EVALUATION OF WWTP WITH ACTIVATED SLUDGE TECHNOLOGY COMBINED WITH MICROORGANISM BIOFILTERS IN IMERI BUILDING

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ABSTRACT

The regulations said that all domestic wastewater first should be treated before being discharged into public drainages. Therefore, IMERI building, as a research and education building located in the Faculty of Medicine, Universitas Indonesia, applies a wastewater management system using activated sludge technology combined with microorganism biofilters. This system is expected to treat the waste generated inside the building. It reprocesses become recycled water and partially discharged into city drainages based on the quality standard and maintenance applied during the operation. By collecting and evaluating primary and secondary data from system planning and routine maintenance results, we assess all performance of the WWTP system. Moreover, this system runs well and has all indicators of effluent categorizes safe. However, routine maintenance and the treatment process with chlorination and tighter monitoring should be taken seriously to keep the whole system's performance.

Keywords: Domestic Wastewater; WWTP Evaluation; WWTP Monitoring

INTRODUCTION

Research on wastewater in DKI Jakarta has concluded that water pollution by sewage has been at the worst point ever since the study conducted by the DKI Jakarta Public Works and Housing (PUPR) and the JICA team (1989). Many issued regulations responded to this condition, starting from government regulation (PP) Number 20 of 1990 and PP Number 82 of 2001 concerning Water Management and Water Pollution Control and renewed to PP Number 22 of 2021 concerning Implementation of Environmental Protection and Management. These regulations said that we must treat all domestic wastewater first before being discharged into public drainages. It is also complemented by the Decree of the Minister of Environment and Forestry number 68 of 2016 concerning Domestic Wastewater Quality Standards. It is said that each person in charge of business or activities of restaurant settlements, offices, commerce, and apartments is obliged to carry out domestic wastewater treatment so that the quality of domestic wastewater discharged into the environment not exceeding the stipulated domestic wastewater quality standards. In this novel regulation, the parameter of Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), and ammonia are tighter than previous regulation. Regulation of the Governor of DKI Jakarta Province number 122 of 2005, where one of the provisions is about Domestic Wastewater Management, aims to improve water originating from household/office activities suitable for disposal into city/drainage channels.

IMERI Building, Faculty of Medicine, Universitas Indonesia, is located at Jalan Salemba Raya no. 6, Kenari, Central Jakarta, one of the Education and Research buildings operating since April 2018. It consists of two basement floors, thirteen floors, including a rooftop with two towers, Education and Research Tower. The Provincial Government of

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DKI Jakarta has issued the permit for wastewater disposal at the IMERI Building, Faculty of Medicine UI, on 21 May 2018 Number: 60/K.8/31/-1.774.15/2018. Moreover, this evaluation refers to the guidance from the Ministry of Health Republic of Indonesia Directorate General of Health Efforts (2011) about Technical Guidelines for Wastewater Treatment Plants with Aerobic Anaerobic Biofilter Systems in Health Care Facilities.

In the sewage treatment system with IFAS, initially, the wastewater is put into the tank under anoxic conditions. In this space, organic compounds are decomposed by microorganisms by utilizing compounds in an oxidized form such as NO3-, NO2- and sulfates as oxygen sources. In this room, there is also a denitrification process. Then the water is put into an aerobic (aerated) tank. Organic compounds will be broken down into simple organic compounds, new cells, CO2, and H2O in this tank. Finally, the new microorganisms that grew expressed as MLSS (Mixed-Liquor Suspended Solids) were deposited in the sedimentation basin. The last room of this system is also equipped with disinfection in the form of chlorine injection so that it is safe and can be directly disposed of into city drains with e-coli content close to zero. The concentration of high total coliform that exceeds the standard limit wastewater quality indicates infectious contamination pathogens that cause spread disease through the medium of water (water diseases). In addition, the content of liquid waste with a concentration of high total coliform can also affect the life of biota organisms in waters. Research on coliforms in the river and determine whether the water is feasible in daily life. The status of river pollution can be categorized as lightly polluted to moderate so that it does not meet the quality standard for aquaculture (Hartaja, 2015).

The purpose of this study was to evaluate the IMERI Building WWTP system's performance based on the results of the data for the last three years to know the quality of wastewater with a system capacity following the DKI Governor Regulation number 122 of 2005.

METHODS

The methodology used in this activity is collecting primary and secondary data and then analyzing these data altogether. The steps taken were conducting field observations on the WWTP system's routine maintenance, analyzing the data as the primary data, and comparing it with planning the WWTP system for the IMERI Building and results from related research as the secondary data.

RESULTS AND DISCUSSION

IMERI BUILDING DOMESTIC WASTEWATER MANAGEMENT

1.1 Processing Principles

Wastewater that enters the WWTP comes from the kitchen/laundry, toilet, urinal, basin room, and laboratory. This processing unit is planned to reduce BOD organic load to a maximum of 350 mg/l to less than 50 mg/l, with a maximum discharge of 150 m3 / day.

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Figure 1. Location of IMERI Building's WWTP

The principle of WWTP processing work from each installation can be seen from the following Flow Diagram and described as follows and figures shown in the appendix:

A. Toilet Shelter from Research Tower and Education Tower

Wastewater from toilets and urinals originating from the Research Tower enters the research toilet's side. Wastewater from toilets and urinals from the Education Tower goes to the education toilet's side. In addition, the toilet shelter of the Education Tower and the Research Tower has a submersible pump that pumps wastewater to the Grit Chamber.

B. Kitchen Shelter from the Research Tower and the Education Tower

Dirty water from the kitchen that comes from the Research Tower goes to the Research Tower kitchen side, and contaminated water from the kitchen from the Education Tower goes to the Education Tower kitchen. A submersible pump in each shelter functions to pump wastewater into the grease trap overflows to the Grit Chamber.

C. Neutralization Tank

The dirty water from the laboratory that has entered the shelter is pumped into a neutralization tank with a diffuser that functions to stir the incoming dirty water. In this tank, the pH is monitored by pH control and is kept in the range of 6.7 - 7.3. If the water that enters this room has a pH of less than 6.7, an acidic solution will be injected by the Dosing Pump 1, and if the pH is more significant than 7.3, then an acid solution will be injected using Dosing Pump 2. Dirty water that has been adjusted to the pH will then be pumped into the Box control. In this tank, there is a Dosing Pump with the following specifications:

Brand: Blue & White
Type: C660P diaphragm
Capacity: 17.4 Lph
Power: 1 pH / 220 V
Head: 80 psi (max)

D. Grease Trap

Dirty water from the Research and Education Tower kitchen then goes to the grease trap with a basket screen. This basket screen functions to capture solid fats and oils that stick to and float on the wastewater surface. Solid fat, oil, and water are separated based on differences in specific gravity. Solid fats and oils with less gravity will float and should always be cleaned regularly in this area. Water with a greater gravity will be in the lower layer and free from grease and oil, then flowed to the Grit Chamber.

E. Grit Chamber

In this room, dirty water from the toilet's Research Tower and Education Tower shelter are collected. Heavy materials such as sand or materials with a density greater than water will be deposited in this room. Furthermore, the water will pass through the bar screen and filter large debris more than two cm in size, such as plastic, rope, wood, paper, and tissue paper. Sediment and waste material on this bar screen must be carried out regularly during daily maintenance. From this grit chamber,

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water will then be pumped into the box control.

F. Box Control

Wastewater from the neutralization basin and grit chamber overflows to the box control then flows back to the Anoxic Contact Tank

G. Anoxic Contact Tank

Wastewater that enters the Anoxic Contact Tank is kept tightly closed and airtight. Bacteria that act as degrading are anoxic bacteria. Complex organic compounds such as proteins, carbohydrates, and long-chain oils/fats by anaerobic bacteria are first degraded into simple and short-chain fatty acids and amino acids and a small amount of hydrogen gas. Furthermore, organic acids and amino acids are further broken down into methane gas (CH4), carbon dioxide (CO2), and small amounts of H2, H2S, and nitrogen (N2), and biomass (MLSS). The source of oxygen is taken from the oxidized form of inorganic compounds such as NO3-, NO2-, and (SO4) 2-. Wastewater flows from the bottom of the tank to the Aerobic Contact Tank 1 (Standar Nasional Indonesia Nomor 6989.59:2008).

H. Aerobic Contact Tank 1

Aerobic Contact Tank 1 is divided into the first chamber with biomedia and the second chamber without biomedia. Biomedia functions as a place for the growth of living microorganisms that actively degrade organic COD compounds. This room is in aerobic condition because a diffuser is installed. In the first chamber, twelve diffusers were installed, and seven diffusers were installed in the second chamber. This diffuser functions to distribute air so that the air is evenly distributed in the aerobic contact tank 1. The valve leading to this tub is opened rather large so that the air supplied is large enough. The degrading bacteria that play a role are aerobic bacteria due to the blower's air supply through the pipe to the diffuser. The efficiency of organic COD and BOD removal was also increased due to the growth of inactive biomass bacteria attached to the honeycomb model biomedia made of rigid PVC. This biomedia has a surface area of 170 m2/m3 so that bacteria can grow by occupying the surface in large numbers. In this space, there are two removal processes for organic substances in wastewater, namely:

1. Organic substances in wastewater are degraded due to the microorganisms present in suspended solid form as activated sludge
2. Organic substances that have not been degraded and pass through the biomedia will grow microorganisms that stick to the biomedia as a thin layer. If this happens continuously, the attached microorganisms will get thicker because they absorb organic substances as food. When the microorganisms attached to this biomedia get more viscous, the innermost layer of the biomedia will rot. The biomass structure will be brittle so that it falls to the bottom of the tank. This thick layer of biomedia can also escape by itself because it is pushed by water friction. Thus the concentration of organic substances in this wastewater decreases (BOD and COD values decrease). Wastewater in aerobic contact tank 1 from chamber 1 flows overflow to chamber 2, the treated water moves to aerobic contact tank 2 through the bottom of the tank**.**

I. Aerobic Contact Tank 2

This tank works the same, just like aerobic contact tank 1, where the tank is divided into two parts. In both these spaces, the conditions are aerobic, and the air supply is distributed through a diffuser. The first chamber has six biomedia and diffusers, and in the

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second chamber, there are no biomedia, and there are seven diffusers. The bacteria that play a role are aerobic. The content of organic pollutants in processed water can be reduced by up to 90%. Furthermore, the treated water is transferred overflow to the aeration tank.

J. Aeration Tank

The condition in the aeration tank is aerobic, and the air supply is distributed through the diffuser as many as twelve pieces. The treated wastewater that enters this chamber can usually reduce organic matter by more than 90%. The smaller the organic matter, the less sludge is formed, and the wastewater becomes clearer. Therefore, in this tank, oxygen supply should be paid more attention to at the minimum level to organic material separation (BOD, COD, and ammonia) in wastewater. Furthermore, the wastewater flows into the sedimentation tank through the bottom of the sedimentation tank.

K. Sedimentation Tank

An airlift pump in the sedimentation tank regulates the return of sludge to the Anoxic Contact Tank. In addition, the sedimentation tank is equipped with a tube settler with a distance between the plates 2 cm and 60º angles and 60 cm height. This tube settler aims that the sediment area becomes more prominent with an average surface loading of 2.15 m3/m2/day, or on the peak hours, the surface loading is 6.45 m3/m2/day. Simultaneously, the maximum design criteria requirements are 16-29 m3/m2/day. Therefore, sludge as MLSS with a greater density will settle at the sedimentation tank's bottom in this tank. MLSS is the total number of suspended solids in organic material, and minerals, including them, are microorganisms. MLSS is defined by filtering the mixed mud with filter paper (filter), then filter dried at a temperature of 105º C, and weight the solids in the sample are weighed.

Because the sludge deposition process occurs continuously, sludge will increase over time and transfer to the Anoxic Contact Tank using an airlift pump. The sludge decomposition will occur at the bottom of the sedimentation tank if the increased sludge does not remove. It caused the aerobic bacteria will die and anaerobic bacteria will appear. Furthermore, there will be flotation of sludge due to the gases produced by the decomposition process, so that the quality of the effluent will be poor (bulking sludge). If the sludge in the sedimentation tank is excess, the sludge must be drained using a fecal suction car.

The treated water on the clear surface of the sedimentation tank has BOD values <20 mg/l and COD <30 mg/l. Then the water overflows to the Intermediate Tank/Chlorination Tank

L. Intermediate Tank/Chlorination Tank

The water flowing into the Intermediate Tank/Chlorination Tank is continuously injected with chlorine solution from the chemical tank using a dosing pump with a capacity of 15.7 LPH (maximum). The dose of chlorine injected into water is maintained at around 15 mg/l as free chlorine or 24 mg/l as chlorine (60%). This chlorine injection aims to kill pathogenic bacteria in water and reduce ammonia which is not oxidized during the biological treatment process. For complete oxidation, the ratio of ammonia to chlorine is 1: 7.6 or 1 mg N - NH3 to 7.6 mg Cl2. The residence period of the water in this tank is set for 30 minutes so that bacteria or pathogenic microorganisms die. The treated water flows to the Effluent Tank from the Intermediate Tank/Chlorination Tank room (if it is not recycled) (Hartaja, 2015).

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M. Effluent Tank

The Effluent Tank holds treated water that has met the requirements for wastewater and is checked regularly at an accredited laboratory.
Treated sewage effluents containing residual pollutants are often discharged into surface water. These effluents can contribute to the pathogens in the environment. A group of bacteria known as coliforms is used to monitor the microbiological quality of water, so it becomes one crucial parameter of suitable wastewater (Trikoilidou et al., 2016; Hendricks & Pool, 2012).

N. Complementary Equipment for WWTP

1. Microbial Breeding Biomedia

Usually, for biofilter media from inorganic materials, the smaller the diameter, the larger the surface area, so the number of microorganisms cultured will also be significant. Still, the cavity volume will be smaller.
Some crucial aspects that need to be considered of picking the best biomedia are:

1. Specific surface area;
2. Cavity volume fraction;
3. The diameter of the free gap;
4. Resistance to deadlock;
5. Type of material;
6. Price per unit surface area;
7. Mechanical strength;
8. Media weight;
9. Flexibility;
10. Maintenance;
11. Energy consumption; and
12. Wettability.

Thus, the biofilter media used for microbial breeding is a wasp nest type with a surface area of 170 m2/m3. Honeycomb biomedia is essential because this medium functions as a place for microorganisms to grow and attach. The two most important traits that any biomedia must have are:

a. The surface area of the medium is sufficiently large per volume
b. The percentage of space is good because the more extensive the free space, the greater the contact of the biomass attached to the supporting media with the substrate in the wastewater.

2. Transfer Pump for Toilet's Shelter of Education and Research Tower

Type: Submersible
Model: Ebara 65DVC 51.5
Capacity: 0.3 m3/min, H = 10 m
Power: 1.5 kW, 380 V, 50 Hz, 3 Phase
Equipment: Lift Chain, QDC

3. Transfer Pump for Kitchen's Shelter of Education and Research Tower

Type: Submersible
Model: Ebara 65DVC5, 75
Capacity: 0.1 m3/min, H = 10 m
Power: 1.5 kW, 380 V, 50 Hz, 3 Phase
Equipment: Lift Chain, QDC

4. Transfer Pump for the Research Tower Laboratory

Type: Submersible (SS)
Model: Apec, JSB 10
Capacity: 0.15 m3/min, H = 10 m
Power: 0.75 kW, 380 V, 50 Hz, 1 Phase
Fittings: Plastic Mine

5. Sump Pump for Neutralization

Type: Submersible
Model: Ebara 65DVC51.5
Capacity: 0.5 m3/min, H = 7.5 m
Power: 1.5 kW, 380 V, 50 Hz, 3 Phase
Equipment: Lift Chain, QDC

6. Sump Pump for Kitchen and Toilet

Type: Submersible
Model: Ebara 50DVC5,4S
Capacity: 0.1 m3/min, H = 8 m
Power: 0.4 kW, 220 V, 50 Hz, 1 Phase
Equipment: Lift Chain, QDC

7. Air Blower in WWTP

Type: Root Blower

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Model: LT.080
Brand: Long Tech
Rotation: 1300 rpm
Capacity: 4.9 m3/min, H = 4 m
Power: 7.5 kW, 380 V, 50 Hz
Operation: one duty, one stand by

8. WWTP Room Diffuser Membrane

Type: Air Fine Bubble
Capacity: 2 - 5 m3/hr (12 CFM/unit)
Pressure: 12 psi
Brand: KAM-AIR
Efficiency: 18% at 3.5 m

9. Dosing Pump for Chlorination

Type: Diaphragm
Capacity: 15.76 lph
Product: Pulse feeder - Chemtech 100/150
Equipment: strainer suction and injection valve, injection hosing, flexible hose

10. Effluent Pump

Type: Submersible
Model: Ebara 50DVC51,5S
Capacity: 0.2 m3/min, H = 10 m
Power: 1.5 kW, 380 V, 50 Hz, 3 Phase
Equipment: Lift Chain, QDC

11. Water Meter

The water meter is installed to complement the control and monitoring system of the WWTP operational system to monitor the discharge of treated and wasted waste into the environment.

1.2 Monitoring and Evaluation of WWTP Performance in IMERI Building

Operation activities provide that a WWTP produces the desired quality and quantity of treated water and meets the standards. At the same time, maintenance is the activity to ensure regular and efficient work of equipment to achieve sustainable operational objectives (Serdarevic & Dzubur, 2018).

After the IMERI Building WWTP's operational period, visual and periodic daily monitoring is carried out in the context of routine system maintenance, and the results are analyzed in an accredited environmental laboratory. Following are the initially treated water laboratory analysis results as an attachment to the Wastewater Disposal Permit issued by the Provincial Government of DKI Jakarta on 21 May 2018 (Pranoto et al., 2019; Pratiwi et al. 2019).

Table 1. Water Analysis Result 18 Apr - 26 Apr 2018

No.	Parameter	Unit	Test Results		Max Rate
			Inlet	Outlet	
1	pH	mg/l	8.0	6.6	6 - 9
2	Suspended Solids	mg/l	156.0	7.0	30
3	Ammonia	mg/l	39.36	3.86	10
4	Oil and Fat	mg/l	<0.54	3.54	5
5	COD (Dichromat)	mg/l	209.56	<10.0	100
6	BOD (20o Celcius, 5 days)	mg/l	43.93	3.05	30
7	Total Coliform	total/100 ml	2.3×10^8	0	3000

From the initial result, after operational began above, it can be concluded that all parameters meet domestic liquid waste quality standards. Furthermore, from the seven parameters, there was a drastic inclination from the inlet and the outlet of WWTP, and it is shown that all systems have worked optimally.
During its operational period, the IMERI Building WWTP conducts a routine analysis of the wastewater produced so we can regularly evaluate the current condition of this WWTP as the following table which shows the result of an investigation from about five months later from a different laboratory (Said, 2018).

Table 2. Water Analysis Result 10 Sept - 17 Sept 2018

No.	Parameter	Unit	Test Results	Max Rate
1	pH	mg/l	6.9	6 - 9
2	Suspended Solids	mg/l	5.0	30
3	Ammonia	mg/l	5.14	10
4	Oil and Fat	mg/l	<0.54	5
5	COD (Dichromat)	mg/l	18.6	100
6	BOD (20o Celcius, 5 days)	mg/l	5.53	30
7	Total Coliform	total/100 ml	<2	3000

Maintenance of WWTP in the IMERI Building involves a third party which is

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carried out every four months by checking the WWTP performance daily, which includes the following activities:

1. Cleaning the grease trap and grit chamber from solid waste and debris. Avoiding the entry of waste in the form of fuel and oil;

2. Draining sludge in equalization and initial settling tanks periodically to drain sludge that cannot be biodegradable. The quantity of waste sludge depends on influent composition and volumetric load and WWTP's operating conditions. Higher loads result in higher biomass yields, while critical operating conditions, such as hydraulic retention time (HRT), solids retention time (SRT), biomass age, food to microorganism ratio (F/M), dissolved oxygen concentration (DO), and alternating conditions (aerobic, anoxic, anaerobic, etc.), significantly affect biomass production;

3. Giving chlorine to the intermediate tank and effluent tank. When using chlorine, it is vital to properly and safely store all chemical disinfectants. The storage of chlorine is strongly dependent on the compound phase;

4. Panel checking and cleaning;

5. Blower air filter cleaning and following blower oil change with other pumps to ensure pump performance. In short, there are a half-dozen pump operating parameters that have to be monitored to ensure proper pump operations: intake pressure (feet), outlet pressure (feet), flow rate (cubic feet per second), pump speed (revolutions per minute), pump efficiency (percentage), and power requirements (watts). In addition to direct monitoring of the operating pump, vibration and noise levels should be checked along with any service fluids such as the fuel tank (and fuel consumption rates) and oil reservoir levels. Monitoring these parameters is best to perform essential maintenance (Said & Utomo, 2007; Yudo, 2010). It is less costly in terms of labor and time (no need to dismantle, maintain, or clean the pump) and does not require the pump to be temporarily brought offline. Furthermore, the accumulated data from this operational monitoring can better plan the frequency and maintenance necessary to keep the pump functioning;

6. General cleaning of WWTP equipment including calibrating;

7. Recording numbers on the water meter; and

8. Perform water analysis in an accredited environmental laboratory. Sampling location point at the inlet

a. It is carried out at a point in a high turbulent flow so that good mixing occurs, namely at the point where the waste flows at the end of the production process to the WWTP.
b. If the location is not possible for sampling, then another place can be determined to represent the characteristics of the wastewater.

Sampling location point at the outlet
A sampling at the outlet is carried out after the WWTP or where wastewater flows before entering the receiving water body (river)

Figure 2. Injection of Chlorine

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Figure 3. Cleaning Process of Sedimentation Tank

Figure 4. Cleaning Process in Grit Chamber

From the following table, we notice the fluctuation of the analysis results from 2019 to 2020.

Table 2. Water Analysis Result in 2019-2020

No.	Parameter	Unit	Test Results 2019 - 2020					Max Rate
			18 Jul-25 Jul 2019	09 Okt-16 Okt 2019	22 Jul-29 Jul 2020	18 Agu-26 Agu 2020	16 Sept-22 Sept 2020	
1	pH (insitu) 20^{o} C	-	7	6	7	7.9	6.9	6 - 9
2	BOD^{5}	mg/l	15	9	9	2.58	8.86	30
3	COD	mg/l	74	42	47	7.4	24	100
4	Suspended Solids	mg/l	4	3	2	1	2	30
5	Oil and Fat	mg/l	<1.8	<1.8	<1.8	<0.54	<0.54	5
6	Ammonia	mg/l	7	13	0.2	<0.15	<0.29	10
7	Total Coliform	total/100 ml			<1.8	1900	2200	3000
8	Debit	L/org/hr	12	12	12	12	12	100

Figure 5. Inlet and Outlet Water Samples Differences

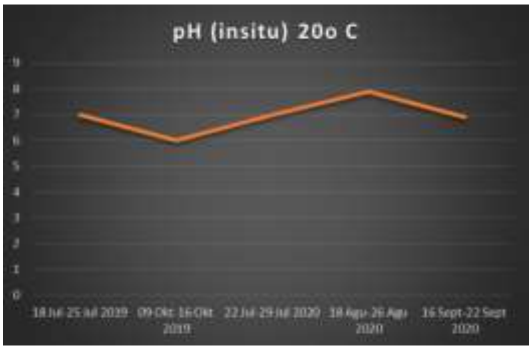

Figure 6. pH Analysis

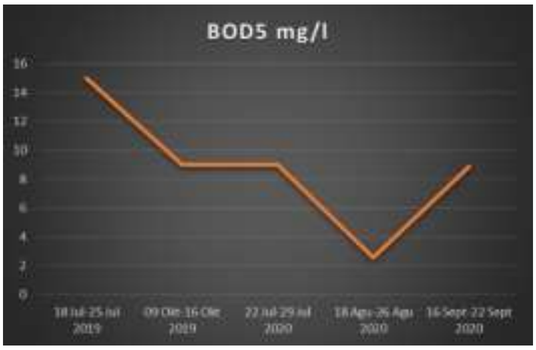

Figure 7. BOD5 Analysis

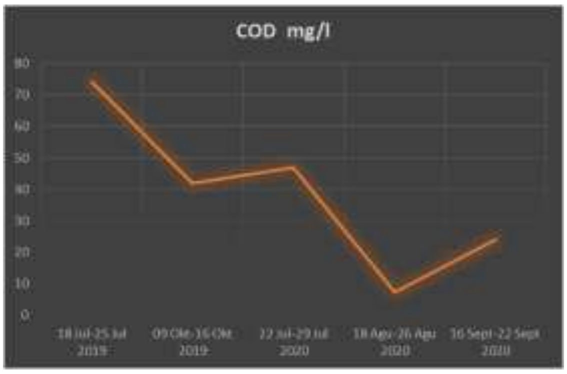

Figure 8. COD Analysis

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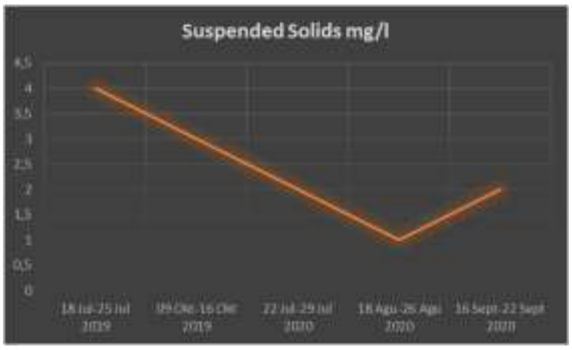

Figure 9. Suspended Solids Analysis

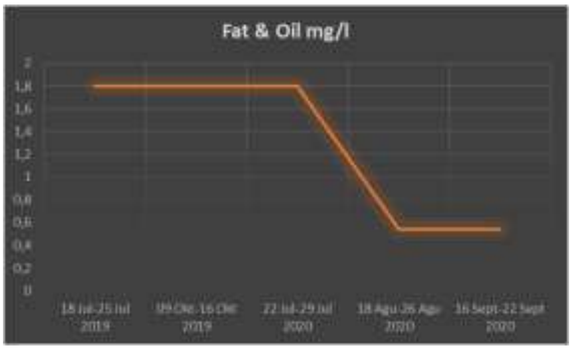

Figure 10. Fat and Oil Analysis

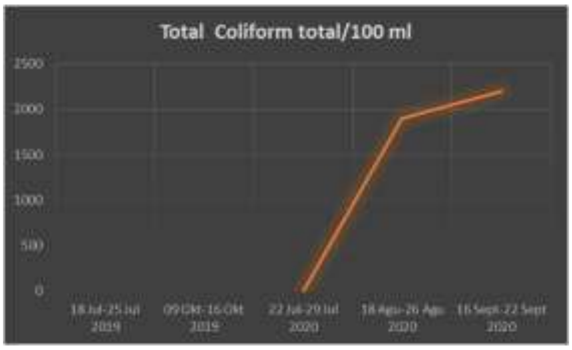

Figure 11. Total Coliform Analysis

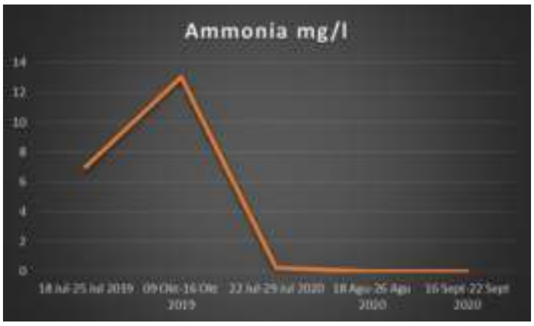

Figure 12. Ammonia Analysis

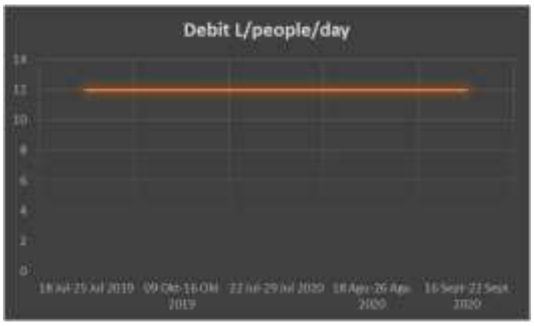

Figure 13. Debit Analysis

Based on the graphics shown above, there is fluctuation from specific parameters and indicates variables that influenced the results. For instance, routine maintenance period has excellent leverage to the effluent quality, especially while chlorination has not been injected regularly. However, it will be impacted by the results of total coliform, BOD5, and COD. In addition, general cleaning from grease trap and grit chamber will affect fat and oil. And the performance of all pumps in the system becomes more crucial to be checked first if there was a maintenance delay (the United States Environmental Protection Agency, 1999).

CONCLUSION

The water analysis results, especially the number of coliforms, COD, and BOD, tended to increase even though they were still within the existing quality standards. From comparing effluent analysis, we sum up that the delay of routine maintenance has a more significant impact on the analysis shown and the system's performance.

For the existing water debit, it is necessary to optimize system utilization (WWTP) by treating waste from the building located in the IMERI Building area. WWTP IMERI Building has adequately worked from the effluent quality analysis described. However, routine maintenance and the treatment process with chlorination and tighter

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monitoring of other factors such as pH and conductivity of wastewater that may play a role in bacterial communities should be tightened to keep the stability of effluent quality.

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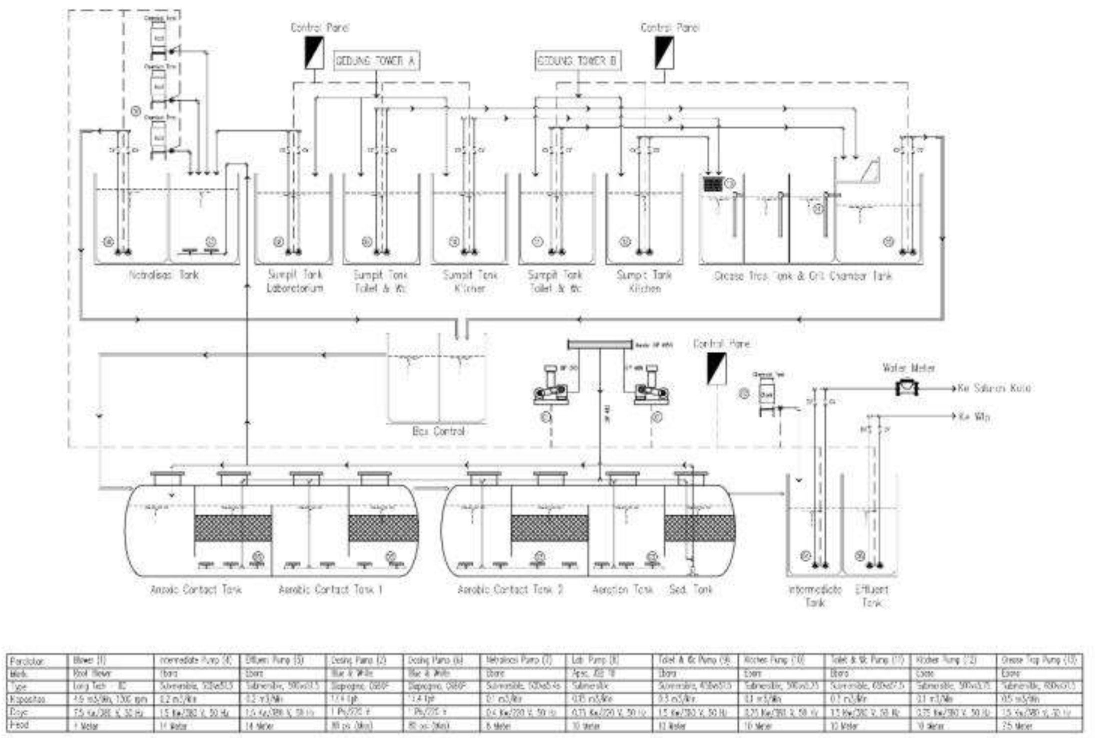
Appendix



Peralatan	Blower (1)	Intermediate Pump (4)	Effluent Pump (5)	Dosing Pump (2)	Dosing Pump (6)	Netralisasi Pump (7)	Lab Pump (8)	Toilet & Wc Pump (9)	Kitchen Pump (10)	Toilet & Wc Pump (11)	Kitchen Pump (12)	Grease Trap Pump (13)
Merk	Root Blower	Ebara	Ebara	Blue & White	Blue & White	Ebara	Aspc. 200 W	Ebara	Ebara	Ebara	Ebara	Ebara
Type	Long Tech - 80	Submersible, 50DVS51.5	Submersible, 50DVS51.5	Diaphragm, C660P	Diaphragm, C660P	Submersible, 50DVS5.4S	Submersible	Submersible, 65DVS51.5	Submersible, 50DVS5.75	Submersible, 65DVS51.5	Submersible, 50DVS5.75	Submersible, 65DVS51.5
Kapasitas	4.9 m3/Min, 1300 rpm	0.2 m3/Min	0.2 m3/Min	12.4 lph	12.4 lph	0.1 m3/Min	0.15 m3/Min	0.3 m3/Min	0.1 m3/Min	0.1 m3/Min	0.1 m3/Min	0.5 m3/Min
Daya	7.5 Kw/380 V, 50 Hz	1.5 Kw/380 V, 50 Hz	1.5 Kw/380 V, 50 Hz	1 Ph/220 V	1 Ph/220 V	0.4 Kw/220 V, 50 Hz	0.75 Kw/220 V, 50 Hz	1.5 Kw/380 V, 50 Hz	0.75 Kw/380 V, 50 Hz	1.5 Kw/380 V, 50 Hz	0.75 Kw/380 V, 50 Hz	1.5 Kw/380 V, 50 Hz
Head	7 Meter	17 Meter	14 Meter	80 psi (bar)	80 psi (bar)	8 Meter	10 Meter	12 Meter	10 Meter	10 Meter	10 Meter	7.5 Meter

Figure 14. WWTP Installation of IMERI Building

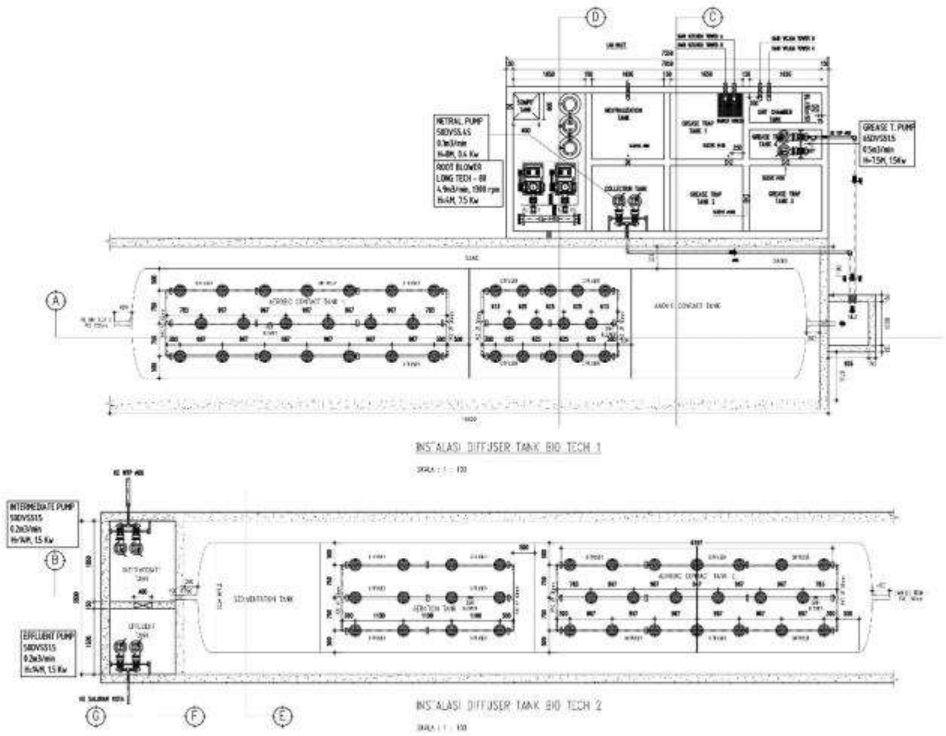


Figure 15. Diffuser Tank Placement

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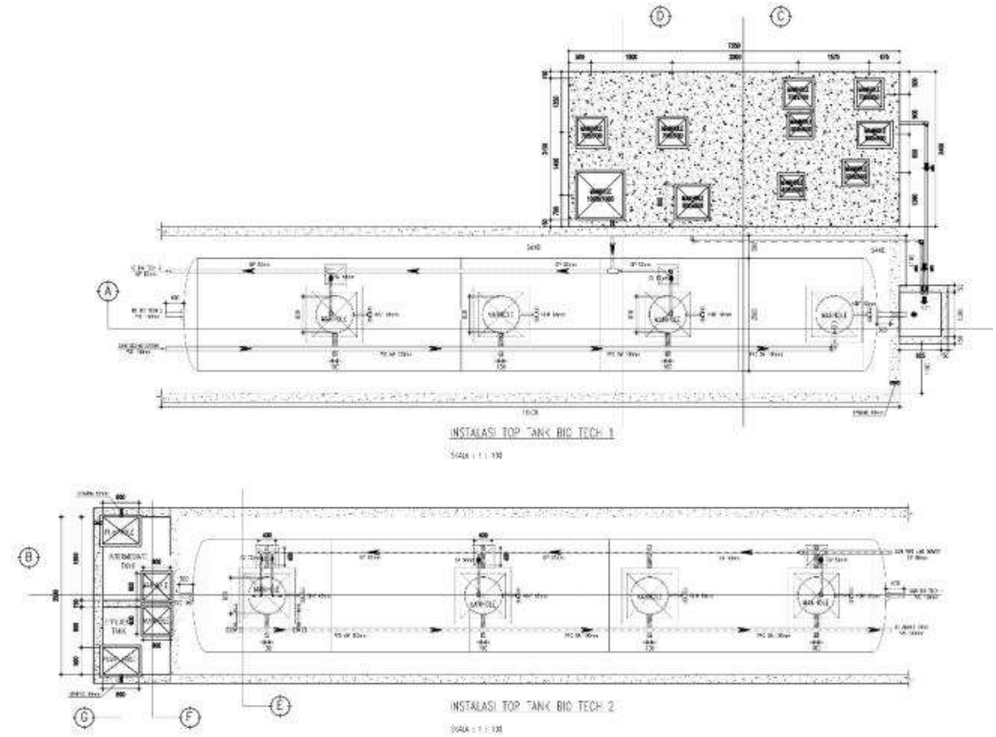

Figure 16. Top View Installation

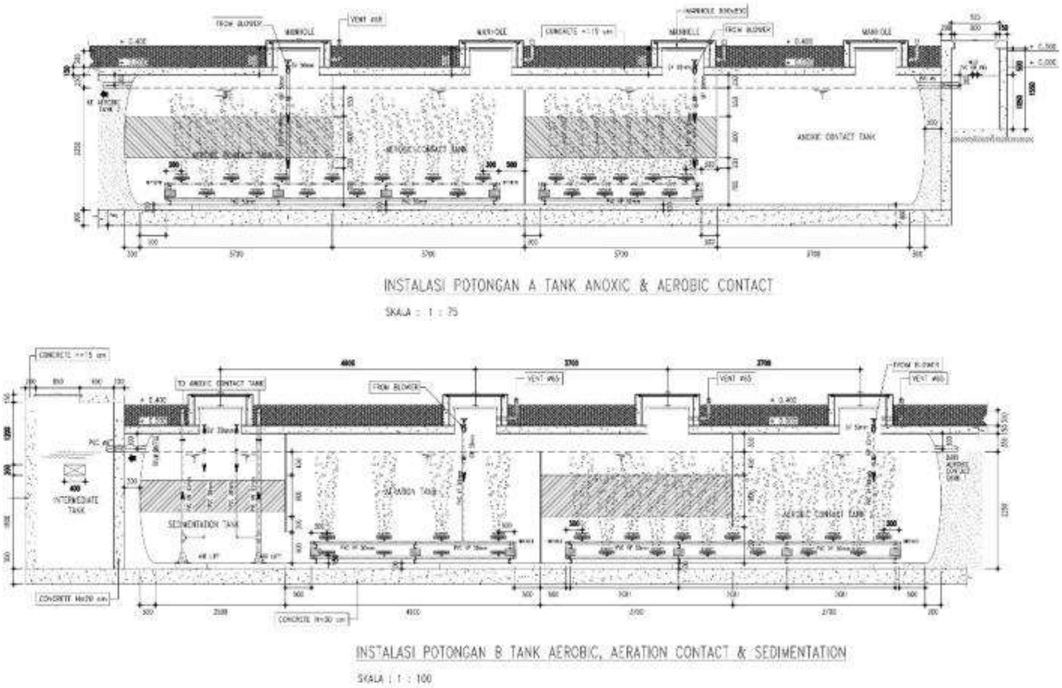

Figure 17. A and B Installation

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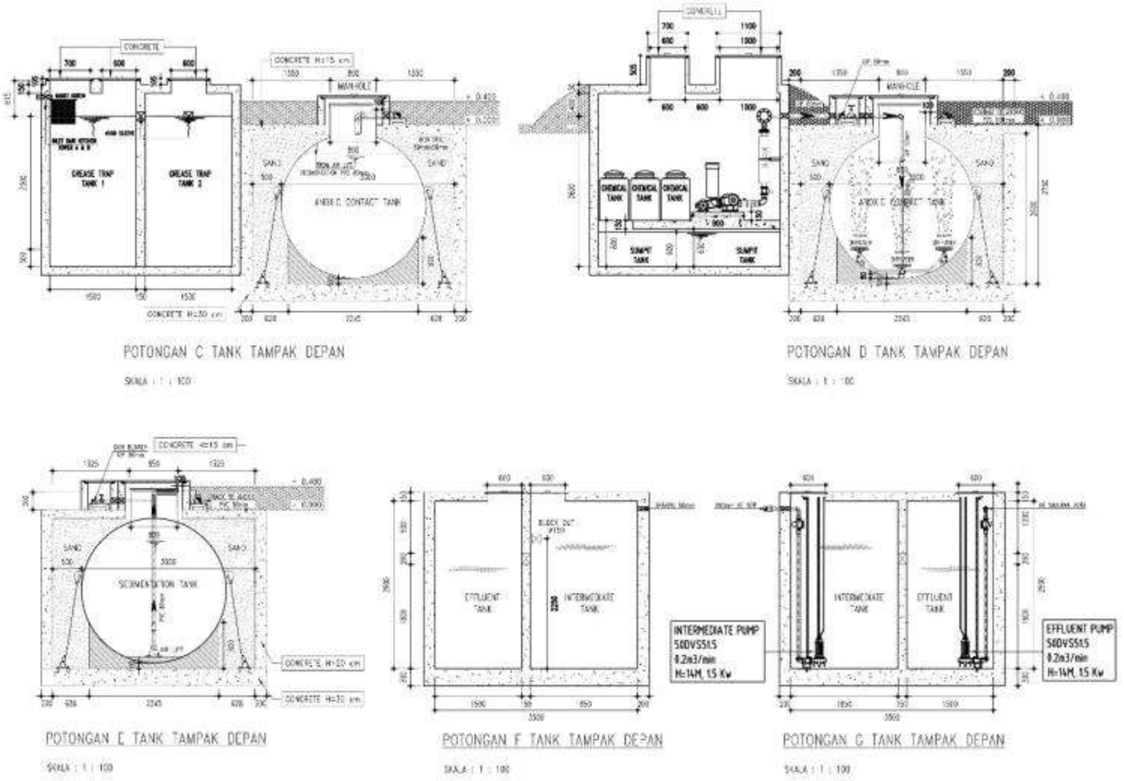

Figure 18. 14 C-G Section Installation

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