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Study of Industrial Black Water Treatment Plant Installation Planning System Based on Sewage Treatment Plant

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Abstract

Wastewater in general is water, in general, is a liquid that comes from households, industries, or other public places that usually contain materials or substances that can endanger human life and disturb the environment. Quid comes from households, industries, or other public places that usually contain materials or substances that can endanger human life and disturb the environment. This study to plan, analyze, and assess the performance conditions of wastewater treatment plants (IPAL) at PT XYZ Bekasi Regency on environmental quality standards. Data and information used are data on the amount of wastewater, sources of wastewater, and behavior of water use as well as secondary data in the form of data that the authors surveyed directly at the research location. The processing method of the output value of WWTP uses the research method of the laboratories from the research method in which the output value exceeds the quality standard of LHK Regulation No. 68 the Year 2016 and has exceeded its planning capacity. And what is identified is not safe. An alternative solution to the problem of unsafe output values is by planning a new wastewater treatment plant.

Keywords

Waste Water Treatment Plant, Black Water, Sewage Treatment Plant

1. Introduction

Wastewater or waste water is residual water that is discharged from households, industries and other public places, and in general contains materials or substances that can be harmful to human health and disturb the environment. Another limitation says that wastewater is a combination of liquid and liquid waste that comes from residential, commercial, office and industrial areas together with ground water, surface water, and rainwater that may be present. (Notoatmodjo, 2003).

Bekasi Regency as an industrial city shows serious symptoms regarding environmental problems originating from industry and housing activities. Every day industrial discharges which show an increase based on the correlation of the growth of factories in the Bekasi district this condition can damage the environment resulting in a decrease in the level of health of the population around the industry.

At PT XYZ in Bekasi district is a company engaged in the manufacturing sector with an actual human resource of 279 in the January 2020 data value of the output at the wastewater treatment plant exceeds the quality standard of LHK candy no 68 in 2016, while the number of projected data sources maximum human power of 315 people.

Based on the explanation above, the problem in this final project is the incomplete value of the output of the existing wastewater treatment plant according to the LHK Permen quality standard No. 68 year 2016 with the condition that the amount of human resources has not been maximally projected.

2. Methodology

The type of research used is analyzing by observing the laboratory method with the aim to determine the effectiveness of Waste Water Treatment Plant (WTP) based on Industrial WTP in Industry and for planning a Waste Water Treatment Plant based Sewage Treatment Plant (STP) in Industry.

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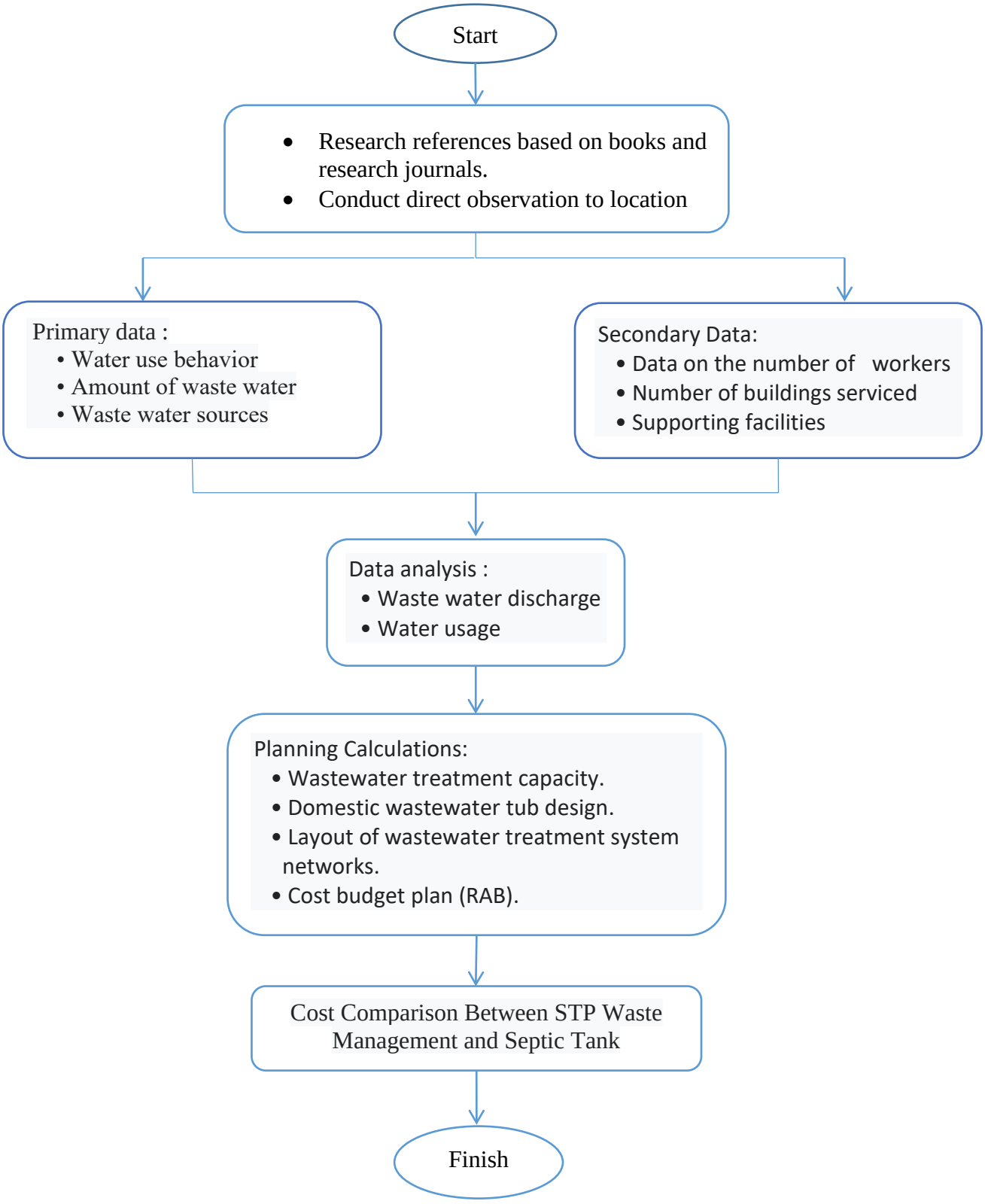

Picture 1 Flowchart of research procedure

2.1 Research Location and Time

The research location is at PT XYZ MM2100 industrial area, West Cikarang District, Bekasi Regency. And the time of the study was conducted in September 2019 - January 2020.

2.2 Study Literatur

Literature or reference materials used in this thesis include:

- Metcalg and Eddy, 2003, Wastewater Engineering Treatment and Reuse, McGraw
- Suharto, 2011, Limbah Kimia Dalam Pencemaran Udara dan Air, Andi Yogyakarta, Yogyakarta
- Kusnoputranto, Haryoto, 1985, Kesehatan Lingkungan, FKM UI, Jakarta
- Tchobanoglous, G, 1985, Teknik Sumber Daya Air, Terjemahan oleh Djoko Sasongko, 1991, Erlangga, Jakarta

2.3 Research Location Survey

a) Primary data :

Sources of liquid waste
Liquid waste discharge
Water use behavior

b) Sekuder data

Data on the number of workers
Number of buildings served
Supporting facilities

2.4 Data analysis

The collected data is then analyzed descriptively as follows:
Planning a domestic wastewater treatment system
Calculate the discharge of wastewater per day / m3

2.5 Domestic Wastewater Treatment System Design

Wastewater tub design
Layout of wastewater treatment system networks
Cost budget plan (RAB)

2.6 Cost Comparison Between Sewage Treatment Plant and Septic Tank Waste Management

Waste water treatment plant construction
Area of land used
Construction time
Total cost

2.7 Conclusions and recommendations

3. Result and Analysis

3.1 Water use behavior

The survey was conducted to find out the behavior of water in daily life which will be input to the wastewater treatment plant in the table below:

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Table 1. Water use behavior

Time	Use
0.00 - 1.00	Empty
1.00 - 2.00	Empty
2.00 - 3.00	Empty
3.00 - 4.00	Prayer
5.00 - 6.00	Prayer
6.00 - 7.00	Toilet
7.00 - 8.00	Empty
8.00 - 9.00	Toilet
9.00 - 10.00	Empty
10.00 - 11.00	Break
11.00 - 12.00	Empty
12.00 - 13.00	Break + Prayer
13.00 - 14.00	Prayer
14.00 - 15.00	Toilet
15:00 - 16:00	Prayer
16.00 - 17.00	Prayer
17.00 - 18.00	Break + Prayer
18.00 - 19.00	Break + Prayer
19.00 - 20.00	Prayer
20.00 - 21.00	Prayer
21.00 - 22.00	Empty
22.00 - 23.00	Toilet
23.00 - 24.00	Empty

Source: Survey results

3.2 Source of Wastewater and Amount of Wastewater

The mapping of wastewater sources at PT XYZ in Bekasi Regency aims to find out what inputs will be input at the wastewater treatment plant, in the table below:

Table 2. Waste Water Source

NO	AREA	WASTE WATER SOURCE	AMOUNT	INFORMATION
1	Workshop	WC	10	Active
2		Urine	7	Active
3		Floor Drain	11	Active
4		Washtaple	6	Active
5	Production Proses	WC	5	Active
6		Urine	5	Active
7		Floor Drain	7	Active
8		Washtaple	5	Active

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9	Production Fillpack	WC	6	Active
10		Urine	3	Active
11		Floor Drain	8	Active
12		Washtaple	6	Active
13	Mushola	WC	2	Active
14		Urine	-	Active
15		Floor Drain	1	Active
16		Washtaple	2	Active
17	Loker	WC	3	Active
18		Urine	2	Active
19		Floor Drain	3	Active
20		Washtaple	5	Active
21	Cateen	Washtaple Cleaning Area	3	Active
22	Loker	Washtaple Pantry	1	Active

3.3 Number of Workers Data

a. Number of Actual Workers

Data on the number of human resources as a reference to determine the dimensions of the body that will be planned at the waste water treatment plant (IPAL) based on Sewage Treatment Plant in the table below:

Table 3. Number of actual workers

JAM KERJA	JUMLAH PEGAWAI (orang)	AIR LIMBAH DIHASILKAN (m3/hari)
Produksi Fillpack	214	17,1
Produksi Proses	47	3,76
Enginering	18	1,44
Minimum		1,44
Maksimal		17,1
Debit per day		22,3

Source: PT XYZ work schedule

b. Maximum Projection Number of Workers Data

Data on the number of human resources as a reference to determine the dimensions of the body that will be planned at the waste water treatment plant (IPAL) based on Sewage Treatment Plant in the table below:

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Table 4. Maximum projection number of wokers data

WORKING HOURS	NUMBER OF EMPLOYEES (PEOPLE)	WASTE WATER PRODUCED (m3/day)
Shift 1	120	9,6
Non Shift	60	4,8
Shift 2	100	8
Shift 3	35	2,8
Minimum		2,8
Maksimal		9,6
Debit per day		25.2

Source: Human Resource department projection data

The capacity of domestic wastewater produced by PT XYZ, as a reference to determine the dimensions of the wastewater treatment tank to be planned. Wastewater produced is related to clean water that is used for daily needs.

Total human resources = 315 person
Liquid waste = 80 liter/person/day
Total liquid waste = Total SDM × liquid waste per person
= 315 person × 80 liter/person/day
= 25.200 liter/day → 25,2 m^3/day
Total waste water treatment capacity = 25.200 liter + (15% × 25.200 liter)
= 30.000 liter/day → 30 m^3/day

3.4 Calculation of Waste Water Treatment Plant Installation Planning Based on Sewage Treatment Plant

3.4.1 Screening

Wastewater discharge(Q) = 30 m3/day
BOD in = 350 mg/l
BOD ef = 315 mg/l
Efficiency = 10 %
Hours running time = 1,5 jam
Tub volume required = Q in x HRT

$$= \frac{1{,}5\ \text{h}}{24\ \text{h}} \times 30\ \text{m}^3/\text{day}$$

$$= 1{,}875\ \text{m}^3/\text{day}$$

After knowing the volume value, the dimensions can be determined according to the volume as follows:
High = 1,45 m
Long = 0,7 m
Wide = 1,8 m
Freeboard = 0,3 m
Check HRT averge :

$$T = \frac{P \times L \times T}{Q} \times 24\ \text{h/day}$$

$$T = \frac{0{,}7\ \text{m} \times 1{,}8\ \text{m} \times 1{,}45\ \text{m}}{30\ \text{m}^3/\text{day}} \times 24\ h/\text{day}$$

$$T = 1{,}4616\ \text{hours}$$

Check Surface Loading :

$$\text{Surface loading} = \frac{Q}{L \times P}$$

Surface loading $= \frac{30\ m^3/day}{1{,}8\ m \times 0{,}7\ m} = 23{,}8\ m^3/day$

Surface loading $20 - 50\ m^3/m^2.hari$ (JWWA)

3.4.2 Biofilter Anaerob

Q = $30\ m^3/day$

BOD in = 315 mg/l → $0{,}315\ kg/m^3$

BOD ef = 126 mg/l → $0{,}126\ kg/m^3$

Efficiency = 40 %

For water treatment using a standard biofilter process, the BOD load per volume of media 0,4 – 4,7 kg $BOD/m^3.day$

Determined the BOD load used : 4,7 kg $\frac{BOD}{m^3}.day$

BOD load in waste water

$BOD\ load = Q \times BOD\ in$

$BOD\ load = 30\ m^3/day \times 0{,}315\ kg/m^3$

$BOD\ load = 9{,}45\ kg/day$

Media voluume required

$V = \frac{BOD\ load}{Standart\ BOD\ load}$

$V = \frac{9{,}45\ kg/day}{4{,}7\ \frac{kg}{m^3}.day} = 2\ m^3$

Volume media = 40 % of the total reactor volume

Reactor volume required

$V = \frac{100}{V\ media\ reaktor} \times V\ media$

$V = \frac{100}{40} \times 2\ m^3 = 5\ m^3$

The residence time in the Anerob reactor

$T = \frac{V\ reaktor}{Q}$

$T = \frac{5\ m^3}{1{,}25\ kg/day} = 4\ hours$

After knowing the volume value, the dimensions can be determined according to the volume as follows:

Effective depth = 1,45 m

Media high = 0,6 m

High space above the media = 0,3 m

High space sludge = 0,3 m

Long = 2 m

Wide = 1,75 m

Freeboard = 0,3 m

Effective volueme = $5\ m^3$

Check the residence time in the Anaerobic reactor:

$T = \frac{V\ reaktor}{Q} \times 24\ h/d$

$T = \frac{5\ m^3}{30\ m^3/day} \times 24\ h/d = 4\ hours$

3.4.4 Bio Filter Aerob

Q = 30 m3/day

BOD in = 126 mg/l → $0{,}126\ kg/m^3$

BOD ef = 50,4 mg/l → $0{,}0504\ kg/m^3$

Efficiency = 40 %

BOD load in waste water

$\text{BOD load} = \text{Q} \times \text{BOD in}$
$\text{BOD load} = 30\ \text{m}^3/\text{hari} \times 0{,}126\ \text{kg/m}^3$
$\text{BOD load} = 3{,}78\ \text{kg/day}$

The amount of BOD removed

$$\text{BOD removed} = \frac{\text{Efficiency}}{100} \times \text{BOD load}$$

$$\text{BOD removed} = \frac{40}{100} \times 3{,}78\ \text{kg/day}$$

$\text{BOD removed} = 1{,}51\ \text{kg/day}$
BOD load per media volume = 4 kg BOD/m3.day
Media volume required

$$\text{V media} = \frac{\text{BOD load waste water}}{\text{BOD load per Volume}}$$

$$\text{V media} = \frac{3{,}78\ \text{kg/day}}{4\ \text{kg/m}^3\text{day}} = 0{,}94\ \text{m}^3$$

Volume media = 40% from the reactor volume

$$\text{Volume reaktor} = \frac{100}{40} \times \text{V media}$$

$$\text{Volume reaktor} = \frac{100}{40} \times 0{,}94\ \text{m}^3 = 2{,}35\ \text{m}^3$$

Time of residence required by HRT

$$\text{T} = \frac{\text{V reaktor}}{\text{Q}}$$

$$\text{T} = \frac{2{,}35\ \text{m}^3}{1{,}25\ \text{m}^3/\text{hours}} = 1{,}88\ \text{hours}$$

After knowing the volume value, the dimensions can be determined according to the volume as follows:

Effective depth = 1,45 m
Media high = 0,58 m
High space above the media = 0,3 m
High space sludge = 0,57 m
Long = 0,93 m
Wide = 1,75 m
Freeboard = 0,3 m
Check the residence time in the Aerobic reactor:

$$\text{T} = \frac{\text{V reaktor}}{\text{Q}} \times 24\ \text{h/day}$$

$$\text{T} = \frac{2{,}35\ \text{m}^3}{30\ \text{m}^3/\text{day}} \times 24\frac{\text{hours}}{\text{day}} = 1{,}88\ \text{hours}$$

3.4.5 Final settling tub
Q = 32,8 m3/day
BOD in = 50,4 mg/l → $0{,}05\ \text{kg/m}^3$
BOD ef = 47,88 mg/l → $0{,}0478\ \text{kg/m}^3$
Efficiency = 5%
Hours running time 1,5 hours – 2 hours, and HRT used 1,5 hours
Tub volume required

$$\text{V} = \frac{\text{HRT}}{24\ \text{h}} \times \text{Q}$$

$$\text{V} = \frac{1{,}5\ \text{h}}{24\ \text{h}} \times 1{,}366\ \text{m}^3 =$$

After knowing the volume value, the dimensions can be determined according to the volume as follows:

Wide = 1,8 m

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Effective depth = 1,45 m
Long = 0,8 m
Freeboard = 0,3 m

3.4.6 Budget Plan (RAB)

Development costs in waste water treatment plant (WWTP) based on Sewage Treatment Plant (STP) in the table below

Table 5. Budget plan

NO.	JOB DESCRIPTION	SPESIFIKASI	UNIT	VOLUME	UNIT PRICE Rp.	TOTAL PRICE Rp.	TOTAL PRICE Rp.
I.	Prepare work						
1	Mobilization and demobilization	Mob demob material dan the worker	ls	1,000	2.000.000,00	2.000.000,00	
2	Working aids and scalfolding	APD dan scafolding	ls	1,000	2.000.000,00	2.000.000,00	
3	Clean the work area	Clean the work area	ls	1,000	1.500.000,00	1.500.000,00	
						5.500.000,00	5.500.000,00
II	Foundation work						
1	Install begesting around the foundation	Mutilpek 9mm kaso	m2	7,98	250.000,00	1.995.000,00	
2	Attach the reinforcing iron	wiremesh M10 double layer	m2	33,00	290.000,00	9.570.000,00	
3	Concrete foundation	Readymix K 300	m3	9,90	1.100.000,00	10.890.000,00	
4	Unload begesting	Unloading and tidying	m2	7,98	50.000,00	399.000,00	
5	Concrete begesting	Finishing	m2	41,34	20.000,00	826.800,00	
						23.680.800,00	23.680.800,00
III	PUMP HOUSE						
1	Install hebel bricks	hebelblock 7x20x600	m2	4,50	125.000,00	562.500,00	
2	Practical concrete	Sitemix, tul 10,8mm	m1	9,00	150.000,00	1.350.000,00	
3	Aci plester	Mortal Drymix	m2	9,00	90.000,00	810.000,00	
4	Install the roof	zincalume	m2				

5	Wall paint	0.35 Jotashield	m2	4,000 9,000	250.000,00 60.000,00	1.000.000,00 540.000,00	
						4.262.500,00	4.262.500,00
IV	UNLOADING TANk						
1	Procurement of forklifts	forklif 7 ton	unit	1,000	5.000.000,00	5.000.000,00	
						5.000.000,00	5.000.000,00
V	STP System Capacity 30 m3/day		unit	1,000	200.000.000,00	200.000.000,00	
1	Honey comb, bio ball aeration and circulation piping, blowers, effluent pumps , installations, control panels					200.000.000,00	200.000.000,00
Total							238.443.300,00
							238.400.000,00

4. Conclusion

From the results of the field survey and analysis the conclusions obtained are:

1. Domestic wastewater discharge generated by PT XYZ with projected human resource data is a maximum of 25.5 m ^ 3 / day or 25,500 liters / day.
2. The domestic wastewater treatment system used is a centralized system
3. From the results of the calculation can be the size of the Wastewater Treatment Plant (IPAL) based on Sewage Treatment Plant (STP) that is = 2000 mm × 6500 mm
4. This Wastewater Treatment Plant (IPAL) serves 315 employees.
5. The planning process of this Waste Water Treatment Plant (WWTP) amounts to Rp. 238,443,300.00.

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6. Biography

Ridi Nurardiansyah is the name of the author of this journal. The author was born in Tangerang on February 24, 1997. The writer studied at SDN Balaraja 3 (graduated in 2009), went on to Setu Bekasi 4 Junior High School (graduated in 2012), and Bekasi MM2100 Bekasi Industrial Vocational School (graduated in 2015), and the University Mercu Buana was finally able to take a period of study at the Faculty of Civil Engineering.