TEST Engineering & Management

March-April 2020
ISSN: 0193-4120 Page No. 2545 - 2549

Effect of Gasification Process for Energy Generation from Biomass – A Plant Origin

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Article Info
Volume 83
Page Number: 2545 - 2549
Publication Issue:
March - April 2020

Article History
Article Received: *24 July 2019*
Revised: *12 September 2019*
Accepted: *15 February 2020*
Publication: *19 March 2020*

Abstract:
While biomass has effectively been co-fired of being at pulverized coal boilers in power posts for a high-efficiency use of biomass, there have been gasification techniques representing the co- gasification processes using entrained flow gasifiers, which are accepted for the inclusive integrated gasification combined with cycle plants in different parameters. This study deals with the gasification and combustion of biomass derived from plant materials which depicts the chemical kinetics as well as the various stages undergone under gasification and its installation conditions whose syngas composition is recorded with precision. The influence of temperature, pressure and air-oxygen ratios on the exit gas was evaluated for the generation of energy.

Keywords: *Biomass origin, Gasification, Combustion, Thermo-chemical reactions.*

1. Introduction

Gasification is a method where the fossil-based carbonaceous components are directly converted into hydrogen, carbon dioxide and carbon monoxide that is to be namely called as “producer gas” which is achieved on a process where each of the individual component is elevated to high temperatures crossing above 700 degrees in Celsius without indulging with the process of combustion and simultaneously comprising of steam as well as oxygen within that is obtained through a whole series of thermos-chemical reactions. The final product obtained from this is called syngas as a result of the synthesis gas that is also a commonly known fuel. This gas remains as a low-heat valued fuel that comprises of a calorific value that stands between 1000-1200 kcal/Nm3. The overall energy extracted from these methods of gasification and combustion of the final gas is known to have a major foundation from renewable energy since the components that undergo gasification are entirely gained from biomass. (Teriin.org, 2019)

End results proven from the earlier prospects inspire the shared use of the various biomass fuels without the use of any type of significant modifications within the course of installation, even though agricultural wastes would also prime toward leading to more effective gasification procedures. Such latter wastes seem to be interesting fuels to give out a producer gas which is to be of usage when it comes to being under internal combustion engines or gas turbines, (It would produce high gasification efficiency and gas yield) whereas sawdust would be a very adequate type of fuel to generate a hydrogen rich gas that comprises to have the interest of fuel particles because of its constant high reactivity. But, the gasification techniques and characteristics were not to be influenced by the reaction temperatures as much as the biomass ratio. (Lapuerta et al., 2019)

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II .Process Description

Biomass gasification, its main objective for the thermo-chemical biomass gasification process is the finest possible means of conversion for solid biomass fuels into a very high calorific product gas. Henceforth, biomass reacts with the help of another product called the fumigator (air, oxygen, steam or CO2), that gives the necessary oxygen which is required for the entire process. Because of the thermal cracking occurrence and the partial oxidation, a product gas is molded. The composition of this product gas mainly depends upon the biomass fuel, the reaction conditions where it performs and the fumigator which consists of different concentrations of hydrogen (H2), carbon monoxide (CO), steam (H2O) and methane (CH4). The charcoal and hydrocarbons are usually the final products of a gasification process that tends to be incomplete. (Bios-bioenergy.at, 2019)

The fuel cells present in fixed bed gasifiers are not to be moved by the gas movement and hence the fuel within the gasifier is considered as the fixed bed. The fuel feeding of most reactors is at a position which is above the fuel bed whereas the final end products are extracted from the bottom of the fuel bed. The four main stages of the gasification process tend to occur in a place which is distinguishable as drying, pyrolysis, oxidation and the reduction zone. (Liu and Gibbs, 2003) The biomass fuel changes from the top to the bottom of the fuel bed which ends in relatively a long residence time for the fuel present within the gasifier. A distinctive design of fixed bed gasifiers includes a fuel feeding from lower part of the fuel bed. Depending on which side the direction of the product gas flows, relative to the direction of the fuel transport, the fixed bed gasifiers are categorized into co-current, counter-current or cross flow gasifiers. The figure below depicts the three simple and basic outlines of the fixed bed gasifiers and the characteristic reaction regions of each gasifier. (Di Blasi, 2009)

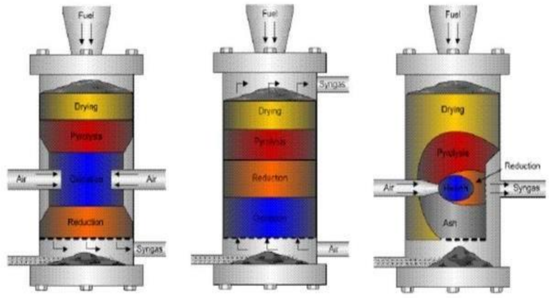

Fig.1. The various designs of the fixed bed gasifiers including the characteristic reaction regions based on each of the gasifier design being, 1.Co-current Gasifier, 2. Counter-current gasifier and 3. Cross flow gasifier. (Niksa and Kerstein, 1987)

The designs of the fixed-bed are basically updraft (counter-current) or down draft (co-current). In updraft kind of gasifiers, the fuel bed moves in the downward direction and the gasification agent moves from bottom to up (updraft). As the gas is allowed to leave the reactor next to the pyrolysis region, the gas produced in the updraft gasifiers consists of a high content of organic materials (Difelice et al., 1999)

Fluidized bed gasifiers tend to have a number of advantages over fixed beds, especially when it comes with regard to the mixing, reaction rates, and also the possibility of it being produced in sizes far above than those of the fixed-bed gasifiers that are usually in the market. (Wang and Yan, 2008). As the end result, it seems that in the short form, most of the processes for biomass and waste gasification at a bare medium and also large scale will use FB designs. The gasification type of concepts can be gathered into two different methods, depending on the medium of the heat for gasification to be provided onto the gasifier. This fractional oxidation could be carried out using air or by oxygen. Steam could also be a useful addition to these kinds of oxidants. (Lv et al., 2004)

INSTALLATION SCHEME

This kind of an installation contains of a raw material supply scheme, an alumina reaction pipe, an Agilent 3000 micro-GC with a thermal conductivity detector (TCD) or indicator, that which allows the rapid measurement of the producer gas materials through two separate columns (a molecular sieve column to measure CO, H2, CH4, N2, and O2 and a Plot-U column to measure CO2 and C2H6), and a

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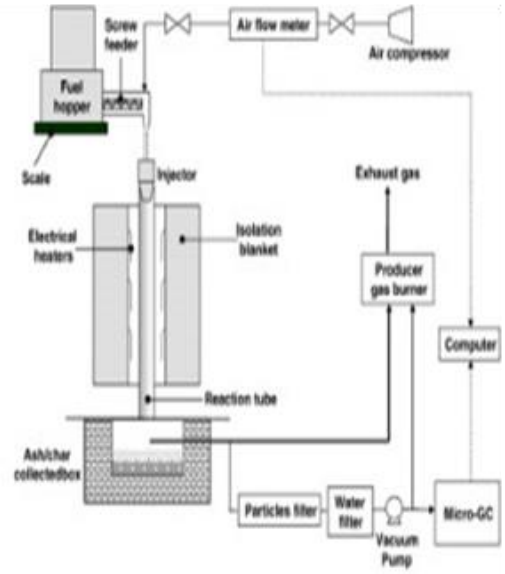
ISSN: 0193-4120 Page No. 2545 - 2549

charcoal collected box placed at the bottom of the equipment. The alumina reaction tube (Al_2O_3) has 1.2 m length, an inner diameter of 75 mm (width 7.5 mm), thermal conductivity of 30 W/mK, and three different stages of $MoSi_2$ electrical resistances (with a power of 7 kW per resistance) that allows the supreme foundations for the influence of the temperature on the producer gas quality.



Three thermocouples (R-types) were introduced outside the alumina tube in order to keep it in control and keep the desired temperature in each reaction zone (the gasification temperature is expected to be a little bit lower than that of the reaction tube). Also, before the gasification tests, all the fuel samples that were tested was milled to less than 800 µm, just in order to safeguard the homogeneity on the biomass compositions. Air from the compressor was used as an oxidant reagent in all the gasification tests. The air flow rate was even found through a volumetric flow controller which was placed after the air regulation valve, while the fuel feeding rate was estimated as the weight difference of the fuel hopper before as well as after the test. (Lapuerta et al., 2019)

Conclusion

Higher temperature improves the effectiveness of the gasification process. It increases both the production of hydrogen and the carbon conversion efficiency. Carbon monoxide and methane represent the decreasing tendencies with increasing temperature. Carbon dioxide generation and carbon transformation efficiency increase by increasing the ER. Though, hydrogen, carbon monoxide and methane decrease when ER is increased so precautions must be taken before that occurs which in turn increases the steam-biomass ratio. The cell average size would not show a substantial influence on the procedure with the composition of the product gases.

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