# Waste Power Plant Modeling Based Landfill Pretreatment and HCCI (*Homogeneous Charge Compression Ignition)* Generator Engine

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***Abstract – Waste management is crucial problem for major cities in all countries. Technically, MSW (Municipal Solid Waste) biological processes can be converted into LFG (landfill Gas), which can be used as an energy source for electricity generation. LFG utilization as fuel for power generation is also supported by the presence of motor fuel engines based HCCI (Homogeneous Charge Compression Ignition). To ensure the successful adoption of waste power plan based HCCI engine-generator, in the form of mathematical modeling studies of biogas production in a region need to be done carefully. The formulation waste power plant models with engine HCCI, is based on the reference model and reference experimental results of each part in the power plant waste that includes, production of biogas from landfill, biogas filter, generator power conversion HCCI. The production of biogas from landfills using multicomponent models, biogas filter using a filter system with a suspension of dolomite, and for the conversion of electricity using a generator HCCI referring to the results of experiments that has been conducted by Bedoya, 2012. Waste power plant modeling result shows, if power output 3.725 .10$^{-3}$ of capacity HCCI engine fuel consumption.***

***Index Terms-HCCI Generator Engine, modeling, waste power plant.***

## INTRODUCTION

Waste management is cruisal problem for major cities in all countries. The problem increases significantly every year related to solid waste in urban areas called Municipal Solid Waste (MSW). MSW uncontrolled, would affect human life through contamination of ground water as a source of drinking water and air. Besides disturbing human respiratory, air pollution also has the potential to add to the content of greenhouse gases causing global warming and climate change.

Technically, MSW biological processes can be converted into LFG (landfill Gas), which can then be used as an energy source for electricity generation. VOC (Volatile organic compounds) content in LFG or biogas only halogen-containing compounds, chlorine and other compounds and tracked (trace elements) in a very low number. It is an indication that the biogas fits for use as fuel for the power plant (Naros, 2009). LFG utilization as fuel for power generation is also supported by the presence of motor fuel engines based HCCI (Homogeneous Charge Compression Ignition) (Bedoya 2012). The utilization of biogas in HCCI engines can reduce the content of hydrocarbons in emissions. Besides the presence of CO2 in the biogas, it is beneficial to absorb the gas combustion heat release. Thus, the exhaust gas temperature is not too high, as is usually the case in HCCI diesel engine (Nathan, 2010).

Mathematical models are needed to provide a detail description about the potential electrical energy, biogas consumption per hour, generating operating time, full-time landfill. Furthermore the results of this modeling can be used as a reference in the feasibility test waste power plant development in a region. Therefore, the purpose of this study is to obtain a model of this mathematical equation.

## RESEARCH METHODOLOGY

Waste power plant models with HCCI engine formulation is based on the reference model and reference experimental results of each part in the waste power plant, including the production of biogas from landfill, biogas filter and HCCI generator power conversion. Waste power generation systems to be modeled as in the following scheme,

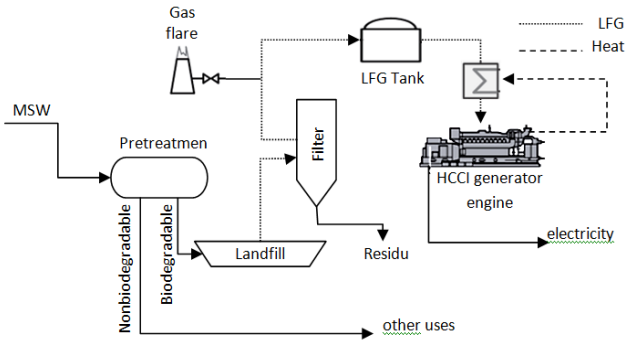


**Figure 1.** Waste Power Plant scheme

The production of biogas from landfills uses multicomponent models (Mahar, 2014). This model the closest estimation of LFG production with the landfill pretreatment system controlled. For biogas filter use a

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filter system with a suspension of dolomite (Makarevicience, 2015). This filter system reduces the content of CO2, H2S and H2O in the biogas. The conversion of electricity uses a HCCI generator referring to the results of experiments that have been conducted Bedoya (2012). Modeling is prepared by combining the model and the value of each piece. Modeling is generated in the form of mathematical equations.

## RESULTS AND DISCUSSION

Biogas production using multi component models. This model shows, one ton of garbage to produce about 235 $m^3$ LFG. The anaerobic process lasts about 400 days.

Filter systems using dolomite suspension. The amount of flow needed dolomite suspension, which amounted to 39.6 $m^3$/h with a temperature of 20-30 °C. Concentration of dolomite in suspension is 2%, this system will generate LFG that has been purified with the speed of 280 $m^3$/h. Concentration of CH4 has increased, from 58% to 83%.

The power generated waste power plant is affected by the capacity of the machine. The more increase the amount of fuel consumption. Stoichiometric combustion ratio is set at 0.4, with a mixture pressure of 2.2bar. In this condition, combustion efficiency will be obtained more than 80%, and the efficiency of the system is 40%. The amount of LFG that can be generated by the landfill will affect how long PLTSa can operate. For one ton of MSW can generate 235.31 $m^3$ LFG. While the number of LFG is influenced by how much MSW in landfills. The amount of waste that can be accommodated by the landfill and landfill capacity is affected by the density of MSW. Waste power plant modeling results using HCCI engine can be written as follows,

$$P_{out} = 3{,}725\ .10^{-3}.K_{bm}$$

With,
$P_{out}$ is HCCI generator output power (MW)
$K_{bm}$ is capacity HCCI engine fuel consumption ($m^3$ / hour)

As for the plant operating time can be written as follows,

$$t_{op} = 0{,}019.(1 - g_{los}).m_b.t_l/K_{bm}$$

With,
$t_{op}$ is operational time of plant (Year)
$g_{los}$is loses of LFG (%)
$m_b$ is Mass of biodegradable waste (Ton/day)
$t_l$ is full time landfill (day)
$K_{bm}$is capacity HCCI engine fuel consumption (m3/hour)

For full-time landfill can be written,

$$t_l = \frac{L.D}{m_b/\rho_s}$$

With,
$L$ is landfill area ($m^2$)
$D$ is depth of Landfill (m)
$m_b$ is mass of biodegradable waste (Ton/day)
$\rho_s$ is density of biodegradable waste (Ton/$m^3$)

## CONCLUSION

Conclusions of this study is,

1. The power generated by the plant affected by the capacity of the machine.
2. The amount of LFG produced determine how long the plant can operate
3. Waste power plant modeling result shows, if power output 3.725 $.10^{-3}$ of capacity HCCI engine fuel consumption.

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