Int.J.Curr.Microbiol.App.Sci (2018) *7*(12): 2813-2816

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 7 Number 12 (2018)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2018.712.319

Performance Evaluation of Gasifier with Different Sizes of Feed Stock

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A B S T R A C T

Keywords

Evaluation, Gasifier, Different sizes of feed stock

Article Info

Accepted:
20 November 2018
Available Online:
10 December 2018

Particle size is important parameter affecting the composition, quality and final applications of the producer gas. Fine grained or fluffy feed stock may cause flow problems in the gasifier as well as an inadmissible pressure drop over the reduction zone and a high proportion of dust in the gas. To avoid such problems briquetted material considered for gasification. The developed gasifier was tested with different sizes of briquettes of 15, 30 and 45 mm width and 90 mm diameter. The volatile matter, fixed carbon and ash content of briquette were found as 71.87%, 17.07% and 4.31%, respectively. Briquette consumption rate was low at air flow rates of 20 to 25 $m^3 h^{-1}$ but it was observed by that increasing of air flow rate, feed consumption rate was also increased up to 35 $m^3 h^{-1}$and decreased with increase of further air flow rate. Hence, 30 mm briquette size considered for gas production.

Introduction

Particles size play very important role because its affects the composition, quality and final applications of the producer gas (Reed and Das, 1988). Indeed, fuel particle size influences the process time required for gasification, as well as the reactor dimensions. It also plays a key role in all the sequential reaction stages such as fuel heating, reactant and product diffusion between the particle and the reaction atmosphere, and solid–gas reactions, which occur during the conversion of fuel into product gas.

To avoid such problems briquetted material considered for gasification. Briquetting of biomass is a densification process which improves the handling characteristics of the biomass, enhances its volumetric calorific value and reduces the transportation cost. Briquetting of biomass can be done by mixing it with some binder or direct compacting without binder. Essentially, all agricultural residues and saw dust from timber mills, can be briquetted (Tripathi, 1998). Agricultural residues which do not pose collection and drying problems are more suitable for briquetting (Grover, 1996).

The developed gasifier was tested with different size of briquettes of 15 mm, 30 mm and 45 mm width and 90 mm diameter**.**

Materials and Methods

Biomass waste such as saw dust, maize cobs, cotton stalks, redgram stalk and ground shell mixtures were used for briquetting. The briquette material consist major portion of 80 per cent saw dust followed by corn cobs, redgram stalk, cotton stalks and ground shell. The developed gasifier was tested with different sizes of briquettes of 15, 30 and 45 mm width and 90 mm diameter.

Moisture content

The moisture content of briquette can be estimated by taking a small pre-weight sample. The sample with an initial mass is placed in drying oven in which a temperature of 110 °C is maintained. After 24 hour the mass is noted as final weight. The moisture content (m) in percentage of briquette on wet basis is calculated.

Volatile matter

The amount of volatile matter, which is a function of the carbon to hydrogen ratio. The amount of volatile matter is determined by heating a dried ground sample of briquette with an initial mass (M_i) in a closed crucible in an oven at temperature of 600 °C for six minutes followed by heating the sample in an oven with temperature of 900 °C for six minutes and then its weight (M_f) is measured.

$$V = \frac{M_i - M_f}{M_i} \times 100 \quad ...(1)$$

where,

V = Volatile matter, %
M_i = Initial mass, g
M_f = Final mass, g

Ash content

Ash is the non-combustible component of the biomass. The higher the amount of ash in a fuel, it indicates the lower calorific value of the fuel. The amount of ash is determined by heating a dry sample of briquette in crucible in a furnace which is kept at 900 ^oC for 15 minute to burn fuel completely. The dried sample is taken out of the furnace and the residue remaining in the crucible is ash. The percentage of ash is determined by following equation

$$A = \frac{M_s}{M_i} \text{ x } 100 \quad ...(2)$$

where,

A = Ash content, g
M_s = Weight of ash, g
M_i = Initial weight of sample, g

Fixed carbon

The final step in proximate analysis is the determination of the amount of fixed carbon (C) by using mass balance calculations.

$$C = 100-(m+A+V) \quad \ldots ($$

where,

C = Fixed Carbon, %
m = Moisture content, g
A = Ash content, g
V = VOLATILE MATTER, %

Results and Discussion

Proximate analysis of biomass briquette

The result obtained by proximate analysis of selected briquette was given in Table 1. The volatile matter of briquette was found to 71.87%, this result revealed that considerable amount of volatiles were available in the material of gasification (Fig. 1).

The ash content of briquette was found 4.31 per cent. For efficient gasification ash content of the fuel should be below 10 per cent. It is desirable to use lower ash content fuel for gasification. This fuel was found suitable for gasification. High ash content fuel seriously interferes with the operation of gasifier and increase pressure drop, whereas fixed carbon content briquette found 17.07%.

Equivalence ratio of different air flow rate and different size of briquettes 15 mm, 30 mm and 45 mm with a diameter of 90 mm tested for feed consumption rate were presented in Table 2. Variation of briquette consumption rate at different air flow rates as shown in Figure 2. In general 15 mm, 30 mm and 45 mm briquette consumption rate was low at air flow rates 20 to 25 $m^3 h^{-1}$ but observed that increase of air flow rate feed consumption rate was increased up to 35 $m^3 h^{-1}$ and decreased with increase of further air flow rate. The 45 mm size briquette consumption rate at 20 and 25 $m^3 h^{-1}$ was low due to insufficient stoichiometric air available for reaction.

Table.1 Proximate analysis of briquette

	Proximate composition, %		
	Fixed carbon	**Volatile matter**	**Ash content**
Briquette	17.07	71.87	4.31

Table.2 Briquette consumption rate of different sizes of feed stocks at different air flow rates

Air flow rate, $m^3 h^{-1}$	Equivalence ratio	Briquette consumption rate, $kg\ h^{-1}$		
		15 mm width	**30 mm width**	**45 mm width**
20	0.29	12.00	11.50	10.25
25	0.37	12.50	12.75	11.50
30	0.44	13.50	14.00	15.50
35	0.51	14.75	15.00	16.00
40	0.59	13.50	14.00	16.00

Fig.1 Proximate composition of briquette

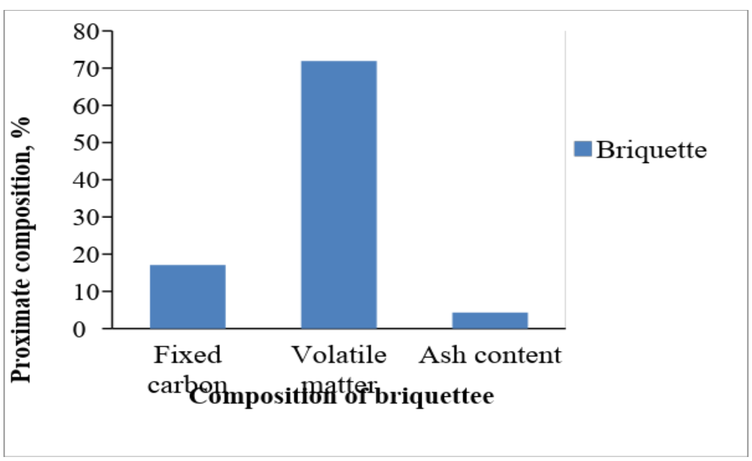
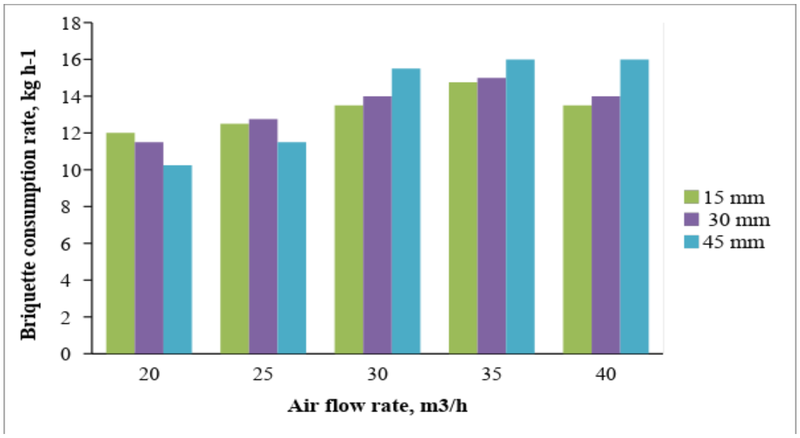


Fig.2 Briquette consumption rate of different sizes of feed stocks at different air flow rates



In conclusion the volatile matter, fixed carbon and ash content of briquette were found as 71.87%, 17.07% and 4.31%, respectively. Briquette consumption rate was low at air flow rates of 20 to 25 $m^3 h^{-1}$ but it was observed by that increasing of air flow rate, feed consumption rate was also increased up to 35 $m^3 h^{-1}$ and decreased with increase of further air flow rate. Consumption rate at air flow rates of 20 and 25 $m^3 h^{-1}$ for 45 mm size briquette was low due to insufficient stoichiometric air available for reaction. The 30 mm briquette size gave a maximum efficiency, after optimization at an air flow rate of 30 $m^3 h^{-1}$. Hence, 30 mm briquette size considered for gas production. The average calorific value increased with increasing air flow rate and dropped at 40 $m^3 h^{-1}$.

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How to cite this article:

Swamy, R., K. Sivala, D.D. Smith, K. Sadasivarao and Lakshimipathy, R. 2018. Performance Evaluation of Gasifier with Different Sizes of Feed Stock. *Int.J.Curr.Microbiol.App.Sci.* 7(12): 2813-2816. doi: https://doi.org/10.20546/ijcmas.2018.712.319