi with maximum pressure of 110 psi, electric power: 48 volts dc
10. ***Nanofiltration Membrane***
    British Portacle, Ceramic, Tubular Device, Standard 2 x 10 inch *Water Quality USA*. *Typical Flow Rate* 45 PSI 1,3 GPM. *Typical Flow Rate* 3 Bar 5 LPM.
11. **Pressure Gauge**
    It serves to see the water flow pressure entering the RO
12. **Flow Meter**
    It serves to see the water flow rate entering the RO
13. **Reverse Osmosis**
    Model RO 2012-100, 25^{0}C, pH 6,5-7, *Membrane type Thin-Film Composite, Membrane material Polyamide (PA), Element Configuration Spiral Wound.*
14. ***Anti Flow* 300 cc**
    It has forms like a water sensor swithc which makes it suitable for connecting to the RO hose and has a food grade and function to deliver discharge water from RO membrane filtration. In addition, there is a one way dual advantage that blocks the direction of water opposite to the norla flow direction. This function makes the RO membrane unpolluted.
15. ***Pressure Gauge***
    It serves to see the water flow pressure exiting the RO (permeat).
16. ***Flow Meter***
    It serves to see the water flow rate exiting the RO (permeat)
17. ***Post Carbon***
    Material : *Coconut Shell Activated Carbon*with the size of 10" and the use-lifetime of 3-4 months. *Design flow rate max*: 1.9 LPM or 50 GPM. *Maximum temperature*: 100 ^{0}F (38 ^{0}C). *Minimum temperature*: 35 ^{0}C. *Maximum pressure*: 125 psi (8,6 bar).

18-21 Permeat container tank and concentrate

Quantitative analysis of antibiotic levels in Hospital wastewater

Samples from 2 liters of the sample were analyzed by the high-performance liquid chromatography (HPLC) Empower 3 Alliance Waters C 2695 to determine the concentration of Ciprofloxacin antibiotics before and after the treatment.

The detection of contaminated wastewater which contents specific micropollutants especially drugs could be analyzed using HPLC (Ren et al., 2008; Dolar et al., 2013; Mendoza et al., 2015; Sabry et al., 2015). According to Ferrer and Thurman (2012), The use of High-resolution Mass Spectroscopy (LC/Q-TOF/MS) with the principle of mass spectrometry allows the identification and characterization of over 100 drugs and metabolites in water sources at the smallest concentration in parts per trillion (ppt). That analysis provides the good sensitivity and selectivity in the identification of untrammeled antibiotics in low concentration in water samples.

Research sample

The sample which is used in the true experiment research is taken by the sampling process technique that refers to SNI 6989.59:2008 with grab and composite method at some points of retrieval (base, center, and surface of the pond). The wastewater sample was further homogenized and transferred into a temporary container.

Hospital wastewater treatment system

In 2016, the data from the health office department of Palembang city showed that there were 31 hospitals in Palembang consisting of 10 state-owned hospitals (31.25%) and 21 private hospitals (68.75%). From 10 of hospitals in palembang, only one hospital which is owned by the government of Palembang city which is the general hospital of Palembang region Bari. The other provincial government hospitals are Moh. Husin Hospital, Eye Hospital, etc. Hospitals are almost spread throughout the district of Palembang (Figure 4.1. Maps of the hospital's location in Palembang). The potential of hospitals in the producing of wastewater from the hospital activity can accumulate in the aquatic environment.

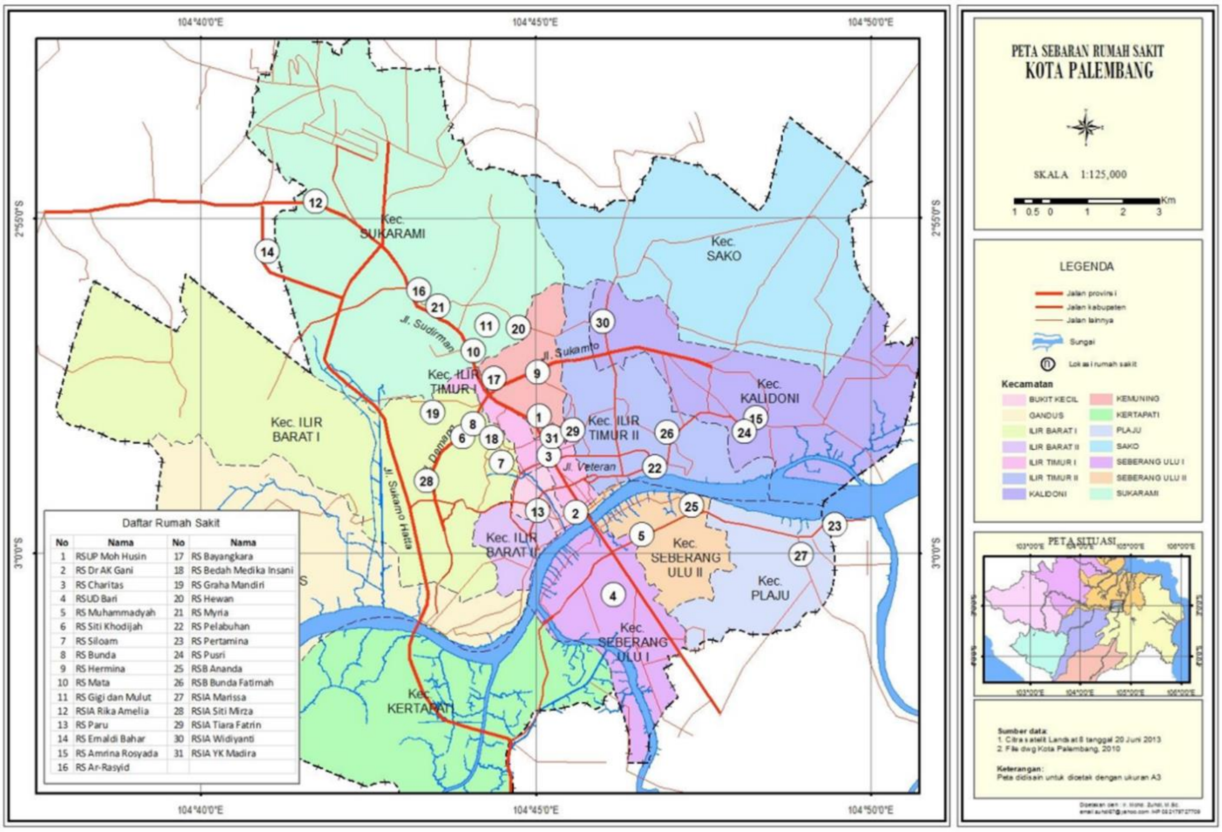

Fig. 4.1 Maps of the hospital's location in Palembang

The hospital wastewater could be generated from the bathrooms, washing room, kitchen, treatment room, polyclinic room, action room, laboratory room, delivery room, surgery room, morgue, etc, which generate the chemicals (toxic), infectious, and radioactive. The X hospital wastewater treatment system (Figure 4 and 5) uses a combination of integrated physic, chemical, biological process. The stages of X hospital wastewater treatment is shown as follows:

1. Wastewater is first processed in the*Primary pond*with a tube size of 2.4 m x 1.9 m x 4.0 m with a value of ± 18,2 m3.The primary pond is wastewater storage pond of the first control or effluent basin after passing through the screening.
2. The next stage is *Equalisation pond* with a tube sizing of 4.85 m x 3.95 m x 4 m with a volume of ± 76,6 m3. Equalisation pond serves as a wastewater discharge container that has variations of wastewater characteristics such as high pH from laundry, fat from the kitchen, and waste from the bathroom.

3. *Clarifier pond* with a tube sizing of 4 m x 2 m x 4 m with a volume of ± 32 m^3. *Clarifier pond* is a place to aerated the wastewater to provide the contact between the wastewater and air to assist the separation process between solid and water.
4. *Buffer pond* serves as a temporary pond of wastewater before being processed into the Biodetox with a tube sizing of 4 m x 2,6 m x 2,1 m with a volume of ± 24 m3. Biodetox is made by a stainless material which has uniqueness in water flow and bacterial house design.
5. *Chlorination pond*with a tube sizing of 1,5 m x 1,5 m x 5 m with a volume of ± 3,1 m^3. *Chlorination pond* is a place to add some dosages of chlorine that serves to reduce or kill the existing germs.
6. *Polishing pond* with a tube sizing of 3,45 m x 1,75 m x 4 m with a volume of ± 24,2 m^3. *Polishing pond* is used as the the last sediment pond before entering the treated water pond.
7. *Treated water pond* with a tube sizing of 0,97 m x 0,80 m x 4 m with a volume of ± 31 m^3. *Treated water pond* is used as the temporary holding place of wastewater that has met the BMLC requirements. In addition, wastewater in the treated water pond will be screened. The filter serves to separate the suspended particles which have the fine particle size. Filter media comprised of 40 cm quartz sand, 15 cm fine pebbles, 15 cm rough pebbles, and 10 cm activated carbon.The sediment from the*Clarifier pond*and*Polishing pond*is storage in *Sludge pond* with a tube sizing of 2,3 m x 2 m x 4 m with a volume of ± 18,4 m^3. Sludge pond uses the Airlift system. The processing product from sludge pond will be returned to the primary pond.

Figure 4. The condition of Waste Water Treatment Equipment and Systems

(1) Operator room

(2) *Underground* gate

(3) Biodetox

(4) Biodetox

Figure 5. Location of Wastewater Treatment

The conventional wastewater treatment process produces several problems which become the negative impacts of derivatives on the environment within a certain period of time. The conventional WWTP (physic, chemical, and biological) do not have a convenient performance to remediate the hospital wastewater containing the drugs (Zorita et al., 2009; Kosma et al., 2010; Deegan et al., 2011; Jelic et al., 2011; Gracia-Lor et al., 2012). The alternative technology is needed to address the problem. The green aspect becomes the main focus in the designing a hospital wastewater treatment system. Membrane technology is an alternative solution that can be done to solve some problems that can not be solved by a conventional method. Furthermore, within 20 years in the improving of the quality of waste, the processing cost using membrane system will be similar with the processing cost using the conventional sludge (Young et al., 2012). Membrane hybrid process (nF-RO) could integrate the wastewater treatment system to provide the quality of the antibiotic effluent that is environmentally safe.

The use of Antibiotics in the studied hospital

The study was conducted in the X hospital which was the type B of the hospital. The primary data was collected through the time series method of retrieving data on the use of antibiotics in the period of the month or a certain period. All the data can be regarded as historical data or time series. X hospital refers to WHO (2004) regulation in the use and antibiotics criteria for patient and the criteria are:

a. The use of antibiotics is adjusted for the disease indication

b. The treatment is based on the individual complaints and accurate physical examination results
c. The appropriate dosing is done through various criteria (depending on age, weight, and chronological disease)
d. The antibiotics treatment is performed using appropriate intervals of time, distance, and administration of drugs was adjusted to prescribed use rules, and in certain cases requiring the administration of drug within a certain period of time.
e. The given-drug should be effective with a guaranteed quality, avoiding the expired drug administration and do not in accordance with the type of complaint of the illness of patients.
f. The type of medicine is easy to get with the affordable prices
g. The minimizing the dose to reduce the side effects and drug allergies.

In general, the use of antibiotics in X hospital can be seen in Table 1. Table 1 showed the information on qualitative uses of antibiotics in X hospital in the period of July to September 2016. All the antibiotics are given to the inpatients and outpatients of X hospital through the oral and injection treatments.

Table 1. Qualitative Information on Antibiotic Usage at RS X Palembang July-September 2016 Period

Antibiotics	Medicines	Use	Group
Amikacin	Amikacin, Amiosin	Injection	*Aminoglycosides*
Amoxicillin	Amoxicillin, Amoxsan	Syrup, Tablet	*Beta-lactam*
Amoxicillin dan Clavulanat	Co Amoxiclav, Capsinat	Syrup, Tablet	*Beta-lactam*
Azitromycin	Azomax, Infimycin, Zibramax, Zistic	Syrup, Tablet, Injection	*Macrolide*
Ampicillin dan Sulbactam	Bactesyn	Injection and Tablet	*Beta-lactam*
Cefadroxyl	Cefradoxyl, Cefat, Renasistin	Syrup, Kapsul	*Cephalosporins*
Cefixime	Cefixime, Fixacep, Nucef, Starcef	Syrup, Kapsul, Drop	*Cephalosporins*
Cefuroxime	Anbacim	Injection	*Cephalosporins*
Cefotaxime	Cefotaxime, Biocef, Kalfoxim	Injection	*Cephalosporins*
Cefoperazone	Cefoperazone, Cefoject	Injection	*Cephalosporins*
Ceftriaxone	Broadced	Injection	*Cephalosporins*
Ceftazidime	Ceftazidime, Ceftum, Zibac	Injection	*Cephalosporins*
Ceftizoxime	Ceftizoxime	Injection	*Cephalosporins*
Ceftriaxone	Ceftriaxone, Elpicef	Injection	*Cephalosporins*
Clindamycin	Clindamycin	Capsule	*Clindamycin*
Cotrimoxazol	Cotrimoxazol	Syrup, Tablet	*Sulfonamides*
Ciprofloxacin	Ciprofloxacin, Baquinor, Renator	Tablet	*Quinolones*
Doxixyclin	Doxixyclin	Capsule	*Tetracycline*
Erytromycin	Erytromycin, Erysanbe	Tablet, Syrup	*Macrolide*
Kanamycin	Kanamycin	Injection	*Aminoglycosides*
Levofloxacin	Cravit, Volequin	Tablet, Infusion	*Quinolones*
Lincomycin	Lincomycin	Capsule, Syrup	*Lincosamide*
Metronidazole	Farnat	Infusion	*Nitroimedazole*

Meropenem	Merem, Merofen, Meropenem	Injection	*Beta-lactam*
Netilmicin	Netromycin	Injection	*Aminoglycosides*
Ofloxacin	Ofloxacin, Pharflox	Tablet	*Quinolones*
Primadex	Primadex	Tablet, Syrup	*Sulfonamides*
Tetracycline	Tetracycline, Tetrasanbe	Capsule	*Tetracycline*
Thiamphenicol	Thiamphenicol, Biothicol	Capsule	*Thiamphenicol*

Antibiotics are anti-bacterial substances which are produced by various species of microorganisms (bacteria, fungi, and actinomycota) that can suppress the growth and or kill other microorganisms. According to Hadi (2009), 30%-80% of patients in Indonesia do not use the antibiotics based on the indication experienced by the patients whereas in the other developed country 13-37% of all hospitalized patients get either single or double antibiotics. Nowadays, the use of irrational antibiotics is common in both the developed and developing country.

Based on the legislation, X hospital has a hospital pharmacy installation which has the leadership of a pharmacist who is assisted by several pharmacists. A pharmacy installation is a place of the facility for the operation which is responsible for all work and pharmaceutical services including antibiotics. In X hospital, the use of antibiotics is classified based on the mechanism of action of the use of antibiotics. The classification is shown below.

1. Beta-lactam, Cephalosporins, Lincosamide, Nitroimedazole classare treated for inhibiting the synthesis or demaging the cell wall of bacteria or protozoa.
2. Aminoglycosides, Thiamphenicol, Tetracycline, Macrolide, Clindamycin,class are used to modify or inhibit the protein synthesis.
3. Sulfonamides type is used to inhibit the essential enzyms in the folic metabolism,
4. Quinolones type is used to synthesise or metabolizes the nucleic acid.

The high number uses of antibiotics is not accompanied by the cultures and habits that are not good in the handling of antibiotic residue. The residue of the use of antibiotics in the form of fluids especially from the vials and infusion in medical service activities is often discharged into the pipeline which eventually empties into the primary pond and then mixed with the wastewater from all hospital activities. The small number of antibiotics in the wastewater could be dangerous for the environment. From the field study, there was a flow pattern of wastewater in the sewage system in the hospital WWTP (Figure 6). The flow pattern chart shows that there is a potential of antibiotics remnants from the hospital activities that mix with hospital wastewater from all hospital activity systems.

Hybrid membrane process

In the first step in hybrid membrane process (Fig. 6), an operation test is performed to determine the performance of the membrane system in general by using incoming distilled water feed into the processing system with various operating pressures and run for 30 minutes for each operating pressure. The test results on each of the membrane performance variables can be seen in Table 2.

Figure 6.The design result of hybrid membrane process

Table 2.the variable of the performance hybrid membrane (nF-RO)

Variables	Operation performance
Minimum *Pressure*	60 psi
Maximum *Pressure*	80 psi
The average of Volume Permeat	± 13 L NF and 9 L RO
The average of flow rate	± 16 L/h NF and 8 L/h RO
The average ofFlux	± 8 $L/m^2.h$ NF and 7 L/m^2 .h
The average of WRP	± 45% NF and 50% RO
The average of TMP	± < 2 psi from the operation pressure

In this study, the design process is different from the previous research. Beier et al., (2010) makes the design of hospital wastewater with 250 L as the treatment capacity with the biometric membrane bioreactor (MBR) and two stage-nanofiltration (nF) commercial and one stage-reverse osmosis (RO) commercial with flow cross flow system and high pressure (60 bar). In the other study, Dolar et. al., (2012) have built the 700 L/day of hybrid membrane process using coagulation pretreatment using FeCl3. The process used two stage-Nanofiltration (NF) Dow/FilmTec NF270 and NF90 Polyamide and one stage-reverse osmosis (RO) extra low-energy Dow/FilmTec XLE Polyamide, for each type cross flow.

The results of quantitative analysis prove that there was a ciprofloxacin antibiotic detected with the concentration of 4.7 ppm. There was a correlation between the level of antibiotic use in hospital activity with the antibiotic content which was found in the hospital wastewater. The levels of antibiotics use in hospital X at the time of sampling in March 2017 can be seen in Figure 7 to 9.

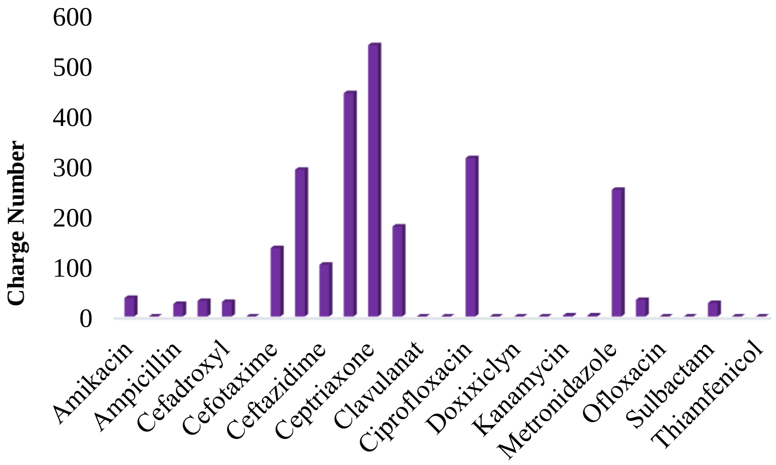

Fig. 7. The use of vial of infusion antibiotics in X hospital per March 2017

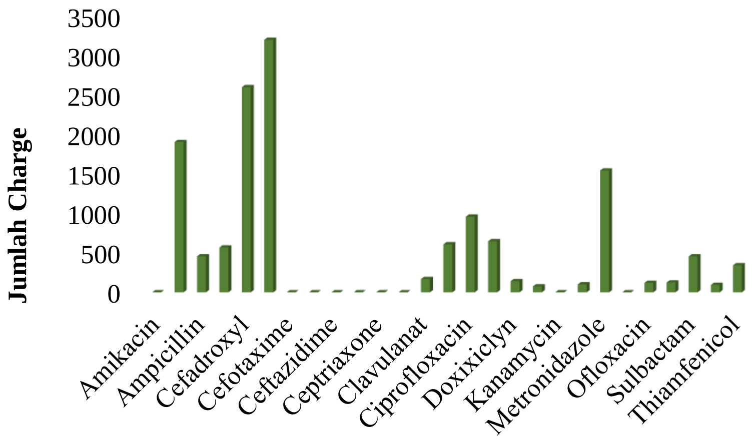

Fig. 8. The use of capsule/tablet antibiotics in X hospital per March 2017

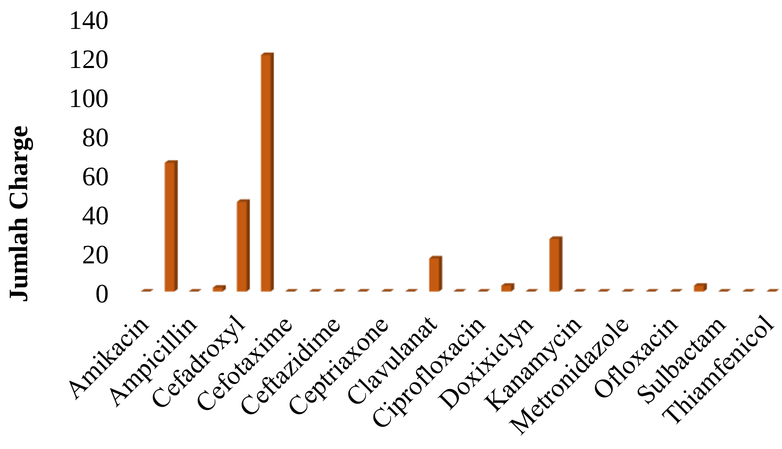

Fig. 9. The use of syrup/drop antibiotics in X hospital per March 2017

Membrane Rejection

Membrane rejection is performed to determine the membrane performance in the removing a contaminant contained in the feed. The research uses to types of commercial membranes namely NF ceramics and RO composite polyamide. The hybrid membrane is operated under the same condition by first passing through the nF and terminated on the RO process. The feed through NF is the result of ineffective pretreatment process in the reducing of Ciprofloxacin levels while the feed into RO is a permeate feed of NF.

The process is run for 2 hours in each pressure (60, 70, 80 psi) with the sampling of Ciprofloxacin levels every 30 minutes. The result of NF and RO rejection coefficient calculation is shown in Table 3. The determination of Ciprofloxacin concentration is conducted using standard curve equations and AUC values of the curves of each process resulting in the obtained-CIP concentration of each stage of the process for the use of wastewater sample.

Table 3.NF-RO CIP X hospital wastewater rejection

Code	Pressure (atm)	t (hour)	Cf (ppm)	Cp (ppm)	R (%)	R System(%)
NF - 1	4,082	**0,5**	**4,79**	**3,86**	**19,36**	98,55
RO - 1		0,5	3,86	0,06	**98,21**	
NF - 2		1	4,79	3,88	18,89	98,09
RO - 2		1	3,88	0,09	97,64	
NF - 3		1,5	4,79	4,04	15,51	98,19
RO - 3		1,5	4,04	0,086	97,86	
NF - 4		2	4,79	3,96	17,24	98,11
RO - 4		2	3,96	0,09	97,72	
NF - 5	4,763	0,5	4,79	3,90	18,42	98,17
RO - 5		0,5	3,90	0,08	97,76	
NF - 6		1	4,79	3,86	19,37	98,38
RO - 6		1	3,86	0,07	**97,99**	
NF - 7		1,5	4,79	3,96	17,30	97,95
RO - 7		1,5	3,96	0,09	97,53	
NF - 8		2	4,79	3,97	17,03	98,04
RO - 8		2	3,97	0,09	97,64	
NF - 9	5,443	0,5	4,79	4,07	14,98	98,53
RO - 9		0,5	4,07	0,07	98,27	
NF - 10		1	4,79	4,07	14,99	98,44
RO - 10		1	4,07	0,07	98,16	
NF - 11		1,5	4,79	4,07	14,88	**98,56**
RO - 11		1,5	4,07	0,06	**98,31**	
NF - 12		2	4,79	4,08	14,78	97,55
RO - 12		2	4,08	0,11	97,12	

The ciprofloxacin rejection through nF using hospital wastewater feeds has the highest performance at the first operational (60 psi, 4.08 atm, 1.2 hours) with the yield performance of 19.36%. The increasing of processing time showed the decreasing of rejection. The advanced process using RO process produces the highest rejection of 98.31% (80 psi; 5,44 atm, 1,5 hour). The comparison of these results indicates that the ceramic nF membrane is less effective in the reducing of ciprofloxacin level but the RO polyamide composite is highly effective in the reducing of ciprofloxacin levels. This result showed that there can be no antibiotic rejection process in one step membran process.

The small ceramic membrane rejection is affected by the nF membrane pore size and non-maximal ceramic raw material in the filtration process with feed containing the organic matter and microorganism whereas the polyamide composite has the better capacity (Charcosset, 2012). The study showed that the nF-RO process has the highest rejection performance of 98.56% (80 psi, 1.5 hours). The performance of the nF-RO system has decreased the value of rejection along with the length of the process. This fact justifies the theory of concentration on the membrane surface where the length of operation time could increase the concentration of membrane at its pore resulting the cloves pores.

The research which is conducted by Beier et al. (2010) showed the percentage of rejection of ciprofloxacin on nF and RO which were 97.02% and 98.15%, respectively. In addition, Dollar et al (2012) reported that the rejection has the below the LOD value. In this study, the RO rejection shows the better yield which results in 98.31% (0.068 ppm) and the final concentration is also below the LOD (0.18 ppm). On the other hand, this study uses the simpler operational condition compared to the previous studies which are more complex (Table 4 shows the comparison of the current and previous research).

European legislation regulates the maximum ciprofloxacin antibiotic content with EC50 ≤ 1 ppm in the environment. The results also showed that the final result of ciprofloxacin concentration process was below 1 ppm which is fulfilled the rules of European legislation. According to Stuart et al. (2012), hospital waste is one source of contaminants in the waters. The ability of membrane rejection which capable to reduce the CIP in the wastewater contribute significantly to the clean water conservation program by increasing the volume of clean water that people can still consume.

Ciprofloxacin in the hospital activities is widely used in the form of infusions and capsules/tablets. Ciprofloxacin which is detected in the hospital wastewater comes from the residual infusion of patients discharged through the hospital waste stream and mixed in the primary pond. Tabel 4 showed some antibiotics findings especially Ciprofloxacin in the hospital wastewater. According to Certificate of Analyzed (COA), Ciprofloxacin is issued by Dexa Medica (Attachment file 6) and it has the physical properties dissolved in water even in the relatively small amount. The nature of the solubility might determine the amount of concentration of the substance present in the hospital wastewater.

Table 4.The research history of the ciprofloxacin content in the hospital wastewater

Researcher	Sampling Location	Ciprofloxacin Contents	Legislation
		Europe	
Beier *et al.*, 2010	German	7,2 mg/L	
Dolar *et al.*, 2012	Croasia	17,48 mg/L	
Santos *et al.*, 2013	Spain	3673 ng/L	$EC_{50} \leq 1$ mg/L
Varela, *et al.*, 2014	Portugal	0,88 mg/L	
Tuc *et al.*, 2016	France	11 mg/L	
		Asia	
Hamjinda *et al.*, 2015	Thailand	9,8 mg/L	
Ashfaq *et al.*, 2016	Pakistan	18 mg/L	-
This study (2017)	**Indonesia**	**4,7 mg/L**	

The legislation in Asia particularly Indonesia on the antibiotic content in hospital wastewater has not included these parameters while the legislation is applicable in the European countries through European Union Law (Eur-Lex). Girardi et al. (2011) state that the content of Ciprofloxacin antibiotics in the environment has EC50 ≤ 1 ppm as the threshold and the concentration equal or above the threshold generate the very toxic compound when exposed to the aquatic organism. In addition, the contaminated ciprofloxacin will be very toxic if exposed to the soil organism. The results of the study in Table 4.6 related to Ciprofloxacin antibiotics contained in the hospital wastewater and found that the most concentration has exceeded the existing legislation in Europe. An effort should be made to reduce the concentration of ciprofloxacin using membrane technology by studying the membrane performance.

CONCLUSION

The WWTP system of X hospital uses the primary pond-equalisation pond-clarifier pond-buffer pond-chlorination pond-polishing pond-treated water pond equipped with Biodetox. One of the major problems of the hospital wastewater treatment is undesigned for the processing of antibiotic component. The highest final rejection was owned by an RO membrane of 98.3% (80 psi at 1.5 h) with a 0.06 ppm concentration of Ciprofloxacin at retentate (EC50 <1 ppm) as the main variable for measuring membrane hybrid process (nF-RO) in the decreasing of antibiotic content in Hospital wastewater. Hybrid membrane (nF-RO) as a system showed a rejection of 98.56% removing ciprofloxacin in wastewater. The hybrid membrane can be applied to overcome the problem of antibiotic resistance.

REFERENCES

Abid, M. F., Zablouk, M. A., & Abid-Alameer, A. M. 2012. Experimental study of dye removal from industrial wastewater by membrane technologies of reverse osmosis and nanofiltration, Environmental Health 9(1), 1. http://doi.org/10.1186/1735-2746-9-17.

Alzahrani, S., & Wahab, A. 2014. Journal of Water Process Engineering Challenges and trends in membrane technology implementation for produced water treatment : A review. Journal of Water Process Engineering, 4, 107–133. http://doi.org/10.1016/j.jwpe.2014.09.007

Ashfaq, M., Nawaz, K., Rasool, S., Mustafa, G., Saif-ur-rehman, M., Faizan, M., Yu, C. (2016). Occurrence and ecological risk assessment of fluoroquinolone antibiotics in hospital waste of Lahore , Pakistan. Environmental Toxicology and Pharmacology, 42, 16–22. https://doi.org/10.1016/j.etap.2015.12.015

Bayer, A., Asner, R., Schüssler, W., Kopf, W., Weib, K., Sengl, M., & Letzel, M. 2014. Behavior of sartans (antihypertensive drugs) in wastewater treatment plants , their occurrence and risk for the aquatic environment. Environ Sci Pollut Res. http://doi.org/10.1007/s11356-014-3060-z.

Bebianno, M. J., Rey 2015. Ecotoxicological Risk of Personal Care Products and Pharmaceuticals. Aquatic Ecotoxicology. Elsevier Inc. http://doi.org/10.1016/B978-0-12-800949-9.00016-4.

Beier, S., Ko, S., Veltmann, K., Schro, H. F., & Pinnekamp, J. 2010. Treatment of hospital wastewater effluent by nanofiltration and reverse osmosis. Water Science & Technology, 1691–1698. http://doi.org/10.2166/wst.2010.119.

Bodzek, M., Konieczny, K., & Kwieci, A. 2012. Application of membrane processes in drinking water treatment – state of art. Desalination and Water Treatment. Taylor and Francis, (December), 37–41.

Brausch, J. M., & Rand, G. M. 2011. Chemosphere A review of personal care products in the aquatic environment : Environmental concentrations and toxicity. Chemosphere, 82(11), 1518–1532. http://doi.org/10.1016/j.chemosphere.2010.11.018

Brausch, John M. Connors K.A, Brooks, W.B.,2012. Human Pharmaceuticals in the Aquatic Environment.

Bu, Q., Wang, B., Huang, J., Deng, S., & Yu, G. 2013. Pharmaceuticals and personal care products in the aquatic environment in China : A review. Journal of Hazardous Materials, 262, 189–211. http://doi.org/10.1016/j.jhazmat.2013.08.040

Charcosset, C. 2012. 1 - Principles on membrane and membrane processes. Membrane Processes in Biotechnologies and Pharmaceutics. http://doi.org/http://dx.doi.org/10.1016/B978-0-444-56334-7.00001-0.

Chonova, T., Keck, F., Labanowski, J., & Montuelle, B. 2016. Science of the Total Environment Separate treatment of hospital and urban wastewaters : A real scale comparison of ef fl uents and their effect on microbial communities. Science of the Total Environment, 542, 965–975. http://doi.org/10.1016/j.scitotenv.2015.10.161

Cuong, Do Manh Kim Kyoung-Woong, Toan Tran Quang, P. T. Da. 2013. Geosystem Engineering Review : Source , Fate , Toxicological Effect and Removal Technology of Pharmaceuticals in the Environment. Taylor and Francis, (June 2013), 37–41.

Daughton, C. G. 2013. Pharmaceuticals in the Environment : Sources and Their Management. Analysis, Removal, Effects and Risk of Pharmaceuticals in the Water Cycle (2nd ed., Vol. 62). Elsevier B.V. http://doi.org/10.1016/B978-0-444-62657-8.00002-1

Deegan, A. M., Shaik, B., Nolan, K., Urell, K., Tobin, J., & Morrissey, A. 2011. Treatment options for wastewater effluents from pharmaceutical companies. International Journal Science Technology, 8(3), 649–666.

Dolar, D., & Ignjati, T. 2012. Membrane treatment of veterinary pharmaceutical wastewater : comparison of results obtained on a laboratory and a pilot scale. Environmental Science and Pollution Research, 1033–1042. http://doi.org/10.1007/s11356-012-0782-7

Dolar, D., Košutić, K., Periša, M., & Babić, S. 2013. Photolysis of enrofloxacin and removal of its photodegradation products from water by reverse osmosis and nanofiltration membranes. Separation and Purification Technology, 115, 1–8. http://doi.org/10.1016/j.seppur.2013.04.042

Escher, B. I., Baumgartner, R., Koller, M., Treyer, K., Lienert, J., & Mcardell, C. S. 2010. Environmental toxicology and risk assessment of pharmaceuticals from hospital wastewater. Water Research, 45(1), 75–92. http://doi.org/10.1016/j.watres.2010.08.019

Eurostat.http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&plugin=1&language=en&pcode=ten00011.

Evgenidou, E. N., Konstantinou, I. K., & Lambropoulou, D. A. 2015. Occurrence and removal of transformation products of PPCPs and illicit drugs in wastewaters : A review. Science of the Total Environment, 505, 905–926.http://doi.org/10.1016/j.scitotenv.2014.10.021

Ferrer, I. and Thurman, E.M. 2012.Analysis of 100pharmaceuticals and their degradates in water samplesby liquid chromatography/quadrupole time-of-flightmass spectrometry”J. Chromatography A 1259,148-157.

Frédéric, O., & Yves, P. 2014. Pharmaceuticals in hospital wastewater: Their ecotoxicity and contribution to the environmental hazard of the effluent. Chemosphere, 115, 31–39. http://doi.org/10.1016/j.chemosphere.2014.01.016

Girardi, C., Greve, J., Lamshöft, M., Fetzer, I., Miltner, A., Schäffer, A., & Kästner, M. (2011). Biodegradation of ciprofloxacin in water and soil and its effects on the microbial communities. Journal of Hazardous Materials, 198, 22–30. https://doi.org/10.1016/j.jhazmat.2011.10.004

Gracia-lor, E., Sancho, J. V, Serrano, R., & Hernández, F. 2012. Chemosphere Occurrence and removal of pharmaceuticals in wastewater treatment plants at the Spanish Mediterranean area of Valencia. Chemosphere, 87(5), 453–462. http://doi.org/10.1016/j.chemosphere.2011.12.025

Greenlee, L. F., Lawler, D. F., Freeman, B. D., Marrot, B., Moulin, P., & Ce, P. 2009. Reverse osmosis desalination : Water sources, technology, and today’s challenges. Water Research, 43(9), 2317-2348. http://doi.org/10.1016/j.watres.2009.03.010

Hadi, U. 2009, Resistensi Antibiotik,Buku Ajar Ilmu Penyakit Dalam, Edisi V,Jilid III, Jakarta, Interna Publishing

Hamjinda, N. S., Chiemchaisri, W., Watanabe, T., & Honda, R. 2015. Toxicological assessment of hospital wastewater in different treatment processes. Environmental Science and Pollution Research. http://doi.org/10.1007/s11356-015-4812-0

Huerta-fontela, M., Teresa, M., & Ventura, F. 2010. Occurrence and removal of pharmaceuticals and hormones through drinking water treatment. Water Research, 45(3), 1432–1442. http://doi.org/10.1016/j.watres.2010.10.036

Jelic, A., Gros, M., Ginebreda, A., Cespedes-Sánchez, R., Ventura, F., Petrovic, M., & Barcelo, D. 2011. Occurrence, partition and removal of pharmaceuticals in sewage water and sludge during wastewater treatment. Water Research, 45(3), 1165–1176. http://doi.org/10.1016/j.watres.2010.11.010

Jiang, J., Zhou, Z., & Sharma, V. K. 2013. Occurrence, transportation, monitoring and treatment of emerging micro- pollutants in waste water- A review from global views. Microchemical Journal. http://doi.org/10.1016/j.microc.2013.04.014

Kim, S. D., Cho, J., Kim, I. S., Vanderford, B. J., & Snyder, S. A. 2007. Occurrence and removal of pharmaceuticals and endocrine disruptors in South Korean surface, drinking, and waste waters. Water Research, 41(5), 1013–1021. http://doi.org/10.1016/j.watres.2006.06.034

Kosma, C. I., Lambropoulou, D. a, & Albanis, T. 2010. Occurrence and removal of PPCPs in municipal and hospital wastewaters in Greece. Journal of Hazardous Materials, 179(1-3), 804–17. http://doi.org/10.1016/j.jhazmat.2010.03.075

Kusumawati, N., Tania, S., 2012. Pembuatan dan uji kemampuan membran kitosan sebagai membran ultrafiltrasi untuk pemisahan zat warna rhodamin B, MIPA KIMIA UNS, 1. http://doi.org/10.1017/CBO9781107415324.004

Kurniawan, I., Nasir, S., Hermansyah, Mardiyanto, 2016. Hospital Wastewater: Prediction of Contaminant Characteristics and The Possibility of Hybrid Membrane Process. Proceedings of Sriwijaya International Conference on Engineering Science and Technology (Sicest 2016). ISBN 979-578-621-1.

Kurniawan, I., Nasir, S., Hermansyah, Mardiyanto, 2017. The Screening of Potential Antibiotics from Hospital Wastewater in Tropical Region (Case Study at Palembang, South Sumatra, Indonesia). Pollution Research Journal, Vol. 36, Issue 2, 2017; Page (343-351). ISSN 0257 – 8050.

Lea, M., Sapozhnikova, Y., Pennington, P., Clum, A., Fairey, A., & Wirth, E. 2012. Pharmaceuticals and personal care products (PPCPs) in treated wastewater discharges into Charleston Harbor , South Carolina. Science of the Total Environment, 437, 1–9. http://doi.org/10.1016/j.scitotenv.2012.07.076

Li, K., Wang, J., Liu, J., Wei, Y., & Chen, M. 2015. Advanced treatment of municipal wastewater by nanofiltration: Operational optimization and membrane fouling analysis. JES, 1–12. http://doi.org/10.1016/j.jes.2015.09.007

Kyzas, G. Z., Fu, J., Lazaridis, N. K., Bikiaris, D. N., & Matis, K. A. 2015. New approaches on the removal of pharmaceuticals from wastewaters with adsorbent materials. Journal of Molecular Liquids, 209, 87–93. http://doi.org/10.1016/j.molliq.2015.05.025

Madaeni, S. S., Ghaemi, N., & Rajabi, H. 2015. 1 - Advances in polymeric membranes for water treatment. Advances in Membrane Technologies for Water Treatment. Elsevier Ltd. http://doi.org/10.1016/B978-1-78242-121-4.00001-0

Mendoza, A., Aceña, J., Pérez, S., Alda, M. L. De, Barceló, D., & Gil, A. 2015. Pharmaceuticals and iodinated contrast media in a hospital waste- water : A case study to analyse their presence and characterise their environmental risk and hazard. Environmental Research, 140, 225–241. http://doi.org/10.1016/j.envres.2015.04.003

Nam, S., Jo, B., Yoon, Y., & Zoh, K. 2014. Chemosphere Occurrence and removal of selected micropollutants in a water treatment plant. Chemosphere, 95, 156–165. http://doi.org/10.1016/j.chemosphere.2013.08.055

Oller, I., Polo-l, I., & Miralles-cuevas, S. 2014. Advanced Technologies for Emerging Contaminants Removal in Urban Wastewater. Springer International Publishing Switzerland. http://doi.org/10.1007/698

Orias, F., & Perrodin, Y. 2013. Science of the Total Environment Characterisation of the ecotoxicity of hospital ef fl uents : A review. Science of The Total Environment, 455, 250–276. http://doi.org/10.1016/j.scitotenv.2013.02.064

Plakas, K. V, & Karabelas, A. J. 2012. Removal of pesticides from water by NF and RO membranes — A review. Desalination, 287, 255–265. http://doi.org/10.1016/j.desal.2011.08.003

Pandey, S.R., Jegatheesan, V., Baskaran, K., Shu, L. Fouling in reverse osmosis (RO) membrane in water recoveryfrom secondary effluent: a review. Environ Sci Biotechnol. 2012; 11:125-145

Periasamy, D., Sundaram, A. 2013. A novel approach for pathogen reduction in wastewater treatment. Journal of Environmental Science and Engineering, 1–9.

Prayitno, Kusuma, Z., Yanuwiadi, B., & Laksmono, R. W. 2012. Study of Hospital Wastewater Characteristic in Malang City. International Journal of Engineering and Science, 2(2), 13–16.

Radjenović, J., Petrović, M., Ventura, F., & Barceló, D. 2008. Rejection of pharmaceuticals in nanofiltration and reverse osmosis membrane drinking water treatment. Water Research, 42(14), 3601–3610. http://doi.org/10.1016/j.watres.2008.05.020

Ratola, N., Cincinelli, A., Alves, A., & Katsoyiannis, A. 2012. Occurrence of organic microcontaminants in the wastewater treatment process . A mini review. Journal of Hazardous Materials, 239-240, 1–18. http://doi.org/10.1016/j.jhazmat.2012.05.040

Ren, S., Park, M., Sah, H., & Lee, B. 2008. Effect of pharmaceutical excipients on aqueous stability of rabeprazole sodium. International Journal of Pharmaceutics, 350, 197–204. http://doi.org/10.1016/j.ijpharm.2007.08.035

Rivera-utrilla, J., Sánchez-polo, M., Ferro-garcía, M. Á., & Prados-joya, G. 2013. Pharmaceuticals as emerging contaminants and their removal from water . A review. Chemosphere. http://doi.org/10.1016/j.chemosphere.2013.07.059

Sabry, S. M., Belal, T. S., & Mahgoub, A. A. 2015. Development and validation of HPLC-DAD method for the simultaneous determination of amoxicillin, metronidazole and rabeprazole sodium . Application to spiked simulated intestinal fluid samples. Annales Pharmaceutiques Francaises. http://doi.org/10.1016/j.pharma.2015.04.008

Santos, L. H. M. L. M., Gros, M., Rodriguez-Mozaz, S., Delerue-Matos, C., Pena, A., Barceló, D., & Montenegro, M. C. B. S. M. 2013. Contribution of hospital effluents to the load of pharmaceuticals in urban wastewaters: Identification of ecologically relevant pharmaceuticals. Science of The Total Environment, 461-462, 302–316. http://doi.org/10.1016/j.scitotenv.2013.04.077

Sharma, P., Mathur, N., Singh, A., & Sogani, M. 2015. Monitoring hospital wastewaters for their probable genotoxicity and mutagenicity. Environment Monitoring Assessement. http://doi.org/10.1007/s10661-014-4180-0

Shon, H. K., Phuntsho, S., Chaudhary, D. S., Vigneswaran, S., & Cho, J. 2013. Nanofiltration for water and wastewater treatment – a mini review. Drinking Water Engineering and Science, 6(1), 47–53. http://doi.org/10.5194/dwes-6-47-2013

Singh, R. 2015. Membrane Technology and Engineering for Water Purification. Butterworth-Heinemann. Elsevier Science & Technology Books

Stuart, M., Lapworth, D., Crane, E., & Hart, A. 2012. Review of risk from potential emerging contaminants in UK groundwater. Science of the Total Environment, The, 416, 1–21. http://doi.org/10.1016/j.scitotenv.2011.11.072

Sui, Q., Cao, X., Lu, S., Zhao, W., Qiu, Z., & Yu, G. 2015. Occurrence , sources and fate of pharmaceuticals and personal care products (PPCPs) in the groundwater : A review. Emerging Contaminants, 1(1), 14–24. http://doi.org/10.1016/j.emcon.2015.07.001

Tran, N. H., Li, J., Hu, J., & Ong, S. L. 2013. Occurrence and suitability of pharmaceuticals and personal care products as molecular markers for raw wastewater contamination in surface water and groundwater. Environmental Science and Pollution Research. http://doi.org/10.1007/s11356-013-2428-9.

U.S Department of Enegry. 2016. Fact - Sheet of Advanced, energy-efficient hybrid membrane system for industrial water reuse and Hybrid Membrane System for Industrial Water Reuse. Energy.gov

Taylor, D., & Senac, T. 2014. Human pharmaceutical products in the environment–The problem in perspective. Chemosphere, 1–5. http://doi.org/10.1016/j.chemosphere.2014.01.011

Tuc, D.,Q., Elodie, M., Pierre, L., Fabrice, A., Marie-jeanne, T., Martine, B.,Marc, C. (2016). Science of the Total Environment Fate of antibiotics from hospital and domestic sources in a sewage network. Science of the Total Environment. https://doi.org/10.1016/j.scitotenv.2016.09.118.

Varela, A. R., Nunes, O. C., Manaia, M., Rita, A., & Andre, S. 2014. ScienceDirect Insights into the relationship between antimicrobial residues and bacterial populations in a hospital-urban wastewater treatment plant system. Water Research, 4. http://doi.org/10.1016/j.watres.2014.02.003

Vasquez, M. I., Lambrianides, A., Schneider, M., Kümmerer, K., & Fatta-kassinos, D. 2014. Environmental side effects of pharmaceutical cocktails : What we know and what we should know. Journal of Hazardous Materials, 279, 169–189. http://doi.org/10.1016/j.jhazmat.2014.06.069

Vasquez, M. I., Michael, I., & Ku, K. 2015. Bioassays Currently Available for Evaluating the Biological Potency of Pharmaceuticals in Treated Wastewater Toxic unit. http://doi.org/10.1007/698

Verlicchi, P., Galletti, A., & Petrovic, M. 2012b. Micro-pollutants in Hospital Effluent : Their Fate , Risk and Treatment Options,http://doi.org/10.1007/698

Verlicchi, P., Aukidy, M. Al, & Zambello, E. 2015. What have we learned from worldwide experiences on the management and treatment of hospital effluent ?- An overview and a discussion on perspectives. Science of the Total Environment, 514, 467–491. http://doi.org/10.1016/j.scitotenv.2015.02.020

World Health Organization. 2004. Promoting Rational Use of Medicine. Geneva: Core Components

WWF, Toxic Chemical Report. www.panda.org.

Xie, H. 2012. Occurrence , Ecotoxicology , and Treatment of Anticancer Agents as Water Contaminants. Environmental and Anaytical Toxicology. http://doi.org/10.4172/2161-0525.S2-002

Yangali-Quintanilla, V., Kim, T.-U., Kennedy, M., & Amy, G. 2008. Prediction of RO/NF membrane rejections of PhACs and organic compounds: a statistical analysis. Drinking Water Engineering and Science Discussions, 1(1), 21–44. http://doi.org/10.5194/dwesd-1-21-2008

Young, T., Muftugila, M., Smoota, S., & Peetersb, J. 2012. MBR vs. CAS: Capital and operating cost evaluation. Water Practice & Technology, 7(4). Diakses 23 Maret, 2015, dari http://www.iwaponline.com/wpt/007/0075/0070075.pdf

Zakrzewska-trznadel, G. 2013. Advances in membrane technologies for the treatment of liquid radioactive waste nuclear activities decommissioning of nuclear, Desalination, 321, 119–130. http://doi.org/10.1016/j.desal.2013.02.022

Zorita, S., Mårtensson, L., & Mathiasson, L. 2009. Occurrence and removal of pharmaceuticals in a municipal sewage treatment system in the south of Sweden. Science of The Total Environment, 407(8), 2760–2770. http://doi.org/10.1016/j.scitotenv.2008.12.030