Design of Hazardous Waste Storage Area for Fecal Sludge Briquettes by Waste Impoundment in Indonesia

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Abstract

The high production and sufficient calorific value content of the fecal sludge make it can be made as a raw material for producing briquettes. This supports the world's program in an effort to create alternative energy to replace fossil fuels. The purpose of this research is to design a production building and storage of fecal sludge into briquettes in a sewage treatment company so as to minimize the potential hazards of the sludge (accidents in the work placement and the negative impact on the environmenty) as flammable hazardous waste. At the beginning of the design, 3 alternative designs were assessed using the Analytical Hierarchy Process (AHP) method. the chosen alternative is alternative 3 with the proposed redesign of the briquette storage building, production site, and fecal sludge storage area separately, where the sludge storage area which was originally a hangar was converted into a waste impoundment system. The building design criteria for alternative 3 are fire-resistant buildings whose specifications are regulated by the Indonesian National Standard 03-1736-2000 and several other regulations (PERMENLHK No. 12, 2020 and BAPEDAL No. 1, 1995). With a planned storage duration of 1 year, the waste impoundment is designed to cover an area of 2304 m^3 of fecal sludge, 72 storage drums for carbonated sludge, and 95 storage drums for fecal sludge briquesttes. In addition, the waste impoundment design is based on the PERMENLHK standard No. 12 of 2020. Waste impoundment can reduce the pH and Total Suspended Solid (TSS) of hazardous waste to below the quality standard threshold. the acidity level of the waste can be neutral to pH 7.79 (threshold 6-9), and TSS down to 86.67 mg/l (threshold 200 mg/l). The results of this study can make a major contribution to the field of hazardous waste management, especially fecal sludge, not only for Indonesia but also for countries that have similar conditions.

Keywords: Analytical Hierarchy Process, Calorific Value, Fecal Sludge Briquette, Flammable Hazardous Waste, Waste Impoundment

Introduction

The use of biomass energy as fuel is one solution to create alternative energy based on waste. This is a special concern at this time because it can reduce the volume of waste and minimize the use of fossil fuels (Riandy, 2022; Strande et.al., 2014). One form of waste-based energy is charcoal briquettes made from feces and organic waste. These fecal sludge and organic waste have the potential to be processed into charcoal briquettes because it is available in abundance and has not been widely used.

Fecal sludge is sourced from household waste consisting of feces, urine, and other wastewater such as bathrooms, kitchens, and laundry, containing 99.9% water and 0.1% solids (Kusnoputranto, 1997; Kusnoputranto & Susana, 2000). Along with the times, population growth is directly proportional to the increase in the amount of waste produced. Moreover, big cities produce more domestic waste than small cities (Silvia, 2015). Jakarta as the nation's capital is able to produce an average of 5600 tons of waste every day, of which 55.37% is organic waste (PUPR, 2017). This makes the problem of feces and garbage a matter that must be followed up so as not to pile up and have a bad impact on the environment. One of the largest waste treatment companies in Indonesia must accommodate the volume of sewage sludge up to 104400 m^3/year. The high volume of sludge produced has prompted a study on the utilization of the final sludge into charcoal briquettes as a source of power generation in the area. The results showed that the calorific value of the sludge briquettes was around 4000 Cal/gram with a burning rate of 0.0406 gram/second. This proves two things, namely, fecal sludge briquettes do have the potential to be an alternative energy source based on waste but need special handling because they can be categorized as flammable hazardous materials.

Currently, the company is developing a bio-drying method for fecal sludge to then turn it into fecal sludge briquettes but the process is still very simple using bamboo cages. This has the potential to endanger the parties around the company from exposure to hazardous waste. In addition, the briquette storage and production area also function as a place to store machines and other materials. Therefore, the fecal sludge briquette management system needs to be designed in accordance with flammable hazardous material standards starting from the raw material storage process, production, to product storage. This needs to be done to minimize the potential for fires in storage warehouses and production warehouses for fecal szasludge briquettes, as well as to minimize accidents in the work placement and the negative impact on the environment.

One method that has been widely used for hazardous waste storage is waste impoundment. waste impoundment can prevent the leakage of hazardous waste pollutants into groundwater and the runoff of hazardous waste caused by management activities or natural events. This method is also relatively economical because it can reduce the volume of hazardous waste by bio-drying within a planned period of time. If it is not processed into a new product, hazardous waste can be sent to the processor in less frequency so as to reduce transportation costs (PPRI, 2020). Besides, this research also discusses about a place for storage and production of briquettes that can meet flammable hazardous material storage standards based on the laws and regulations in Indonesia.

Previous research on the waste impoundment have been conducted, however there is no research about design of waste impoundment for fecal sludge as well as the place to store the sludge and its production process into briquettes. Strande et.al have done research about fecal sludge management related to system approach for implementation and operation in low – middle-income countries (Strande et.al., 2014), while McSpirit et.al., discussed about risk perception after coal waste impoundment failure (McSpirit et. al., 2007). Geotechnical properties of mine sediment in impoundment have already investigated by Slavik on 2018, where waste impoundment was also analyzed in the state of Indiana by Walsh et al., on 2006 (Slavik, 2018; Walsh et al., 2006). Research on mapping waste impoundment in the Western U.S related to understanding community context and risk, migration and fate of metallic elements in a waste mud impoundment and affected river downstream in South China, and Coal combustion waste impoundment have conducted (Greenberg, 2016; Chen et. al., 2018; Dewberry & Davis, 2009). The results of this study can make a major contribution to the field of hazardous waste management, especially fecal sludge, not only for Indonesia but also for countries that have similar conditions. This research aims to design a better system for management of fecal sludge-based briquettes in accordance with Indonesian government regulations regarding the management of hazardous material and hazardous waste (Government Regulation No. 74 of 2001).

Material and Methods

The form of this research is quantitative - descriptive where primary data were used to calculate exact figures on the generation of sewage sludge and the existing conditions where the disposal is carried out. Meanwhile, secondary data were obtained from various literatures to support the design analysis. With this, it is necessary to consider in determining alternative solutions to solve the problems. There are 3 alternatives to be considered, namely:

1. Alternative 1: The first alternative is to add a briquette storage area and a mud storage area in the building using a compact model. In the existing building, a briquette storage room with fire-resistant construction was added. The addition of this room aims to facilitate the storage of briquettes after the production process, this can also minimize the use of transportation because the briquette storage and mud storage are still in the same building as the production site.
2. Alternative 2: This alternative is planned to redesign the design of the briquette storage

building and production site, as well as a separate sludge storage area, where the sludge storage area utilizes a hangar and uses HDPE drums as a sludge storage container. The existing production building was redesigned into a building with concrete masonry in order to minimize the occurrence of fires and to add storage space for the briquettes that have been produced.

3. Alternative 3: Redesign of the briquette storage building, production site, and sludge storage area separately, where the sludge storage area which was originally a hangar was converted into a waste impoundment system. The existing production building has been redesigned into a building with concrete masonry in order to minimize the occurrence of fires and to add storage space for the production.

The selection of design alternatives is based on analysis using the Analytic Hierarchy Process (AHP) method with budget plan criteria, land area, impact on the environment, and energy use. AHP helps in determining the priority of several criteria by conducting a pairwise comparison analysis of each criterion. In determining the Analytic Hierarchy Process (AHP) it is necessary to prioritize the order of criteria to be the basis for the assessment reference.

Cost is an important criterion in the assessment because in this project the minimum expenditure is desired. Land area is the second priority because in this project, large enough land is needed so that the design capacity can be fulfilled. Then the impact on the environment becomes the third priority because the impact on the environment resulting from this project can still be overcome by applying waste impoundment as an effort to control water pollution and silencers to overcome noise problems. Then the use of energy becomes the last priority in the criteria, because the energy requirements (diesel fuel) in each alternative design tend to be the same and not too large.

a. Budget plan

Economic analysis is one of the considerations for selecting which design alternatives to use. Economic analysis is carried out using the budget Plan. Alternative 1 spend about 1.273.418.996 IDR for demolition preparation costs, foundation costs, finishing costs and additional costs (compact building). Alternative 2 spend about 1.780.039.709 IDR for two separate buildings (fecal sludge storage and briquette production & storage), while alternative 3 spend about 1.044.863.750 IDR for waste impoundment and briquette production & storage building.

b. Land area

In alternative 1, which only uses 1 building (sludge hangar) requires a land area of 1,058.4 m^2 with building dimensions of 54 x 19.6 x 3.14 m. The sludge hangar is then partitioned into 4 parts where the area for storing dewatered sludge is 686 m^2; briquette production site with an area of 215.6 m^2; and storage of dry sludge and storage of finished briquettes covering an area of 98 m^2 each. While in alternative 2 and alternative 3, 2 buildings are used consisting of a sludge hangar covering an area of 1,058.4 m^2 with building dimensions of 54 x 19.6 x 3.14 m and a briquette hangar covering an area of 160 m^2 with building dimensions of 20 x 8 x 5.78. m. In these two alternatives, the briquette hangar will be partitioned into 3 parts where the briquette production space will be designed with an area of 80 m^2 with dimensions of 10 x 8 x 5.87m; as well as a dry sludge storage room and a briquette storage room each covering an area of 40 m^2 with room dimensions of 10 x 4 x 5.87 m. The estimated land area calculation is based on manual calculations with direct surveys of existing conditions in the field. The comparison of land area on the three alternatives can be seen in Table 1.

Tabel 1. Land requirements for each alternative design

Alternative	Sludge Storage Area (m^2)	Land Area for Briquette Production and Storage (m^2)	Total Area (m^2)
Alternative 1	637	421,4	1.058,4
Alternative 2	1.058	160	1.218
Alternative 3	1.058	160	1.218

c. Energy Use

The use of energy in the alternative design using diesel as vehicle fuel to transport sludge at the factory. In the first alternative, the energy use is 0 due to the sludge storage is integrated with the briquette production hangar so that it does not require a vehicle to move the sludge. In the second alternative, the use of diesel fuel is 7.69 liters due to the separate location with a distance of 1.5 km so that it requires a sludge transport vehicle. In the third alternative, the use of diesel fuel is 7.69 liters because the location of the waste impoundment to the briquette hangar is 1.5 km away, so it requires a sludge transport vehicle. The number of 7.69 liters is obtained from usage data for a month (26 working days), which is 200 liters (the average usage per day is 7.69 liters).

d. Impact on the environment

Analysis of the environmental impact assessment of each alternative seen from the aspect of noise and water pollution with a severity rating based on the risk assessment table by Aven & Cox (2020) (see Table 2). In the first alternative, the increase in probability reach to 4 due to the location of the briquette production site with combined briquette and sludge storage areas so that if workers are exposed to it continuously, it can have an impact on workers' hearing. The use of a hammer mill machine in the briquette production process is estimated for 5 hours per day, the level generated from the machine is 96 dB (Nofirza & Sepriantoni, 2015). Referring to the Regulation of the Minister of Labor and Transmigration of the Republic of Indonesia No. 13 of 2011 concerning Threshold Values for Chemical Factors in the Workplace, the time to use the machine exceeds the predetermined limit. It should be as high as 96 dB then the allowed exposure time is 30 minutes (PPRI, 2011). This is very disturbing hearing and focus on work, where speech at work is not heard clearly. Then the impact on water can be categorized as moderate because the dewatering process, the sludge to be stored still has a water content of 7% (PUPR, 2017). While the remaining water content can be stored in the HDPE drum which has a low possibility of leakage. And if it occurs, the ratio of damage occurs will be high because the sludge has a concentration of BOD5 value of 7000 mg/L (Metcalf & Eddy, 1991), so it can pollute water bodies and the surrounding environment. According to the Decree of the Minister of Environment No. 112/2003 concerning the quality standard of domestic wastewater, the BOD5 content permitted to be discharged into waters is 100 mg/L (RI, 2003).

Table 2. Assessment of Severity Ranges on Environmental Impacts

		Severity of Harm (Impact)		
		Low (L)	Medium (M)	High (H)
Likelihood	High (H)	3	4	5
	Medium (M)	2	3	4
	Low (L)	1	2	3

Source: Aven & Cox, 2020

In the second alternative, the scale of noise is smaller than in the first alternative (2) because the production location and storage are not integrated, and noise will only occur at the production site. However, because in the production of briquettes the hammer mill tool is used for 5 hours and the noise generated from the machine is 96 dB (Nofirza & Sepriantoni, 2015), then workers can be exposed indirectly to the noise of the tool and if it continues it can disturb workers. Furthermore, water pollution has a high severity level compared to alternative 1, due to storage of sludge in alternative 2 using sacks. The use of these sacks can result in easy leakage if the stored sludge still has a large enough water content. The water content contained in the sludge can contaminate water bodies or the surrounding environment. Although the stored water content is the same as alternative 1, which is 7%, however, the level of possibility of leakage is greater, this is because the use of sacks is more prone to leakage than HDPE drums.

In the third alternative, the ratio of severity to noise is 2 because the location of the production site and the storage area are not integrated. However, because in the production of briquettes the hammer mill tool is used for 5 hours and the noise generated from the machine is 96 dB (Nofirza & Sepriantoni, 2015), then workers can be exposed indirectly to the noise of the tool and if it continues it can disturb the workers' hearing. Then the water pollution in the third alternative has a low ratio because the water is accommodated using a waste impoundment system, so that water can be systematically directed to water reservoirs to prevent spread.

Analytical Hierarchy Process (AHP)

The AHP method is different from other selection methods because it does not use utility theory, but a decision-analytic approach. AHP can give better result because of the broader knowledge. Moreover, the possibility of debates that may arise and change people's understanding is also an advantage of AHP method (Danner & Grote, 2017). Obtaining preferences with comparisons between decision criteria and alternatives can be done on AHP (see Table 3) (Saaty 1977; Dolan 1989). In order to measure the logical consistency of pairwise judgment within alternatives, AHP allows calculation of a "consistency ratio (CR)". Consistency index (CI) and random index (RI) are needed for getting the number of CR. Basically, CI/RI defines CR. The closer CI and RI are, the higher the CR and the greater the probability that judgments in a comparison matrix result from a completely random decision process. The smaller the CI in relation to the RI, the smaller the CR and the higher the probability that judgments are the result of a consistent decision process (Danner & Grote, 2017). In this paper, by doing an assessment of the importance of each alternative based on the range of criteria weights, the results of the criteria assessment for each alternative are determined as shown in Table 4. In addition, CR value of the criteria weight assessment were obtained 0.060 (comparison between alternatives), 0.09 (comparison between budget plan criteria of alternatives), 0.000 (comparison between budget plan criteria of alternatives), 0.012 (comparison between impact on environment criteria of alternatives), and 0.000 (comparison between energy use criteria of alternatives). When the value of CR<0.1 (Saaty, 1990), then the inconsistency of the alternatives being compared is acceptable. Based on Table 4, alternative 3 has the highest weight (0.669) so the chosen alternative is the design of the storage and production of briquettes based on sludge with separate waste impoundment

Table 3. Criteria Weight Range

Level of Importance	Definition
1	just as important as the others
3	moderate importance than others
5	more important than others
7	very strong importance than others
9	extreme/absolute importance over others
2, 4, 6, 8	the value between two adjacent values
Reciprocal	if element i has one of the above numbers when compared to j, then j has the opposite value when compared to element i

Source: Saaty 1977; Dolan 1989

Table 4. Results of the Assessment of the Weight of the Criteria on Each Alternative

Alternative	Budget Plan	Land Area	Impact on Environment	Energy Use	Comparison of Weights between Criteria and Criteria
A1	0.185	0.111	0.094	1.957	0.251
A2	0.064	0.444	0.168	0.217	0.173
A3	0.751	0.444	0.738	0.217	0.669

Result and Discussion

The re-design of the briquette production system includes redesigning the briquette production hangar and the sludge storage hangar for briquette production. The calculations for the planning design of the two buildings are:

1. Calculation of Design of Fecal Briquette Production and Storage Buildings

Production of fecal sludge is planned with a production period of 1 year, where in 1 year the sewage treatment at the factory produces 2,304 m^3 of fecal sludge. The target for using fecal sludge as raw material for briquettes is 50% of the sludge generated from processing for 1 year (1.152 m^3). There are 10 carbonation machines available in the factory for briquette production 30kg/machine/day. It can be calculated that the factory can produce about 300kg briquettes/day. If we plan the shelf life of carbonated sludge is 2 days, 72 storage drums are needed. In addition, storage of fecal sludge briquettes is planned with a shelf life of 2 months, means 96 storage drums are needed (19.2 m^3 briquettes were produce in 2 months). The design criteria for fecal sludge briquette production and storage building is shown in Table 5.

Table 5. The Design Criteria for Fecal Sludge Briquette Production and Storage Building

No.	Design Criteria for Fireproof Building	Reference	Design	Explanation
1.	Wall			
a	Walls, columns, and other building materials must be of non-combustible materials, using reinforced concrete with a minimum thickness of 15 cm, red brick walls with a minimum thickness of 23 cm, and blocks with a thickness of 30 cm.	SNI 03-1736-2000	✓	Column walls and materials used reinforced concrete
2.	Floor			
a	Located directly above the ground	SNI 03-1736-2000	✓	The floor is directly above the ground
b	Floor with open access (to accommodate electrical service and electronic equipment)	SNI 03-1736-2000	✓	
3.	Roof			
a	Fully installed sprinkler system according to applicable standards	SNI 03-1736-2000	✓	There are 3 sprinkler systems installed
b	Having an effective height of not more than 25 m and a ceiling directly under the roof having a resistance to the initial spread of fire to the roof space of not less than 60 minutes.	SNI 03-1736-2000	✓	
c	Roof light holes have a total area of not more than 20% of the roof surface area	SNI 03-1736-2000	✓	
d	Located not less than 3 m from the boundary of the building parcel, and does not apply to	SNI 03-1736-2000	✓	

	boundaries with roads or public spaces				
e	Located not less than 3 m from each roof light hole or the like which is located in an adjoining single dwelling	SNI 03-1736-2000	✓		
f	Located not less than 3 m from any roof light holes or the like in adjacent building parts separated by fire-resistant walls	SNI 03-1736-2000	✓		
No.	Design Criteria of Fire Suppression System				
1.	Fire detection systems and equipment	PERMENLHK No.12, 2020	✓		
2.	Other appropriate emergency response equipment	PERMENLHK No.12, 2020	✓		There is a fire extinguisher
No.	Design Criteria of Flammable Hazardous Material Storage				
1.	If the building is adjacent to another warehouse, a fire-resistant separation wall must be made in the form of a reinforced concrete wall, a minimum thickness of 15 cm	BAPEDAL No.1, 1995	✓		
2.	Location of emergency doors are not on the fireproof wals	BAPEDAL No.1, 1995	✓		
3.	If the building is separated from other buildings, the minimum distance from the building is 20 meters.	BAPEDAL No.1, 1995	✓		
4.	For structural stability in the fire retaining wall, it is recommended that reinforced concrete poles used are not penetrated by electrical cables	BAPEDAL No.1, 1995	✓		
5.	The supporting structure of the roof consists of non-combustible materials. The roof construction is made light, and easily destroyed when there is a fire, so smoke and heat will easily escape.	BAPEDAL No.1, 1995	✓		
6.	Lighting, if using lamps, must use an installation that does not cause an explosion / electric spark (explotion proof)	BAPEDAL No.1, 1995	✓		

7.	Other factors that must be met			
a	Fire detection and suppression system	BAPEDAL No.1, 1995	✓	
b	Water supply for fire fighting	BAPEDAL No.1, 1995	✓	
c	Fire hydrants and hydrant protection	BAPEDAL No.1, 1995	✓	
No.	Criteria for storing hazardous waste using drums			
1.	Stacked by packaging type		✓	
a	For packaging in the form of plastic drums with a capacity of 200 liters, the stack is at most 3 layers with each layer given a pallet base for 4 drums	PERMENLHK No.12, 2020	✓	The drums are laid out in 3 stacks and each stacked on a pallet pad.
2.	The distance between the stack of packaging and the roof is at least 1 (one) meter	PERMENLHK No.12, 2020	✓	
3.	Stored in a block system with the condition that each block consists of 2 x 3 and has a width of at least 60 cm between blocks or adjusted to operational needs for human traffic and transport vehicles (forklifts).	PERMENLHK No.12, 2020	✓	Drums are stored with an aisle width between blocks of 60 cm
No.	Hazardous Waste Packaging Criteria Using Drum			
1.	Marked with symbols and labels in accordance with the provisions regarding marking on hazardous waste packaging	PERMENLHK No.12, 2020	✓	
2.	Always tightly closed and only opened if there will be addition or collection of hazardous waste from it	PERMENLHK No.12, 2020	✓	
3.	Stored in a place that meet the requirements for storing hazardous waste and complies with storage procedure	PERMENLHK No.12, 2020	✓	
4.	Packages that have been emptied, if they are to be reused to pack other hazardous waste with the same characteristics, must be stored in a hazardous	PERMENLHK No.12, 2020	✓	

	waste storage facility with the label "EMPTY"

2. Calculation of Waste Impoundment Design
waste impoundment is designed in the form of a prism where the surface area is wider than the base area. The surface area is 637 m^2 (P x L = 49 m x 13 m), and base area is 517 m^2 (P x L = 47 m x 11 m). The volume of waste impoundment is calculated (height = 4 m) as V = 1/3 x h x ((A1 + A2) + (A1 x A2)^{0,5}) and obtain 2304 m^3. Therefore, designed waste impoundment capacity can accommodate the amount of sludge generated for 1 year of production, which is 2304 m^3. Waste Impoundment will be equipped with several facilities, which is shown in Table 6.

Table 6. Design and Design Criteria for Waste Impoundment

Design Criteria	**Reference**	**Design**	**Explanation**
Have embankments around the waste impoundment with a height of at least 1 (one) meter from the ground surface to avoid water overflow.	PERMENLHK No.12, 2020	✓	The size of the embankment is 1 m high and 0.5 m wide.
Have a spillway to drain water of hazardous waste from water storage ponds.	PERMENLHK No.12, 2020	✓	Spillway building around the waste impoundment with a height of 0.5m and a width of 0.2m to accommodate spilled water and drain it to the water treatment unit. In addition, waste impoundment is also accompanied by a pipe at the bottom with a pipe diameter of ½ inch to drain water when a leak occurs to the water treatment unit.
Has a groundwater monitoring well facility that is built in the upstream and downstream parts of the waste impoundment facility which is placed according to the pattern of the direction of groundwater flow.	PERMENLHK No.12, 2020	✓	Groundwater monitoring well facilities are built in every corner of the waste impoundment building with a

			height of 4m with a width and length of 0.3m.
Have first aid facilities, spill handling and loading and unloading equipment.	PERMENLHK No.12, 2020	✓	Designed with additional first aid and emergency response facilities, spill handling equipment facilities and loading and unloading facilities.
Built using concrete construction.	PERMENLHK No.12, 2020	✓	There are 2 layers of concrete.
Coated with waterproof construction material.	PERMENLHK No.12, 2020	✓	Coated with mixed materials so that the concrete is designed with a waterproof concrete construction.
Flood free area	PERMENLHK No.12, 2020	✓	
Not prone to natural disasters such as landslides, volcanic hazards, earthquakes, faults, sink holes, subsidence, tsunamis, or mud volcanoes.	PERMENLHK No.12, 2020	✓	
The maximum soil permeability is 10^{-5} cm/second.	PERMENLHK No.12, 2020	✓	Built in the factory area which is dominated by clay soil, so it has a soil permeability of less than 10^{-5} cm/second.

Have an impermeable layer above the ground with a maximum permeability of 10-7 cm/second in the form of high-density polyethylene (HDPE) and/or a layer of concrete construction.	PERMENLHK No.12, 2020	✓	Designed using an additional 1mm thickness geomembrane with a permeability of 10-12 cm/second.

Based on PERMENLHK No.12 (2020), waste impoundment can reduce the pH and Total Suspended Solid (TSS) of hazardous waste to below the quality standard threshold. the acidity level of the waste can be neutral to pH 7.79 (threshold 6-9), and TSS down to 86.67 mg/l (threshold 200 mg/l). The floor plan/sketch and sections of the production and storage building for sludge briquettes and waste impoundment can be seen in Figures 1, 2, 3 and 4.

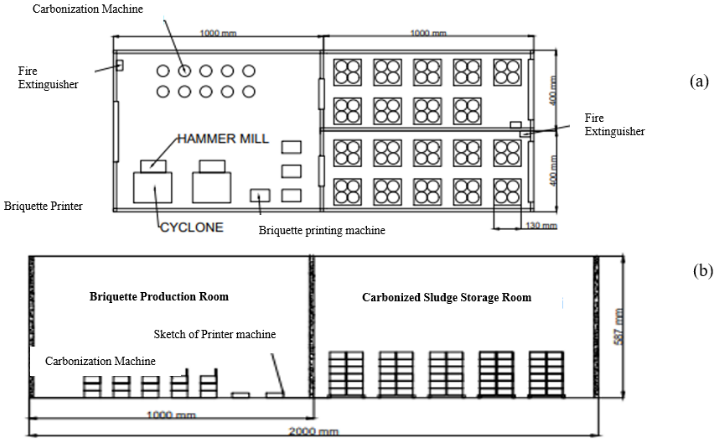

Figure 1. Design of the Production and Storage Building for Sludge Briquettes (a) Sketch, (b) Section

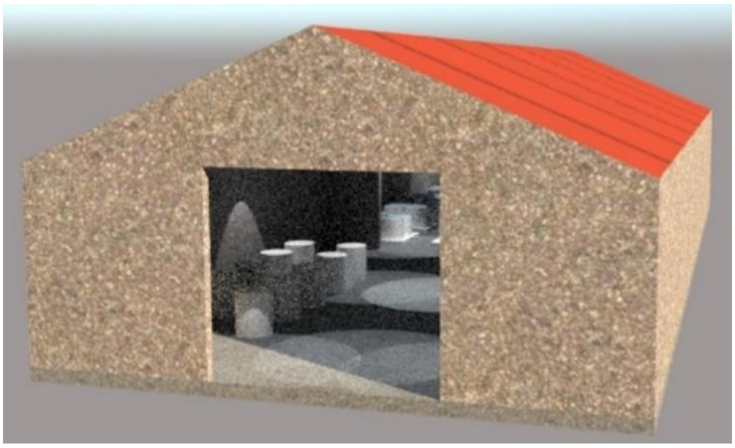

Figure 2. 3D Design of Hangar Briquettes

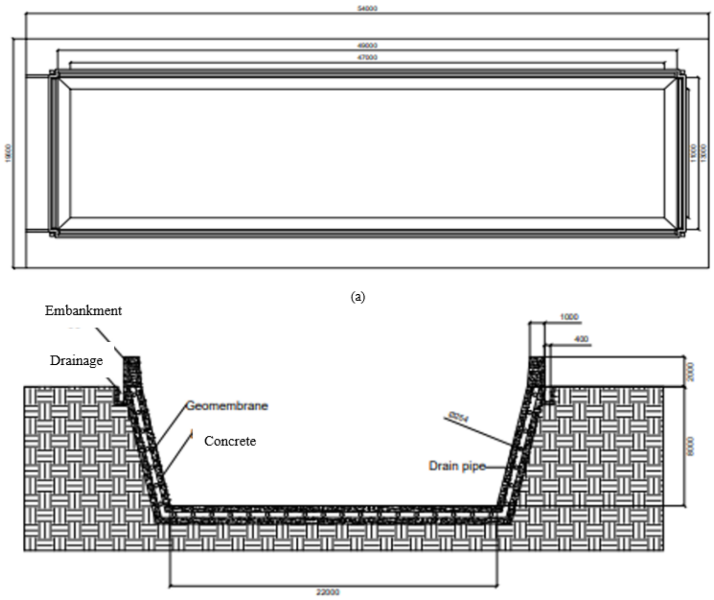

Figure 3. Design of the Waste Impoundment (a) Sketch, (b) Section

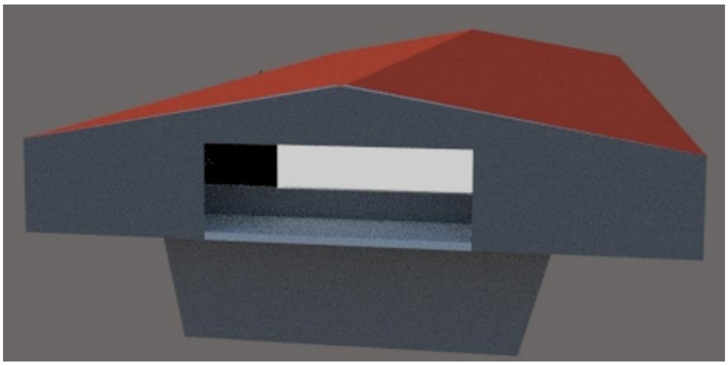

Figure 4. 3D Design of Waste Impoundment

Conclusion

Based on the 3 proposed alternative designs, alternative 3 was selected from the assessment using the AHP method. Alternative 3 is redesign of the briquette storage building, production site, and sludge storage area separately, where the sludge storage area which was originally a hangar was converted into a waste impoundment system. Based on the planning of production of sewage sludge for 1 year (2304 m^3 of fecal sludge) and 50% of production target into briquettes, it needs 72 storage drums for carbonated sludge and 96 storage rooms for briquettes. The design of the storage building and the production of sludge briquettes is planned based on Indonesian national standards and other related regulations (PERMENLHK No. 12, 2020 and BAPEDAL No. 1, 1995). These design criteria are design criteria for fire-resistant buildings. This is due to the flammable characteristics of fecal sludge. as well as the criteria for waste impoundment, designed based on the regulation of the ministry of environment and forestry No. 12, 2020. The volume of waste impoundment is designed to be the same as the company's sewage production in 1 year, which is 2304 m3. The shape of the building is a prism with a base smaller than the surface. With waste impoundment, sewage sludge can be neutralized with acidity to 7.79 (threshold = pH 6-9), and total suspended solids are reduced to 86.67 mg/l (threshold 200 mg/l).

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