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Reduce Detergent and Coliform Bacteria Content in The Recycling Process of Wastewater into Clean Water at Hospital Wastewater Treatment Plant (WWTP) Outlets Using Microfiltration Membranes

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Abstract

Sources of clean water from hospitals generally use groundwater. 80% of the clean water used by hospitals becomes wastewater. Problems arise when there is a tax charge on the use of groundwater by hospitals. This of course will burden the operational costs of the hospital, because currently a Groundwater Permit (SIPA) is required for those who use groundwater, this has an impact on paying high groundwater taxes. The solution to reducing groundwater use is the use of microfiltration membranes to treat hospital wastewater into clean water. The clean water is used for cleaning, washing and watering the hospital garden. A decrease in the use of hospital groundwater can reduce groundwater tax payments. However, for the reuse of wastewater into clean water for hospital purposes, the quality of the wastewater must be considered, namely the concentration of Detergent and Total Coliform. Detergent contained in wastewater when used for watering plants can kill the plants being watered. Coli bacteria present in wastewater when used for washing materials and hospital equipment can result in contamination of pathogenic bacteria which can cause nosocomial infections. Research objectives include 1) To determine the initial quality parameters of Detergent and Total Coliform of wastewater at WWTP Outlet Hospitals 2) To determine the performance of silica sand filters in reducing Detergent and Total Coliform 3) To determine the performance of phase 1 microfiltration membranes in reducing Detergent and Total Coliform 4) To determine stage 2 microfiltration membrane performance in reducing Detergent and Total Coliform. The research methodology used was a quasi-experimental conducted at the Wastewater Treatment Plant (WWTP) at dr. A. Dadi Tjokrodipo Bandar Lampung with pre-test (before treatment) and post-test (after treatment) designs. Sample 1 from Hospital WWTP Outlet, Sample 2 from Filter Tube, Sample 3 From Membrane Filter 1, Sample 4 From Membrane Filter 2. The sample examination was carried out twice, at each location of sample 1, sample 2, sample 3 and sample 4. The results showed: The average quality of WWTP outlet water for Detergent parameters obtained an average number of 1.2 mg/L and coliform parameters 3650 CFU/100 ml, Silica sand filter Detergent parameters 0.12 mg/l and Coliform 2700 CFU/100 ml, Microfiltration Membrane Stage 1 detergent parameters 0.08 mg/l and Coliform 2200 CFU/100 ml sample, Microfiltration Membrane Stage 2 detergent parameters 0.05 mg/l and Coliform 2050 CFU/100 ml sample. The average percentage reduction results for Detergent using recycling equipment were obtained at WWTP outlets of 0%, Filter Tube Outlets of 90%, Stage 1 Microfiltration Membrane Outlets of 93%, Stage 2 Microfiltration Membrane Outlets of 96%. The average percentage of Coliform reduction using recycling equipment was obtained at WWTP outlets 0%, Filter Tube Outlets 20%, Microfiltration Membrane Outlet stage 1 40%, Microfiltration Membrane Outlet stage 2 44%. The suggestion from this research is to carry out further research to reduce the current research discharge so that the reduction in Coliform can be more significant.

Keywords: Microfiltration Membrane, Detergent, Coliform

Full length article **Corresponding Author e-mail: imamsantosa2811@gmail.com*

1. Introduction

The problem in big cities nowadays due to the use of groundwater is land subsidence. Land subsidence can result in building damage, flooding and hampering economic activities in the community. In addition to the problems above, the tax costs for the use of groundwater by hospitals will of course burden the operational costs of the hospital, because currently a groundwater exploitation permit (SIPA) is required for those who use groundwater and has the consequence of paying groundwater tax annual [2]. Even though 80% of hospitals generally use groundwater for their clean water needs. Clean water when it has been used for various activities will be disposed of as wastewater. The solution to reducing groundwater use is to convert hospital wastewater into clean water using microfiltration membrane technology, so that it can be collected and used for cleaning, washing and garden watering purposes. Today the technology for water purification and wastewater treatment can use microfiltration membranes, the microfiltration membrane used has a size of 0.05 µm and is used for oily wastewater with a removal of up to 82.5% [9], explained that microfiltration is an alternative to clean water. %. Micro Membrane is the separation of micron or sub-micron sized particles, commonly shaped like a cartridge, used to remove particles from water that are 0.04 to 100 micrometers in size [1]. Clean water from liquid waste into clean water must be carried out by large groups of water users such as hotels, hospitals and industry by building clean water installations to maintain the sustainability of water use and efforts to minimize waste discharged into the environment [3]. The use of clean water originating from hospital liquid waste is an effort to process wastewater originating from the processing effluent of the Wastewater Treatment Plant (WWTP) so that it can be reused as needed. In addition to microfiltration membranes, Silica Sand Filters can also be used to reduce pollutant levels from wastewater. The average filter removal efficiency using silica sand as a pre-treater for microfiltration membranes in treating wastewater is BOD 78.24%, COD 56.25%, TSS 75.85%, Ammonia 56.49% Phosphate 39.13%, Oil and Fat 34.38% and Coliform 27.27% MPN/100 ml [8].

However, for the reuse of wastewater into clean water for hospital purposes, the quality of the wastewater must be considered, namely the concentration of Detergent and Total Coliform. Detergent contained in wastewater when used for watering plants can kill the plants being watered. Coli bacteria present in wastewater when used for washing materials and hospital equipment can result in contamination of pathogenic bacteria which can cause nosocomial infections. Research Objectives: 1) To determine the initial quality of Detergent and Total Coliform wastewater at the Hospital WWTP Outlet 2) To determine the performance of the filter tube to reduce Detergent and Total Coliform 3) To determine the performance of the stage 1 microfiltration membrane in reducing Detergent and Total Coliform 4) To determine the performance of stage 2 microfiltration membranes in reducing detergent and total coliform.

2. Materials and Methods

The research conducted is quasi-experimental, namely research that aims to explain things that will happen to the research variables with a design using pre-test (before treatment) and post-test (after treatment) for the object studied.

2.1. Research Flowchart

The research flowchart can be seen in the image below in Fig.1. Parameters of Water Quality Outlets of the Wastewater Treatment Plant (WWTP) examined were Detergent and Coliform parameters which are Chemical and Microbiological parameters of wastewater, 2 times of inspection with a repetition time of 1 day difference. Pre-treatment with silica sand media is a pre-processing effort so that the microfiltration membrane 1 does not experience saturation/klogging. The quality of clean water after passing through the silica sand media and the quality of clean water after passing through the silica sand media are the results of the initial stages of processing to show the performance of preliminary processing using silica sand media.

Microfiltration membrane stage 1 is the first stage of processing wastewater into clean water. Microfiltration membrane stage 2 is a medium for processing wastewater into the second stage of clean water which ensures the fulfillment of the quality of clean water. The research was carried out on a field scale and used wastewater originating from a WWTP outlet at one of the dr. A. Dadi Tjokro Dipo in the city of Bandar Lampung, Lampung Province.

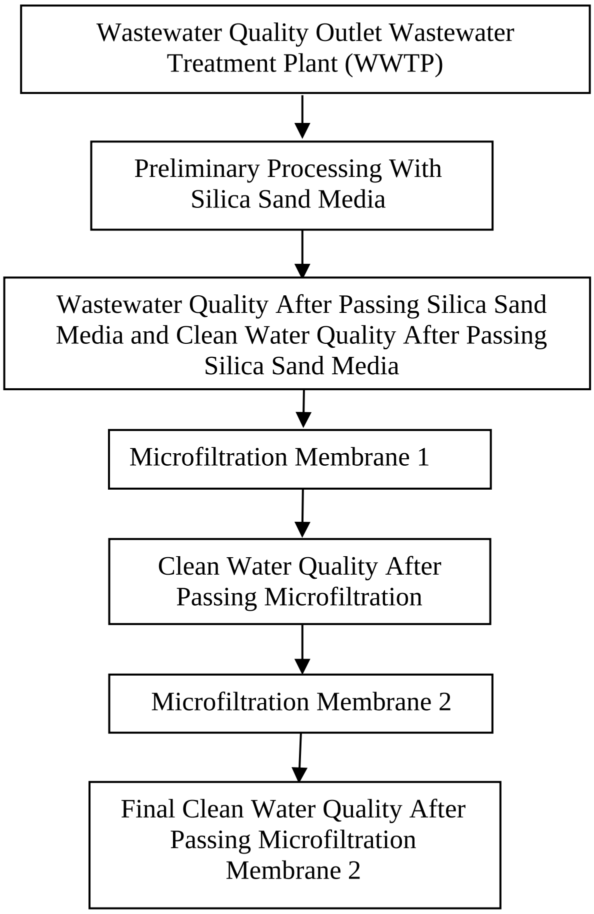

Figure 1. Research Flow Diagram

2.2. Research Reactor

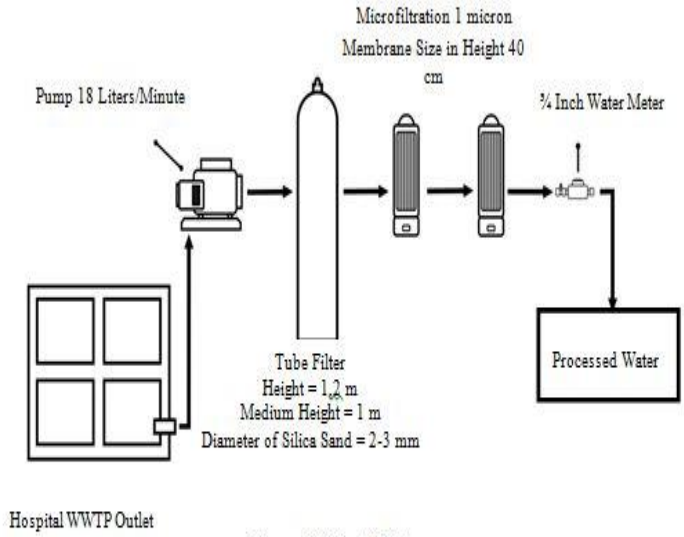

Figure 2. Waste Water Recycling Tool Into Clean Water

Sample 1: Initial sampling location for Detergent and Coliform parameters from Hospital WWTP Outlet

Sample 2: Sampling location for Detergent and Coliform
parameters from Filter Tube

Sample 3: Sampling location for Detergent and Coliform parameters from Membrane Filter 1

Sample 4: Sampling location for Detergent and Coliform

quality parameters from Membrane Filter 2

The sample examination was carried out twice, at each location of sample 1, sample 2, sample 3 and sample 4.

3. Results and Discussions

3.1. Clean Water Quality of Hospital WWTP Outlets

Based on the results of the initial sample research on hospital clean water that has been tested in the laboratory by testing 2 parameters, namely Detergent and Coliform, are as follows:

Table 1: Average Quality of Clean Water for WWTP Outlets

No.	Parameter	Repetition 1	Repetition 2	Average
1.	Detergent (mg/l)	1	1,4	1,2
2.	Coliform (CFU/100 ml)	3800	3500	3650

Based on table 1. Average Water Quality Outlet WWTP Detergent parameters obtained an average number of 1.2 mg/L and coliform parameters 3650 CFU/100 ml. The cause of this difference is the quality of the clean water used at the outlets of the hospital WWTP that comes directly from wastewater sources, such as treatment rooms, laundry installations, kitchens, operating rooms, and laboratories where concentrations and discharges change. When compared with Permenkes No. 32 of 2017 [6] concerning environmental health quality standards and water health requirements for sanitary hygiene purposes, swimming pools, Solus per Aqua, and public baths, the Detergent parameter has a maximum level of 0.05 mg/l and Coliform has a maximum of 50 CFU/100 ml so that the WWTP outlet water does not meet the requirements or exceeds the maximum level of quality standards [6].

3.2. Silica Sand Filter Processed Water

The water is pumped into the silica sand filter. Silica Sand Filter Processed Water is presented in table 2 below.

Table 2: Average Quality of Clean Water Outlet Silica Sand Filter

No.	Parameter	Repetition 1	Repetition 2	Average
1.	Detergent (mg/l)	0.14	0.1	0.12
2.	Coliform (CFU/100 ml)	2600	2800	2700

Based on table 2, the quality of wastewater was obtained on the first repetition of the Detergent parameter of 0.14 mg/l and Coliform 2600 CFU/100 ml, on the second repetition the quality parameter of detergent was obtained 0.1 mg/l and coliform 2800 CFU/100 ml sample. When compared with Permenkes No. 32 of 2017 2017 concerning environmental health quality standards and water health requirements for sanitary hygiene purposes, swimming pools, Solus per Aqua, and public baths , the Detergent parameter has a maximum level of 0.05 mg/l and Coliform has a maximum of 50 CFU/100 ml, the processed water of the silica sand filter does not meet the requirements or exceeds the maximum level of quality standards [6].

3.3. Test Results of Processed Wastewater Samples of Stage 1 and 2 Microfiltration Membranes

The water is then pumped through stage 1 and stage 2 microfiltration membranes. Processed water of stage 1 and stage 2 microfiltration membranes is presented in table 2 below.

Table 3: Average Quality of Clean Water Outlet Membrane Stage 1

No.	Parameter	Repetition 1	Repetition 2	Average
1.	Detergent (mg/l)	0.08	0.08	0.08
2.	Coliform (CFU/100 ml)	2200	2200	2200

Based on table 3, the quality of clean water obtained an average quality parameter of detergent 0.08 mg/l and coliform 2200 CFU/100 ml sample. When compared with Permenkes No. 32 of 2017 2017 concerning environmental health quality standards and water health requirements for sanitary hygiene purposes, swimming pools, Solus per Aqua, and public baths, the Detergent parameter has a maximum level of 0.05 mg/l and Coliform has a maximum of 50 CFU/100 ml, the processed water of stage 1 microfiltration membrane does not meet the requirements or exceeds the maximum level of quality standards [6].

Table 4: Average Quality of Clean Water Outlet Membrane Stage 2

No.	Parameter	Repetition 1	Repetition 2	Average
1.	Detergent (mg/l)	0.06	0.04	0.05
2.	Coliform (CFU/100 ml)	2000	2100	2050

Based on table 3, the quality of clean water obtained an average quality parameter of detergent 0.05 mg/l and coliform 2050 CFU/100 ml sample. When compared with Permenkes No. 32 of 2017 2017 concerning environmental health quality standards and water health requirements for sanitary hygiene purposes, swimming pools, Solus per Aqua, and public baths, the Detergent parameter has a maximum level of 0.05 mg/l and Coliform has a maximum of 50 CFU/100 ml, then the processed water of stage 2 microfiltration membrane Detergent content meets the requirements or does not exceed the maximum level of quality standards while 2 levels of Coliform do not meet the requirements or exceed the maximum levels of quality standards [6]

3.4. Decrease Performance of Wastewater Recycling Equipment to Clean Water

The performance of the Wastewater Recycling Tool into Clean Water is presented in the table and graph below:

Table 5: Average Decrease in Detergent

No.	Parameter	WWTP outlets	Filter Tube Outlet	MF Membrane Outlet 1	MF Membrane Outlet 2
1.	Detergent (mg/l)	1,2	0.12	0.08	0.05

Based on the table above, the results of the average sample test results of wastewater treatment using a microfiltration membrane recycling device on the Coliform parameter obtained results, namely at the WWTP outlet 1.2 mg/l, Filter Tube Outlet 0.12 mg/ll, Microfiltration Membrane Outlet stage 1 0.08 mg/l, Outlet Microfiltration Membrane stage 2, 0.05 mg/l.

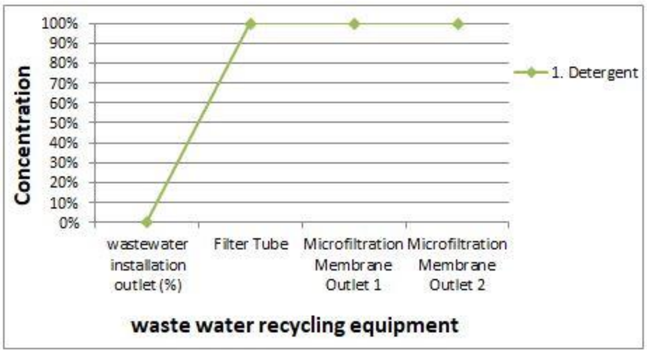

Figure 1: Average Percentage Results for Reducing Detergent Levels

Based on the graph above, the results of the average sample test results of wastewater treatment using a microfiltration membrane recycling device obtained results, namely at the WWTP outlet 1.0 %, Outlet Tube Filter 90 %, Outlet Microfiltration Membrane stage 1 93 %, Outlet Microfiltration Membrane stage 2 96 %.

Table 6: Average Coliform Reduction

No.	Parameter	WWTP outlets	Filter Tube Outlet	MF Membrane Outlet 1	MF Membrane Outlet 2
1.	Total Coliform (CFU/100 ml)	3650	2700	2200	2050

Based on the table above, the results of the average sample test results of wastewater treatment using a microfiltration membrane recycling device on the Coliform parameter obtained results, namely at the WWTP outlet 3650 CFU/100 ml, Filter Tube Outlet 2700 CFU/100 ml, Microfiltration Membrane Outlet stage 1 2200 CFU/ 100 ml, Outlet Microfiltration Membrane stage 2 2050 CFU/100 ml. Based on the graph above, the results of the average sample test results of wastewater treatment using a microfiltration membrane on the total coliform parameter showed that the WWTP outlet was 0%, Filter Tube Outlet was 20%, Microfiltration Membrane Outlet stage 1 was 40%, Microfiltration Membrane Outlet stage 2 was 44 %. The phenomena of degradation by silica sand filters and microfiltration membranes can be explained by the descriptions below.

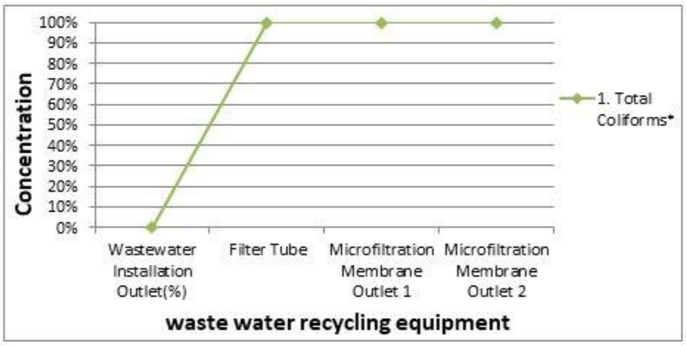

Figure 2: Results of the Average Percentage of Coliform Reduction

3.5. Silica Sand

The filter tube containing silica sand media plays an important role in the pre-treatment process of the microfiltration membrane, this can be seen from the descriptions presented above. In this study, the decrease in detergent and Coliform levels could be caused by silica sand because silica sand is the result of weathering of rocks containing main minerals such as quartz and feldspar, in general, silica sand is used at the initial stage as a filter in treating dirty water into clean water. The phenomenon of decreasing levels of detergent and Coliform parameters is explained in the research of [7], in this study it was explained that a silica sand filter has the ability to act as a filter that can separate solid and liquid chemical compounds, where liquid from liquid waste passes through porous media so that fine suspended solids can be transferred or milked. Silica sand media as a porous filtration medium can separate solids from liquids using the principle of gravity so that suspended solids are removed [7].

3.6. Microfiltration membrane

Membrane process membranes are the Best Available Technology for water treatment processes. In waste treatment, membrane technology can be applied directly and indirectly. In direct applications, membrane technology is aimed at waste minimization and reuse. Waste minimization is carried out by recovering the water contained in the waste so that the waste discharge becomes minimum. The pore size of the membrane in such a way will produce water that meets the requirements for use as process water so that the concept of reuse can be achieved. The most common contaminants in hospital wastewater are those from laundry. Laundry residue due to use with a high pH (alkaline). With the increasing number of laundry liquid waste containing oil-neutralizing detergent, the carrying capacity of self-cleaning water is also getting better. It also happens when the ratio of residual determination and oil/fat is balanced. If it is not sufficient, the oil and fat will enter the wastewater treatment unit so that it can interfere with the aerobic and anaerobic processes in the WWTP installation [10]. So, microfiltration membranes become a solution to overcome detergent pollution in WWTP processed water. Microfiltration membranes function to filter macromolecules of more than 500,000 g/mol or particles that have a size of 0.1 – 10 μm with a dissolved solids content of not more than 100 ppm. Many applications in industry are carried out in the water sterilization process with the aim of separating microorganisms (bacteria, fungi) and oil and water emulsion filtration with an operating pressure of 0.5-2 atm [4].

4. Conclusions

The conclusions of this study are as follows:

1. The average quality of WWTP Outlet Water for Detergent parameters obtained an average value of 1.2 mg/L and the Coliform parameter was 3650 CFU/100 ml.
2. The average quality of treated Filter Tube parameters Detergent 0.12 mg/l and Coliform 2700 CFU/100 ml
3. The average quality of treated water Microfiltration Membrane Stage 1 detergent parameters 0.08 mg/l and Coliform 2200 CFU/100 ml sample.
4. The average quality of treated water Microfiltration Membrane Stage 2 detergent parameters 0.05 mg/l and Coliform 2050 CFU/100 ml sample.
5. The average percentage of detergent reduction using recycling equipment was obtained at WWTP outlets 0%, Filter Tube Outlets 90%, Microfiltration Membrane Outlets stage 1 93%, Microfiltration Membrane Outlets stage 2 96%.
6. The average percentage of Coliform reduction using recycling equipment was obtained at WWTP outlets 0%, Filter Tube Outlets 20%, Microfiltration Membrane Outlet stage 1 40%, Microfiltration Membrane Outlet stage 2 44%.

Suggestions from this study are as follows:

Carry out further research to reduce the current research discharge so that the reduction in Coliform can be more significant

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