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Evaluation of Communal Wastewater Treatment Plant Operating Anaerobic Baffled Reactor and Biofilter

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ABSTRACT - *Construction of communal Waste Water Treatment Plant, WWTP in city of Malang since 1998 but until recently had never done an evaluation the performance. Communal WWTP performance evaluation is needed to see how far the efficiency of processing result. Until now, Environmental Agency Malang City only measure effluent from WWTP Communal to know the suitability with domestic wastewater quality standards. Effluent quality data in 2014 showed value above the quality standard of domestic wastewater from East Java Governor Regulation No. 72 in 2013 for parameters BOD and COD. WWTP Communal USRI research objects are on a six (6) locations by involving the user community during the planning, construction, operation and maintenance. Technology choice of ABR followed by a biofilter reactor with the stone media proved capable of processing organic matter of BOD and COD with the removal levels respectively by 78% -99% and 71% -99%. As for the parameters of TSS, NO_3 and PO_4 have the ranges of removal respectively by 56% -100%, (43%) - 72%, (2%) - 13%. Ratio BOD and COD in influent are low and ranged from 0.22 to 0.41. From the evaluation shows that high organic matter concentrations in influent along with the HRT and operation time high will result in a higher removal level.*

Keyword-*Communal WWTP performance, Level of removal, Ratio BOD and COD , HRT.*
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1. INTRODUCTION

Wastewater management resettlement cities / regencies in Indonesia have target of access 100% [1]. One option of wastewater treatment system in the residential facilities scale-city is Communal WWTP with Anaerobic Baffled Reactor (ABR) as biological treatment unit. The use of the communal system in the future consider the management of flexible, simple technology and cost effectiveness [2,3]. ABR technology developed by Mc Carty, et al at Stanford University in the early 1980s [4]. The flow that are up and down in the ABR cause the flow of incoming wastewater (influent) have more intensive contact with an anaerobic biomass, thereby improving processing performance. BOD decrease in ABR higher than the septic tank, which is about 70-95%. Need to include airways. For the initial operation needs 3 months to stabilize the biomass at the beginning of the process [5].

Since 1998, it has carried out the construction of communal WWTP in the city of Malang but until recently had never been done an evaluation of the performance of this reactor. Communal WWTP performance evaluation is needed to see how far the efficiency of processing is generated. Environmental Agency at Malang City (BLH kota Malang) evaluate only on the outlet quality of the Communal WWTP. Outlet quality data in 2014 showed a value above the quality standard of domestic wastewater from East Java Governor Regulation No. 72 In 2013 for the parameters BOD and COD. While the Brantas river water quality data on the location of the WWTP effluent discharge Communal showed high content of ammonia (0.13 to 1.14 mg / L) and nitrite (0.102 to 0.423 mg / L).

WWTP communal funded by USRI that become research objects are on a six (6) locations in the city of Malang by involving the user community during the planning, construction, operation and maintenance. Expected from the results of the performance evaluation Communal WWTP can provide input feasibility ABR technology as an option of domestic wastewater treatment technology in Indonesia. In addition, the performance evaluation activities Communal WWTP also be input for optimization of WWTP so generated better effluent quality and can be reused for agriculture. The benefit of the WWTP optimization providing performance solutions to problems rather than renewing the existing WWTP infrastructure that requires high cost.

2. MATERIALS AND METHODS

Communal WWTP performance evaluation activities as in the image below.

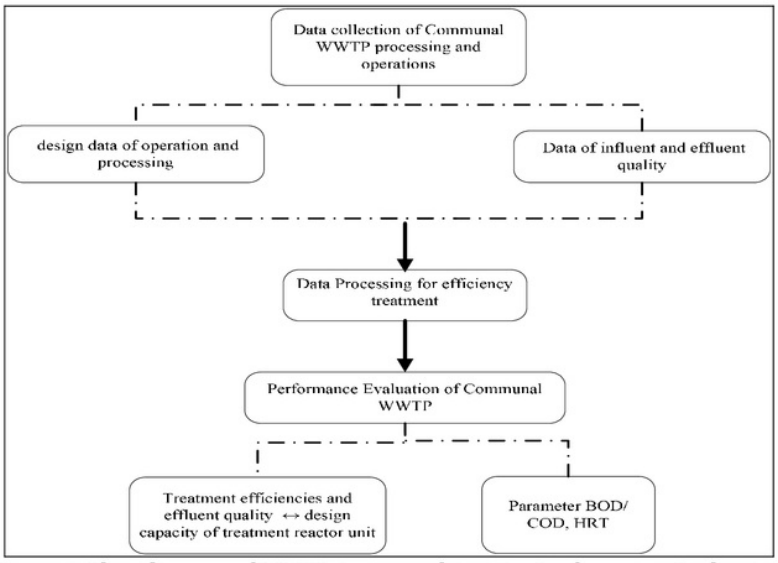


Figure 1. Flow diagram of WWTP Communal Activity Performance Evaluation

The description of each stage of the following activities:

1. Data collection and processing operations Communal WWTP comprising of operations and process design data of the Agency for Family Planning and Community Empowerment (BKBPM) Malang and User Groups and Sustainer (KPP) as manager of the Communal WWTP.
2. Sampling and analysis of influent and effluent quality parameters in any communal wastewater treatment unit that includes the concentration of BOD, COD, TSS, NO_3, and PO_4. Sampling of wastewater was conducted by moment sampling (grab sampling) in accordance with SNI 6989.57: 2008 on Method of Wastewater Sampling.
3. Analysis of the quality of wastewater samples carried out by the Water Quality Laboratory PJT I by using the following method.

Table 1. Parameter Wastewater Analytical Methods

No.	Parameter	Unit	Analysis Method
1.	BOD	mg/L	APHA.5210 B-1998
2.	COD	mg/L	QI/LKA/19 (Spektrofotometri)
3.	TSS	mg/L	APHA.2540 D-2005
4.	NO_3	mg/L	QI/LKA/65
5.	PO_4	mg/L	SNI 19-2483-1991

4. Processing of the data to gain treatment efficiencies.
5. Evaluation of the performance of the communal wastewater from treatment efficiency, BOD / COD and HRT.

3. RESULTS AND DISCUSSION

Overview Object Study

USRI Communal WWTP located on the upstream and middle stream Brantas river in the city of Malang as in the image below.

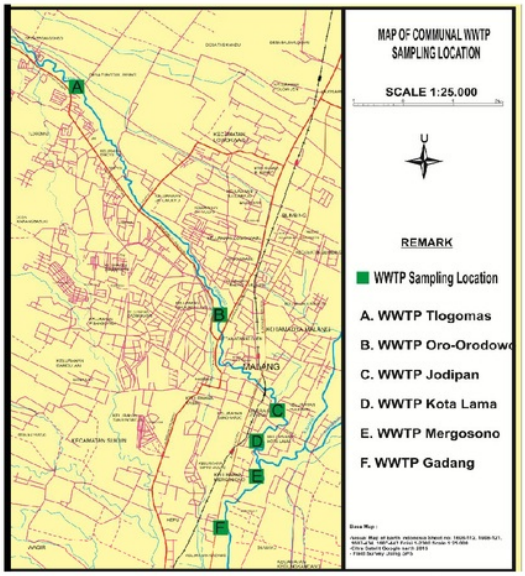


Figure 2. Map Of WWTP Location Sampling

General overview of USRI Communal WWTP becoming object in this study as follows.

Table 2. General description Communal WWTP

NO.	LOCATION	OPERATION STARTED	OPERATION CAPACITY (%)
1.	RT5 RW5 Tlogomas	2012	137
2.	RT12 RW2 Oro-Oro Dowo	2013	66
3.	RT6 RW6 Jodipan	2013	67
4.	RT4 RW9 Kota Lama	2013	86
5.	RT6 RW6 Mergosono	2012	121
6.	Jl. Gadang 5A Gadang	2013	86

USRI Communal WWTP operating unit use DEWATS technology with ABR processing unit and anaerobic filter with stone media. Treatment scheme can be seen on the following figure.

Communal wastewater treatment systems in use DEWATS system consisting of a sedimentation unit for separating solids, Anaerobic Baffled Reactor for biological treatment and anaerobic filter unit as tertiary treatment. DEWATS system is a system option scale decentralized wastewater treatment in peri-urban area [6]. Some of the benefits of this system is tolerant to fluctuations inflow, long-term and reliable application, low cost for operation and maintenance and has the potential for reuse. Effluent from DEWATS system applications on the object of study is still directly discharged to the river. From research performance evaluation is expected to be developed as a potential water reuse for plant and fish growing media.

Communal WWTP Evaluation Results

The result of the influent and effluent concentrations of water quality parameters COD and BOD can be seen in the chart below

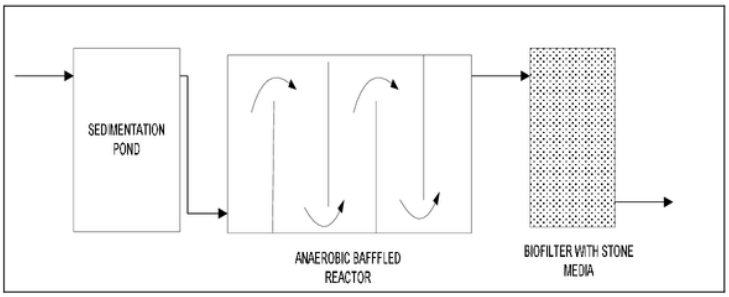
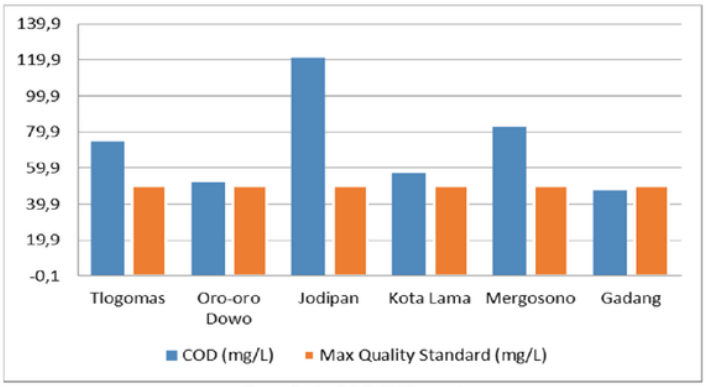
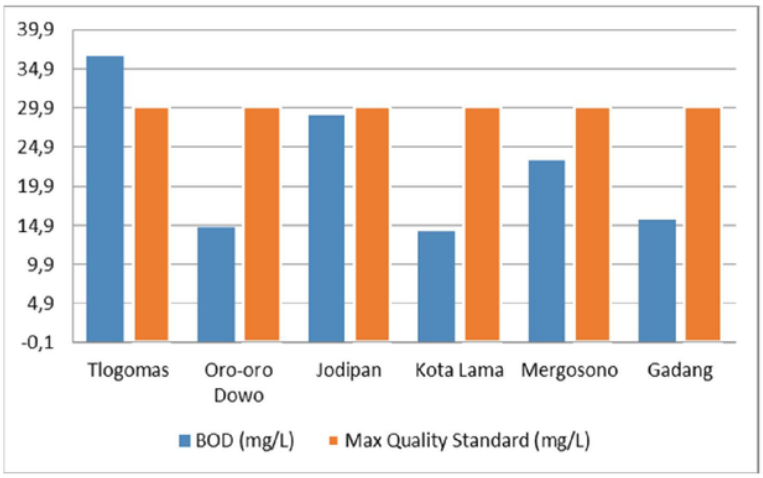


Figure 3. Schematic Processing Unit Communal WWTP



Graph 1. COD Effluent

From the graph one can see only the Gadang Communal WWTP that has the quality of COD under the standard. Jodipan effluent COD still have high (121.2 mg / L). High influent content of COD derived from the use of cleaning materials Communal WWTP users.



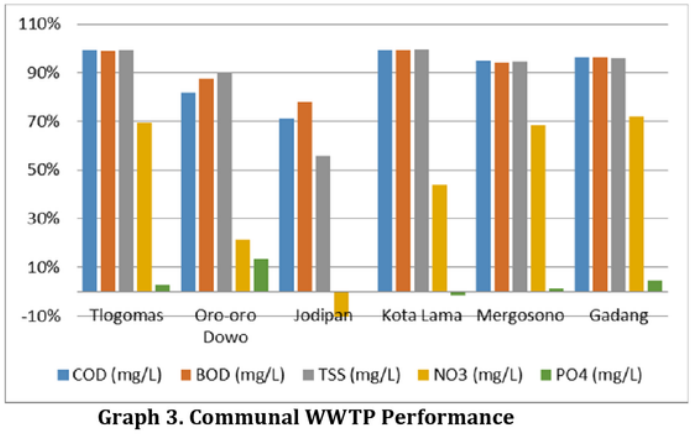
Graph 2. BOD Effluent

Quality of Communal WWTP effluent BOD is generally lower than the standard unless the WWTP Communal Tlogomas higher value (36.5 mg / L). Comparison of BOD / COD is used as an indicator of the capacity of biodegradation or Biodegradation Index [7]. Biogedradation index value for domestic wastewater varies from 0.4-0.8 and decreased to 0.1 after a good secondary processing. From Table 3 can be seen the value of the ratio of BOD / COD Communal WWTP influent on the object of study ranged from 0.22 to 0.41. Whereas in some Communal WWTP effluent impaired ratio of BOD / COD namely Oro-oro Dowo and Jodipan. While the ratio of BOD / COD in wastewater Communal Tlogomas, the Kota Lama and Mergosono increased. Ratio BOD / COD in Gadang Communal WWTP remains. Of the value of biodegradation indexs that fixed and increased showed high content of biodegradable organic matter in influent that potentially interfere with the processing of organic material in the wastewater.

The use of ABR as anaerobic pre-treatment system and pond of stabilization with the media as a post-treatment system has been studied as the option of choice of domestic wastewater treatment technology that suitable for tropical and sub-tropical regions in developing countries [8]. Technology choice of ABR followed by a filter reactor with the stone media on WWTP Communal proved capable of processing organic matter of BOD and COD with removal levels respectively by 78% -99% and 71% -99% (chart 3). As for the parameters of TSS, NO_3 and PO_4 have the range of removal respectively by 56% -100%, (43%) - 72%, (2%) - 13%.

Table 3. Ratio of BOD-COD

Communal WWTP	BOD/COD	
	Inlet	Outlet
Tlogomas	0,38	0,49
Oro-oro Dowo	0,41	0,28
Jodipan	0,31	0,24
Kota Lama	0,22	0,25
Mergosono	0,25	0,28
Gadang	0,33	0,33



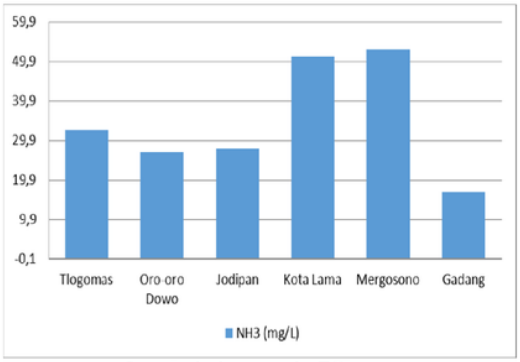
Graph 3. Communal WWTP Performance

ABR is a high rate anaerobic digestion reactor. SRT separate from HRT to maximize performance of pollutants processing by anaerobic bacteria that slow [9]. Reactor with high SRT will minimize the HRT so the

volume load become greater. HRT of the ABR on WWTP Communal varies with the value of 12 hours, 15 hours and 26 hours. Effluent concentration of BOD and COD also varied with concentrations of 148 mgCOD / L - 3921 mgCOD / L, 84 mgBOD / L - 1860 mgBOD / L. The strength characteristics of this waste varies. In the study of artificial wastewater treatment with low COD concentration of 300-400 mg / L resulted in the level of removal of 87.2% for HRT 24 hours and 91% for HRT 24 hours [10]. WWTP Communal Mergosono operating for 3 years with a high influent COD concentration (3921 mg / L) resulted in the removal rate of 95% with a HRT 26 hours and the operating capacity exceed design capacity (121%). Whereas, for the WWTP Communal Oro-oro Dowo with the operation time 2 years and influent COD concentration is low (149 mg / L) resulted in the level of removal of 82% with a HRT of 12 hours and the operating capacity below design capacity (66%). From the results of this evaluation shows that the high influent concentrations in line with the duration of HRT and the operation time will result in a higher removal level. This condition indicates the availability bacterial of decomposition and optimal conditions for the processing of organic material. The anaerobic bacteria are a group of bacteria metabolic consisting of microorganisms hydrolytic, fermentative, syntrophic and methanogenic which outlines the complex organic compounds in the process of anaerobic degradation [11].

Removal level that obtained is the result of processing biofilter with the stone media because the effluent was taken after the biofilter. Organic load that is too low cause biomass limited to degrade organic matter and resulting organic matter removal levels that low. Biofilter performance is highly dependent on the microbial activity. A substrate sources that constant required for the consistency and effectiveness of operations. Biofilter success depends on the growth and maintenance of biomass on the surface of the media. Three important things in understanding the mechanism of processing using a biofilter is (1) attachment of biomass, (2) The use of the substrate and the growth of biomass and (3) Sloughing of biomass. Strong attachment process and colonization of biomass depends on the influent characteristics (eg organic and concentration) and the surface properties of the filter media. A key factor in the performance of the process of biofilm formation is the amount of the growth and physical factors that affect the release of biofilm. The process of erosion, abrasion, sloughing and grazing or predation often examined and to be studied on the mechanism of release of biomass. Evaluation of biomass lost during washing the filter is very important in the operation of the filter. But previous studies showed the biomass that effectively responsible in organic matter removal is not lost during washing filter normally. Most studies show that the loss of biomass only because of the shear stress of the fluid [12].

The existence of ammonia in anaerobic degradation can be an inhibiting factor [13]. Ammonium is an important nutrient for the growth of methanogens, then the excess of free ammonia will disrupt the process of methanogenesis. Methanogenesis more sensitive to the rise in pH resulting free ammonia as shown in the reaction: Norg → NH_4 + + $OH^- \leftrightarrow NH_3$ + H_2O. The concentration of ammonia in the effluent wastewater can be seen in chart 4.



Graph 4. Ammonia Effluent

Ammonia in the effluent of communal WWTP should be treated by post treatment so can be reused. WWTP evaluation results become input for the development of wastewater treatment technologies, especially in communal scale at Malang city. Through optimization of wastewater treatment processes, will be achieved conservation of water resources.

4. CONCLUSIONS

Technology choice of ABR followed by a biofilter reactor with the stone media proved capable of processing organic matter of BOD and COD with the levels of allowance respectively by 78% -99% and 71% -99%. Parameter TSS, NO_3 and PO_4 have the ranges of allowance respectively by 56% -100%, (43%) - 72%, (2%) - 13%.

The value of the ratio of BOD / COD WWTP Communal of the influent on the object of study ranged from 0.22 to 0.41.

From the evaluation shows that the high concentrations of organic matter in influent in line with the high of HRT and operation time will result in a higher allowance level. With the organic loading that is too low cause biomass limited to degrade organic

matter and result low levels of organic material separation. The presence of ammonia in anaerobic degradation should be treated to produce biogas and nutrient-N.

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REFERENCES

[1]. Cipta Karya, P. 2015. *RPJM*. Jakarta: PU.

[2]. Hendrawan, e. 2013. Evaluation Of Centralized Wwtp And The Need Of Communal WWTP in Supporting Community-Based Sanitation in Indonesia. *European Scientific Journal. edition vol.9, No.17 ISSN: 1857 – 7881*, 229-239.

[3]. Massoud, M., & Tarhini, A. d. 2009. Decentralized approaches to wastewater treatment and management: Applicability in developing countries. *Journal of Environmental Management Volume 90, issue 1*, 652-659.

[4]. Movahedyan, H. A. 2007. Performance Evaluation of Anaerobic Baffled Reactor Treating Wheat Flour Starch Industry Wastewater. *Iran Journal Environment Health Science and Engineering Vo. 7, Nr. 2*, 77-84.

[5]. TTPS, T. T. 2010. *Buku Referensi Opsi Sistem dan Teknologi Sanitasi*. Jakarta: ISSDP.

[6]. Borda. (2015, Juni 19). Retrieved from Bremen Overseas Research and Development Association: http://www.borda-sea.org.

[7]. Abdalla, K. Z. 2014. Correlation Between Biochemical Oxygen Demand and Chemical Oxygen Demand for Various Wastewater Treatment Plant in Egypt to Obtain The Biodegradability Indices. *International Journal of Science : Basic and Applied Research (IJSBAR) Volume 13 Nr. 1*, 42-48.

[8]. Yu, H. J.-H. 1997. A sustainable municipal wastewater treatment process for tropical and sub tropical region in developing country. *Water Science and Technology*, 191-198.

[9]. Nguyen, H. S. 2010. *The Anaerobic Baffled Reactor*.

[10]. Maraniotis I., G. S. 2002. Low-Strength Wastewater Using an Anaerobic Baffled Reactor. *Water Environmental Research 74 (2)*, 170-176.

[11]. Satoh, H. M. 2007. Layered Structured of Bacterial and Archaeal Community and their in situ activity in anaerobic granules. *Applied Environment Microbiology 73*, 7300-7307.

[12]. Durgananda Singh Chaudhary, S. V.-H. 2003. Biofilter in water and wastewater treatment. *Korean Journal Chemistry Engineering*, 1054-1065.

[13]. Garcia, M. A. 2009. Interaction between Temperature and Ammonia in Mesophilic Digester for animal waste treatment. *water resources 43*, 2373-2382

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