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CO-GASIFICATION OF COAL

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ABSTRACT

With the growing energy demands and depleting natural resources, it is of utmost importance to work on developing alternating source of energy and to improve the existing technology to utilize the existing resources. Coal-based energy generation meets around 70 percent of our energy needs. Now, to move forward towards a cleaner energy production mechanism and to attain the energy security of the country, judicious utilization of Indian coal is essential. The quality of Indian coal is poor and is worsening since the higher quality resources have already been exploited. Coking coal accounts for around 18-20 percent, of which only a small percentage is of prime coking quality. CO-gasification is the technology to improve the utilization of coal to increase the efficiency of coal utilization.

Keywords: Biomass, Coal-Gasification, Coking coal, Gasifier

1. INTRODUCTION

Worldwide energy consumption has been greatly increased over the last several decades, due to the global growth in industrialization, economy, and population. As a result, the global energy demand increases exponentially and the increasing rate will become more rapid in the future. India is currently the world's third-largest coal-producing, fourth in terms of coal importer. Coal has played a decisive role in shaping modern India's energy requirement. It is poised to make tremendous economic strides over the next ten years, with significant economic development already in the planning stage. Indian coal is characterized by high ash content. This is because the majority of coal in India is located in Gondwana sediments, which characterized by mineral sediments, and is further increase due to the open cast mining production. India coal also has a particularly high moisture content, while sulfur content and calorific value are low.

Biomass, including all land and water-based vegetation, is produced by green plants and all organic wastes and is widely considered as a renewable energy resource. At present, biomass is mainly used for electricity and heat through direct combustion. Making liquid fuel through biomass gasification has several potential advantages; however, it is not economically viable using the current technologies due to the high costs of processing the low energy density biomass feedstock.

1.1 GASIFICATION

Gasification is defined as the reaction of solid fuels with air, oxygen, steam, carbon dioxide, or a mixture of these gases at a temperature exceeding 700 °C, to yield a gaseous product suitable for use either as a source of energy or as a raw material for the synthesis of chemicals, liquid fuels or other gaseous fuels.

Gasifiers are usually classified by the flow regime inside the reactor. There are three main categories:

- Fixed or Moving bed gasifier
- Fluidized bed gasifier
- Entrained flow gasifier

Fixed bed gasifiers can be classified into two types: updraft and downdraft gasifiers depending on the flow direction of gasification agent and producer gas. In the downdraft gasifier, carbonaceous solid fuel enters the gasifier from the top, and while moving to the bottom by the effect of gravity it undergoes drying, pyrolysis, combustion, and gasification sequentially, and finally, the residue ash leaves the gasifier from the bottom. The gasification agent is fed into the reactor at the location above the stationary grate, where combustion takes place and flows downward through the gasification zone where most H_2 and CO are generated. The producer gas leaves the gasifier from the reactor bottom. On the other hand, for the updraft gasifier, solid fuel enters from the top producer gas leaves from the reactor top. Comparing the two types of fixed bed gasifier, the downdraft version has the apparent advantage of low tar content in the producer gas, since the gas product from the pyrolysis goes through the combustion zone where the temperature can be above 1000°C. In this way, the tar and heavy hydrocarbons in the volatile area will be cracked and the producer gas will be clean. Also, the solid bed of feed fuel and char acts as a filter that removes the fine particulates. The disadvantage of this type of gasifier is the relatively low energy efficiency as the hot producer gas exits at a high temperature. On the other hand, the updraft gasifier has the advantage of high energy efficiency because the inlet solid fuel contacts the hot producer gas; hence the producer gas provides heat for the feed solid fuel for drying and pyrolysis. In this way, the producer gas leaves the reactor at a relatively low temperature. The issue of the updraft gasifier is that the producer gas has high tar content hence gas cleaning is required to remove these contaminants. For both types of fixed bed gasifiers, the temperature distribution is non- uniform and the gas-solid contact is non-homogeneous. Therefore, fixed bed gasifiers are suitable for small-medium scale plants of less than 1 MW for downdraft, and 1-10MW for updraft gasifiers.

1.2 Fluidized bed gasifier:

A fluidized bed gasifier is operated at the flow regime from the bubbling to circulation fluidized region. Apart from solid fuel, inert particles, normally silica sand and dolomite, are used as bed material as heat carriers or for enhancing heat and mass transfer between the gas and solid phases. The inert bed material is normally 95wt% of the total bed inventory. The combustion and gasification reactions are promoted by intensive heat transfer and thorough mixing of solid fuel and gases within the bed. In operating the fluidized bed gasifier, the bed is firstly heated to the desired temperature, then solid fuel is fed into the reactor. The gasification agent (air, pure oxygen, steam or their mixture) is fed from the bottom of the gasifier and evenly injected into the bed by passing through a distributor, which also acts as a fluidization agent. Based on the flow region and gasifier configuration, fluidized bed gasifiers are normally classified as bubbling fluidized beds (BFB) or circulating fluidized beds. As described earlier, in BFB the gas flow rate is maintained between the minimum fluidization Velocity.

1.3 Entrained bed gasifier:

An entrained flow gasifier handles the fine particles of feedstock fuel. The gasification agent velocity is very high so that the solid fuel particles are evenly dispersed and suspended in the stream. Under this flow condition, the gas flow entrains all of the fuel particles and then is injected into the reaction chamber where the fuel is ignited rapidly at a very high temperature, possibly over 2000^{o}C. The heat released by this intensive combustion leads to the instantaneous pyrolysis and simultaneous char gasification of the fuel to produce the producer gas consisting mainly of H_2 and CO. The producer gas of an entrained flow gasifier does not contain tars due to its very high operating temperature, however, all ash is entrained by the producer gas thus ash removal is required downstream additional energy consumption is required in milling the feedstock into fine particles to a diameter less than 75 µm.

2. Materials and Method

Fluidization experiments have been carried out for the following samples: coal, rice husk, and sawdust at different bed height. These samples are mixed in different proportions on a weight basis.

2.1 Coal and Rice husk:

The Co-gasification experiment was carried out with coal and rice husk in which the proportion of biomass taken was 10 and 20 (wt/wt). A major finding of these experiments was that carbon conversion efficiency increased with an increase in biomass content in a particular gasification temperature. The calorific value of product gas polynomially decreased with an increase in rice husk percentage in the blend. Seoetal. reported that gas production increases at all temperatures with an increase in biomass ratio due to the transfer of H_2 radicals from biomass to coal that causes more decomposition of coal in the feed.

2.2 Coal and Sawdust:

According to Irfan et al. carbon conversion efficiency (CCE) increases with biomass content in the desired blend sample. But in our experiment, it does not follow the same trend.

3. Result ans discussion

When material for experiment usage as Coal and Rice husk, total gas production parabolically increases with biomass content and does follow the same trend with the Seoetal. H_2 decreases polynomially with increases in the proportion of biomass in a blend.

Coal and Sawdust, But in ou, it does not follow the same trend. CCE increases with increase in biomass weight percentage i.e. from 20-40% but it decreases with increases in the blend from

10-20%.

The calorific value of product gas for coal and sawdust set of the experiment; increases with an increase in the percentage of sawdust because the calorific value is enhanced due to the higher content of hydrocarbon.

Carbon conversion efficiency, total gas production increases with an increase in biomass content whereas heating value and H_2 (%) decrease with it for the different blend of rice husk. For the sawdust set of experiment, heating value and cold gas efficiency increase with biomass content whereas CO (%), CO_2 (%) decreases with it.

Rice husk and sawdust do not fluidized well and therefore they are mixed with coal in different proportions for the fluidization experiment; it shows a peak and trough when the minimum fluidization velocity is attained and follows the standard trend of pressure drop of bed and velocity.

Successful co-gasification experiments were carried out by blending coal and biomass in the proportion of 10 and 20%. Syngas generation per kg feed. Carbon conversion efficiency, heating value, and cold gas efficiency increase with the increase in gasification whereas methane is almost constant during the entire set of experiments.

4. CONCLUSION:

Co-gasification experiments were carried out for high ash coal and different in fluidized bed gasifier. Fluidized bed gasifier is suitable for Indian coal because Indian coal has high ash percentage and it does not form slag during the gasification process. It can handle solid feed material such as high ash coal, sub-bituminous coal, biomass resources, etc.

5. REFERENCES:

[1]. Badwal, S., Giddey, S., Ciacchi, F., Clarke, R., and Kao, P. (2007). "Research and developments in hydrogen technologies."Advances in Applied Ceramics, 106(1-2), 40-44.

[2]. Brown, R. C., Liu, Q., and Norton, G. (2000). "Catalytic effects observed during the co- gasification of coal and switchgrass." Biomass and Bioenergy, 18(6), 499-506.

[3]. Campbell, C. J. (1996). "Oil shock."EnergyWorld(240), 7-12.

[4]. Clemens, A. H., Damiano, L. F., and Matheson, T. W. (1998). "The effect of calcium on the rate and products of steam gasification of char from low rank coal." Fuel, 77(9–10), 1017- 1020.

[5]. Clemens, T., Gong, D., and Pearce, S. (2006). "Study on the suitability of New Zealand coals for hydrogen production." International Journal of Coal Geology, 65(3-4), 235-242.

[6]. Collot, A. G., Zhuo, Y., Dugwell, D. R., and Kandiyoti, R. (1999). "Co-pyrolysis and co- gasification of coal and biomass in bench-scale fixed-bed and fluidized bed reactors." Fuel, 78(6), 667-679.

[7]. Demirbas, A. (2007). "Progress and recent trends in biofuels." Progress in Energy and Combustion Science, 33(1), 1-18.

[8]. Goyal, H. B., Seal, D., and Saxena, R. C. (2008). "Bio-fuels from thermochemical conversion of renewable resources: A review." Renewable and Sustainable Energy Reviews, 12(2), 504- 517.

[9]. Hotchkiss, R. (2003). "Coal gasification technologies." Proceedings of the Institution of Mechanical Engineers, Part A: Journal of Power and Energy, 217(1), 27-34.

[10]. Khatib, H. (2012). "IEA World Energy Outlook 2011—A comment." Energy Policy, 48(0), 737- 743.

[11]. Korpela, S. A. (2006). "Oil depletion in the world." Current Science, 91(9), 1148-1152.

[12]. Kotowicz, J., Sobolewski, A., and Iluk, T. (2013). "Energetic analysis of a system integrated with biomass gasification." Energy, 52(0), 265-278.

[13]. Kumabe, K., Hanaoka, T., Fujimoto, S., Minowa, T., and Sakanishi, K. (2007). "Co-gasification of woody biomass and coal with air and steam." Fuel, 86(5–6), 684-689.

[28]. Kumar S, Sangwan P, V DRM, Bidra S. Utilization of rice husk and their ash: A Review 2013:126-9

[29]. Folkeson B. Propensity of various bed materials used in fluidized bed to retain ash-forming elements from biomass fuels n.d.

[30]. Kunii D, Levenspiel O. Fluidization and Mapping of Regimes. Fluid. Eng. Second, Butterworth-Heinemann;1991,p.61-94.

[31]. Emami-tabs L, Irfan MF Fuel blending effect on the co-gasification of coal and biomass-A review. Biomass and Bioenergy 2013;57:249-63.