

# Study On Waste Water Treatment Installation And Its Electricity Distribution

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## ABSTRACT

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**Abstract** - Hospital wastewater is a source of pollutants for the environment that can have a negative impact. Hospital waste can contain various kinds of microorganisms depending on the type of hospital and the level of treatment carried out after the waste is disposed of. Therefore, it is necessary to conduct a study on Wastewater Treatment Plants so that the discharged wastewater meets the requirements of wastewater discharged from the hospital. From the results of this study it can be concluded that the initial process to the final process and after that it is necessary to check the quality of wastewater to determine the efficiency of treatment at least 2 times a year. The results of the Domestic WWTP engineering design are a capacity of 150 m<sup>3</sup> per day, BOD of wastewater average 300 mg / l, SS concentration of 300 mg / l, total processing efficiency of 90-95%, BOD of treated water is 20 mg / l and SS treated water by 20 mg / l. Meanwhile, the distribution of electric power is in the form of MCB 1 phase 6 Amp - 220 Volt with a power of 1122 watts which is used to supply 1 unit of 250 watts of recycler pumps and 4 units of air / blower pumps of 800 watts or a total requirement of 1050 watts. Whereas for the MCB 3 phase 32 Amp - 380 Volt with a power of 17,902,478 watts, it is used to supply 10 units of the pump for collecting tubs of 3500 watts and 1 unit of wastewater pumps of 350 watts or a total requirement of 3,850 watts. It is recommended that the fat filter tub be transported every day so that grease and other impurities do not accumulate. The sewage pipe that is found to have leaks should be repaired immediately and there is a need for fish in the control tub which functions as a control medium as an indicator that the waste treatment process is going well.

**Keywords:** Hospital, Wastewater, Electricity

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## 1. INTRODUCTION

Hospital wastewater is a source of pollutants for the environment that can have a negative impact. Hospital waste can contain various kinds of microorganisms depending on the type of hospital and the level of treatment that is carried out after the waste is disposed of. Hospital wastewater can contain dangerous chemical compounds and contain pathogenic microorganisms that can cause disease and pollute the environment.

Liquid waste is all wastewater generated from all hospital activities and other supporting activities. Liquid waste consists of domestic waste and clinical waste. Domestic wastewater comes from offices, kitchens, bathrooms, and laundry, while clinical wastewater is waste water originating from laboratories, water from washing wounds and blood, and others.

Based on the Decree of the State Minister for the Environment of the Republic of Indonesia Number KEP-58 / MENLH / 12/1995 [1], regarding the quality standards of liquid waste for hospital activities, hospitals are required to provide facilities for managing both liquid and solid waste so that all waste to be discharged into public channels meet the waste quality standards stipulated in accordance with the applicable regulations.

On that basis, it is necessary to have sufficient capacity of the wastewater treatment plant, namely a water structure that functions to treat all waste originating from activities in the hospital. So that the waste to be disposed of into the environment has met existing quality standards and does not cause disturbances to the surrounding environment, but several hospitals already have Wastewater Treatment Plant standards in accordance with the standards so that the waste disposed of into the environment meets the quality standards set. And it is also necessary to study a sufficient and efficient electrical system to supply electricity to the WWTP. The Grati Regional General Hospital is one of the hospitals located in the Pasuruan area and is a class B hospital that produces liquid waste from hospital activities every day. The Grati Regional General Hospital does not have an IPAL system which according to the regulations meets the standards for an IPAL. Therefore, it is necessary to carry out planning and construction of IPAL buildings so that the discharged wastewater meets the requirements of the wastewater discharged from the

hospital. Processing of liquid waste with a combined chemical and biological system requires a long, long processing and relatively expensive processing costs [2].

## 2. Literature Review

### 2.1. Hospital wastewater

Hospital waste is all waste generated by hospital activities and other supporting activities. Hospital waste can contain a variety of microorganisms depending on the type of hospital and the level of treatment performed prior to disposal. Hospital wastewater can contain organic and inorganic materials which are generally measured and the parameters of BOD, COD and TSS. Meanwhile, hospital solid waste consists of perishable waste, infectious waste, etc. These wastes are likely to contain pathogenic microorganisms or hazardous toxic chemicals that cause infectious diseases and can be spread to the hospital environment due to inadequate health care techniques, mishandling of contaminated materials and equipment, and poor sanitation provision and maintenance [3].

The waste produced by the hospital can endanger public health, namely waste in the form of viruses and germs originating from the Virology and Microbiology Laboratory and is difficult to detect. Liquid waste and solid waste originating from the hospital can function as a medium for spreading disturbances or diseases for officers, sufferers, and society. The disturbance can be in the form of air pollution, water pollution, soil pollution, food and beverage pollution [4].

This waste disposal is carried out by sorting waste into various categories. Different types of waste disposal methods apply to each type of category. The general principle of hospital waste disposal is to avoid the risk of contamination and trauma as far as possible

Hospital Liquid Waste is all wastewater including feces originating from hospital activities, which may contain pathogenic microorganisms, toxic materials, and radioactivity as well as blood that is harmful to health [5].

Hospital wastewater is all liquid waste originating from the process of all hospital activities, which includes: domestic liquid waste, which is discharge from the hospital which may contain microorganisms, toxic chemicals and radioactive [6]. Wastewater or used water is water that is not clean and contains various substances that are harmful to human or animal life, which usually arise due to the results of human actions, including industry.

To treat water containing organic compounds, generally using biological wastewater treatment technology or a combination of biological processes with chemical-physical processes. Hospital wastewater treatment is a very important part of the hospital's environmental health efforts which have the aim of protecting the public from environmental pollution. Wastewater that is not handled properly will have a negative impact, especially on health [7]. This biological process can be carried out under aerobic conditions, anaerobic conditions or a combination of anaerobic and aerobic conditions

Aerobic biological processes are usually used for wastewater treatment with a low BOD load, while anaerobic biological processes are used for wastewater treatment with very high BOD loads. In this paper the description focuses on the aerobic wastewater treatment process. Aerobic biological wastewater treatment can be broadly divided into three, namely:

- a. Biological processes with suspended cultures
- b. Biological processes with inherent culture, and
- c. Processing with a lagoon or pond system.

Biological process with suspended culture is a processing system that uses the activity of microorganisms to decompose pollutant compounds in water and the microorganisms used are cultured suspended in a reactor. The treatment process with this system is: standard / conventional activated sludge process, *step aeration*, *contact stabilization*, *extended aeration*, *oxidation ditch* and others

Biological process with inherent culture is a waste treatment process where the micro-organisms used are cultured on a medium so that the microorganisms are attached to the surface of the media. Some examples of wastewater treatment technology in this way include: trickling filter or biofilter, *rotating biological contactor (RBC)*, *contact aeration/oxidation* and others The process of treating wastewater biologically with a lagoon or pond is to collect wastewater in a large pond with a long enough residence time so that with the activity of micro-organisms that grow naturally, the pollutants in the water will break down.

To speed up the process of decomposing pollutants or shortening the residence time, aeration processes can also be carried out. One example of a wastewater treatment process in this way is an

aeration pond or stabilization pond. Processes with the lagoon system are sometimes categorized as biological processes with suspended cultures.

In choosing the type of technology or process to be used for wastewater treatment, several things need to be considered, including the characteristics of wastewater, the amount of waste and the expected quality standards for treated water. The wastewater treatment process technology used to treat hospital wastewater is basically the same as the processing technology for wastewater that contains other organic pollutants. The selection of the type of process used must consider several factors, including the quality of waste and the expected quality of treated water, the amount of wastewater, the available land, and no less important, namely the energy source. Hospital wastewater treatment process technologies that are often used include: activated sludge process, biological rotary reactor, contact aeration process, and biofilter processing "Up Flow", as well as processing with the system "biofilter anaerob-aerob".

## 2.2. Characteristics of wastewater in hospitals

According to Arifin [8] hospital waste is all waste and waste generated by hospital activities and other supporting activities. According to Permenkes RI No.1204 / Menkes / SK / X / 2004 [9], hospital waste is all waste generated from hospital activities in solid, liquid and gas forms. The quantity of liquid waste is calculated based on the use of clean water. The quantity of domestic wastewater is estimated at (60-85)% of domestic clean water use, while non-domestic liquid waste is estimated at (85-95)% of net non-domestic use [10].

Liquid waste is all waste material in liquid form which may contain pathogenic microorganisms, toxic chemicals and radioactivity. According to the Indonesian Ministry of Health [11], wastewater exposure can be distinguished as follows:

- a. Chemical exposure: the results of chemical waste disposal are used by microbes in the water environment as food, other than that chemical waste in water forms a suspension as colloids or particles. Organic materials and inorganic salts enter the water domestically or industrially, generally contributing to water pollution. Chemical water examination used BOD, COD, TSS and pH tests. If about 5 (five) days of chemical waste becomes carbon dioxide, conventionally the organic material undergoes decomposition which stabilizes the organic pollutants in its natural environment. Biological Oxygen Demmand is a measure of the use of oxygen by microorganisms.
- b. Physical exposure: physical exposure to water can be seen from the smell, the color of the wastewater is grayish and contains kerosene.
- c. Biological Exposure: biologically hazardous waste in the presence of endemic pathogenic microorganisms that have an impact on public health.

## 2.3. Liquid waste quality standards

According to the Decree of the Minister of Health of the Republic of Indonesia Number 129 / MENKES / SK / II / 2008 [12] concerning Minimum Hospital Service Standards, it is stated that the types of hospital services that are required at least to be provided by hospitals Regarding waste management, the indicators and standards are as follows:

Table 1. Hospital Waste Quality Standards Based on Ministerial Decree Health of the Republic of Indonesia Number 129 / Menkes / SK / II / 2008

No.	Kind of Service	Indicator	Standard
		Liquid waste quality standards	
1	Waste management		a. BOD < 30 mg/l b. COD < 80 mg/l c. TSS < 30 mg/l d. pH 6 – 9
2		Management of infectious solid waste according to regulations	100%

Source: Decree of the Minister of Health RI Number 129 / Menkes / SK / II / 2008

## 2.4. Electricity Distribution in Wastewater Treatment Plants

In the electricity management at the Wastewater Treatment Plant, it is divided into 2 parts including: Main supply and reserve supply. The main supply of electrical energy is usually supplied by the State Electricity Company and the electricity supply is used if there is a disturbance in the main supply, in this case, a generator is usually used [13].

### 3. METHODOLOGY

#### 3.1 Research Place

For an overview of the research location at the Grati General Hospital which is located in Gratitunon Village, Grati District, Pasuruan Regency, geographically it is located at  $7^{\circ} 30'12.95''$  South Latitude and  $112^{\circ} 30'40.48''$  East Longitude, with an altitude of  $\pm 53$  m above sea level. Grati General Hospital is directly adjacent to: East, West and South bordering rice fields, North bordering settlements.

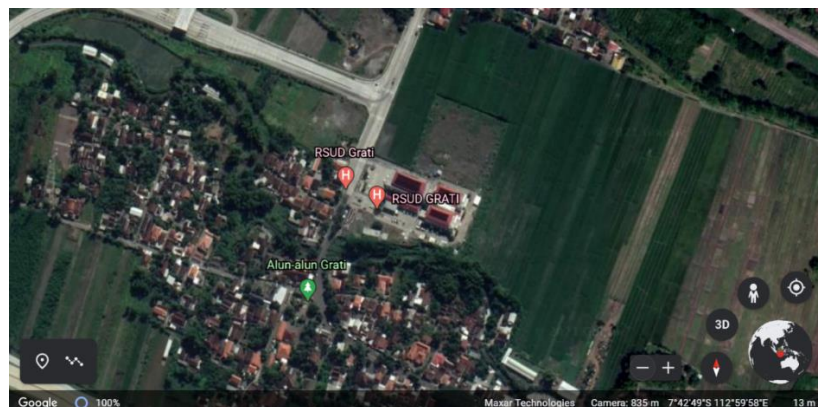


Figure 1. Research Location

#### 3.2 Design of Waste Water Treatment Installation

Data calculation:

- Fat / Oil separator tub
- Equalization Tub / Waste Water Storage Tank
- Sewage Pump
- Initial Settling Tub
- Anaerobic Biofilers
- Aerobic Biofiler
- Final Settling Tub
- Microbial Culture Media
- Circulating Water Pump
- Electrical Power Distribution And Control Panel

#### 3.3 Operation and Maintenance Process of Waste Water Treatment Installation

- WWTP operation
- Air Blower Operation
- Wastewater Pump Operation And Circulation
- Ipal Care

#### 3.4 Calculation Method

- Fat / Oil Separator Tub  
Volume of the separating tub (retention time) / ((60 minutes x 24 hours)) x planned processing capacity
- Equalization Tub or Waste Collection Tub  
Required tank volume: (residence time in trough) / (24 hours) days x planned processing capacity
- Initial Settling Tub  
Required tank volume = (residence time in trough) / (24 hours) x planned treatment capacity
- Retention time average (T) = (dimension of collection tub) / (planned processing capacity) x 24 hours in a day
- Anaerobic biofillers  
BOD load in wastewater = planned treatment capacity x BOD included  
Volume of media required = (BOD load in wastewater) / (BOD load specified)  
Reactor volume required = 100 / Media volume x Volume of media required

Residence Time in Anaerobic Reactors = (Reactor volume required) / (Design processing capacity) x 24 hours / day

f. Aerobic biofiller

BOD load in wastewater = Design Capacity X BOD in

Amount of BOD removed = efficiency x BOD load in wastewater

g. Final settling tub

Required tank volume = (residence time in trough) / (24 hours a day) x Design processing capacity

Average Retention Time = (pool dimension) / (plan processing capacity) x 24 hours / day

Surface load (surface loading) = (plan processing capacity) / (width x length)

#### 4. Results and Discussion

Based on the desired criteria for domestic wastewater treatment, the technology used is a combination anaerobic - aerobic biofilter process.

##### 4.1 Domestic WWTP process design

All wastewater generated from domestic activities, namely kitchen wastewater, bathroom waste water, washing wastewater, sink wastewater, runoff water from septic tanks and other wastewater, all of them are channeled into a fat or oil separator. The fat separator tub functions to separate fats or oils from kitchen activities, as well as to settle sand, soil or solid compounds that cannot be biodegradable.

Furthermore, the runoff from the fat separating tub is channeled to the equalization tank (Sum Pit) which functions as a waste collection basin and flow control basin. The wastewater in the equalization basin is then pumped to the WWTP unit.

In the WWTP unit, first the wastewater is flowed into the initial settling basin, to settle particles of mud, sand and suspended organic impurities. Apart from being a sedimentation tank, it also functions as a sink for decomposing organic compounds in the form of solids, sludge digestion (decomposing sludge) and collecting sludge.

Runoff water from the initial settling basin is then channeled to the anaerobic contactor basin in the direction of flow from top to bottom. Inside the anaerobic contactor tub is filled with special media made of honeycomb type plastic material. The number of anaerobic contactor tub consists of two rooms. The decomposition of organic substances present in wastewater is carried out by anaerobic or facultative aerobic bacteria. After several days of operation, a film of micro-organisms will grow on the surface of the filter media. These micro-organisms will decompose organic substances that have not yet been decomposed in the settling bath.

Wastewater from the anaerobic contactor (biofilter) tank is channeled to the aerobic contactor tank. In this aerobic contactor tub, it is filled with special media made of honeycomb type plastic material, while aerated or blown with air so that the micro-organisms that exist will decompose the organic substances present in the wastewater and grow and stick to the surface of the media. Thus, the wastewater will come into contact with microorganisms that are suspended in the water or attached to the surface of the media, which can increase the efficiency of decomposing organic matter, and speed up the nitrification process, so that the efficiency of removing ammonia is greater. This process is often referred to as Contact Aeration

From the aeration bath, water is drained to the final settling bath. In this basin activated sludge containing micro-organisms is deposited and some of the water is pumped back to the initial settling basin with a sludge circulation pump.

Meanwhile, some of the runoff water (outlet / over flow) is channeled into the tank planted with fish, and the other part is channeled to the chlorination tank / chlorine contactor. In this chlorine contactor bath, the wastewater is contacted with chlorine compounds to kill pathogenic micro-organisms. The addition of chlorine can be done using chlorine tablets or with a chlorine solution supplied via a dosing pump. Processed water, namely water that comes out after the chlorination process, can be discharged directly into rivers or public channels. With the combination of anaerobic and aerobic processes, besides being able to reduce organic substances (BOD, COD), ammonia, suspended solids (SS), phosphate and others can also decrease significantly.

##### 4.2. Domestic technical WWTP design

a. Calculation of Clean Water and Wastewater Discharge

Clean water consumption at the hospital is calculated based on the number of beds, the number of employees, the patient's family, outside patients, and the consumption of clean water for purposes. According to Soufyan M. Noerbambang [14] the consumption of clean water at the hospital is as follows:



net fair:  $500 \text{ L / bed / day} = 500 \text{ L / day} \times 52 \text{ bed} = 26,000 \text{ L / day}$   
 fair net for staff or employees =  $120 \text{ L/person/day} = 120 \text{ L/person / day} \times 53 \text{ people} = 6,360 \text{ L / day}$   
 clean fair for patient's family: average  $160 \text{ L / day}$   
 clean fair for outside patients: average  $8 \text{ L / day}$   
 So the total need for clean water:  $= (26,000 + 6,360 + 160 + 8) \text{ L / day} = 32,528 \text{ L / day}$   
 According to Soufyan M. Noerbambang (2000) the use of clean water at the hospital is only used for ten (10) hours per day. Q clean water for the kitchen, laundry, and others  $18,207 \text{ m}^3 / \text{day}$ .  
 The total need for clean water for hospital activities is  
 $= (26 + 32,528 + 6,36 + 18,207) \text{ m}^3 / \text{day} = 83,095 \text{ m}^3 / \text{day}$ .  
 Wastewater q average =  $70\% \times \text{total keb. Hospital clean water}$   
 $= 70\% \times 83,095 \text{ m}^3 / \text{day} = 58.1665 \text{ m}^3 / \text{day}$ .  
 $Q_{\text{min}}$  of waste water =  $0.5 \times Q \text{ average} = 0.5 \times 58.1665 \text{ m}^3 / \text{day} = 29.08325 \text{ m}^3 / \text{day}$ .  
 $Q_{\text{max}}$  of wastewater =  $2 \times \text{average} = 2 \times 58.1665 \text{ m}^3 / \text{day} = 116,333 \text{ m}^3 / \text{day}$ .

b. Planned Domestic WWTP Capacity

Planned Design Capacity:

Processing capacity:  $150 \text{ m}^3 \text{ per day}$ :  $6.25 \text{ m}^3 \text{ per hour}$ :  $104.17 \text{ liters per minute}$

Wastewater BOD Average:  $300 \text{ mg / l}$

SS concentration:  $300 \text{ mg / l}$

Total Processing Efficiency:  $90\text{-}95\%$

BOD of Processed Water:  $20 \text{ mg / l}$

SS Processed Water:  $20 \text{ mg / l}$

### 4.3 Design Calculations

a. Fat / Oil Separation Tub Design

The planned grease removal bath is of the simple gravity type. The tub consists of two rooms equipped with a bar screen at the inlet.

Processing capacity:  $150 \text{ m}^3 \text{ per day}$ :  $6.25 \text{ m}^3 \text{ per hour}$ :  $104.17 \text{ liters per minute}$

Planning criteria: Retention Time = + 30 minutes.

The volume of the tank required =  $30 / (60 \times 24) \text{ days} \times 150 \text{ m}^3 / \text{day} = 3.125 \text{ m}^3$

Body Dimensions:

Length:  $3.0 \text{ m}$

Width:  $1.2 \text{ m}$

into the water:  $1.0 \text{ m}$

Free Space:  $0.5 \text{ m}$

Effective volume:  $3.6 \text{ m}^3$

Construction: K300 Concrete

Wall thickness:  $20 \text{ cm}$

The design of the oil / fat separator bath is shown in Figure 2 below:

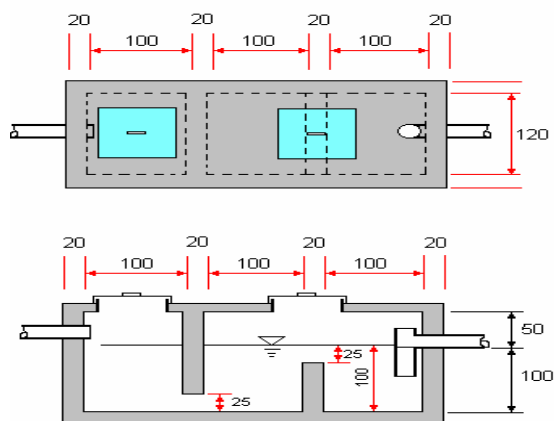


Figure 2. Fat separating tub

b. Design of equalization basins / waste water storage tanks

Time of stay in the tub (HRT) = 4-8 hours

Defined: The residence time in the equalization tank is 5 hours. So,

Volume of trough required:  $5/24 \text{ days} \times 150 \text{ m}^3 / \text{day} = 31.25 \text{ m}^3$

Defined: Body Dimensions:

Body depth: 2.0 m

Tub width: 4.0 m

Tub length: 4, m

Free Space: 0.5 m

Construction: K275 Concrete

Wall thickness: 20 cm

Chek:

Effective volume:  $32 \text{ m}^3$

Dwell time: HRT in the tub = 5.12 hours The design of the equalization bath is shown in Figure 3. Below:

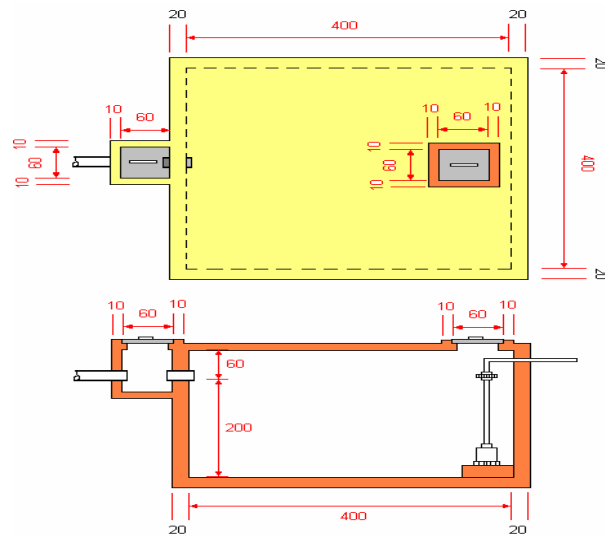


Figure 3. Equalization basin design

#### c. Sewage Pump

Wastewater discharge =  $150 \text{ m}^3 / \text{day} = 6.25 \text{ m}^3 / \text{hour} = 104.17 \text{ liters per minute}$ .

Pump Specifications:

Type: Submersible pump Type Capacity: 40 - 120 liters per minute

Total Head: 5 - 8 m

Electrical output: 120 - 350 watts

Material: Fiber glass and technopolymer Recommended pump:

Brands: Showfou, Pedrollo, HCP or equivalent.

Type: SC0511

Brand: Pedrollo

Type: Top 2

Or an equivalent type

Sewage pump = number of pumps x electricity output

Sewage pump =  $1 \times 350 \text{ watts} = 350 \text{ watts}$

Operates for 8 hours a day, therefore =  $350 \text{ watts} \times 8 = 2800 \text{ wh} = 2.8 \text{ Kwh}$

Therefore, the price of electricity in the area is Rp. 550, - per Kwh then:

=  $2.8 \times 550 = \text{Rp. } 1,540, \text{ - per day}$

Because the waste water pump and the collection tank pump are used the same, then:

Collecting tub pump = number of pumps x electricity output

Pump collecting basin =  $10 \times 350 \text{ watts} = 3,500 \text{ watts}$

Operates for 8 hours a day, therefore =  $3500 \text{ watts} \times 8 = 28000 \text{ wh} = 28 \text{ Kwh}$

Therefore, the price of electricity in the area is Rp. 550, - per Kwh then:

=  $28 \times 550 = \text{Rp. } 15,400, \text{ - per day}$

#### d. Initial Settling Tub

Wastewater Discharge:  $150 \text{ m}^3 / \text{day}$

BOD Inlet:  $300 \text{ mg / l}$

Efficiency: 25%  
 BOD Out: 225 mg / l  
 Time to stay in the tub = 2 - 4 hours  
 The volume of the trough required =  $3/24 \times 150 \text{ m}^3 = 18.75 \text{ m}^3$   
 Dimensions Defined:  
 Width: 4.0 m  
 Effective water depth: 2.0 m  
 Length: 2.5 m  
 Free space height: 0.4 m (adapted to field conditions).  
 Construction: K275 Concrete  
 Wall thickness: 20 cm  
 Chek:  
 Average retention time (T)  
 $T = (4 \text{ m} \times 2.5 \text{ m} \times 2 \text{ m}) / (150 \text{ m}^3 / \text{day}) \times 24 \text{ hours} / \text{day} = 3.2 \text{ hours}$   
 Surface load (surface loading) =  $(50 \text{ m}^3 / \text{day}) / (4 \text{ m} \times 2.5 \text{ m}) = 15 \text{ m}^3 / \text{m}^2 \cdot \text{day}$   
 Residence time at peak load = 1.6 hours (assuming 2 x average amount of waste).  
 The average surface loading =  $15 \text{ m}^3 / \text{m}^2 \cdot \text{day}$   
 Surface load at peak =  $30 \text{ m}^3 / \text{m}^2 \cdot \text{day}$ .  
 Standard: Residence time: 2 - 4 hours.  
 Surface load: 20 - 50  $\text{m}^3 / \text{m}^2 \cdot \text{day}$ . (JWWA)

e. Biofiter Anaerob

BOD Inlet: 225 mg / l  
 Efficiency: 80%  
 BOD Out: 45 mg / l Waste Discharge:  $150 \text{ m}^3 / \text{day}$   
 For water treatment with standard biofilter process BOD load per media volume 0.4 - 4.7 kg BOD /  $\text{m}^3 \cdot \text{day}$ .  
 Determined the load BOD used =  $1.0 \text{ kg BOD} / \text{m}^3 \cdot \text{day}$ .  
 BOD load in wastewater =  $150 \text{ m}^3 / \text{day} \times 225 \text{ g} / \text{m}^3 = 33,750 \text{ g} / \text{day} = 33.75 \text{ kg} / \text{day}$   
 The volume of media required =  $(33.75 \text{ kg} / \text{day}) / (1.0 \text{ kg} / \text{m}^3 \cdot \text{day}) = 33.75 \text{ m}^3$ .  
 Media volume = 60% of total  
 Reaktor volume, Reactor volume required =  $100/60 \times 33.75 \text{ m}^3 = 56.25 \text{ m}^3$   
 Dwell Time in Anaerobic Reactor =  $(56.25 \text{ m}^3) / (150 \text{ m}^3 / \text{day}) \times 24 \text{ hours} / \text{day} = 9 \text{ hours}$   
 Defined dimensions of the Anaerobic Reactor:  
 Dimensions:  
 Width: 4.0 m  
 Effective water depth: 2.0 m  
 Length: 7.0 m  
 Free space height: 0.4 m  
 Effective volume:  $56 \text{ m}^3$   
 Number of spaces: divided into 2 rooms  
 Construction: K300 Concrete  
 Wall thickness: 20 cm  
 Average residence time of anaerobic reactor =  $(56 \text{ m}^3) / (150 \text{ m}^3 / \text{day}) \times 24 \text{ hours} / \text{day} = 9 \text{ hours}$   
 Average residence time: 4.5 hours  
 Mud chamber height: 0.2 m  
 Bed height of microbial culture media: 1.2 m  
 Water height above the media bed: 30 cm  
 Media volume in the anaerobic biofilter:  $1.8 \text{ m}^3$   
 BOD Loading per media volume =  $(33.75 \text{ kg BOD} / \text{day}) / ((4 \times 7 \times 1.2) \text{ m}^3) = 1.0 \text{ Kg BOD} / \text{m}^3 \cdot \text{day}$   
 Standard high rate trickling filter: 0.4 - 4.7 kg BOD /  $\text{m}^2 \cdot \text{day}$ . (Ebie Kunio, 1995)  
 If the media used has a specific area of +  $150 \text{ m}^2 / \text{m}^3$  of media, then:  
 Loading BOD per surface area of media =  $6.0 \text{ gr BOD} / \text{m}^2 \text{ per day}$

f. Biofiter Aerob

Waste Discharge:  $150 \text{ m}^3 / \text{day}$   
 BOD In: 45 mg / l  
 Efficiency: 60%



BOD Out: 18 mg / l

BOD load in wastewater =  $150 \text{ m}^3 / \text{day} \times 45 \text{ g} / \text{m}^3 = 6,750 \text{ g} / \text{day} = 6.75 \text{ kg} / \text{day}$

The amount of BOD removed =  $0.6 \times 6.75 \text{ kg} / \text{day} = 4.05 \text{ kg} / \text{day}$

BOD load per volume of media used =  $0.5 \text{ kg} / \text{m}^3 \cdot \text{day}$ .

Volume of media required =  $(6.75 / 0.5) = 13.5 \text{ m}^3$

Volume of media = 40% of Reactor Volume

Volume of Aerobic Biofilter Reactor Required =  $100/40 \times 13.5 \text{ m}^3 = 33.75 \text{ m}^3$

Aerob Biofilter consists of two rooms, namely an aeration room and a Media bed room.

Aerobic Biofilter Reactor Dimensions:

1. Aeration Room:

Width: 4.0 m

Effective water depth: 2.0 m

Length: 2.0 m

Free space height: 0.4 m

2. Media Bed Room:

Width: 4.0 m

Effective water depth: 2.0 m

Length: 2.4 m

Free space height: 0.4 m

Total Effective Aerobic Biofilter Volume =  $4 \text{ m} \times 4.4 \text{ m} \times 2 \text{ m} = 35.2 \text{ m}^3$

Construction: K275 Concrete

Wall thickness: 20 cm

Chek:

Average total residence time =  $(35.2 / 150) \times 24 \text{ hours} = 5.6 \text{ hours}$

Total residence time at peak load: 2.8 hours

Mud chamber height: 0.5 m

Bed height for microbial culture media: 1.5 m

The total volume of media in the aerobic biofilter =  $4 \text{ m} \times 2.4 \text{ m} \times 1.5 \text{ m} = 14.4 \text{ m}^3$ .

Chek:

BOD Loading per media volume =  $(6.75 / 14.4) = 0.47 \text{ Kg BOD} / \text{m}^3 \cdot \text{day}$ .

Standard high rate trickling filter: 0.4 - 4.7 kg BOD / m<sup>2</sup>·day.

If the media used has a specific area of 150 m<sup>2</sup> / m<sup>3</sup>, then,

Loading BOD = 3.13 g BOD / m<sup>2</sup> media area per day.

Oxygen Requirement:

The oxygen demand in the aerobic biofilter reactor is proportional to the amount of BOD removed.

So: theoretical requirement = amount of BOD removed = 4.05 kg / day.

The safety factor is set to + 2.0

Theoretical Oxygen Needs =  $2 \times 4.05 \text{ kg} / \text{day} = 8.1 \text{ kg} / \text{day}$ .

Average air temperature = 28 o C

Air weight at 28 o C = 1.1725 kg / m<sup>3</sup>.

It is assumed that the amount of oxygen in the air is 23.2%.

So: Total Theoretical Air Requirements =  $(8.1 \text{ kg} / \text{day}) / (1.1725 \text{ kg} / \text{m}^3 \times 0.232 \text{ g O}_2 / \text{g Air}) = 29.8 \text{ m}^3 / \text{day}$

Diffuser Efficiency = 3%

Actual Air Requirement =  $(29.8 \text{ m}^3 / \text{day}) / 0.05 = 596 \text{ m}^3 / \text{day} = 0.41 \text{ m}^3 / \text{minute} = 410 \text{ liters} / \text{minute}$ .

Air Blower Required:

Blower Specifications:

Type: HIBLOW 200

Blower capacity: 200 liters / minute

Head: 2000 mm-aqua (2 meters)

Quantity: 4 units

Power: 200 watts X 4 = 800 watts

Outlet pipe: ½ Inc.

Electrical: 1 phase

Air diffuser:

Total air transfer = 800 liters / minute

Diffuser type used: Perforated Pipe Diffuser or equivalent (disc shape diffuser etc).

Air pump / blower = number of blowers x power output

Air pump / blower = 4 x 200 watts = 800 watts  
 Operating 24 hours a day = 800 watts x 24 = 19200 wh = 19.2 Kwh  
 Therefore, the price of electricity in the area is Rp. 550, - per Kwh then:= 19.2 x 550 = IDR 10,560 per day

g. Final Settling Tub

Waste Discharge: 150 m<sup>3</sup> / day  
 BOD Inlet: 18 mg / l  
 BOD Out: 18 mg / l  
 Time to stay in the tub = 2 - 4 hours  
 The volume of the trough required =  $\frac{3}{24} \times 150 \text{ m}^3 = 18.75 \text{ m}^3$   
 Dimensions:  
 Width: 4.0 m  
 Effective water depth: 2.0 m  
 Length: 2.5 m  
 Free space height: 0.4 m (adapted to field conditions).  
 Construction: K275 Concrete  
 Wall thickness: 20 cm  
 Chek:  
 Average Retention Time =  $(4 \text{ m} \times 2.5 \text{ m} \times 2 \text{ m}) / (150 \text{ m}^3 / \text{day}) \times 24 \text{ hours} / \text{day} = 3.2 \text{ hours}$   
 Surface loading (surface loading) =  $(150 \text{ m}^3 / \text{day}) / (4 \text{ m} \times 2.5 \text{ m}) = 15 \text{ m}^3 / \text{m}^2 \cdot \text{day}$   
 Residence time at peak load = 1.6 hours (assuming 2 x average amount of waste).  
 The average surface loading =  $15 \text{ m}^3 / \text{m}^2 \cdot \text{day}$   
 Surface load at peak =  $30 \text{ m}^3 / \text{m}^2 \cdot \text{day}$ .  
 Standard: Residence time = 2 - 4 hours  
 Surface load = 20 - 50 m<sup>3</sup> / m<sup>2</sup> · day. (JWWA)

h. Microbial Culture Media

The biofilter media used is a medium made of plastic material that is light, durable, has a large specific area, is light and has a large volume of cavities so that the risk of media deadlock is very small.

Biofilter media specifications used:

Material: PVC sheet  
 Module Size: 25 cm x 30 cm x 30 cm  
 Thickness: 0.15 - 0.23 mm  
 Specific Contact Area: 150 m<sup>2</sup> / m<sup>3</sup>  
 Hole diameter: 3 cm x 3 cm  
 Color: clear transparent.  
 Specific Weight: 30-35 kg / m<sup>3</sup>  
 Cavity Porosity: 0.98  
 The total amount of media needed = 24 m<sup>3</sup> + 7.2 m<sup>3</sup> = 31.2 m<sup>3</sup>

i. Circulating Water Pump

Hydraulic Circulation Ratio (Hydraulic Recycle Ratio, HRR) = 0.25–0.5

Circulation Rate: 37.5 - 75 liters per minute

Pump Specifications:

Type: Submersible Pump

Capacity: 37.5 - 75 liters per minute

Total Head: 5-6 meters

Quantity: 2 pieces (one for spare)

Electricity: 250 watts, 220-240 volts

Recommended pump:

Brand: Grundfos

Type: KP.150 Automatic or an equivalent type

From this, then:

Circulating water pumps = number of pumps x power output

Circulating water pump = 1 x 250 watts = 250 watts

Operates 24 hours a day, therefore = 250 watts x 24 = 6000 wh = 6 Kwh

Therefore, the price of electricity in the area is Rp. 550, - per Kwh then:

$$= 6 \times 550 = \text{Rp. } 3,300, - \text{ per day}$$

#### 4.4 Power Distribution And Control Panel

The distribution of electricity at the wastewater treatment plant is as follows:

a. MCB 1 phase 6 Amp - 220 Volt

$$\text{So } P = V \times I \times \cos\phi = 220 \text{ volts} \times 1 \text{ ampere} \times 0.85 = 187 \text{ watts}$$

$$\text{Then } P = V \times I = 220 \text{ volts} \times 6 \text{ amperes} = 1122 \text{ watts}$$

Used to supply on:

1 unit recycler pump of 250 watts

Air pump / blower 4 units of 800 watts

So the total requirement is 1050 watts, then the MCB 1 phase 6 Amp - 220 Volt can be used.

b. MCB 3 phase 32 Amp - 380 Volt

$$\text{So } P = V \times I \times \cos\phi \times \sqrt{3} = 380 \text{ Volt} \times 1 \text{ ampere} \times 0.85 \times \sqrt{3} = 559.46$$

$$\text{Then } P = V \times I \times \cos\phi \times \sqrt{3} = 380 \text{ Volt} \times 32 \text{ amperes} \times 0.85 \times \sqrt{3} = 17,902.478 \text{ watts}$$

Used to supply on:

Pump collecting tanks as many as 10 units of 3500 watts

1 unit of wastewater pump of 350 watts

So the total requirement is 3850 watts, then MCB 3 Phase 32 Amp - 380 Volt can be used.

#### 5. Conclusion

Based on the results of the study on the wastewater treatment plant and the distribution of electricity, it can be concluded that the following are

1. Result of Domestic WWTP Process Design:

Before the WWTP is operated, all mechanical and electrical equipment must be ensured that they are in good working order and that the process flow is as follows: Wastewater originating from domestic activities is discharged into a waste water collection basin or equalization tank; The discharge of the waste water pump is regulated according to the WWTP capacity, which is 150 m<sup>3</sup> per day; When the WWTP was first operated, the tank for the WWTP, namely the anaerobic biofilter reactor, the aerobic biofilter reactor had to be completely filled with wastewater.; After that, the aeration process and the process of circulating water from the final settling bath to the initial settling tank in the aerobic reactor are carried out.; The process of microbial culture is carried out naturally because the domestic waste water contains microbes that can break down existing pollutants; Breeding takes about 4-8 weeks; Physical microbial growth can be seen from the presence of a layer of mucus or biofilm attached to the surface of the media; After two months of operation, it is necessary to check the quality of the wastewater to determine the efficiency of treatment at least 2 times a year.; The WWTP units that have been installed are not yet equipped with a sludge drying basin, the sludge is drained periodically and discharged to a dirty water treatment plant. Draining the sludge in the equalization basin is carried out at least once a year.

2. Result of Domestic Ipal Engineering Design:

Domestic ipal capacity: 150 m<sup>3</sup> per day

Wastewater BOD Average: 300 mg / l

SS concentration: 300 mg / l

Total Processing Efficiency: 90-95%

BOD of Processed Water: 20 mg / l

SS Processed Water: 20 mg / l

3. Electric Power Distribution

a. MCB 1 phase 6 Amp - 220 Volt or Power = 1122 watts

Used to supply on:

1 unit recycler pump of 250 watts

Air pump / blower 4 units of 800 watts

So the total requirement is 1050 watts < 1122 watts

b. MCB 3 phase 32 Amp - 380 Volt or Power = 17,902,478 watts

Used to supply on:

Pump collecting tanks as many as 10 units of 3500 watts

1 unit of wastewater pump of 350 watts

#### 6. Suggestion

a. So We recommend that you transport the fat filter tub every day so that fat and other impurities do not accumulate.

- b. Any sewage pipeline that has a leak should be repaired immediately.
- c. There is a need for fish in the control tub which functions as a control medium as an indicator that the waste treatment process is going well. the total requirement is 3,850 watts < 17,902,478 watts

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