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Qualitative and Cost Effective Producer gas production system

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ABSTRACT

This paper reveal some misconceptions related to production of qualitative producer gas. In existing system it is observed that to produce power from internal combustion engine by using producer gas, it takes specific biomass and various scrubbing systems which makes this system expensive. In our research we have found that by using ordinary wood as biomass, some nominal scrubbing and change in various governing parameters we can produce excellent quality of gas economically.

Keywords: Gasifier, Biomass, Pyrolysis, Gasification, Producer gas, Scrubbing system, Induced draught, Governing parameters.

1 INTRODUCTION

Nowadays Renewable energy resources are key concern for power production. In that case producer gas is offering a promising potential. On the top of that, it is derived from organic waste and biomass.

Biomass gasification means incomplete combustion of biomass resulting in production of combustible gases consisting of Carbon monoxide (CO), Hydrogen (H2) and traces of Methane (CH4). This mixture is called producer gas. Producer gas can be used to run internal combustion engines, it can be used as substitute for furnace oil in direct heat applications and can be used to produce, in an economically viable way, methanol an extremely attractive chemical which is useful both as fuel for heat engines as well as chemical feedstock for industries. Since any biomass material can undergo gasification, this process is much more attractive than ethanol production or biogas where only selected biomass materials can produce the fuel.

Besides, there is a problem that solid wastes (available on the farm) are seldom in a form that can be readily utilized economically e.g. Wood wastes can be used in hog fuel boiler but the equipment is expensive and energy recovery is low. As a result it is often advantageous to convert this waste into more readily usable fuel from like producer gas. Hence the attractiveness of gasification. However under present conditions, economic factors seem to provide the strongest

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argument of considering gasification. In many situations where the price of petroleum fuels is high or where supplies are unreliable the biomass gasification can provide an economically viable system provided the suitable biomass feedstock is easily available.

1.1 Gasification

The production of producer gas called gasification, is partial combustion of solid fuel (biomass). The reactor is called a gasifier. The combustion products from complete combustion of biomass generally contain nitrogen, water vapor, carbon dioxide. However in gasification where there is a surplus of solid fuel (incomplete combustion) the products of combustion are combustible gases like Carbon monoxide (CO), Hydrogen(H2) and traces of Methane and non usefulproducts like tar and dust. The production of these gases is by reaction of water vapor and carbon dioxide through a glowing layer of charcoal.Thus the key to gasifier design is to create conditions such that

a) biomass is reduced to charcoal and, b)charcoal is converted at suitable temperature to produce CO and H2.

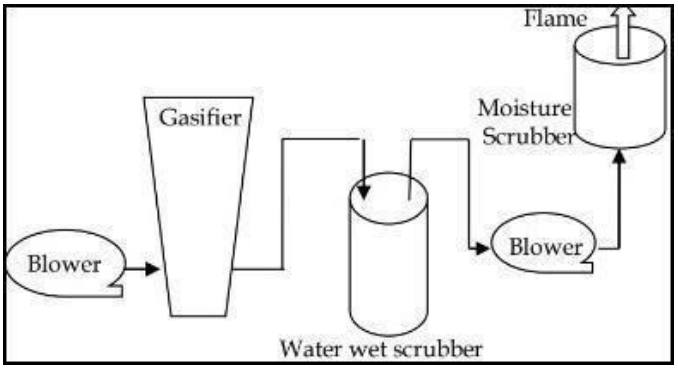

Fig.1 Block diagram of system

1.2 Process Zones

Four distinct processes take place in a gasifier as the fuel makes its way to gasification. They are :

a) Drying of fuel
b) Pyrolysis – a process in which tar and other volatiles are driven off
c) Combustion
d) Reduction

Pyrolysis zone

Wood pyrolysis is an intricate process that is still not completely understood. The products depend upon temperature,pressure, residence time and heat losses.

Reduction zone

The products of partial combustion (water, carbon dioxide and uncombusted partially cracked pyrolysis products) now pass through a red-hot charcoal bed where the following reduction reactions take place.

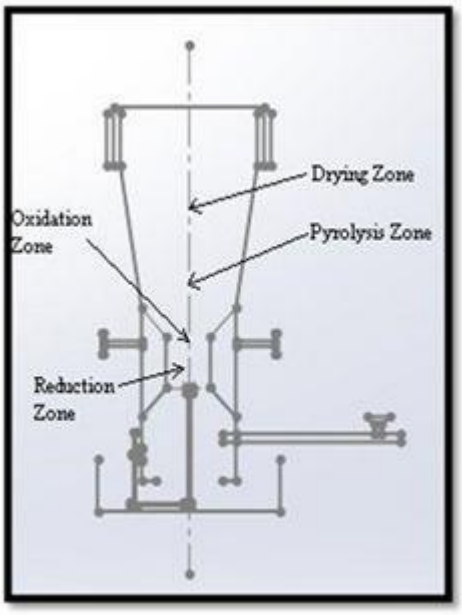

Fig.2 Process zone

The combustible substance of a solid fuel is usually composed of elements carbon, hydrogen and oxygen. In complete combus-tion carbon dioxide is obtained from carbon in fuel and water is obtained from the hydrogen, usually as steam.

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2 IMPURITIES AND UNDESIRABLE CONSTITUENTS IN PRODUCER GAS

Fabric filter is used to figure out various impurities in the producer gas. A cotton cloth (fabric filter) is kept at the outlet of the gasifier and after 20 seconds it is observed that the cotton cloth turn into black in color. As shown in figure, after some visible examination it is found out it consists tar, solid particulates and moisture.

Fig.3 Fabric filter test 2.1

Moisture content

To get qualitative producer gas it is necessary to separate moisture completely. Producer gas with moisture content deteriorate the engine performance as well as life of engine. So before supply into engine it is desirable to remove moisture content completely. Moisture scrubbing system is used for this purpose which is discussed later.

2.2 Solid particulates

During partial combustion there are many small ash particles forms and comes out with gas at outlet. Obviously it should be separated to enhance the quality of gas which is done by adding water wet scrubbing system.

2.3 Tar content

Tar is one of the most unpleasant constituents of the gas as it tends to deposit in the carburetor and intake valves causing sticking and troublesome operations. It is a product of highly irreversible process taking place in the pyrolysis zone. The physical property of tar depends upon temperature and heat rate and the appearance ranges from brown and watery (60%water) to black and highly viscous.

3 NECESSITIES OF SCRUBBING SYSTEM

The combustible gases from the gasifier can be used

a) In internal combustion engines,

c) For direct heat applications and

d) As feedstock for production of chemicals like methanol.

However in order for the gas to be used for any of the above applications it should be cleaned of tar and dust and be cooled. As previously mentioned cooling and cleaning of the gas is one of the most important processes in the whole gasification system. The failure or the success of producer gas units depends completely on their ability to provide a clean and cool gas to the engines or for burners. Thus the importance of cleaning and cooling systems cannot be overemphasized. This

gas has to be cooled in order to raise its energy density. Various types of cooling equipment have been used to achieve this end. Since the gas also contains moisture and tar. Thus ideally the gas going to an internal combustion engine should be cooled to nearly ambient temperature. In the wet scrubber the gas is washed by water. The scrubber also acts like a cooler. At outlet of the gasifier moisture contents are found and after passing from water wet scrubbing system, moisture content of the gas increases and to overcome this drawback moisture scrubbing system need to be installed.

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4 PROBLEM ASSOCIATED WITH EXISTING SYSTEM

4.1 Specific Biomass

The existing technology is required specific biomass when it is needed to be used in IC engine. Specific biomass may not necessary to be available at everywhere. So, this type of system is only suitable where this type of specific biomass is easily available otherwise it leads to high transportation cost.

4.2 Excessive scrubbing

This existing system use many different types of scrubbers which uses special type of scrubbing materials which are not easily available and also somewhat costly to obtain qualitative producer gas to run the engines

5 SCRUBBERS

5.1 Water wet scrubbing system

Water wet scrubbing system consists of a 50 liter capacity plastic drum which is filled with water around 40-50% of its capacity.It uses ordinary water for scrubbing.It separates almost all tar particulates and somewhat CO2 in the form of carbonic acid.

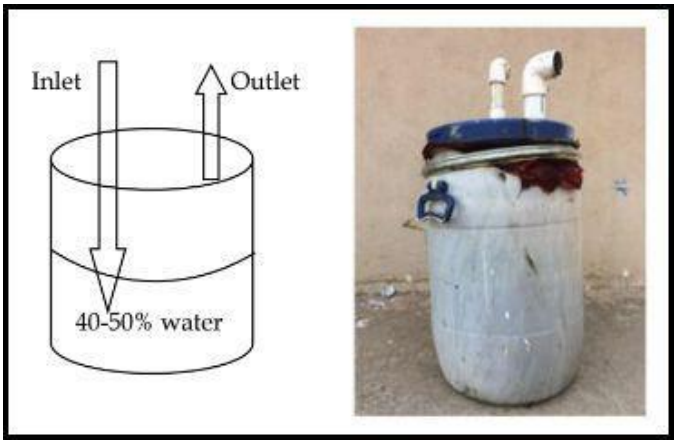

Fig. 4 Water wet scrubbing system

Moisture removal scrubber is cylindrical in shape and uses wood chips as moisture absorbing material. So, when producer gas flows in co-centric way and passes through wood chips, the moisture and residual tar particulates get absorbed and we get qualitative producer gas at outlet.

Fig.5 Moisture scrubber

6. RESULT

6.1 Removal of tar contents

After passing from water wet scrubbing system almost all the tar and solid particulates get separated which is illustrated in the below figure.

Fig. 6 Removal of tar

From the figure it can be comprehended that the ability of water wet scrubbing system to remove the tar and solid particulates. The color of water is completely change and turn to black. The producer gas after scrubbing is almost free from tar.

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6.2 Removal of moisture contents

After passing from moisture scrubbing system the moisture content of the gas is reduced significantly which is shown in the figure.

Fig. 7 Removal of moisture

6.3 Fabric filter test

After tar and moisture scrubbing, quality of test is assessed on fabric filter. The significant change is observed.

Fig 8(a) Before scrubbing

Fig 8(b) After scrubbing

6.4 Change in flame color

After passing the gas from scrubber the quality of the gas is enhanced.

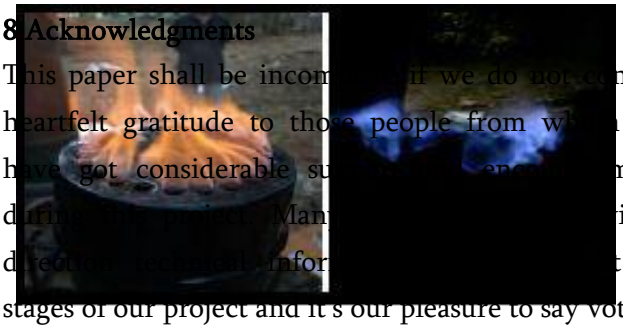

Fig. 9 (a) Before scrubbing

Fig. 9 (b) After scrubbing

7 Benefits

1. It use ordinary wood as biomass which can easily available. It is suitable for rural area.
2. To separate tar, water wet scrubbing system is used in which require tap water.
3. For moisture scrubbing wood chip is used.
4. Simple scrubber design.
5. Cost effective scrubber.

8 Acknowledgments

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CONCLUSION

Qualitative and cost effective producer gas can be produced by nominal scrubbing and it is capable to produce required quality of producer gas. It is sufficient enough to run the I.C engine. This can be referenced in the body of the paper.

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