



DOMESTIC WASTEWATER TREATMENT PLANT DESIGN (CASE STUDY: MITA MULIA HOTEL, BANDA ACEH)

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ABSTRACT

Mita Mulia Hotel is located within the largest university in Aceh Province, Indonesia. The number of rooms occupied increases when events such as graduation ceremonies occur, resulting in a higher volume of wastewater generation. Mita Mulia Hotel produces approximately 30,000 liters of wastewater from the cafe, kitchen, laundry, bathrooms, and washbasins daily. Preliminary water quality tests for Mita Mulia Hotel's wastewater, including COD, BOD, TSS, Oil and Grease, and Ammonia parameters, have been shown to exceed the standards set by the Minister of Environment and Forestry Regulation Number 68 Year 2016 regulate Domestic Wastewater Quality Standards. Mita Mulia Hotel uses the Anaerobic-Aerobic Biofilter method to treat their wastewater, equipped with Grease Trap Tank, Initial Sedimentation Tank, Anaerobic Biofilter Tank, Aerobic Biofilter Tank, and Final Sedimentation Tank. The total planned land area required is 18.75 square meters, with the Bill of Quantities (BoQ) encompassing activities ranging from standard soil excavation for construction to reinforcement works with plain concrete steel (rebar). These include formwork for floors, walls, and roofs.

Keywords : Domestic Wastewater; WWTP; Anaerobic-Aerobic Biofilter

ABSTRAK

Mita Mulia Hotel merupakan salah satu industri perhotelan yang terletak di lingkungan kampus terbesar di Aceh. Hal ini menyebabkan meningkatnya jumlah kebutuhan kamar pada hari besar seperti wisuda, sehingga air limbah yang dihasilkan lebih banyak pula. Mita Mulia Hotel menghasilkan sebanyak 30.000 L/hari yang dihasilkan dari kafe, dapur, penatu, kamar mandi dan wastafel. Hasil uji pendahuluan kualitas air limbah Mita Mulia Hotel parameter COD, BOD, TSS, Minyak dan Lemak serta Amoniak menunjukkan telah melewati baku mutu yang ditetapkan Peraturan Menteri Lingkungan Hidup dan Kehutanan No. 68 Tahun 2016 Tentang Baku Mutu Air Limbah Domestik. Salah satu teknologi pengolahan air limbah yaitu menggunakan IPAL dengan metode Biofilter Anaerob-Aerob yang dilengkapi dengan Bak Penangkap Lemak, Bak Pengendapan Awal, Bak Biofilter Anaerob, Bak Biofilter Aerob dan Bak Pengendapan Akhir. Total lahan perencanaan yang dibutuhkan yaitu 18,75 m² dengan pengerjaan BoQ dimulai dari perhitungan penggalian tanah biasa untuk konstruksi sampai dengan pekerjaan pembesian dengan besi beton (polos) yaitu bekisting lantai, dinding dan atap.

Kata kunci : Air Limbah Domestik; IPALD; Anaerobik-Aerobik Biofilter

Introduction

Today's tourism sector's development has an important role in national or regional development. It is not just for increasing foreign exchange but also for expanding job opportunities to increase other economic sector activities such as transportation and household industries, including hotels and the accommodation sector (Ekaningrum, 2016). Tourism industries, especially hotels, are one of Indonesia's economy's main supports; this causes hotel growth in Indonesia to increase (Mubarak et al.,2018). As the hotel industry develops, various perspectives emerge from the community; one of the problem concerns is the environmental negative impact due to hotel operations (Riskiyanto,2019).

Environmental pollution caused by wastewater from hotel activity will increase if it is disposed of directly without treatment. The type of activity carried out will affect the quality of wastewater produced by the hotel, so it is necessary to adjust the use of wastewater treatment technology (Setiyono, 2009). It is influenced by the source of facilities at the hotel, while the volume of the hotel wastewater is estimated from the number of hotel rooms, occupancy percentage, number of employees, and the other supporting facilities (Siswanto et al.,2015).

Wastewater treatment processes, especially those containing organic compound pollutants, mostly use the activity of microorganisms to decompose organic pollutant compounds. The wastewater treatment process with the microorganism activity is usually called the "biological process". The biological wastewater treatment process can be done under aerobic conditions (with oxygen), anaerobic conditions (without oxygen), or combinations of anaerobic and aerobic (said, 2000). Aerobic biological processes are generally used for the treatment of wastewater with a low BOD load, while anaerobic biology is used for the treatment of wastes with a very high BOD charge. Biological wastewater treatment can be largely divided into three processes, namely, suspended culture, attached culture, and processes with lagoon or pond systems (Tilley et al., 2008).

Based on observations carried out at Mita Mulia Hotel, the total number of hotel rooms was 48 bedrooms with a division of Twin beds of 15 rooms, Single bed of 20 rooms, Family room of 10 rooms, and Deluxe of 3 rooms with an average of guests staying there were 28 people and room usage there were 14 rooms per day. Wastewater sources at Mita Mulia Hotel are from the laundry, bathroom, sink, canteen, and septic tank facility. At Mita Mulia Hotel, there is no special treatment for the sewage, but it is only stored in a shelter tub with a capacity of 4m x 2m at a height of 1.8m before a third party takes the wastewater. This wastewater treatment problem needs special treatment before discharging into the water body.

The primary purpose of wastewater treatment is to reduce the content of pollutants, especially organic compounds, suspended solids, pathogenic microbes, and organic compositions that cannot be naturally decomposed by microorganisms. In addition, wastewater treatment is carried out to reduce and eliminate the adverse effects of wastewater on human health and its environment and to improve the quality of the living environment through treatment, disposal, and/or utilization of

wastewater for the benefit of human life and the environment (Wulandari,2014). In order to avoid the adverse impact of such domestic wastewater disposal, it is necessary to design a household wastewater treatment facility that reduces the concentration of pollutants before the wastewater is discharged into the recipient water body (Riyanda & Kemala, 2019).

Based on the results of the preliminary test on the wastewater of Mita Mulia Hotel at the Environmental Engineering Laboratory and the Technical Laboratory of Environment Quality Testers of the University of Shiah Kuala, the results were obtained from the parameters COD is 336 mg/L, TSS is 128 mg/ L, pH is 7.4, BOD is 236 mg / L, ammonia is 11.25 mg / l, and Oil and Fats is 3.55 mg/ l. Referring to the Regulation of the Minister of Environments and Forests of the Republic of Indonesia about domestic wastewater quality standards, the measurement results of parameters BOD, COD, TSS, and Ammonia showed that they had passed the standard of wastewater quality prescribed for domestic activities. Therefore, it is necessary to implement the Biofilter anaerobic-aerobic technology in the hotel's domestic wastewater treatment plant (WWTP) to protect the environment and water bodies around the hotel area.

Methods

This research uses a mixed methodology or a mix of qualitative and quantitative methodology where field observations and interviews with stakeholders are conducted, as well as literacy on previous research. The research was carried out by taking the wastewater of Mita Mulia Hotel as a sample that will be tested before treating wastewater with a feasible technology. In addition, there are field observations and interviews with the relevant parties in the hotel. The secondary data was collected from books, journals, previous research, and relevant government regulations, such as the regulation of the Minister of Environment and Forestry of the Republic of Indonesia No. 68 of 2016 about domestic wastewater quality standards.

Detailed Technical Planning Guidelines for Centralized Domestic Wastewater Treatment Systems (SPAL-D) of the Ministry of Public Works and People's Housing No. 4 of 2017. Government Regulation of the Republic of Indonesia No. 22 of 2021 on implementation of environmental protection and management: Appendix VI.

Hotel administrative data are also listed in the research methodology, where the data required are the number of hotel beds, employees, hall maximum capacity, the number of washing machines at the unifying facilities, and the number of kitchens.

Results and Discussion

The wastewater was obtained from the output of Mita Mulia Hotel, Teuku Nyak Arief, Kopelma Darussalam, Banda Aceh. The preliminary tests were conducted with pH, COD, BOD, Oils, and Fats, as well as Ammonia with a pH result of 7.4, COD 336 mg/l, DOD 236 mg / l, Oil and Fat 3.55 mg/ l and Ammonie 11.25 mg/L which showed the results of COD, BOD, Oils & Fats and ammonia have passed the quality standards listed in the Regulations of the Minister of Environment and Forestry of the Republic of Indonesia No. 68 of 2016. Therefore, special treatment

should be carried out in advance before the wastewater is discharged into the body of the water receiver with IPAL technology using the plastic medium of the pipe nest as well as using the method of combination of anaerobic and aerobic with the expected result that the wastewater meets the quality standards before discharge into the water recipient body. Here are the results of the preliminary testing of the wastewater quality of Mita Mulia Hotel.

No	Parameter	Units	Preliminary Test	Quality Standards	Description
1	pH	-	7,4	6-9	
2	COD	Mg/L	366	100	
3	BOD	Mg/L	236	30	
4	TSS	Mg/L	128	30	
5	Oil and Fat	Mg/L	3,55	5	
6	Ammonia	Mg/L	11,25	10	

Based on the above table, the pH and Oil and Fats parameters still meet the established quality standards, while the COD, BOD, TSS, and Ammonia parameters have passed the quality standards, so they require special treatment before discharging into the body of the water recipient. According to a study conducted by Neshart (2021), factors that influence high levels of BOD in wastewater are the content of organic material present in water, temperature, plankton density, pH values of dissolved oxygen, and the presence of microbes, which can result in the depletion of solute oxygen through the decomposition process of aerobic organic materials and a decrease in the pH value in water. TSS parameters are closely linked to the roughness in water caused by the content of suspended solid substances such as fine sand, clay, and natural mud, which is inorganic material or can also be organic material floating in water. Therefore, it is necessary to plan the construction of WWTP to treat the wastewater of Mita Mulia Hotel so that the quality of wastewater produced is environmentally friendly.

It is necessary to calculate the parameter of the pollutant load generated per day to determine the duration of each processing unit in the WWTP.

The calculation of wastewater drainage is based on the maximum capacity of the hotel guests as follows:

Known:

Total number of rooms: 48

rooms Maximum capacity: 202 persons

Number of employees: 11 persons

Wastewater potential: 80% of clean water use (Said,2017)

Debit calculation:

Volume of clean water usage by guests = 202 persons x 150 L/person/day0

= 30.300 L/ day
 = 30.3 m³/day

Volume of clean water use by employees = 11 persons x 75 L/person/day
 = 825 L/day
 = 0.825 m³/day

Water usage volume = 30,3 M³/day + 0,825 M³/Day
 = 31.125 L/day + 20%
 = 37.350 L/Day
 = 3.735 L/person/Hour

Waste volume = 37,350 m³/Day + 80%
 = 29,88 M³/Day
 = 30 M³/Day
 = 30,000 L/Day
 = 3,000 L/hour

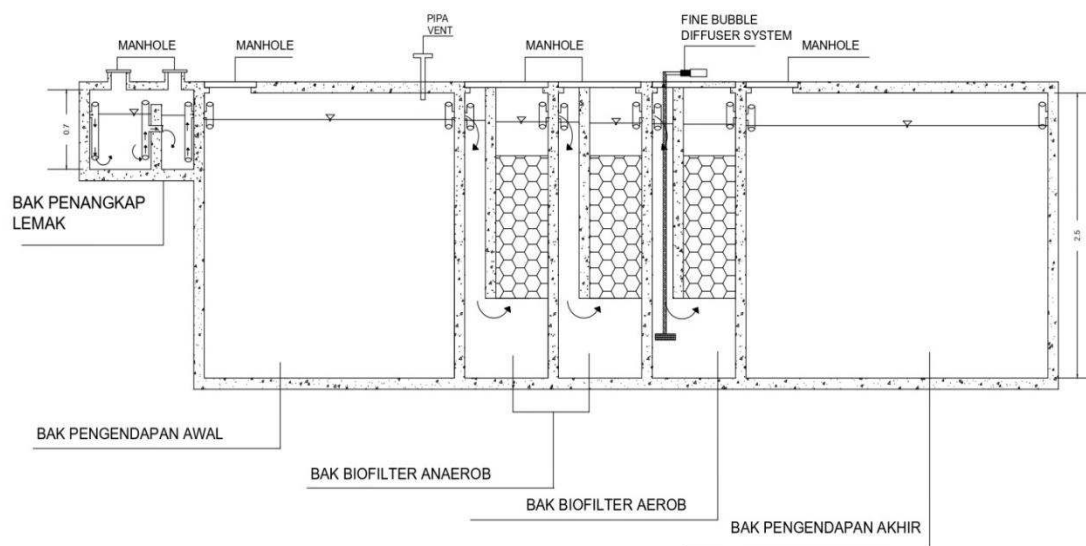


Figure 1. Design of Domestic Wastewater Treatment Installation

Conclusion

Based on the results of the WWTP domestic design calculations for Mita Mulia Hotel, it can be concluded that:

1. The calculation of wastewater leakage, carried out based on primary, secondary, and administrative data, has been obtained. The wastewater discharge generated by Mita Mulia Hotel is 30,000 Liters/day. Using clean water for 10 hours/day results in a depletion of 3,000 Litres/person/hour.
2. The wastewater treatment technology that can be applied at Mita Mulia Hotel uses an anaerobic and aerobic biofilter system consisting of 5 compartments, namely a Grease Trap, Primary Sedimentation Tank, Anaerobic Biofilter Tank, Aerobic Biofilter Tank, and Secondary Sedimentation with a total area of 18,75 m³.
3. The Bill Of Quantity (BoQ) work to be planned is land excavation, sand grinding with compression, K-225 concrete, building wall concrete, and building cement work. There is also the work of concrete iron, floor cutting, wall cutting, and roof cutting.

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