Plastic To Fuel Technology As Alternative Operation Of Gas Engine Sukawinatan Waste To Energy In Palembang

Plastic To Fuel Technology As Alternative Operation Of Gas Engine Sukawinatan Waste To Energy In Palembang

N Fithri and E Fitriani
Departement of Electrical Engineering, Universitas Bina Darma, A Yani 12, Indonesia

Email: normaliaty@binadarma.ac.id

Abstract. Construction of power plant (PLTSa) which can produce energy up to 500 kWH. Sukawinatan landfill which is predicted to produce CH_4 around 12 nmh3 / hour in each well, with the calculation of 50 wells can produce 600 nmh3 / hour. However, for the current status, it turns out that CH_4 at TPA wells which able to generate up to 500 kW in volume decrease so that it can only operate with a load of 45-94 kW, therefore in 2018 PLTSa Optimization review has been carried out Sukawinatan which is a study of composition calculation waste and gas potential as a basis for consideration for the development of TPA wells including the technical design. The optimization of PLTSa Sukawinatan has not been implemented because the generating capacity has not yet received the best value due to technology that did not meet the requirements. In this study, researchers used a Descriptive Action Research methodology focused on implementing actions aimed at improving quality and providing solutions problems in the area under study. The Ministry of Energy and Mineral Resources offers an alternative use of PLTSa Sukawinatan with the addition of the Plastic to Fuel scheme as a solution for generating fuel. It is expected this research can contribute to the Government of the City of Palembang and the Palembang community as a result of the application of waste management as a source of sustainable electrical energy source of lighting for Palembang.

1. Introduction

According to Law No. 30/2007 concerning ENERGY, the Government of the Republic of Indonesia states that energy will be managed under the principle of beneficial use, rationality, fair efficiency, increased value added, sustainability, community welfare, preservation of environmental functions, national security, and integrity by prioritizing national capabilities.

Clause 20 paragraph (5) : Provision of energy from new energy sources and renewable energy sources carried out by business entities, permanent businesses, and individuals can obtain facilities and / or incentives from the Government and / or regional government in accordance with their authority for a period of time certain. One of the types in question is PLTSa Renewable Energy Technology.

Construction of a waste power plant (PLTSa) Sukawinatan in Palembang is a form of accelerated scenario accompanied by efficiency in energy requirements implemented by the Central Government and the City of Palembang as a guarantee of energy availability and supply of industrial needs that can be optimally utilized by the people in Palembang City.

The Ministry of Energy and Mineral Resources through the Directorate General of New Energy and Renewable Energy Conservation (EBTKE) has built a power plant at the Sukawinatan landfill site in Palembang City. The construction of a waste power plant (PLTSa) in the future can produce up to 500 kWH of energy.

It is predicted that Sukawinatan landfill can produce methane gas (CH_4) of around 12 nmh3 / h in each well LFG, with a calculation of 50 wells can produce 600 nmh3/h. The use of waste into electricity is the first time in Indonesia. Already 50 drill wells are installed pipes to the engine engine. [1].

Data: commissioning Wt'E Sukawinatan 2016

Figure 1. Sukawinatan Well LFG

However, for the current status, it turns out that methane gas (CH_4) in landfill wells that are able to generate up to 500 kW has decreased in volume so that it can only operate average a load at 45-94 kW for Normally Stady State and 300 kW for Test Engine with Dummy Load.
For this reason, in 2018 a technical study on the optimization of Sukawinatan PLTSa has been carried out, which is a calculation of the composition of waste and gas potential as a basis for the consideration of developing landfill wells, including its technical design. calculation of the composition of waste and gas potential as a basis for consideration for the development of landfill wells including the technical design.

2. State of the art

The optimization of PLTSa Sukawinatan has not been implemented because the generating capacity has not received the best value because of the technology with the condition of raw materials that do not meet the requirements. The Ministry of Energy and Mineral Resources offers an alternative utilization of PLTSa Sukawinatan if the assets have been handed over, namely by the scheme: Reducing landfill waste with Local Waste Processing Site. (Local waste management system using aerobic fermentation, pelletization and gasification methods) which is called by Plastic to fuel. The final mechanism of cooperation will be carried out between the Regional Government or BUMD.

This method has a useful output, namely:

a. The pellets produced can be used as substitutes for firewood for households and SMEs (The Pilot Project was carried out in Gunaksa Village, Klungkung Regency, Bali. Needs of 86 tons pellets / 24hour running day using a gas engine by generating 40 kW of electricity. Additional needs are engine enumerator and gasifier)
b. Processing plastic waste into synthetic fuel.

It is expected that with this proposed method scheme, the existing plants can be used and produce electricity.

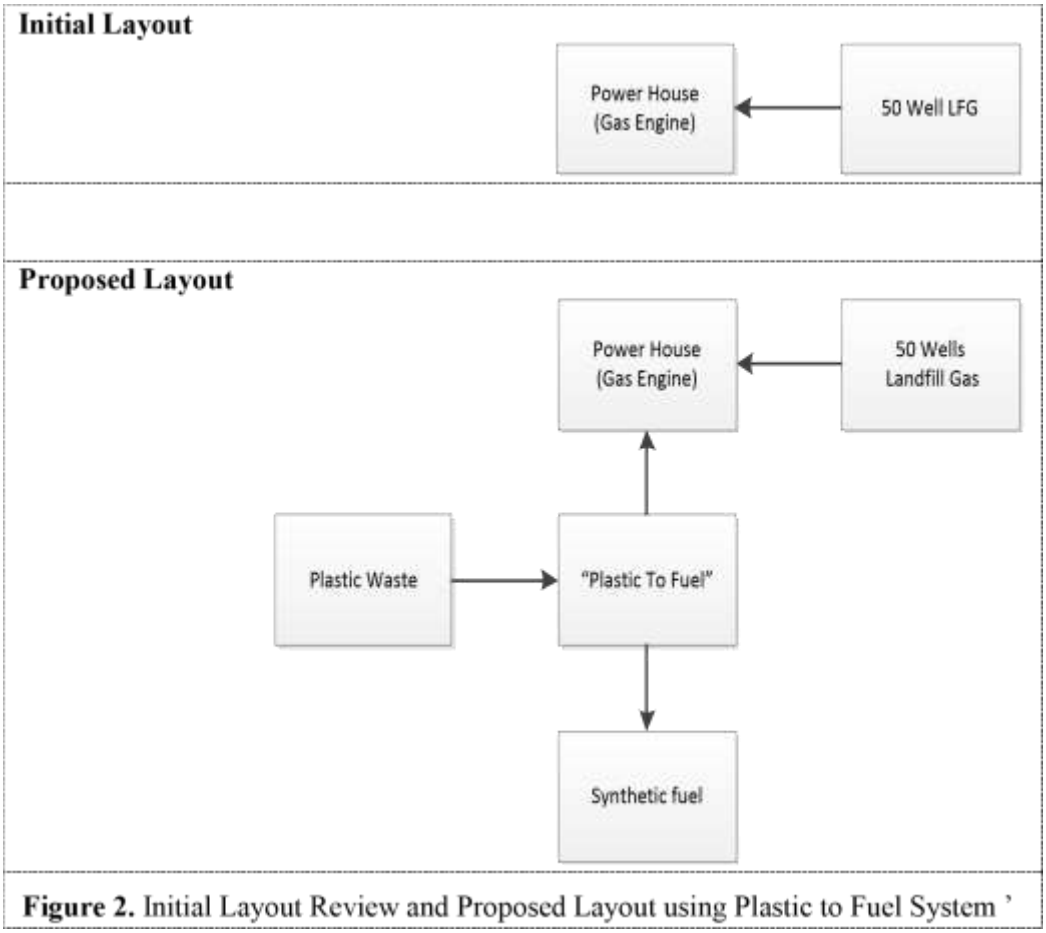

Figure 2. Initial Layout Review and Proposed Layout using Plastic to Fuel System '

3. Method and Procedure

3.1 Descriptive Action Research Method
Descriptive method is finding facts with the right interpretation [2].

There are main characteristics in the descriptive method, namely:

- Focusing on the actual problem.
- Describe facts facts that focus on balanced rational interpretations.
- Not only gives a description of the phenomena, but also explains the relationship, testing and producing predictions of a problem.

Grundy and Kemmis (1990: 322) suggest that for an Action Research study there are two main objectives, namely involving (involving) and improving (improving). Descriptive Action Research is a research that focuses on the implementation of actions aimed at improving quality and providing solutions to problems in an area studied and making observations on the success of their actions [3].

According to Kemmis and McTaggart (1982), there is a model used which is a cycle that will always rotate :

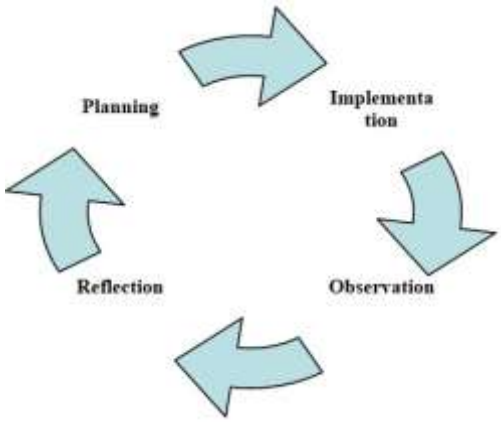

Figure 3. Cycle that always rotates

3.2 Method implementation

Beginning with the steps of planning, implementing, observing, and reflecting which is the implementation of the cycle model that is always rotating.

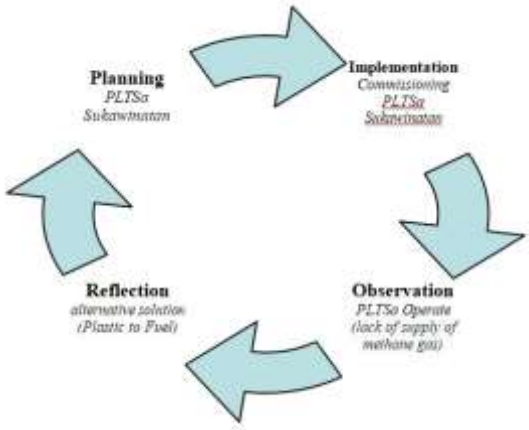

Figure 4. Solution Cycle

a. Planning

2014, PLTSa Sukawinatan Development

Gas volume formed

The Sukawinatan landfill produces methane gas of 12 nm3 / h in each well (LFG), with a calculation of 50 wells producing 600 Nm3 / h.

$$V_{TPA} = Vm \times W_{LFG}$$
$$= 12 \text{ nm3/h} \times 50 \text{ well LFG}$$
$$= 600 \text{ Nm3/h}$$

The Sukawinatan TPA Sukawinatan Landfill Power Plant (PLTSa) development plan is a 500 kW electricity generation from the Landfill gas Methane gas extract, estimated to require approximately 270 - 300 Nm3 / h as fuel for the gas engine. [4].

Landfill Gas to Energy Design

Domestic waste in the Sukawinatan landfill which is processed by the Landfill sanitary system will produce biogas in the form of methane gas (CH_4) which can be used as an energy source in the gas engine to produce electricity. [4].

b. Implementation

2015, March - Construction completed, End of year - Commissioning of PLTSa Sukawinatan

Figure 5. Power House Sukawinatan

c. Observation

2016, April - Commissioning of PLTSa Sukawinatan is complete

Table 1. Test Engine with Dummy Load --August 15, 2015

Time	Voltage			Ampere			Load			Keterangan
	R-S	S-T	T-R	R	S	T	R-S	S-T	T-R	
10:45	397	397	397	75	74	74		50		***Start load bank***
11:00	397	397	397	146	146	146		100		
11:10	397	397	397	291	291	291		200		
11:25	397	397	397	366	366	366		250		
11:55	397	397	397	440	441	441		300		
										stop load bank
13:30	397	397	397	146	146	146		100		
13:40	397	397	397	291	291	291		200		
14:05	397	397	397	361	361	361		250		
14:30	397	397	397	440	441	441		300		
14:45	397	397	397	509	509	509		350		
15:00	397	397	397	583	583	583		400		
15:10	397	397	397	657	657	657		450		
15:30	399	399	399	731	731	731		500		
16:30	399	399	399	731	731	731		500		

17:00	397	397	397	657	657	657	450	
17:10	399	399	399	731	731	731	500	
17:20	397	397	397	694	694	694	475	
17:30	399	399	399	731	731	731	500	
17:40	399	399	399	731	731	731	500	
17:45	399	399	399	731	731	731	500	
17:50	399	399	399	731	731	731	500	
18:30								***engine stop***

Data: commissioning Wt'E Sukawinatan 2016

Data: commissioning Wt'E Sukawinatan 2016

Figure 6. Test Engine with Dummy Load

landfill wells that are able to generate up to 500 kW has decreased in volume so that it can only operate average a load at 45-94 kW for Normally Stady State and 300 kW for Test Engine with Dummy Load.

2017-2018, The Sukawinatan PLTSa system cannot operate commercially because there is a shortage of methane gas from LFG.

2018, There has been a decrease in volume so that it only operates with a load of 45-94 kW for Normally Stady State and 300 kW for Test Engine with Dummy Load.
Do Study of gas potential and financing of Landfill Well Development.

d. Reflection

2019, Regarding the alternative cooperation in PLTSa operations offered, prospective investors need to be studied.

3.3 Plastic To Fuel (PTF)

Changing plastic waste with pyrolisis technology into synthetic fuel / fuel with its output is syngas which can be used as CH4 replacement from Well LFG, where the product is in the form of Fuel, board and Electric fuel which can also be used as fuel for Sukawinatan landfill garbage trucks and excavators.

Pyrolysis is a thermo-chemical decomposition process in which organic matter is converted into solid and stable carbon-rich material by heating in the absence of oxygen [4].
Pyrolysis is a thermochemical decomposition process in biomass by converting biomass into useful products. In the process of pyrolisis, complex molecular hydrocarbons from a biomass will disintegrate into smaller molecules resulting in syngas (bio-gas), liquid (bio-oil) and car (biocharcoal) [5].

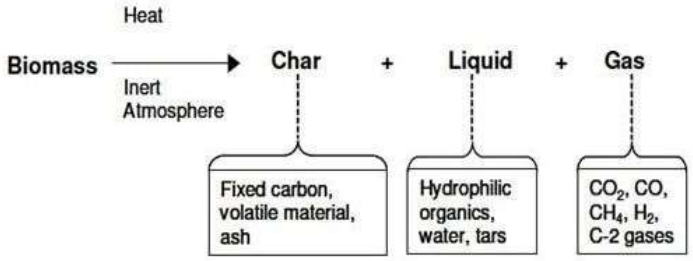

Figure 7. Pyrolisis process

Technically and in the Test phase, Pyrolysis has also gone through a test phase that produces benefits:

a. Hossain, 2013 in Fadly 2017 [6], states that:
Pyrolysis can produce fuel which can then be used as an alternative source of new fuel energy, for gas producers using gasification techniques and can also be a gas engine fuel.

b. Ziahaq, 2002 in Fadly 2017 [6], states that:
The fuel produced from the pyrolisis process is more effective than the waste combustion process due to better combustion efficiency.

c. Agung and Gandidi, 2012 in Fadly 2017 [6] stated that: Pyrolysis results in lower environmental pollution impacts.

d. Gandidi et al., 2011 in Fadly 2017 [6] stated that: bio-gas and bio-oil pyrolisis can be used for fuel in the process of drying agricultural and plantation products.

3.4 Pyrolysis
Pyrolysis is the treatment of a material by the process of decomposition in the position of high temperature vacuum oxygen. The decomposition process is also called devolatilization, which enters into a type of chemical reaction by breaking down compounds into components into a simple form. [8]

Products produced from pyrolysis depend on the heat that takes place in the reactor:
- Gas: containing hydrogen, carbon monoxide, methane, carbon dioxide, and various other gases.
- Liquid:
  containing tar, acetic acid, acetone, methanol, and other complex hydrocarbons that function as fuel as well.
- Solids:
  Charcoal (char) in the form of pure carbon, along with other materials that are in solid form from the original biomass. [7]

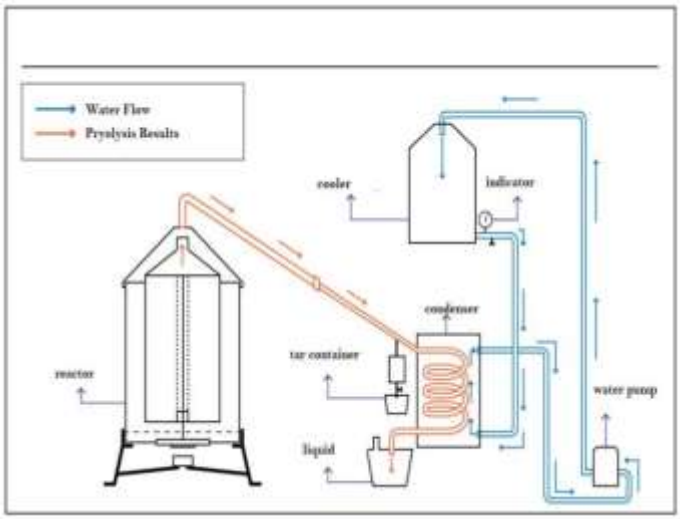

Figure 8. Pyrolysis scheme [7]

Pyrolysis is processed in a tube as a container of solid black oil liquid, there are also other objects in the form of smoke until finally toward the condenser.
Indicator indicators that the pyrolisis process ends can be seen in the absence of gas coming out of the indicator pipe. Generally the pryolysis process is carried out at a temperature of more than 300 degrees Celsius with an interval of 4-7 hours. [7]

Pyrolysis in plastic waste uses plastic waste techniques which are burned at a temperature of 800-1000 degrees Celsius with stages:

a) plastic waste as a treatment of raw materials is cut and weighed first;
b) plastic waste as a treatment of raw materials and then put into the reactor;
c) temperature setting is carried out;
d) the process is terminated after obtaining liquid hydrocarbon compounds which will be processed into good quality lubricating oils. [7]

4. Results

Regarding the alternative cooperation in PLTSa operations offered, prospective investors need to be studied.

Identification of problems that have not been able to optimize Sukawinatan PLTSa, because the fuel capacity of the gas engine which is CH_4 in the power plant has not gotten the best value. For this reason, use the Plastic to Fuel layout as an effort to optimize the PLTSa performance.

Proposed Optimization of PLTSA Sukawinatan:

a) Local Waste Processing Site by utilizing waste that is converted into pellets as a raw material for generating.
b) Additional gasifier is needed to be able to use TOSS pellets and the addition of chopper machines and pellet machines to make the TOSS waste pellets.
c) Pellet products are garbage and electricity, where the economic cost of producing waste pellets must be studied
d) Mechanism of cooperation with Local Government or BUMD.

5. Conclusion

The success of the Optimization of Operation of PLTSa Sukawinatan in the form of the Implementation of "Plastic to Fuel" was supported because of the interaction between the Directorate
General of Renewable Energy and Energy Conservation of the Republic of Indonesia with the Palembang City Government with various facilities and interactive collaboration patterns, starting with an optimal planning focused on fulfilling all technological facilities that are appropriate and understood in detail on the infrastructure needed by PLTSa Sukawinatan.

References

[1] Unnamed, 2016 *Modul TPA Sukawinatan* Palembang, Indonesia.
[2] F L Whitney 1960 *The Elements of Resert.Asian Eds* Osaka Overseas Book Co
[3] https://idtesis.com/metode-deskriptif/ (accessed date: 3rd July 2019)
[4] Endah Norma 2017 Studi *Kelayakan PLTSa Sukawinatan sebagai Sumber Energi Alternatif di Kota Palembang* (Universitas PGRI : Jurnal Ampere) Volume 2 Nomor 2 Palembang Indonesia
[5] A Demirbas 2002 *Carbonization ranking of selected biomass for charcoal, liquid and gaseous products* Energy Conversion and Management 42 1229-1238. Trabzon.
[5] Basu Prabir 2010 *Biomass Gasification and Pyrolysis Practical Design and Theor* (Academic Press : Elsevier)
[6] A Fadly Wiraputra 2017 Pengaruh *Pyrolysis Non-Isothermal* Terhadap Kualitas Bio-Oil Dari Sampah *Real* Kota Bandar Lampung (Universitas Lampung : Skripsi)
[7] https://ptsse.co.id/halamanlinibisnis/detail/penelitian-dan-pengembangan (accessed date: 3rd July 2019)