DOMESTIC COMMUNAL WASTEWATER TREATMENT PLANT EVALUATION
IN SINDANGRASA, BOGOR, INDONESIA

Purnomosutji Dyah Prinajati1*

1) Department of Environmental Engineering, Universitas Sahid, Indonesia

Abstract

The communal domestic wastewater treatment plant functions to collect and treat domestic wastewater at the source location according to the communal scale treatment capacity. The communal Wastewater Treatment Plant (WWTP) in RT (neighborhood association) 01 / RW (citizen association) 09 Sindangrasa was built in 2016 using the Anaerobic Baffled Reactor (ABR) system. This study aims to evaluate the Communal WWTP by analyzing the quality of wastewater compared to PerMenLH No. 68 of 2016, calculates the processing efficiency and analyzes the water quality of the community wells around the Communal WWTP compared to regulation of PerMenKes No.416/MENKES/PER/IX/1990. Data collection techniques using the Slovin technique in the pre-research stage, direct sampling on location and testing in an accredited laboratory. The results showed the quality of wastewater exceeds the quality standard for BOD, TSS and Total Coliform parameters, the quality of residents' well water exceeds the quality standard for parameters pH, Cr VI and Total Coliform. Communal WWTPs in RT 01/ RW 09 Sindangrasa have not been efficient in treating residents' domestic wastewater. The management of Communal WWTPs needs to be improved so that the effluent quality and processing efficiency values meet the specified regulatory standards.

Keywords: domestic wastewater, evaluation, WWTP

Introduction

Along with the increase in population, the opportunity for environmental problems also increases, especially the impact caused by the disposal of both liquid and solid waste. The results of the national statistical analysis showed that as much as 67.89% of households had access to proper sanitation, but the proportion of households that still discharged domestic wastewater into sewers/ drainage channels reached 32.11%. Problems that dominate and the majority derives from household waste.

Sindangrasa village has a high population density and high sanitation hazard conditions for the RT (neighborhood association) 01/ RW (citizen association) 09 area in the Ciliwung River Basin, so that a good sanitation system is needed. Communal-based Wastewater Treatment Plant (WWTP) in RT 01/ RW 09 Sindangrasa was built to treat domestic wastewater in the form of feces and waste from

*Corresponding Author:
E-mail: iinsoekandar@gmail.com

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the bathroom by installing house connections to
the sewage treatment plant.

Water treatment is carried out centrally so that
the quality of treated water is safe for the
environment. After the communal WWTP on
RT 01/ RW 09 has been operating for 2 years,
residents have begun to feel the negative impact
of the construction of domestic wastewater
treatment plants in RT 01/ RW 09. Smells
around the area of the processing unit appear
and disturb the comfort of local residents. The
existence of a communal domestic wastewater
treatment plant also pollutes the clean water
wells of residents which are located quite close
to the treatment unit. If left unchecked and not
handled, it is feared that it will interfere with the
health of local residents. Ineffective treatment
and inconsistent maintenance of installations are
the most likely causes of these negative impacts
(Chandra, 2012), so it is necessary to evaluate
the communal domestic wastewater treatment
plant in Sindangrasa by analyzing wastewater
quality compared to the Minister of
Environment and Forestry Regulation No. 68 of
2016 concerning the quality standards of
domestic wastewater, calculates the treatment
efficiency and conducts an analysis of the
quality of the well water of residents around the
processing unit in accordance with Regulation of
the Minister of Health No.416/MENKES/PER/
IX/1990 to determine the effect of treatment
results on the issue of contamination that occurs.

Research Methodology

This research is a descriptive method through
qualitative and quantitative analysis. The study
was conducted at Communal WWTP RT 01/
RW 09 Sindangrasa Sub-District, East Bogor
District which has a high population density
with residential areas in the Ciliwung River
Basin.

The study was conducted using the Slovin
technique at the pre-research stage, water
sampling using the grab sampling method which
was then analyzed in an accredited laboratory at
the research stage in order to obtain reliable
results. The percentage of pollutant allowance is
calculated based on inlet and outlet quality data
which will then be compared in value to
determine the efficiency of the processing unit.

This study is using primary data and secondary
data. Primary data were obtained from
observations in the pre-study, results of testing
wastewater samples at the inlet and outlet,
results of testing surface water samples at
receiving water bodies treated from WWTP,
results of testing the quality of clean water of
residents around the study site and analysis of
processing efficiency data. Meanwhile,
secondary data was obtained from a literature
study from KSM (Group of Community) Melati
as the caretaker and person in charge of
communal WWTP in RT 01/ RW 09, applicable
standards and regulations (Direktorat Jenderal
Bina Upaya Kesehatan Kementerian Kesehatan
Republik Indonesia, 2011), (Iskandar et.al,
2016), previous research, references (MetCalf &
Eddy, 2003) and journal papers with similar
research topic (Dian et.al, 2016)

Result and Discussion

Physical Analysis on Unit of Communal WWTP

The communal wastewater treatment plant in RT
01/ RW 09 Sindangrasa uses an anaerobic
baffled reactor treatment system equipped with
filters, Sindangrasa Communal WWTP capacity
and 48 KK beneficiaries. The Melati KSM
management structure responsible for
maintaining the communal WWTP consists of 6
people. The survey was conducted on the
surrounding residents and management,
maintenance carried out at the communal
WWTP for 2 years of operation that is checking
the control basin so that no material is clogged
and mud drainage has never been carried out and
monitoring the quality of treated wastewater
entering the receiving water body. The
evaluation of the Communal WWTP unit was
compared with the requirements of Minister of Public Works and Public Housing Regulation No. 04/PRT/M/2017 concerning the implementation of domestic wastewater management systems and it was found that there was a mismatch of unit designs at the primary treatment stage. Physical analysis is carried out on each processing unit as described in the table below.

**Table 1. Physical Analysis Results of WWTP Units**

| No | Treatment Unit          | Physical Analysis                                                                 |
|----|-------------------------|-----------------------------------------------------------------------------------|
| 1. | Control basin           | The flow of wastewater is low. There are fabric and plastic waste found in the basin, which prevents flow to the inlet. |
| 2. | Collector basin/ Inlet  | The basin are filled with feces that are quite dense on the surface of the water. |
| 3. | Settling pond           | The removal process does not function properly because there is plastic waste and tetrapack apart from the solid stool which is finer in size compared to the stool in the collecting basin above the water surface. Wastewater then flows into the pond by gravity. |
| 4. | Anaerobic Baffled Reactor | The water in the pool is black, foamy, there is fine stool mud, there are 2 rooms equipped with wasp nest filter media and anaerobic process occurs in this unit, and 1 room before the outlet basin that is not equipped with filters serves as a further solid separator. |
| 5. | Outlet pond             | There is no mud in this pool, the wastewater is black but without suspended particulate. |

**Analysis of Communal WWTP Wastewater Quality**

All wastewater that is treated at communal WWTP is wastewater generated from domestic activities, namely toilet activities such as urination and washing hand. Characteristics of wastewater entering the installation unit contain BOD, COD, TSS, oil & fat, ammonia and total Coliform which tends to be moderate after compared with the characteristics of domestic wastewater in general. The results of the wastewater analysis compared with the domestic wastewater quality standard according to the Minister of Environment and Forestry Regulation No.68 Year 2016 shows the quality of wastewater at the communal WWTP inlet of KSM Melati Sindangrasa Village exceeds the quality standard except the ammonia and oil-fat parameters. The quality of wastewater at the Communal WWTP WWTP Melati Sindangrasa Village also exceeds the threshold values for BOD, TSS and Total Coliform parameters. The TSS content that exceeds the quality standards at the communal WWTP outlet flows into the drainage and will affect the penetration of light so that it interferes with photosynthesis (Susanti et.al, 2018). The decrease in TSS content was influenced by the length of time the wastewater contacted with microorganisms contained in the WWTP compartment (Wulandari, 2012). The longer the contact time the TSS reduction efficiency will increase (Susanti et.al, 2018). High levels of BOD at communal WWTP outlets are caused by the high content of organic materials entering the WWTP system. The high total coliform in effluents can be due to the deposition of fecal sludge at the outlet bath. The high total coliform discharged into the environment can cause problems for public health.

Table 2 shows the result of wastewater laboratorium analysis according to the regulated parameters of sampling points of the wastewater treatment plant.
Table 2. Results of Wastewater Quality Laboratory Analysis

| No | Parameter       | Unit | Analysis Result | Standard | Analysis Method                       |
|----|----------------|------|-----------------|----------|---------------------------------------|
|    |                |      | Inlet           | ABR      | Outlet                                |
| 1  | pH             | -    | 7.2             | 6.9      | 6.5                                   | 6-9                     | SNI 06-6989.11-2004 |
| 2  | BOD            | mg/L | 60.00           | 42.00    | 34.80                                 | 30                      | SNI 6989.72:2009   |
| 3  | COD            | mg/L | 119.28          | 82.14    | 72.45                                 | 100                     | SNI 06-6989.15-2004|
| 4  | TSS            | mg/L | 148.90          | 59.30    | 35.50                                 | 30                      | SNI 06-6989.26-2005|
| 5  | Minyak & Lemak | mg/L | 3.50            | 1.40     | 0.40                                  | 5                       | SNI 06-6989.10-2004|
| 6  | Amoniak        | mg/L | 7.04            | 4.92     | 4.50                                  | 10                      | SNI 06-6989.30-2005|
| 7  | Total Coliform | MPN/100 mL | $4 \times 10^3$ | $1 \times 10^5$ | $6 \times 10^4$ | 3000 | APHA |

Surface Water Quality Analysis at Receiving Water Bodies

Data on the results of surface water quality testing on receiving water bodies after Communal WWTP Melati Sindangrasa showed that 83% of testing parameters met quality standards in accordance with Government Regulation of the Republic of Indonesia (PPRI) No.82 of 2001. Parameters exceeding the quality standard for BOD parameters were 34.80 mg/L, TSS at 35.50 mg/L and Total Coliform at $6 \times 10^4$ MPN/100 mL.

Efficiency of Communal WWTP

Percentage of pollutant removal did not reach the criteria set in the communal WWTP Manual that is 80% for overall processing results, according to regulation of PerMenPUPR No. 04 Year 2017, the efficiency value was calculated for TSS, BOD and COD pollutant parameters. The percentage of total allowance for suspended solids (TSS) is 76.16%, COD allowance is 39.26%, and BOD removal is 42%. Based on these results, the Communal WWTP KSM Melati has not been efficient in treating domestic waste from residents.

Analysis of Clean Water Quality of Residents Around the Communal WWTP

The issue of contamination that occurs to the well water of RT 01 / RW 09 residents whose homes are located around the communal WWTP area is the basis for conducting laboratory testing of clean water samples from the complainant and several houses that are randomly sampled according to distance and conditions in applicable standards.

The results of tests on the quality of community well water that is suspected to be polluted (ASWC) and the quality of community well water (ASW) which are both in the area of ± 200 meters from the location of the Communal WWTP Melati Sindangrasa, obtained two parameters that exceed the quality standards in well water polluted residents namely odor and Cr VI parameters in addition to the pH and Total Coliform content showed concentrations close to the quality standard according to the Minister of Health Regulation (PerMenKes) No.416 of 1990. While the analysis on samples of other residents' well water showed all parameters met the quality standard standard. Physically, residents' well water suspected to be polluted. It feels slimy which can be caused by high pH of water.
Table 3. Results of Analysis of Community Well Water Quality Located Around the WWTP

| No | Parameter                  | Unit | Analysis Result | Standard of PerMenKes No.416:1990 |
|----|----------------------------|------|-----------------|-----------------------------------|
|    |                            |      | ASWC            | ASW                               |
| 1  | TDS                        | -    | 87.00           | 106.00                            | 1000                             |
| 2  | Temperature (onsite)        | ºC   | 28              | 27.80                             | 22 - 28                          |
| 3  | Color                      | TCU  | <4.773          | <4.773                            | 15                               |
| 4  | Arsen (As)                 | mg/L | <0.0020         | <0.0020                           | 0.05                             |
| 5  | Selenium (Se)              | mg/L | <0.0238         | <0.0238                           | 0.01                             |
| 6  | Iron (Fe)                  | mg/L | <0.0238         | <0.0177                           | 1                                |
| 7  | Fluoride (F)               | mg/L | <0.0177         | <0.0177                           | 1.5                              |
| 8  | Cadmium (Cd)               | mg/L | <0.0087         | <0.0087                           | 0.005                            |
| 9  | Hardness (CaCO₃)           | mg/L | <0.0087         | 81.03                             | 500                              |
| 10 | Chloride (Cl)              | mg/L | 56.72           | 18.27                             | 600                              |
| 11 | Chromium VI (Cr VI)        | mg/L | 18.03           | <0.005                            | 0.05                             |
| 12 | Manganese (Mn)             | mg/L | <0.005          | 0.027                             | 0.5                              |
| 13 | pH (onsite)                | -    | 8.6             | 7.2                               | 6.5 – 9.0                        |
| 14 | Zinc (Zn)                  | mg/L | 0.029           | <0.0456                           | 15                               |
| 15 | Sulphate (SO₄)             | mg/L | <0.0456         | <1.349                            | 400                              |
| 16 | Lead (Pb)                  | mg/L | <0.0591         | <0.0591                           | 0.05                             |
| 17 | Detergent (MBAS)           | mg/L | <0.0591         | <0.0591                           | 0.5                              |
| 18 | Total Coliform (MPN)       | MPN/100 mL | 46 | 8.4 | 50 |
| 19 | Odor                       | mg/L | Fishy           | Odorless                          | Odorless                         |
| 20 | Taste                      | mg/L | Tasteless       | Tasteless                         | Tasteless                        |
| 21 | Nitrate, as N              | mg/L | 6.50            | 2.60                              | 10                               |
| 22 | Nitrite, as N              | mg/L | 0.063           | 0.007                             | 1                                |
| 23 | Cyanide (CN)               | mg/L | <0.0005         | <0.0005                           | 0.1                               |
| 24 | Organic matter (KMNO₄)     | mg/L | 1.44            | 0.96                              | 10                               |

Conclusion

Evaluation

1. The quality of treated wastewater at the Communal WWTP based on laboratory test results shows that BOD value of 60.00 mg/L, COD value of 119.28 mg/L, TSS value of 148.90 mg/L and Total Coliform of 4×10⁵ MPN/100 mL.

2. Treated wastewater quality exceeds the quality standard for BOD parameters of 34.80 mg/L, TSS of 35.50 mg/L and Total Coliform of 6×10⁴ MPN/100 mL.

3. Evaluation of the performance of Communal WWTP as a whole shows a low and insignificant efficiency condition with the percentage reduction in total suspended solids (TSS) of 76.16%, COD reduction of 39.26%, and reduction of BOD by 42%. The percentage of BOD and COD allowance is not in accordance with the PerMenPUPR standard criteria No.04 of 2017. The expected efficiency value is based on the Sindangrasa Communal WWTP work plan manual which is 80% for the overall processing results.

Recommendation

1. Solid waste that is discharged through sewerage can inhibit the performance of WWTP so it is necessary to add screen and a grease trap unit to separate oil from water. In channels that
have been equipped with grease trap units, regular and scheduled cleaning must be carried out by management and residents. The addition of the bar screen unit to the Communal WWTP is needed so that the processing process runs well and accordingly.

2. It is necessary to regularly drain the mud that crusts on the inlet and the settler unit.

3. A backwash system needs to be added to the Anaerobic Baffled Reactor treatment unit so that the sludge does not accumulate and causes excess nutrients.

4. It is necessary to conduct socialization and provide understanding back to the residents so as not to throw garbage in the bathroom or toilet channels as well as increase understanding of the functions of Communal WWTP, duties and responsibilities as a user.

5. There needs to be an improvement in the management of the Sindangrasa Communal WWTP located in RT 01/ RW 09 so that the management and residents actively maintain the installation buildings that have been provided by the government as an effort to improve environmental health and hygiene.

6. Further assessment needs to be carried out on the design of each Communal WWTP unit so that the test results at the outlet tub meet the quality standards and are safely disposed of in the environment.

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