Gasification behavior of woody biomass Review

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Abstract- **The use of sawmill residues for energy has lower impacts because it involves no additional harvesting; it is waste from other operations of the wood industry. The impact will be most positive for the climate if they are utilized on-site for energy generation using gasification process without any associated transport or processing emissions. Thus the objective of this work is**

- **To study about a simulation based investigation aimed at developing an efficient process for air gasification of woody biomass in the absence of added catalysts from the previous research papers**
- **To prepare review about the effect of the Air to Biomass ratio, Gasification temperature and air inlet temperature used for gasification process syngas quality.**

Index Terms- **Gasification. woody biomass etc.**

I. INTRODUCTION

Gasification is the process which is occurs due to partial oxidation of a carbonaceous material, and it is flourished by supplying less oxygen than the stoichiometric necessity for whole combustion. It is a central procedure between combustion i.e. thermal degradation with excess oxygen and pyrolysis i.e. thermal degradation in the absence of oxygen, it gates at temperatures ranging between 700 and 1400˚C. Based upon the procedure type with operating conditions, low- or medium-value producer gas i.e. a combination of combustible and non-combustible gases; is created.

Gasification innovation has been broadly used to deliver business energizes and chemicals. Current advancements in the compound assembling and oil refinery enterprises demonstrate that utilization of gasification offices to deliver combination gas will keep on rising. A striking element of the innovation is its capacity to deliver a dependable, top notch syngas item that can be utilized for vitality creation or as a building hinder for compound assembling forms.

1.1 Gasification Process

Amid gasification of biomass, the material is warmed to a high temperature, which causes a progression of physical and concoction changes that outcome in the advancement of unstable items and carbonaceous strong deposits. The measure of volatiles created and their organizations rely upon the reactor temperature, sort, and attributes of fuel material. It is for the most part acknowledged that the roast gasification organize is the rate constraining in the gasification of biomass in light of the fact that the DE volatilization arrange is quick.

The composition of the final product gas is also dependent on the degree of equilibrium achieved by various gas-phase reactions, particularly the water-gas shift reaction. In the absence of a catalyst, gasification of char with reactive gases such as O_2, H_2O and CO_2 occurs at higher temperatures (700˚C to 1000˚C) according to the following reaction:

$$Char + Limited\ Oxygen \rightarrow Gas + Tar + Ash$$

When char is gasified in the presence of steam, the gas produced is composed mainly of CO_2, CO, H_2 and CH_4. Steam may be added from an external source or from the dehydration reactions of crop residues. In reactors operating at low temperatures, low heating rates and very high pressure, secondary reactions are very important because of long residence times (of the volatile products in the reaction zone). On the other hand, at low pressure, high temperature, and high heating rates, most of the volatile products escape instantaneously from the fuel particles during pyrolysis, hence reducing the chances of a solid char-gas interaction. In fluidized bed gasifier, the latter prevails but because of the mixing nature of the bed, secondary reactions in the gas-solid and gas-gas phases take place.

1) Dehydrating of the feedstock;
2) Pyrolysis to yield volatile matter with char;
3) Gasification of in situ formed char with reactive gases like as CO_2, H_2O, H_2 and O_2; finally

4) Secondary reactions of primary gases with tars.

1.1 Air gasification

The least complex gasification process utilizes air as a gasifying specialist. Overabundance roast shaped by the pyrolysis procedure inside the gasifier is scorched with a constrained supply of air (more often than not at an identicalness proportion of 0.25). The item is a low-vitality gas containing fundamentally hydrogen and carbon monoxide weakened with the nitrogen from the air. The warming estimation of the delivered gas is in the 3.5 - 7.8 MJ/Nm^3 territory, which makes it reasonable for evaporator and motor applications yet not for utilizes that require its transportation through pipelines.

Walawender and Fan (1978) studied the air gasification of feedlot manure and found that gas yield, heating value, and energy recovery increased by 131%, 77% and 244%, respectively, when the temperature increased from 900 to 1100 K. *Ergudenler (1993)* studied the effect of air flow rate on the gas quality and quantity during air gasification of wheat straw in a fluidized bed gasifier. The results showed that at equivalence ratio of 0.25, the mole fraction of the combustible component achieved their maximum.

Cao et al. (2005) demonstrated a fluidized bed air gasification system using sawdust. They combined two individual regions of pyrolysis, gasification, and combustion of biomass in one reactor. The primary air stream and the biomass feedstock were introduced into the gasifier from the bottom and the top, respectively. Secondary air was injected into the upper region of the reactor to maintain elevated temperature.

Woody Biomass

Biomass, in its simplest form, is defined as organic matter renewable over time. Woody biomass is the accumulated mass, above and below ground, of the roots, wood, bark, and leaves of living and dead woody shrubs and trees. Woody biomass is primarily comprised of carbohydrates and lignin produced through the photosynthetic process.

Woody biomass can be used for generating electricity, producing biofuels, and making bio-chemicals such as adhesives, solvents, plastics, inks, and lubricants. Rising fuel costs, uncertainty about energy supplies, dependence on foreign energy sources, and concern about global climate change and air quality make renewable natural energy alternatives more attractive, such as that produced from woody biomass.

Wood biomass includes wood chips resulting from forestry operations, residues coming from lumber, pulp or paper and furniture mills and fuel wood for space heating. 'Black Liquor is known to be the largest and only source of wood energy. It is actually a residue of pulp, paper and paperboard production. It functions towards supplying more than fifty per cent of all the above mentioned energy requirements of the industry. Manufacturers of lumber mills and furniture tend to utilize saw dust, chips and bark for more than 60% of requirements for energy.

II. LITERATURE REVIEW

Many researchers have been work for the gasification of Woody biomass, some of them are as:

1. *"Influence of controlled handling of solid inorganic materials and design changes on the product gas quality in dual fluid bed gasification of woody biomass*", 2018, Matthias Kuba, Stephan Kraft, Friedrich Kirnbauer, Frank Maierhans, Hermann Hofbauer

Utilizing biomass feedstock in thermal conversion technologies to reduce greenhouse gas emissions is a promising way to substitute for fossil fuels. Gasification of biomass allows for the production of electricity, district heat, high-grade fuels for transportation and synthetic chemicals. Investigations at the HGA Senden industrial scale dual fluidized bed gasification power plant have shown the potential for improving gas quality by the controlled handling of solid inorganic materials in the reactor. Two measures for optimization were implemented and investigated on-site.

2. *"Experimental investigation of woody and non-woody biomass combustion in a bubbling fluidised bed combustor focusing on gaseous emissions and temperature profiles"* 2017, Farooq Sher, Miguel A. Pans, Daniel T. Afilaka, Chenggong Sun, Hao Liu

Air organizing is an outstanding successful strategy to control NOx outflows from strong fuel ignition boilers. Nonetheless, additionally look into is as yet expected to clear up the impact of air arranging at various infusion areas on the vaporous outflows of Fluidised Bed Combustion (FBC) boilers that fire 100% biomass powers, especially non-woody biomass energizes. The principle goal of this work is to examine the impact of the arranging air infusion area on the vaporous outflows (NOx and CO) and temperature profiles of a 20 kWth gurgling fluidised bed combustor terminating three non-woody (straw, miscanthus and peanuts) and two woody biomass powers. The test comes about demonstrated that infusing the optional air at the higher area could prompt a more prominent NOx decrease because of the way that the biomass burning response principally occurred in the sprinkle zone and additionally start of the freeboard

3. *"Anaerobic digestion and gasification hybrid system for potential energy recovery from yard waste and woody biomass"* 2017, Zhiyi Yao, Wangliang Li, Xiang Kan, Yanjun Dai, Yen Wah Tong, Chi-Hwa Wang

There is a rapid growing interest in using biomass as an alternative source for clean and sustainable energy production. In this work, a hybrid systemwas developed to combine anaerobic digestion (AD) and gasification for energy recovery from yard waste and woody biomass. The feasibility of the proposed hybrid system was validated experimentally and numerically and the energy efficiency was maximized by varying energy input in the drying process. The experiments were performed in two stages. At the first stage, AD of yard waste was conducted by mixing with anaerobic sludge. At the second stage, co-gasification was added as post-treatment for the AD residue for syngas production.

4. *"Exposure of refractory materials during high-temperature gasification of a woody biomass and peat mixture"*, 2017, Markus Carlborg, Fredrik Weilanda, Charlie Mac, Rainer Backman, Ingvar Landälv, Henrik Wiinikka

Finding versatile recalcitrant materials for slagging gasification frameworks can possibly diminish costs and enhance the general plant accessibility by expanding the administration life. In this examination, diverse hard-headed materials were assessed under slagging gasification conditions. Recalcitrant tests were ceaselessly presented for up to 27 h in a barometrical, oxygen blown, entrained stream gasifier let go with a blend of bark and peat powder. Slag invasion profundity and microstructure were contemplated utilizing SEM EDS. Crystalline stages were related to powder XRD. Expanded levels of Al, starting from headstrong materials, were found in all slags. The intertwined cast materials were slightest influenced, despite the fact that disintegration and slag entrance could in any case be watched. Thermodynamic balance counts were improved the situation blends of headstrong and slag, from which stage gatherings were anticipated and viscosities for the fluid parts were assessed.

5. *"Energy from poultry waste: An Aspen Plus-based approach to the thermo-chemical processes",* 2017, Gianluca Cavalaglio, Valentina Coccia, Franco Cotana, Mattia Gelosia, Andrea Nicolini, Alessandro Petrozzi

A specific way to deal with the undertaking of vitality transformation of a remaining waste material was legitimately experienced amid the execution of the national supported Enerpoll venture. This task is a contextual analysis created in the home of a poultry cultivate that is situated in a provincial zone of focal Italy (Umbria Region); such a ranch was decided for the examination venture since it is relatively illustrative of numerous comparative little measured reproducing realties of the Italian local setting. The motivation behind the contextual investigation was the transfer of a waste material (i.e. poultry compost) and its vitality recuperation; this errand is in concurrence with the primary targets of the new Energy Union approach. Thinking about this foundation, an imaginative gasification plant (300 KW warm power) was picked and introduced for the experimentation.

6. *"Co-gasification of woody biomass and chicken manure: syngas production, bio-char reutilization, and cost-benefit analysis",* 2017, Wei Cheng Ng, Siming You, Ran Ling, Karina Yew-Hoong Gin, Yanjun Dai, Chi-Hwa Wang

The management and disposal of livestock manure has become one of the top environmental issues at a global scale in line with the tremendous growth of poultry industry over the past decades. In this work, a potential alternative method for the disposal of chicken manure from Singapore local hen layer farms was studied. Gasification was proposed as the green technology to convert chicken manure into clean energy.

Through gasification experiments in a 10 kW fixed bed downdraft gasifier, it was found that chicken manure was indeed a compatible feedstock for gasification in the presence of wood waste. The co-gasification of 30 wt% chicken manure and 70 wt% wood waste produced syngas of comparable quality to that of gasification of pure wood waste, with a syngas lower heating value (LHV) of 5.23 MJ/Nm^3 and 4.68 MJ/Nm^3, respectively. Furthermore, the capability of the gasification derived biochar in the removal of an emerging contaminant (artificial sweetener such as Acesulfame, Saccharin and Cyclamate) via adsorption was also conducted in the second part of this study.

7. *"Life Cycle Assessment of a Sewage Sludge and Woody Biomass Co-gasification System".* 2017, Srikkanth Ramachandran, Zhiyi Yao, Siming You, Tobias Massier, Ulrich Stimming, Chi-Hwa Wang

Supplanting a piece of vitality got from non-renewable energy sources with bioenergy got from strong waste streams might be a promising technique to handle the double emergency of expanding waste heap up and worldwide environmental change. In this examination we propose a decentralized sewage slop and woody biomass co-gasification framework for Singapore. We assess the ozone harming substance discharge of the proposed framework and contrast it with the current framework through life cycle evaluation. The proposed framework is required to give a net yearly emanation lessening of 137.0 to 164.1 kilotonnes of CO_2 eq. Increment in power recuperation, carbon sequestration in the bio-roast delivered and the shirking of the utilization of supplementary fuel for sewage ooze cremation are the significant benefactors for the emanation decrease.

8. *"High temperature steam gasification of woody biomass - A combined experimental and mathematical modeling approach*", 2015, Elango Balu, Uisung Lee, J.N. Chung

The main objective of this study is to investigate the characteristics of woody biomass conversion to syngas using a steam thermal gasification process. The entering steam maintained at 877˚C and 1000˚C, respectively was used as the gasifying agent. A lab scale apparatus was built to perform the gasification experiment and the produced syngas was accurately analyzed using gas chromatography. The results clearly indicate that the syngas from steam gasification contains relatively higher H2 concentrations, and the heating values of the syngas reach 9-10 MJ/m^3. A thermodynamic equilibrium thermochemical model that accounts for the deposition of solid carbon as a function of the entering steam temperature and the steam to biomass molar ratio was developed. The model was successfully verified by experimental results. Based on the results of model, an optimal range of the steam to biomass molar ratio is recommended.

9. *"Air-blown gasification of woody biomass in a bubbling fluidized bed gasifier"*, 2013, Young Doo Kim, Chang Won Yang

Air-blown gasification of woody biomass was investigated in a pilot-scale bubbling fluidized bed gasifier. Air was used as the gasifying agent as well as a fluidizing gas. Fuel was fed into the top of the gasifier and air was introduced from the bottom through a distributor. In order to control the composition of the product gas, the amounts of feedstock and gasifying agent being fed into the gasifier were varied, and the temperature distribution in the gasifier and the composition of the syngas were monitored. It was shown that the distribution of the reaction zones in the gasifier could be controlled by the air injection rate, and the composition of the syngas by the equivalence ratio of the reactants. Although the obtained syngas had a low caloric value, its heating value is adequate for power generation using a syngas engine.

10. *"Co-gasification of woody biomass and microalgae in a fluidized bed",* 2013, Kai-Cheng Yang, Keng-Tung Wua, Ming-Huan Hsieh, Hung-Te Hsu, Chih-Shen Chen, Hsiao-Wei Chen.

In this examination, the microalgal (Spirulina platensis) torrefied pellet and woody biomass (Eucalyptus globulus) torrefied pellet were co-gasified in a 30 kW foaming fluidized bed gasifier to explore the impact of gasification temperature, comparability proportion (ER), feedstock blending proportion and steam infusion on syngas organizations, the lower warming quality (LHV), tar content, and so forth. Before nourishing into the gasifier, the microalgal and woody biomass pellets were torrefied to build the warming esteems.

III- CONCLUSION

For prediction of the syn gas quality resulted from the previous papers obtained that gasification process was predicted with respect to the various variables like as Air to Biomass ratio, Gasification temperature and air inlet temperature provided to the thermal processes etc.

The following observations can be concluded

- Lower heating value increases with the increment of Gasification temperature.
- The same tradition has been shown in increasing the air inlet temperature, as same as Gasification temperature. CO_2 and H_2 shows the decrement in composition while CO, N_2 and CH_4 shows the increment while increasing the air inlet temperature.

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