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The Design of Simple Environmentally Friendly A coal Gasifier in Small Scale with Maximum Capacity of 2 Kgs/Hour

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ABSTRACT

The design of a a coal gasification system is a workable unit or device whose work principle to change a coal fuel that has low-calorie value to be gas with a coal gasification system. Gas which is produced from a coal gasification system is a clean gas and environmentally friendly that its gasifier unit is used. The gasification process can be defined as the building process of gas fuel (CO, H2, and N2) in a small sump from a chemical reaction solid fuel characteristically Carbonaceous or Cellulosic, for example, coal, wood, and agriculture rubbish. Reaction process of gasification a chemical going on complexly, with the step as follows: drying, oxidation, and reduction. The aim of making a coal gasification system design is for using gas fuel as replaced solar fuel in the industry. For long time which will be got in this research is the use of a coal that has low-calorie value gasification system design on a big scale with a maximum capacity of more than 50 kgs/hour. The method which is used in this research is the design method and ratio method suitable with the gas that has been produced and go on with designing and existing of a the coal gasification system. The result from this research is drawing design of a coal gasification system and gas production as big as 0,5 kg from burning of a coal fuel as 2 kgs, already formed a fire on the stove, the gas temperature can reach T3 at 400°C and gas pressure is 0,88 Atm.

Key words: Clean gas, gasification system, gasifier, low-calorie a coal

1.INTRODUCTION

As one of the important components in production cost, some industries in Indonesia depend a lot on fossil fuel. However, as a non-renewable source of energy, fossil fuel price keeps soaring, this causes some industries to collapse, small-to-medium-scale industries survive partly because they are highly subsidized by the government. Therefore, a coal with low-calorie value must be appealing alternative energy as it is inexpensive and relatively abundant. Indonesia is estimated to have 61,3-billion-ton reserves found mostly in Kalimantan and Sumatra. Nevertheless, more than 65% of the reserves have low quality as it contains high water and high volatile matter, a coal with low calorific value. Besides, direct use of a coal on a massive scale will only contribute to environmental damage. In solid form, a coal is only utilized in industries and to generate electric power [1].

To produce butane equal to 0,5 litter/hour Diesel, a coal gasification system is a technology preferred in this research, small-scale a coal gasifier unit that is environmentally friendly is designed to process 2 kgs of low-calorie of a coal to produce the expected outcome. This research specifically aims at designing of a coal gasification system as a workable unit or suitable device resulted from plans and methods used [2].

The abundance of low-calorie a coal and direct a coal combustion in Indonesia turns out to have some downsides including air pollution (from the ashes resulted from burning), difficulties in controlling flames, and different burning systems and designs. Therefore, conversion from fossil fuel is used to a coal gasification systems may encounter some constraints like alternating burning systems; long breakdown time; costly investment high risks for industries with high standard hygiene.

A simple and small-scale a coal gasifier is hoped to be the right technology that can solve the above constraints that generally come along with direct combustion. In addition, this technology can suit the need of small-to-medium industries having limited skilled labor force. However, there are things to do before applying that technology. The following barriers should be solved to reach the expected outcome of the a coal gasifier unit: a technique to keep the flame from a simple and cheap a coal gasification system to continuously burn, an effective technique to keep the operation going, problems in keeping the temperature of gasification room controlled, and a technique to have a simple and inexpensive burner.

This research aims at developing a simple gasification system on a small scale. The gasification process will rely on low calorific a coal available the local market that will produce burning gas as a substitute for diesel. And this gas will help supply the power needed in industries. The a coal gasifier unit developed here will have a capacity of 2 kgs/hour production. And the design is developed through

the following phases: collecting data on a coal calories on the local market, formulating the simple design of unit or device of gasification system that is user-friendly, examining equipment to ensure the possibility of further research &analyzing the economy and the financial impacts of this simple gasification system.

2.THEORETICAL REVIEW

A coal gasification is old technology, at the era when a coal was a primary source of energy, gasification technology developed tremendously, however, as time went by its popularity faded away. The booming of fossil fuel was replaced by a coal. Fossil fuel came along with the advantages outweighing a coal. This technology won a place as well in Indonesia, especially in big cities. The installation producing the gas was called State Gas Plant (Government Gas Factory) and the gas produced was called city gas, which was distributed through pipes stretched directly to consumers. PGN owned eight plants located in big cities including Medan, Jakarta, Bogor, Bandung, Cirebon, Semarang, Surabaya, and Makassar. They heavily depended on a coal as the raw material. They even imported the caking a coal type from countries like Germany, Australia, and the USA. Later, a coal became scarce, this forced those plants to convert to fossil fuel as their raw material. Surabaya gas plant used a coal up to 1957 and diesel oil through the catalytic cracking process afterward. Meanwhile, the Semarang plant stopped using a coal in 1969 and started using fossil fuels since then. Bandung gas plant seemed to be the last one converting to fossil fuel. Its operation still relied on a coal power up to 1975 [3].

A coal gasifiers differ in terms of how a coal has contact with reactant and the contact system determines the design of the reactor. In this research, the contact between a coal and the reactor in gasifier reactor used fixed – bed system. A coal gasification technology is already commercialized using a fixed bed system. [4].

A. Gasification Process

Gasification refers to a process of gas fuel forming (CO, H2, and CH4 in small amounts) as a a chemical reaction of carbonaceous or cellulosic solid material like a coal or wood waste.

A chemical reaction of gasification process takes place in complex gradual phases: drying, pyrolization, oxidation and reduction. Main reaction is simply predicted as follows: C + CO = CO2 C + CO2 = 2CO; C + H2O = CO + H2; C + 2H2 = CH4.

The calorific value of the gas produced is results from the calorific value of each flammable gas component, that is CO, H2, and CH4. The percentage of each component will determine the level of calorific value of gas produced. The flowchart of a the coal gasification process can be seen in Figure 1, below [5].

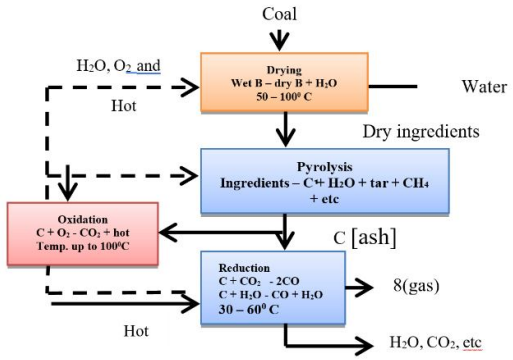


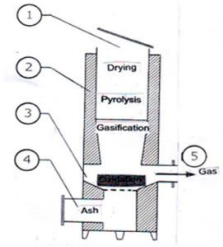
Figure :1 Flowchart of A coal Gasification Process

During a coal gasification process, the main a chemical reaction is an endotherm that requires heat from outside. The most common media used during the process is air and vapor. The products resulted can be categorized into three main forms: compressed liquid (including condensate gas) and permanent gas. Although the gas produced with air as the media has low calorific value, the operational process is simpler. Below are some advantages of gasification technology: it can produce gas that serves as fuel, it can process any fuel input including a coal, heavy oil, biomass, any kind of city waste, and so forth, it can convert waste into useful products, it can reduce solid waste, it can produce non-furan and dioxin gas. The gasification process takes place in several phases: a heating phase when a coal temperature rises before the drying process begins, drying phase when solid a coal evaporates, the extensive heating phase when a coal temperature rises again, devolatilization phase when a coal the volatile matter comes out and only ashes are left. Volatile matter may consist of gas containing H_2O, H_2N_2, O_2, CO, CO_2, CH_4, H_2S, NH_3, C_2H_6 and hydrocarbon, gasification phase, chara coal burning phase if there is air left. Gasification is meant to increase the value and usefulness of a coal with low-calories so that clean gas can be produced. If the air-fuel ratio required during the process is less than 1,5 then it is called gasification.

As gasification refers to a process of converting carbon-based material, then all hydrocarbon, including a coal, can be gasified to produce synthetic gas.

B. Working Principle of Gasifier

Based on their working principles, gasifiers can be worked as follows: The combustion takes place at the lower part of the fuel the material stack in a cylinder. The fuel material is put into the combustion chamber through the top hole. The gas produced will go to the top part passing the fuel material. Gasification technology based on a coal–reactor contact as seen in Figure 2 below [6].



Caption:
1. Input of raw material (coal)
2. Fireproof Stones
3. Retractable gas chamber
4. Burning ash room
5. Gas

Figure :2 Gasification Technology Based on A coal–Reactor Contact

3.RESEARCH METHOD

C. Research Design

This research tries to design a simple system by making use of common equipment available in the local market so that when this research succeeds, the units can be produced by little workshops. They can rely on tools, material, and spare parts available in their vicinity. Therefore, whenever they face any problems with the units, they do not have to look for specialists. Besides, spare parts will be inexpensive and easy to find [6].

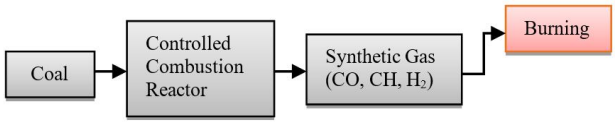


Figure :3 Simple Scheme of Gasification Flow

D. A coal Gasifier Design

The equipment that is used in a coal gasifier design is as follows:

1. The input of raw material (a coal) fireproof stone
2. Retractable gas chamber
3. Burning ash room
4. Water coat gas pipe
5. Water as catcher pitch
6. Water cooling pipe
7. Water as catcher pitch
8. Rugged Stainer
9. Gas products pipeline
10. Fine filter (wire type)
11. Smooth filter
12. Space for remaining gas

The a coal gasifier design, as seen in Figure 4 below.

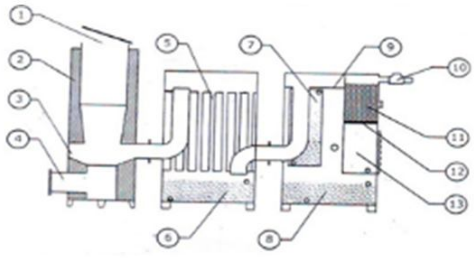


Figure :4 A coal Gasifier Design

E. Research Flowchart

Overall, the process of designing gasifier can be seen in the flowchart as shown in Figure 5.

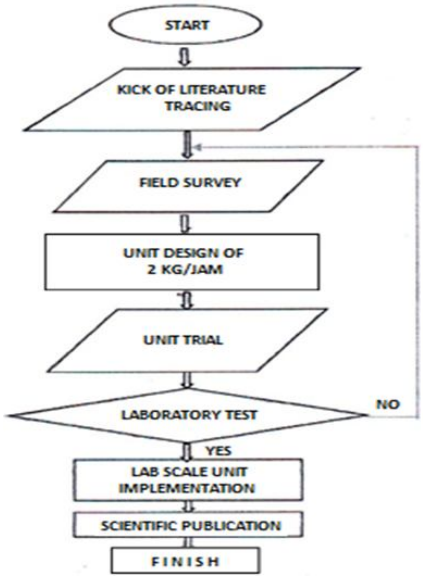


Figure :5 Flowchart of Designing Process

4. RESULTS AND DISCUSSION

The results of the a coal gasification design drawing in this study are a photo-image of an environmentally friendly small-scale a coal gasification tool with a maximum capacity of 2 kg per hour as shown in Figure 6 below.

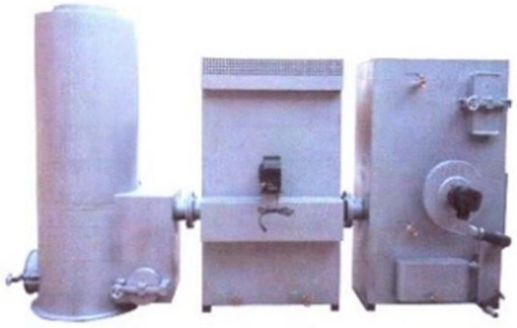


Figure :6 Picture of a coal gasification construction Picture of a coal gasification construction

F. Working Drawing of A coal Gasification tools

Working drawing of a coal gasification tools in this study is shown in Figure 7 below.

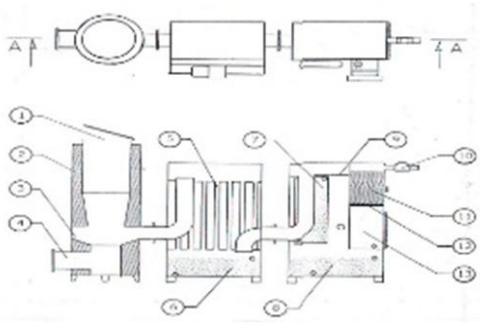


Figure :7 Working drawing of a coal gasification tools

G. Detailed working drawing of a coal gasification filter

Detailed working drawing of a coal gasification tools in this study is shown in Figure 8 below.

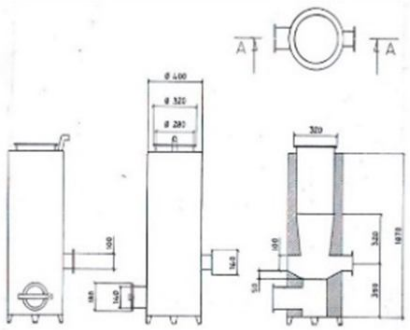


Figure :8 Detailed working drawing of a coal gasification tools

H. Detailed working drawing of a coal gasification cooler

Detailed working drawing of a coal gasification cooler in this study as shown in Figureureure 9.

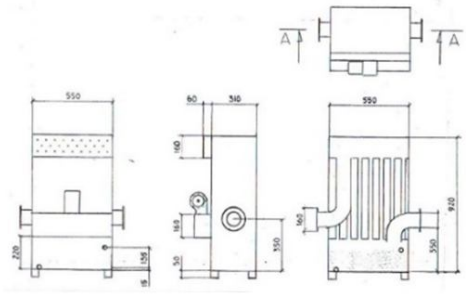


Figure :9 Detailed working drawing of a coal gasification cooler.

I. Detailed working drawing of a coal gasification filter

Detailed working drawing of a coal gasification filter in this study as shown in Figureureure 10 below.

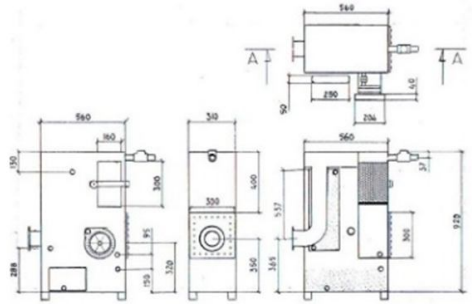


Figure :10 Detailed working drawing of a coal gasification filter.

Based on working drawings of a coal gasification tools as shown in Figureureure 4, detailed working drawing of a coal gasification tools as shown in Figureureure 5, Detailed working drawing of a coal gasification cooler as shown 6 Figureureure 7, and detailed working drawing of a coal gasification filter as shown in Figureureure 10 can be generated construction of a coal gasification as shown in Figureureure 6 is a photo of a coal gasification construction. The cool gasification construction unit has been tested and the result is the production of gas (CO, H2, and CH4 in small quantities) which can be used for the home industry, middle industry such as (soybean cake) factory, tofu factory and others. The test results of this a coal gasification will be explained and summarized in this paper.

J. Temperature Data Retrieval, Methodology and Test Results on the A coal Gasification Unit

Temperature data retrieval on November 18, 2016, at BBIA process laboratory Jl. Cikaret, Bogor, West Java. The methodology of a the coal gasification unit is tested as big as 2 kgs and helped with 500 grs husk as early heat so that a the coal heating process can be easily processed. Gas is resulted by streamed on the stove and then turned on with the help of automatic fire Figureurehters. 3 thermocouples are placed in the gasification equipment and connected with the thermocouples each peaked on T1 is the exit the gas temperature of gasification device; T2 is the exit gas temperature of gas cooling device and T3 is the exit gas temperature of clean up gas device. Each thermocouple is placed on the output pipe of each process to check the temperature and temperature difference each pass through one part of the gasification device, every 10-minute temperature data from each thermocouple is recorded.

Recording of the results at three points is T1, T2, and T3 on the gasification tool as shown in table 1 below.

Table 1: Recording to results on the Controller Thermometer.

Minute to	T1 (C□) Exit Temperature of gasification device	T2 (C□) Exit Temperature of gas cooling device	T3 (C□) Exit Temperature of clean up gas device	Information
10	57,7	35,8	32	
20	77,5	52,6	37,7	Minutes to 20th and T3 = 37,70 degrees Celcius
30	95	61,1	41,9	
40	97,2	64	45,2	
50	137,6	60,2	47,4	
60	137,7	58	48,5	
70	145,8	65,9	51,7	
80	152,3	69,1	56,4	
90	157,4	63,5	60,1	
100	148,5	56,8	54,1	
110	138,3	55,2	46,2	
120	108	43,3	43,7	
130	106	38,7	42	
140	102	36,2	36,7	
150	85,1	34	28	
160	75,4	32,3	26,2	
170	48,7	29,7	25,7	
180	38,4	26,2	24,2	

In Table 1, according to the recording on the thermometer that the results of recording at minute 22 with a temperature of 90 degrees Celsius (T1 = exit temperature of gasification device) and gas pressure as big as 0,88 Atm. The flame formed at minute 22 with a temperature of 40 degrees Celsius, at minutes 59 the flame on the stove goes out. Maximum gas temperature T3 (T3 is exit temperature of clean up gas device), that can ignite on the

stove is 48 degrees Celsius. From the 59th minute to the temperatures in the 84th minute there was an increase of temperatures up to 160 degrees Celsius due to the burning of a coal but did not produce the gas that could be utilized.

As shown in Figureureure 8 below is a graph of experimental results of temperature point 1 : T1 (degree Celsius); point 2 : T2 (degree Celsius) and point 3 : T3 (degree Celsius) of the gasification equipment in a coal.

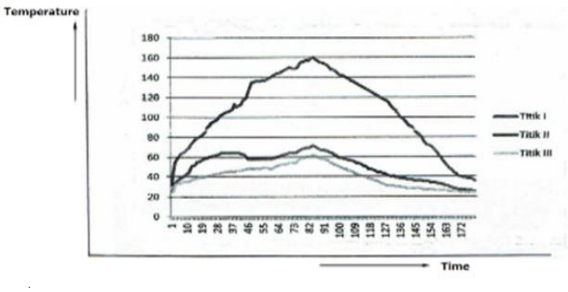


Figure :11 Graph of experimental results of temperature point 1: T1 (degrees Celsius); point 2: T2 (degree Celsius) and point 3: T3 (degree Celsius) of the gasification equipment in a coal

5.CONCLUSIONS

In this research, with the process of making a coal gasification equipment which is done in the workshop based on the working-drawing arrangement and working drawing-detailed and with the installation of tools/components that have been made at the workshop can result in the construction of a coal gasification equipment by following per under with the beginning plan is the Design of Simple Environmentally Friendly A coal Gasifier in Small Scale with Maximum Capacity of 2 Kgs/hour.

Experiments were conducted with this a coal gasification tool using a coal fuel that has low-calorie value, cheap, and easily available in the local market. The results of the tests that have been done on the gasification flow of a coal to produce gas production of a standard gas temperature that is formed on the stove as large 40 degrees Celsius and a gas pressure of 0.88 Atm yard display is used for factories with small and medium caps such as or soybean cake factories, tofu factories, and home industries.

As a suggestion and recommendation from the author is a gasification tool that uses household waste fuel (organic waste) which is converted into briquettes of a certain size. The expected result in the operation of organic waste gasification equipment is the production of standard gas that is environmentally friendly so that the gas production can be used by housewives to cook in the kitchen, the rest of gasification combustion is in the form of fertilizer for the plant. In addition to the above-mentioned results, it can help the Government of DKI Jakarta reduce the disposal of organic waste to the landfill (TPS) in Bantar Gebang – Bekasi.

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