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THE TEST PERFORMANCE FILTER STRAW AS SYNGAS CLEANER MEDIA ON THE APPLIANCE BIOMASS GASIFICATION OF *UPDRAFT SINGLE GAS ELECTRICAL* SYSTEM

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Abstract. In this research developed the gasification technology environmentally friendly with the use of straw as the gas filter. Considering straw is an agricultural waste are just not worth, then used as the filter gas. The superiority of straw besides get easily, capable of binding tar and impurity particles other gas in size of microns, so that gas produced more clean and environmentally friendly. In this research, to produce syngas is more clean then used cyclone, water scrubber, and filter straw. Rice straw that used with variation of weight to get the optimum condition in absorb tar from the gasification process. Based on the results of the gasification process, the most absorption of tar occurred on the weight of straw is 400 gram with percent absorption reach 90.38 produce syngas CH_4 6.90%, CO 13.22% and H_2 9.88%. So it can be concluded that the more density of filter straw, then the tar more absorbed so that syngas obtained more clean then that LHV will be more high.

Keywords**:** Gasification, Biomass, Filter straw, LHV, Syngas

I. INTRODUCTION

Indonesia is an agricultural country, so that have the potential to be biomass source very large, and one of which is the rice husk. Rice husk can be easily obtained because that amount abundance and for now only used as charcoal, even in general agricultural waste is burned so only without used effectively. By knowing the composition and chemical contents are found in the rice husk, that materials can be used as alternative energy sources through the process of gasification.

According Vidian F [13], gasification is a process that use heat to change the solid biomass or other solid carbon become synthetic gas "like natural gas" flammable. Through the process of gasification, we can change almost all organic solid materials into a clean fuel gas, neutral. The gases that are produced can be used for electricity generation as well as the heating element.

One of the efforts to develop biomass is encourage the advantage of industrial waste agriculture and forestry as a source of energy is integrated with the industry and increase the research in the development of waste utilization including agricultural waste for renewable energy.

One of biomass conversion technology that can take advantage of the rice husk become *syngas* is gasification. According Setiawan [11], gasification is a process of changes solid fuel in thermokimia become a gas, where the air that required lower than the air used to the combustion process. The process of biomass gasification done by imperfect combustion in a room that able to resisting the high temperatures. That room can called as reactor or gasifier. Gasifier used in this research is *updraft system.* From all types of gasifier, reactor type *updraft* more simple and can work with both for the test gasification rice husk.

Some research biomass gasification using *updraft gasifier* has done. Saravanakumar [10] do research gasification use the bottom lift *updratf gasifier* with

fuel wood. The results of that research showed that with fuel consumption rate between 9 to 10 kg/hour, then the efficiency of the gasification occurs is 73% and produce the stability of *producer gas* for 5 hours operating with fire temperatures the average 750^{o}C. Wang et al [14], do research gasification using *updraft gasifier* in biomass that is considered to integrate with *reformer* gas to move the engine gas fuel. *Gasifier* fuel used in this research is the pieces of wood *(woodchips)*. The results of research shown that the heat value of gas produced is 3.9 MJ/m^3 with the efficiency of gasification 60 % and the efficiency of the entire system of 27 %. Adi Surjosatyo [12], do research using the updraft gasifier integrated with *swirl gas burner*, with *fuel* that used of gasifier is shell of coconut palm oil. The results of research showed that the temperature of fire on the *swirl gas burner* was happened between 590^{o}C until 677^{o}C, with the lowest emissions CO 65 ppm and NO_x 70 ppm.

In this research developed gasification technology using fuel rice husk and straw as the gas filter. The superiority of straw is in addition to get easily able to bind tar and other impurity particles of gas in the size of microns, so that the gas produced is clean and environmentally friendly. This research aims to find out the influence of the filter straw to the product *syngas* produced.

II. METHOD RESEARCH

This research done with any process that described as follows.

A. Materials and Tools

The materials that used in this research are rice husk, rice straw, and water. The tools that used are raw material collector, reactor gasification, blower, cyclone, sink reservoir, water scrubber, filter straw, venturi burners, pumps, the switch.

B. Approach Design Functional

The research started with creating the prototype of gasification equipment to draw up a model to design which includes the functional design approach and structural design approach. For more details the device model is shown in figure 1.

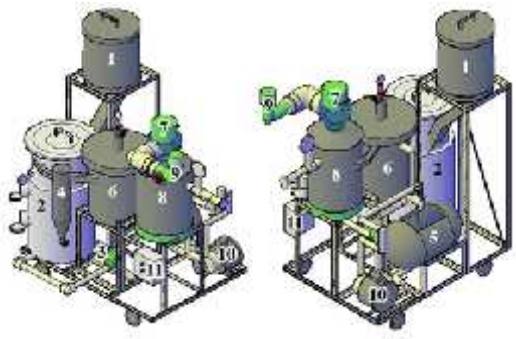

Figure 1. Design of the Appliance Gasification

Details :
1. Feed Tank
2. Reactor Gasification
3. Blower 1
4. Cyclone
5. Water tank
6. Water Scrubber
7. Blower 2
8. Filter Straw
9. Ventury Burner
10. Pump
11. Main Switch

Approach design functional gasification reactor equipped blower (3) as media air for the combustion reactions in the gasification reactor that change into natural gas fuel capable fuel (*syngas*). The gasification results gas still dirty will be cleared using *cyclone* (4) which function as a *gas precleaner* with how to separate the particles from ending up in the syngas continued with the sink reservoir (5) and use the water as a gas cooling media besides water sprayed that can catch solid particle as ashes and tar still participate in syngas. Cold gas then penetrate the filter straw (8) and out toward the *venturi burner* (9) which functions as a flame of fire.

C. Experiment Procedure

1. Preparation Fuel

The fuel will be used there are two types of the rice husks as fuel primary (main) and secondary fuel (aid) in the form of coconut shell. Fuel coconut shell that is used as the lighting of the beginning of the burning in the reactor to become charcoal. Rice husk before used, first done drying with take advantage of the sunlight during ±2 hours so that they can reduce the *moisture content* in the rice husk. Rice husk that has dried up in store for the next test is water content, ash, and *volatile matte*.

2. Preparation of Measuring Tools

Measurement tools used to test consisted of thermocople, anemometer, pressure gauge, flow

meters, and the balance of analytically (scale). Each measure installed according instalation scheme set up and ensured no leakage in the installation.

D. Procedure of Gasification Single Gas Outlet System

1. Insert the filter straw as much as 100 gr followed by turning on the water pump
2. Turn on blower with flow rate of air 5.63 m/s for 5 minutes, so that the reactor formed coals of fire, blower then turned off.
3. Turn on the blower suction cup with flow rate of air 2.6 m/s and rice husk inserted into the reactor slowly as much as 10 kg, until the reactor is fully charged 90% volume. The temperature of the five point in the reactor, namely T_1, T_2, T_3, and T_4, measured , each ten minutes.
4. Wait for ± 30 minutes until gasification process occurs. Turn off the blower suction cup ± 10 minutes to collect *syngas* that has formed.
5. Sparked with fire on the burner to obtain a flame of fire and know of the existence of the *syngas* formed, which is then done the taking of temperature data for each sample gas that formed.
6. After the fire in the *flame* goes out and regarded the experiment finished and continued experiment with weight of straw 200, 300 400, and 500 gram.

E. Step of Measurements

1. Procedure of Gas Sampling

The taking of gas is done when the fire burning constant, and then close the full swing-valve on the burner then open the valve *sampling taking place*. End of the valve connected to the channel which is in the *gas sampling bag* and leave until it is fully charged. After the taking of gas finished, valve *sampling* closed.

2. Procedure of Filter Straw Measurement

Before you begin burning in the reactor, considers the weight of the straw beginning as much as 100 gr. Open the tap under the filter straw to collect the liquid smoke and consider and measure flow rate of *syngas* per hour according to the mass of the straw. Then continue to experiment with the variations in the weight of the straw is 200 gr - 400 gr straw and experiments without straw.

3. Procedure of Turn off the Gasifier

Turn off the blower and water pump. Let the reactor cooling down first, before ejecting the remaining combustion in the reactor. Water there is in the shelter and tar on the cyclone and liquid smoke on the filter straw ejected.

Then remove the residue of combustion and the ashes on the reactor and consideration. Clean the parts of the reactor and burner to avoid tar that hardens.

F. Equipment for Analysis The Results

The Syngas has been in take uses gas sampling bag tested using Gas Chromatography standard ASTM or *Gas Petroleum Analysis standard* (GPA) Series GC 9-A to know the composition of the gas and also the value of the heat insulation on the gas.

III. RESULT AND DISCUSSION

A. Results

The results of research have been done on the determination of characteristic quality of syngas is produced, LHV *syngas*, and straw absorption to impurities substance can be seen in the table 1, 2 and 3. The data from the gasification process is done from preparation samples, running the instrument, and product of gasification, good been taken by direct observation, analysis use of the instrument analysis or calculation. This research use a rice husk 10 kg for one operating time (batch) and variation of the weight of the straw is 100 gr, 200 gr, 300 gr, 400 gr, and without straw as syngas cleaning media.

1. The Influence of the Mass of Straw to Impurities Absorption

Based on the research done it from the results of the calculation of the absorption of straw based on the variation of mass of straw.

TABLE I

THE INFLUENCE OF MASS OF STRAW TO IMPURITIES ABSORPTION

Mass of straw (gr)	Absorption (%)
0	0
100	26,12
200	47,89
300	75,66
400	90.38

2. The Results of the Test LHV syngas to the Mass of Straw

TABLE II

THE RESULTS OF ANALYSIS LHV SYNGAS

Mass of straw (gr)	LHV Syngas (MJ/m^3)

0	0
100	2.91
200	2,89
300	3.07
400	3,58

3. Analysis Testing Syngas based on the Mass of Straw

The results of analysis testing syngas is based on variations in a mass of straw as a media cleaning syngas is can be seen in table 3.

TABLE III

THE INFLUENCE OF FILTER STRAW TO THE RESULT OF ANALYSIS *SYNGAS*

Mass of straw (gr)	CH_4 (%)	CO (%)	H_2 (%)
0	1.97	21.30	6.95
100	2.77	19.81	7.05
200	4.58	17.70	8.22
300	5.89	14.55	9.17
400	6.90	13.22	9.88

B. Discussion

This research is done with prototype of the appliance biomass gasification with the aim to produce syngas capable of fuel (flammable) as an alternative fuel. The calculation includes the absorption of straw as the cleaning media and the influence of *syngas* produced.

1. The Influence of the Filter Straw to the Absorption of Tar

One indication of the capacity filter straw as gas cleaning is its ability to absorb tar contained in syngas. Prabir Basu [3] explained there are two methods of disappearances tar in syngas namely *In-situ tar primary reduction* and *post-gasification secondary reduction of tar* . On the *in-situ tar primary redution* dissipation process more toward a chemical reaction while *postgasification secondary reduction of tar* more use physical methods, such as one *filter barrier*. Where the *barrier* used in this research is the rice straw. The influence of filter straw on percent tar which absorbed can be seen in figure 1.

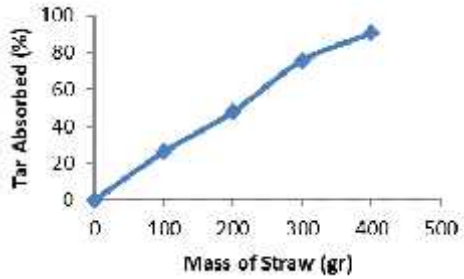

Fig 1. Graph of the influence of the mass of straw to tar absorbed

In the figure 1, it can be seen that the mass of straw 100 grams, tar absorbed reach 26,12%, where tar is absorbed still low when compared with mass of straw 200 grams where tar absorbed reach 47,89% and continues to increase with rising mass straw. In addition mass of straw 400 grams reached optimum conditions, where tar is absorbed reached 90.38%. With the dense filter hay, so that the percentage of tar absorbed increase which means that the effectiveness also increased. It is getting clarify that the more solid straw used and more tar capable of absorbed by a filter straw. Vidian [12] explained more tightly a filter then the absorption will be better. So with the rising density straw, causing filter density increased so that the ability of filter straw in absorbing tar and other impurities will be more high.

2. Test Characteristics of Syngas Gasification Results to Low Heating Value and Composition of Syngas

LHV is an indication of fuel quality that shows how much the heat value capable of produced fuel. In the process of gasification an LHV of *syngas* produced also depends on the cleanliness of the gas . The filter straw as cleaning gas will affect the value of LHV, because filter straw affects on the composition of end *syngas* . Now the influence of filter straws to the production of syngas is also determined from density of straw is used as the filter. The influence of the mass of the straw to LHV syngas can be seen in figure 2.

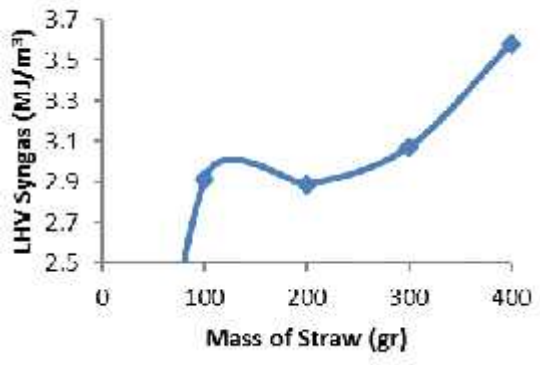

Fig 2. The influence of the mass of the Straw to LHV *Syngas*

In the figure 2, it can be seen that the mass of straw influence an LHV. Adi Surjosatyo [12] explained that an LHV a fuel is influenced by the composition of the syngas itself as H_2, CO, and CH_4 in this case the filter straw able to absorbing some of the components in the syngas gas especially heavy gas such as carbon monoxide. The values of an LHV increase, but on the mass straw 200 grams, an LHV decreases because density of straw not yet solid, and on the mass of straw 400 grams, an LHV obtained achieve optimal limit that 3,58 MJ/m^3.

Prabir Basu [3] also explained the *filter barrier* (filter straw) pass gas clean holding a more heavy gas. In this case the influence of the filter straw only absorbed some components in syngas so that affect the components of the end product of syngas, so that by changing the composition of the syngas and the value of LHV will be changed. So the more clean gas then the LHV will be more high.

The filter straw that function as a gas cleaning of course will affect the quality of the syngas produced. In the table 3 can be seen that the more or solid straw used, then the percentage CH_4, H_2 will increase. This is because the more solid straw so density straw will be tightly, so that some syngas will be absorbed but gas that most absorbed is CO_2 and CO which is a gas that is much more heavy of the other gases that are on syngas, so that will be trapped in the filter straw. The cause of percentage CH_4 on the mass of the straw 300 gr is smaller than that without straw because on the mass of the straw 100 gr, filter density less well so that the absorption of heavy gas less and some light gas absorbed including CH_4 which then reduce the percentages in syngas. So on the mass of straw 100 gr process of gas cleaning less effective.

IV. CONCLUSION

From the results of observation and testing that has been done, then obtained the conclusion as follows:
The highest absorption of impurities reached 90.38 with mass of straw as much as 400 gram. Density of straw is very influential to disappearances impurities in the syngas. The more tightly of filter straw then more tar is absorbed and the percentage is increasing. In the test of characteristic syngas after passing the filter straw gas that most absorbed is CO_2 and CO. The more tightly of straw and the longer the operating time, then flow of syngas produced was decreased. The mass of filter straw affect an LHV and the composition of the syngas.

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