Design for Wastewater Treatment Plants (WWTP) for Cattle in a Single House Model with a Bio Filter Process

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Abstract. Liquid waste generated from cattle farms is discharged directly into culvert and river. The liquid waste is not treated so it has high potential to threaten and pollute the water and ground water environment. With the average flushing done twice a day, the gross amount of wastewater that is wasted is not less than 100-150 liters / day / cattle for weight 400 kg (Saputro et al. 2014). Therefore a wastewater treatment plant (WWTP) is needed to control the massive liquid waste. In addition, WWTP must be simple, inexpensive, and appropriate so that the community can apply it. Data collection is needed, namely data on the number of cattle livestock, waste water quality data and waste water discharge data. The organic parameters of cattle waste that are considered are BOD, COD, TSS, NH3-N, and pH only (Regulation of the State Minister for the Environment Number 11 Year 2009 concerning Wastewater Quality Standards for Cattle and Pork Businesses and / or Activities). Design for wastewater treatment plants (WWTP) model using the MSL (Multi Soil Layering) method (Alternative 1) and the combination of MSL with anaerobic wasps nest biofilter (Alternative 2) (Said et al. 2001). Compare the effluent results in the both alternatives that available the quality standards and analyze more optimally.

Keywords : Wastewater Treatment Plant (WWTP), biofilter, MSL (multi soil layering).

1. Introduction
Livestock waste as a negative factor of livestock business is a phenomenon that cannot be eliminated easily. In addition to obtaining benefits in terms of business, livestock business also has a negative impact on the environment and public health. Waste that is discharged directly into the environment without treatment will contaminate air, water and soil causing pollution. Liquid waste (liquid waste) on cattle farms is all the water used, namely water for washing cows, cleaning cows and cow urine. The liquid waste generally also still contains organic matter, as seen in the urine content of cattle (Hartatik and Widowati, 2004). If the management of liquid waste is poor, it will potentially pollute the environment. The waste also creates unpleasant odors and disturbs human health. In soil, livestock waste can weaken the carrying capacity of the soil, causing soil pollution. Whereas in water, pathogenic microorganisms (causing diseases) derived from livestock waste will pollute the aquatic environment. In one day, one cow produces 100-150 liters of liquid waste (Saputro, 2014). According to Sutopo (2000), the amount of urine released by one cow with an average weight of 400kg is 15 liters / day.

The limited availability of land and community knowledge related to wastewater treatment in the Greater Malang area which includes Malang City, Malang Regency, and Batu City have made cattle farmers not take the initiative to install wastewater treatment plants (WWTP). Almost all breeders
directly dispose of liquid waste into waterways. Because solid waste in the form of faeces is usually used as the main ingredient in making organic fertilizer or usually just piled up.

One village that has a cattle farm is located in Petungsewu Village, Dau District, Malang Regency. This research was conducted in one of the houses of a local resident named Mr. Ichsan with a total of 14 adult cattle owned. So far, waste water has been dumped directly into the back of his house which is also a citrus plantation. Therefore a wastewater treatment plant (WWTP) is needed to control the massive liquid waste. In addition, WWTPs must be simple, inexpensive, and appropriate so that they can be duplicated and applied by the community around Petungsewu village.

Of the many available methods and their advantages and disadvantages, Multi Soil Layering (MSL) methods were chosen because they met the above mentioned criteria. Another factor to consider is the operation and maintenance of the two methods is considered the easiest.

2. Research Methodology

2.1 Study Location
This research was carried out in Petungsewu Village, Dau District, Malang Regency. Dau District has an area of 41.96 km². In general, the subdistrict topography is in the hills and plateaus. In terms of administrative aspects, Dau District is surrounded by other districts. In the north it borders Batu City. In the south it is bordered by Wagir District. Lowokwaru District in the east. And Gunung Kawi District in the west. One of the villages in Dau Subdistrict is Petungsewu Village, which is famous for its orange plantations. In addition, this village is close to Bumi Perkabung Campengan, only 3.4 km away or 11 minutes away by motorized vehicle. The other nine villages in Dau Subdistrict are Gadingkulon, Kalisongo, Karangwidoro, Kucur, Landungsari, Mulyoagung, Selorejo, Sumbersekaru, and Tegalweru villages.

![Map of Dau District, Malang Regency](http://www.dau.malangkab.go.id)

Figure 1. Map of Dau District, Malang Regency

Sumber: www.dau.malangkab.go.id

2.2 Existing Condition
The following is a picture in the top view of a cattle study location in Petungsewu Village, Dau District, Malang Regency.
2.3 Required Data
Data needed in this research study, namely:
1. Data on the number of cattle raised from direct observation are 12 cattles.
2. Data on the quality of wastewater from cattle before and after processing. This data was obtained from the results of wastewater quality testing on wastewater samples. The parameters to be tested are in accordance with the Regulation of the Minister of Environment No. 11/2009 concerning Wastewater Quality Standards for Businesses and / or Cattle and Pig Farming Activities.
3. Data on cattle wastewater discharge is the average liquid waste discharge for dairy cows with a weight calculation of 400 kg of cattle, 100-150 liters / head / day. (Danang Dwi Saputro et al. 2014).

2.4 Sampling Steps
The following are the steps in wastewater sampling:
1. Prepare the equipment needed in the sampling of wastewater as stated in the description above, namely the sample bottle, gloves and cooling box.
2. The sample bottle is washed with plain water to ensure that no foreign matter enters the bottle. Then after washing with plain water, the sample bottle is washed with waste water 3 times so that the condition of the bottle resembles the state of the waste water so it does not change the results of laboratory tests.
3. Choosing the location of waste water sampling, where in this research study conducted at the existing outlet. Waste water sampling is done by grab sampling (instantaneous sample).
4. Storing bottles containing wastewater samples into a cooling box that has a temperature of 40°C ± 20°C to maintain the characteristics and characteristics of the wastewater sample up to the laboratory.
5. Waste water samples are submitted to the laboratory to get the results of the testing of the quality of wastewater including BOD, COD, TSS, NH3-N and pH contents. According to Metcalf and Eddy (2003, p.43), wastewater contains various types of solid material that settles (not dissolved) and material that is mixed (suspended).

3. Results And Discussion

3.1 On Site Activity
Activities at the study site took the form of taking samples of wastewater in the drainage channels and calculating the number of cattle livestock.
- There are 12 head of cattle in one of the houses in Petungsewu Village, Dau District.
- The location for taking wastewater samples before the drainage process is carried out behind the owner's house.
- The WWTP construction site is in an area with a cattle ranch location behind the owner's house.
- Perform waste treatment running with alternative of the MSL filter method.
- Modified MSL (Multi Soil Layering) filter. MSL filter is a series of filter components containing sand, stone, coconut fiber, and carbon charcoal. With a filter frame that has been modified to fit the existing conditions.

![Figure 4. Modified MSL Filter.](image)

- Take effluent samples for each alternative, i.e., in the fourth basin of a WWTP to be tested in the Laboratory of Unit Analysis and Measurement of the Chemistry Department, Faculty of Science, Universitas Brawijaya.
- Comparing sample test results from the alternative.

3.2 Analysis Method
The collected data will then be analyzed and then compared with two alternative methods in the design of a wastewater treatment plant (WWTP) that are suitable for the cattle farm. Perform the process of the design of wastewater treatment plants (WWTP) in detail, starting from the dimensions and stages of the treatment in accordance with existing data. The planning reference used is BPPT, Dep. PU, Pd-T-04-2005-C and previous research journals.
Comparing effluent results in alternative one, namely the MSL method alone with the combination method of MSL with anaerobic biofilter. After that, analyze and compare which is more optimal.

Figure 5. Cross Section of Wastewater Treatment Plant (WWTP).

Table 1. Discharge Calculation.

| Test | 1     | 2     | 3     |
|------|-------|-------|-------|
| Time (sec) | 80    | 83    | 79    |
| Discharge (ltr/sec) | 0.0125 | 0.0126582 |
| Discharge (m$^3$/sec) | 0.0000125 | 1.205E-05 | 1.266E-05 |
| Average discharge (m$^3$/sec) | 1.24021E-05 |
| Average discharge (ltr/sec) | 0.01240214 |

Table 2. Wastewater Quality Standards for Livestock and/or Animal Husbandry and/or Activities.

| Parameter | Maximum Content (Mg/L) | Maximum Pollution Load (gram/head/day) |
|-----------|------------------------|-----------------------------------------|
| BOD       | 100                    | 20                                      | 4                                      |
| COD       | 200                    | 40                                      | 8                                      |
| TSS       | 100                    | 20                                      | 4                                      |
| NH$_3$-N  | 25                     | 5                                       | 1                                      |
| pH        |                        |                                         |                                         |

Maximum Wastewater Quantity
Cow : 200 ltr/head/day
Pig : 40 ltr/ head/day

Source: The Minister of Environment Regulation Number 11, Year 2009
Based on analysis procedure that conducted by Laboratory of Unit Analysis and Measurement of the Chemistry Department, Faculty of Science, Universitas Brawijaya. The analysis results shown in the table below.

**Table 3. Data of Wastewater Quality Test Results.**

| No | Code  | Parameter | Analysis Report | Analysis Method |
|----|-------|-----------|-----------------|-----------------|
|    |       |           | Content         | Unit            |
| 1  | Before| BOD       | 64.27 ± 0.80    | mg/L            |
| 2  | After | BOD       | 18.05 ± 0.03    | mg/L            |
| 3  | Before| COD       | 102.00 ± 2.83   | mg/L            |
| 4  | After | COD       | 64.00 ± 0.00    | mg/L            |
| 5  | Before| N-NH₃     | 65.91 ± 0.94    | mg/L            |
| 6  | After | N-NH₃     | 2.86 ± 0.01     | mg/L            |
| 7  | Before| pH        | 8.35 ± 0.01     | -               |
| 8  | After | pH        | 6.98 ± 0.01     | -               |
| 9  | Before| TSS       | 46.50 ± 0.71    | mg/L            |
| 10 | After | TSS       | 21.00 ± 0.00    | mg/L            |

**Analysis Method**
- Redox Titration
- Amonium Besi (II)
- Sulfat
- Nessler
- Spectrophotometry
- pH metry
- Gravimetry

Noted:
1. The results of this analysis are the average value of the analytical work dipo.
2. The results of this analysis only apply to the samples we received with such sample conditions.

When compared with the wastewater quality standard as shown in Table 2, it can be concluded that all parameters meet the wastewater quality standard of cattle livestock.

**4. Conclusion and Recommendation**

**4.1 Conclusion**

Based on the results of calculations and analysis from the problems that have been carried out in this study, we conclude:
- The test results of cattle livestock wastewater samples conducted at by Laboratory of Unit Analysis and Measurement of the Chemistry Department, Faculty of Science, Universitas Brawijaya, the content of BOD, COD, TSS, NH₃-N and pH are respectively 18.05 mg / L, 64.00 mg / L, 21.00 mg / L, 2.86 mg / L, and 6.98 for alternative design of Wastewater Treatment Plant (WWTP).
- From the design of WWTP for cattle using MSL filter method, the effluent quality of waste water that according to the quality standards set by the Minister of Environment Regulation Number 11 Year 2009. The results of WWTP using the MSL method reduces the efficiency of the BOD content reached 71.92%, COD = 37.25%, TSS = 54.84%, NH₃-N = 95.66% and pH = 16.41%.

**4.2 Suggestion**

Based on the results design analysis for WWTP of cattle livestock which has been done in this study, suggestions that can be considered include:
• Backwater from the control tank which causes by flooding. It should be allowed after running / flowing to be discarded to/through the outlet control tank, it does not need to be drained by a water pump.
• There is indicated septic tanks, so prevention can be closed outlet pipes apart from the WWTP channels.
• When it rainy season will continue to be fully filled because the backwater from the control tank/outlet, so to avoid back water in the outlet is added to the valve cover on the pipe when there is no running / flowing.

5. References
[1] Metcalf, dan Eddy. (2003). Wastewater Engineering Treatment and Reuse – Fourth Edition (International Edition). New York: McGraw-Hill
[2] Peraturan Menteri Negara Lingkungan Hidup, 2009. Baku Mutu Air Limbah bagi Usaha dan/atau Kegiatan Peternakan Sapi dan Babi. 11.
[3] Said, Nusa Idaman & Rina Tresnawathy. 2001. Penghilangan Amoniak Di Dalam Air Baku Air Minum Dengan Proses Biofilter Tercelup Menggunakan Media Plastik Sarang Tawon. Jurnal Teknologi Lingkungan.2 (I): 11-27.
[4] Saputro, Danang Dwi., Burhan Rubai & Yuni Wijayanti. 2014. Pengelolaan Limbah Peternakan Sapi Untuk Meningkatkan Kapasitas Produksi Pada Kelompok Ternak Patra Sutera, Jurnal Rekayasa. 12 (II): 1-8.
[5] Widowati, L.R., Sri Widati, dan D. Setyorini. 2004. Karakterisasi Pupuk Organik dan Pupuk Hayati yang Efektif untuk Budidaya Sayuran Organik. Laporan Proyek Penelitian Program Pengembangan Agribisnis, Balai Penelitian Tanah.

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