The 4th ICIBA 2015, International Conference on
Information Technology and Engineering Application
Palembang-Indonesia, 20-21 February 2015

Design of Portable Digester for Domestic and Restaurant Organic Solid Waste Processing as Clean Biogas In Replacing LPG as Alternative Energy Source

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Abstract

Fuel consumption that reaches 1,3 millions/barrel is unbalance with production that only reaches 1 million/barrel. Its shortage, hence, has to be fulfilled by importing. This research is designated to apply biogas technology in the form of applicative Portable Digester, suitable for public under good quality, reasonable price and applicable in limited area. Based on the research, the selected designs for Portable Digester to be assessed using Scoring concept are: (a) design concept 2 that will later be applied as design A; (b) design concept 3 that will later be applied as design B; (c) design concept 5 that will later be applied as design C. The selected design concept is the concept B with score of 1,98.

Keywords : *biogas, digester, portable digester*

1 INTRODUCTION

The raise of worlds oil price provides huge effects to Indonesian development. Fuel consumption that reaches 1,3 millions/barrel is unbalance with production that only reaches 1 million/barrel. Its shortage, hence, has to be fulfilled by importing. According to 2006 data issued by ESDM, Indonesian oil reserves only 9 billion barrel remain. Excessive oil use will cause terrible consequences to earth, for instance global warming. It elevates within 1% raise every year and continues raising (Qasim 1994). For the last decades, alternative energy source that can be employed as the replacement of petroleum fuel are biofuel and biogas that using sustainable organic material or degradation process. Biogas is a gas that produces microbiologically from anaerobic organic waste (Khorsidi and Arikan, 2008). Biogas consists of methane CH4 (55-70%), CO2 (25-50%), H2O (1-5%), H2S (0-0,5%), N2 (0-5%) and NH3(0-0,05%) (Deublein dan Steinhauser, 2008). Entire biological process can be classified into four consecutive reactions, which are: hydrolysis (liquefaction), acidogenesis, acetogenesis and methanogenesis.

Anaerobic digestion process that is designated to produce biogas of organic matters is influenced by several factors, which are: (1) fermented substrate that is a better substrate

(Winarno, 1992); (2) anaerobe fermentation process is sensitive to temperature changes (Wellinger and Lindeberg, 1999), hence the increasing of temperature can enhance the production of biogas (Metcalf dan Eddy 2003; NAS 1981; Bitton 1999; Wllinger 1999); (3) Neutral pH ranged between 6,6 7,6 is the best pH to be used in anaerobe decomposition process (Ikbal et al 2003; Kadarwati 2003; Reith et al. 2002); (4) Volatile Solids (VS) are the food for hydrolysis process as well as acid formation anaerobically (Karki et al. 1994); (5) Total Solid is the solids that measured based on its remaining quantity (mg/l) on heating temperature between 103-105 C (Isa.etal.,1980); (6) hydraulic retention time (HRT) is the duration of substrate in reactor before flowing out as effluent (Kida et al. 1990)

Biogas process of organic matters that conducted by selecting wastes is reluctant to be performed by Indonesian people. Narrow area also emerged as other potential problems. Hence, the digester unit that produces biogas is created. It uses for cooking by using SOP for domestic scale. It turns to be an effective solution to bridge Indonesias two main problems. This unit later called as Portable Digester. This research is purposed to implement the biogas technology in the form of applicative Portable digester unit, under good quality, reasonable price and able to be installed on limited area. A business unit with capability of designing and producing the Portable Digester is expected as the result of the research. Therefore, it can be distributed to public with competitive cost. This designated to assist society to fulfill their needs on energy yet reducing the burden of governments subsidy cost on energy and waste management.

2 RESEARCH METHODOLOGY

2.1 Data Collecting

Data collecting is conducted under certain ways:

1. Interviewing the waste managements experts by proposing general questions in order to observe the biofuel process

2. Literature study, to be familiar with theories and basic concepts that related to product design and sources of references to formulate basic theories that later will be used as a basic of the research

3. Questionnaire distribution to assess the alternative designs as a filtering process and concept assessment.

2.2 Design Process

This process actively involves stakeholders that highly related to biogas process. Active participation on the designing process involves experts on biofuel, community of waste management and users. First stage consists of several steps. First step is team selection that consists of 1 person from mechanical engineering background, 1 person from waste management field, and another person as a representative of waste management community. Second step is designing Portable Digester with various alternatives by conducting routine discussion based on classification tree that already approved by other team members. Third step is conducting evaluations toward several design alternatives.

2.3 Design Selection

On this stage, Portable Digester unit design selection is performed out of several purposed alternatives under specific steps as follows: (1) Gathering all team members and explaining the method to fulfill the questionnaire; (2)Fulfilling the questionnaire conducted by team members; (3) Processing the questionnaire that will be later used to assess the alternatives of designs. The design that reaches highest score will be the selected design. It will be later designed as expected by waste management community on how a portable digester should be.

2.4 Raw Material and Tools in Making Portable Digester

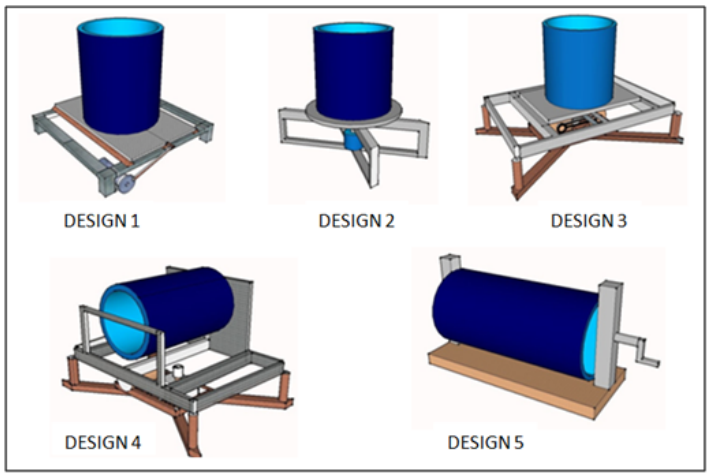

Figure 1: Designs of Portable Digester

Raw material and tools that will be employed are: (1) elbow plate 50x50x4 that is used as main frames supporting; (2) cutting grinding disc that is used to cut elbow plate; (3) Steel plate and axle are used to cover the main frame; (4) Bearing UFC and buckshot 30 mm for upper drum rotating axle; (5) Plastic drum with 220 liter capacity that used to hold the liquid of biofuel former; (6) elbow plate (40x40x4) 4 m for supporting upper drum; (7) bolt nut 14 mm to lock upper drum rotation; (8) trellis plate 4 mm to reinforce side main frame; (9) Bearing 6204 for drum rotating ball; (10) Steel pipe 5 inch to support additional main frame; (11) Various of glues and Shock pipes to flow the liquid inside or outside; (12) Various pipes and faucets for the flows; (13) Epoxy and putty for painting supporting; (14) Spray gun for painting spraying; (15) Thinner to dilute the paints

3 RESULT AND DISCUSSION

3.1 Need Identification of Waste Management Community

Portable Digester is designed based on communitys need as follows:(1)compact design (2)using available material (3)safe (4)reasonable production cost (5)good safety system (6)concise biogas process (7)Flexible usage (8)good durability and strong (9) considerably cheap.

Table 1: Design Concept Filtration of Portable Digester

Selection Criteria	**Alternative Design Concept**				
	Portable Digester 1	**Portable Digester 2**	**Portable Digester 3**	**Portable Digester 4**	**Portable Digester 5**
Compact Production	+	0	+	-	+
Easyto produced	-	+	-	-	+
Cheap Material	0	-	+	+	0
Appropriate extents	+	+	+	0	0
Easy to use	+	+	+	+	+
Easy to fix	-	0	0	-	+
Easyto maintain	0	+	+	0	-
Low Price	-	-	+	+	+
Total +	3	3	6	3	5
Total 0	2	2	1	2	2
Total -	3	2	1	3	1
Final Score	**0**	**1**	**5**	**0**	**4**
Level	**4**	**3**	**1**	**4**	**2**
Decision	**N**	**Y**	**Y**	**N**	**Y**

Description :

N = NO (Design is rejected)

Y = YES (Design is accepted)

3.2 Filtering Identification of Design Concept

The considerations on Portable Digester designing are the shape, materials and biogas process capacity. Based on the concept classification tree and interviews with community and experts of waste management, hence, five alternative concepts of Portable Digester are proposed. They are shown on below figure 1:

According to above five alternative designs, design filtering concept is then conducted. This filtering is based on society and designers assessment. The result of filtering concept is shown on table 1:

From the results shown by table 1, it can be concluded that:

1. Design concept 2 is accepted; therefore, it converted to be design A and later assessed using scoring concept.

2. Design concept 3 is accepted; therefore, it converted to be design B and later assessed using scoring concept.

3. Design concept 5 is accepted; therefore, it converted to be design C and later assessed using scoring concept.

Later, the concept design will be converted to A, B and C as illustrated by figure 2

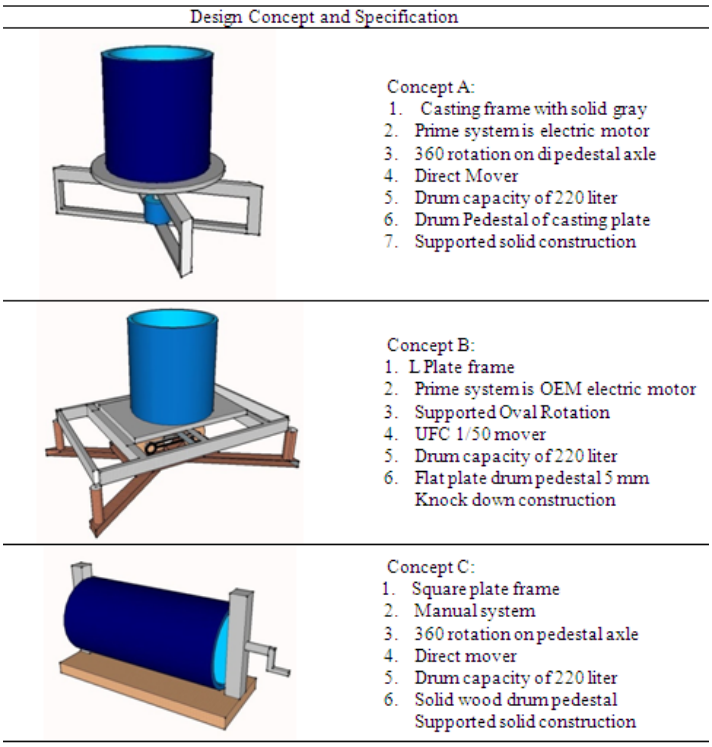

Figure 2: Concept design will be converted to A, B and C

3.3 Selected Portable Digester Design

Table 2 shows the result of filtering and concept assessment using scoring method, while, selected design is shown on figure 3.

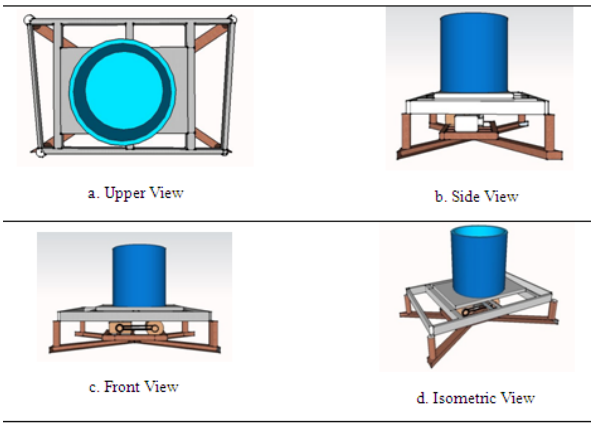

Figure 3: Design of Selected Portable Digester

The selected Portable Digester design is concept B with score of 1,98.

4 CONCLUSION

Based on the research, the selected designs for Portable Digester to be assessed using Scoring concept are: (a) design concept 2 that will later be applied as design A; (b) design concept 3 that will later be applied as design B; (c) design concept 5 that will later be applied as design C. The selected design concept is the concept B with score of 1,98. The design specifications of portable digester are as follows: (1) Frame of digester is using L plate; (2) prime system is using electric motor OEM; (3) rotating drum table is using oval that supported by UCF; (4) the table pedestal is using UCF 1/50; (5) drum capacity is 220 liters; (6) drum plate pedestal is 5 mm; (7) Whole construction is knock down system.

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