STUDY INFLUENCE OF WATER STREAM VARIETY INTO VENTURI SCRUBBER TO REDUCE TAR AND FLAME FORMATION IN BIOMASS GASIFICATION SYSTEM

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ABSTRACT

Tar is organic contaminant which is formed during gasification. Tar is a complex mixture of condensed hydro-carbon. The amount and the composition of resulted tar depends on kind of fuel, condition of pyrolysis process and reaction of gas secondary phase. The ideal condition of weight content of tar that is resulted by gasifier is not more than 1 % out of weight of fuel is used by (JH Howson, K Casnello). Therefore, in many applications, the content of tar is in gas product must be controlled to prevent appeared obstacles on the whole of gasification equipment or others. Venturi Scrubber is one of the cleaners which is used to catch tar in gas producer. Venturi Scrubber uses water as means of its cleaner. The experiment in the water stream variety in this research flows into ventury Scrubber to know how much tar that it could be caught. Thus, it is known that there is an exact water stream which could catch optimum tar in venturi Scrubber of coal gasification laboratory and biomass Mechanical Engineering University of Indonesia and the influence of stream variety to flame in combustion unit.

Key word :Venturi scrubber, gasification, tars, water stream.

1. INTRODUCTION

Gasification is one of process technology which convert solid fuel to gas fuel. Solid fuel on above as biomass, coal, and charcoal from oil refinery process[1]. In this research is used coconut shell as fuel of biomass. Basic of this reason used coconut shell in this research, it is limited for burn only to be charcoal. Coconut shell is one of biomass which have a big potential to generate energy such as to generate electric. Indonesia result about 1,1 million ton per year coconut shell as possible to generate energy approximately 18,7 x 10^6 Gj per year[2].

Gas which is resulted from gasification can be used for heating, power plant, and motor diesel. Result of gasification is gas producer and contaminant like tar and ash. Gasification is one of method which's used to reduce emission which's resulted while fuel as biomass or coal is burned directly. Gas produser from gasification is mixing gas can be ignated (CO, H_2, CH_4) and can't be ignated (CO_2, N_2, tar dan ash)[2]. Sum of element in produser gas depent on variation of fuel used and operational condition.

Contaminant particle such as tar, one of problem which have to be faced in gasification of biomass. If gas produser is used directly like heating, it can not make a problem but if gas produser is used in motor diesel without filteration about tar, thus can influence perform of motor diesel and possible to accelerate engine break [3]. Therefore, to eliminate contain of contaminant like tar and ash are used dry scrubber and wet scrubber.

In coal gasification laboratory and biomass Mechanical Engineering University of Indonesia are used dry scrubber like cyclon dan separator and wet scrubber with venturi scrubber system.

This research is constitute next step from research who is done by Panji Khairumizan in 2008, with title "Studi eksperimental implementasi *venturi scrubber* pada sistem gasifikasi batubara". In that research had been resulted design of venturi scrubber with its experiment but because of resource of water which is used have no constant stream for entering to venturi scrubber, it is done repeat experiment with make a new reservoir to hold water as a resource for streaming into venturi scrubber.

The objective of this research to know how much tar that it could be caught. Thus, it is known that there is an exact water stream which could catch optimum tar in venturi scrubber and the influence of stream variety to flame in combustion unit.

2.METHODOLOGY

Gasification is used in down draft gasifier. Figure.1 show the schematic of experiment in coal gasification laboratory and biomass Mechanical Engineering University of Indonesia.

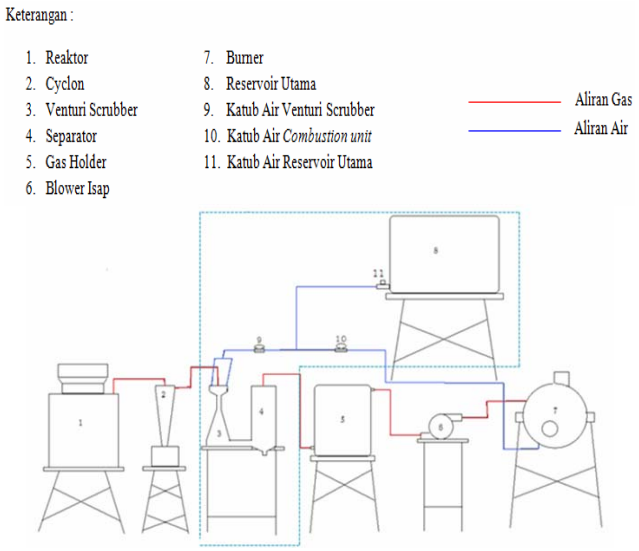


Figure 1. Schematic of experiment

3. Measurment

After all equipment installed, the next preparation is measure of water stream from venturi scrubber valve using glass and stopwatch. Before gas produser will be ignated, make sure that water is flowing in proper stream. In the bellow are stepped of measure flow rate of water in venturi scrubber valve:

- Regulate valve of main reservoir use degree of arch which have function as setting of valve. The first setting is 20^o.
- Regulate valve of venturi scrubber use degree of arch which have function as setting of valve. The first setting is 20^o and fill the glass till 300 ml, and with the same time turn on stopwatch.
- When the surface of water in the glass till 300 ml line. Turn off stopwatch and note its time. This activity is used for three data, and then take a mean of that time.
- Measurement of waterflow in 20^o, devide 300 ml with mean of time. Thus, flow rate of water in ml/second.
- Repeat step number three with regulate valve opening of 30^0, 40^0, 90^0.
- Repeat step in number one till number four with different valve opening until maximum condition.

3.1. Process of Data Collection

1. After gasification smoke indicates tough and slight, started ignition process. After reaching a stable flame in combustion unit, collection data may started. Open the main reservoir valve in the low condition, start from opening valve of 20^o, and then open the venturi scrubber valve start from the low opening condition of 20^o. Regulate venturi scrubber valve is done until maximum condition with five variety opening venturi scrubber valve of 20^o, 30^o, 40^o, dan 90^o, for each variation of setting main reservoir valve.
2. Record all of temperature termocouple variation in combustion unit.
3. Tapping water and tar exit from venturi scrubber.

4. RESULT AND ANALYSIS

Gasification flame of gas produser shows in Figure 2. In this study, fuel used is two kilogram per batch. Stability of flame could be kept about twenty second.

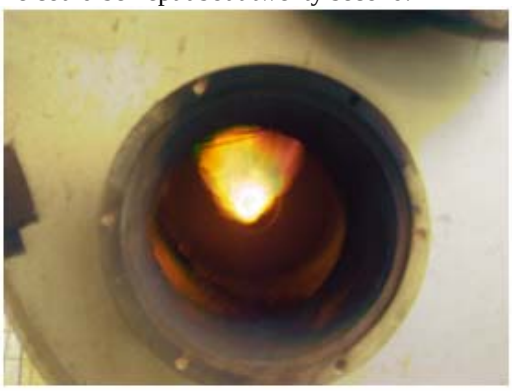


Figure 2. Flame in combustion unit

Temperature Distribution of flame in *Combustion unit*

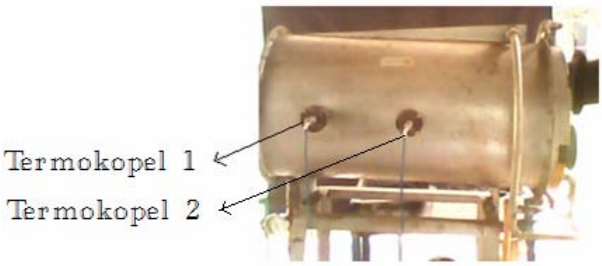
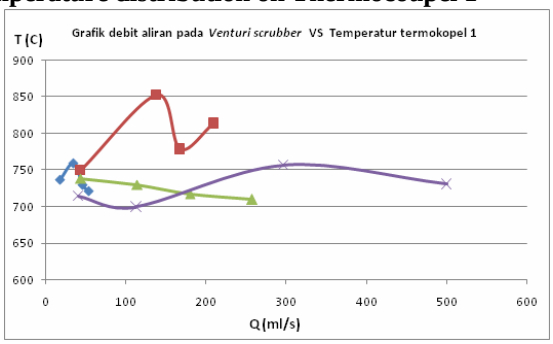


Figure 3. Thermocouple side

Could be seen in above Figure 3, in combustion unit is put on two thermocouple, the function of that thermocouple to measure how high the temperature of flame and how long flame that it could be formed. Its objective to know how far the influence of variation flow rate in venturi scrubber

about flame change that it could be formed in combustion unit.

Temperature distribution on Thermocoupel 1



Ket :

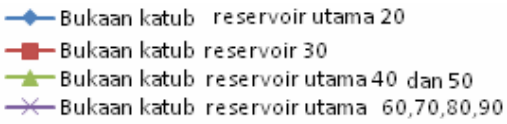
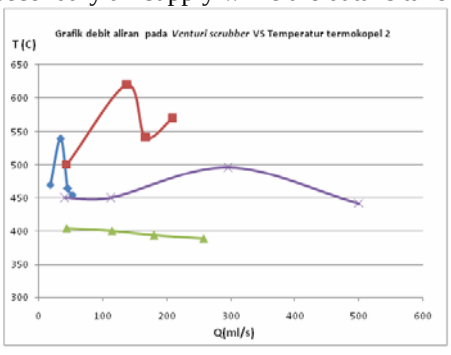


Figure 4. Temperature distribution on Thermocoupel 1

From the above Figure, it is seen that temperature change on thermocouple 1 is not significant under 100°C. The change of temperature which happen in every condition venturi scrubber valve, it is caused by supplied of gas produser into combustion unit unconstant, other reasons that change of temperature is caused by influence from kind of number swirl used in burner and sum of secondary air. This reasons were influence mixing of gas and air in combustion unit.

From the above Figure, it is seen also that in condition of main reservoir valve 30° and condition of venturi scrubber valve 30° to be significant temperature change. In that case, it could be happen because of using variaety of number secondary air supply while the data is taken.



Temperature distribution on Thermocoupel 2

where:

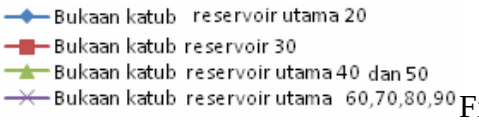


Figure 5. Temperature distribution on Thermocoupel 2

From the above Figure, form of thermocouple 2 Figure same with thermocouple 1 it is happen because of termokopel constitute radiation of thermocouple 1. It could be conclusion that flame is formed in combustion unit is not influence about variation of flow rate of water in venturi scrubber.

Comparison visual of tar with condition main reservoir variety

Refer to sample which is resulted by research for all variety of main reservoir valve, it is gotten the Figure of comparison visual of tar that is resulted for all condition main reservoir valve.

Main reservoir opening valve 20°

The comparison visual of tar for condition main reservoir valve 20° with condition venturi scrubber opening valve of 20°, 30°, 40°, dan 90°.

In Figure 6 shows that the condition main reservoir opening valve of 20°, with condition venturi scrubber opening valve of 30° which has optimum flow rate trapping the tar. Regarding visual observation, that water from venturi scrubber, it is very tough. In this case, condition of flow rate of water is of 33,96 ml/s.

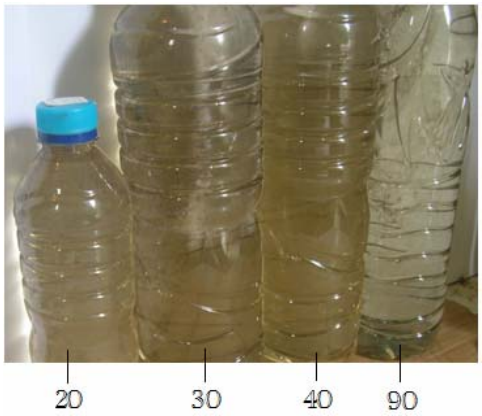


Figure 6. Comparison visual of tar with condition main reservoir valve 20°

Main reservoir opening valve 30°

The comparison visual observation of tar for condition main reservoir valve 30° with condition venturi scrubber valve 20°, 30°, 40°, dan 90°.

In Figure 7, it is seen that the condition main reservoir valve 30°, with condition venturi scrubber valve 20° which had optimum flow rate to be caught tar. It is based on result visual of water exit from venturi scrubber in this condition, it is very tough be compared others. In this case, condition of flow rate of water is 44,32 ml/s.

Figure 7. Comparison visual of tar with condition main reservoir valve 30^o

Main reservoir opening valve 40^o

The comparison visual of tar for condition main reservoir valve 40^o with condition venturi scrubber valve 20^o, 30^o, 40^o, dan 90^o.

In Figure 8, it is seen that the condition main reservoir valve 40^o, with condition venturi scrubber valve 20^o which had optimum flow rate to be caught tar. It is based on result visual of water exit from venturi scrubber in this condition, it is very tough be compared others. In this case, condition of flow rate of water is 43,9 ml/s. But if we saw to result visual of water exit in condition venturi scrubber valve 30^o, 40^o, dan 90^o, it is not tough. In that case, flow rate of water into venturi scrubber up to 100 ml/s. From referance, in that condition, only tar with that had huge diameter is caught, but for tar had small diameter possible could not be caught.

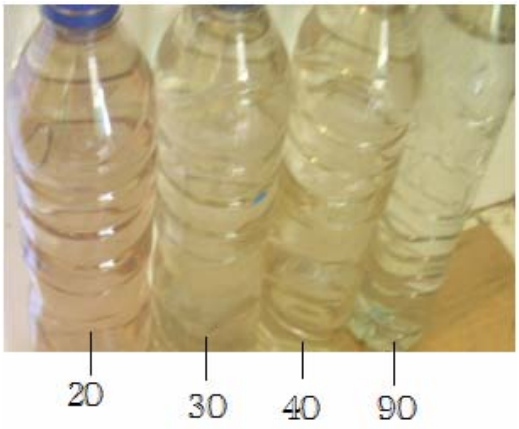


Figure 8. Comparison visual observation of tar with condition main reservoir valve 40^o

Main reservoir valve 90^o

The comparison visual of tar for condition main reservoir valve 90^o with condition venturi scrubber valve 20^o, 30^o, 40^o, dan 90^o.

Figure 9. Comparison visual of tar with condition main reservoir valve 90^o

Similar with the condition in main reservoir valve 40^o, result of water from venturi scrubber is not more tough if it is compared with condition main reservoir for 20^o and 30^o.

Comparison visual observation of tar with variation the condition of main reservoir flow

From comparison visual which had been done, then it is done comparison to use Figure with convert visual of tough to be a value.

Table 1. Convert visual of tough to be a value

Ket :		
	Pekat	4
	agak pekat	3
	tidak pekat	2
	jernih	1

Figure visual of tar with condition main reservoir valve 20^o

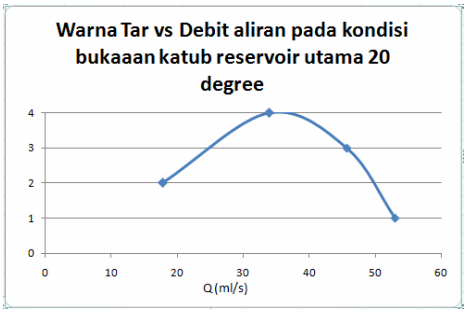


Figure 10. Figure of comparison visual observation of tar with flow rate in venturi scrubber

From the above Figure, it is seen that for flow rate 33,96 $^{ml}/_{s}$, tar that could be caught in optimum condition, it is compared with others flow rate.

Figure visual of tar with condition main reservoir valve 30^o

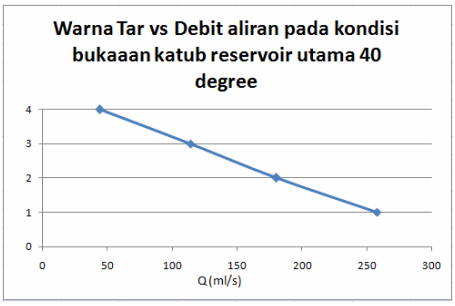


Figure 11. Figure of comparison visual of tar with flow rate in venturi scrubber

From the above Figure, it is seen that the result of optimum condition of tar could be caught while flow rate of water is 43,32 $^{ml}/_{s}$, it is seen from the colour of water, in this condition is very tough.

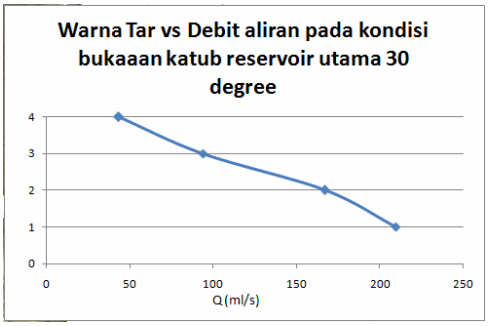


Figure visual of tar with condition main reservoir valve 40^o

Figure 12. Figure of comparison visual of tar with flow rate in venturi scrubber

From the above Figure, it is seen that the result of optimum condition could be caught with flow rate of water is 43,9 $^{ml}/_{s}$.

Visual observation of tar with condition main reservoir opening valve 90^o

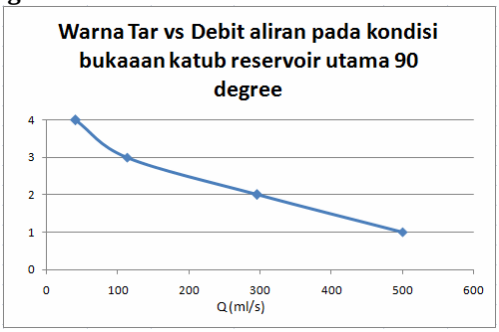


Figure 13. Figure of comparison visual of tar with flow rate in venturi scrubber

From the above Figure, it is seen that the result of optimum condition could be caught with flow rate of water of 40,78 $^{ml}/_{s}$.

ANALYSIS

Based on comparison visual observation of tar variation of main reservoir opening valve, for main reservoir opening valve of 20^o, indicated an optimum condition to catch tar and others contaminant. This is indicated by colour of water is very tough compared with others condition of main reservoir opening valve.

From the literature, the increase sum of flow rate into venturi scrubber, it caused more tar that could be caught until optimum condition [4], and the other reference Gerald T. Joseph mentioned that collection efficiency of venturi scrubber will increase along with increase surface area of water[5], in that case is formed more droplet of water to catch tar and others contaminant.

If it is compared between result of research and reference, in the condition water flow rate of 33,96 $^{ml}/_{s}$, this condition is optimum flow rate, it is seen from tough colour of water tar. From reference said that “Increasing the amount of liquid increases the efficiency” [5]. However, a combination of high liquid usage with small orifices can lead to excessive jet penetration. In this situation, the jet will atomize near the opposite wall facilitating droplet deposition and thus decreasing the amount of liquid available as droplets. It is proof in others condition when the flow rate to be increased, the colour of water would be not tough.

CONCLUSION

A stable flame for twenty second is reached, with all of data is taken with separate two minute from the begining condition.

The flame formed in combustion unit is not influence by different water flow rate in venturi scrubber. It is indicated by temperature distribution on Thermocouple 1 and 2.

The optimum water flow rate for venturi scrubber is reached on 33,96 $^{ml}/_{s}$, this value indicates also onthe time that the water color from venturi scrubber is tough enough compared with other condition.

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