ISSN XXXX XXXX © 2017 IJESC

Research Article Volume 7 Issue No.5

Design and Fabrication of a Compact High Output Wood Gas Gasifier

Pravin Kumar Singh[1], Debojit Deka[2]
Assistant Professor[1], UG Scholar[2]
Department of Mechanical and Automation Engineering
Amity University, Lucknow, India

Abstract:
A wood gas gasifier in present scenario is a mechanical device constructed to produce wood gas by burning wood through incomplete combustion. The present setup consists of an internal combustion unit where wood is burned in controlled present of air and the unburned gas produced is extracted through pipes for combustion in a gaseous stove or is used to run an internal combustion engine. The incomplete combustion yields a gaseous fuel which is very flexible to use and is very efficient compared to normal open wood burning techniques, also it gives the possibility to be used for electricity production and propulsion by using internal combustion engine generators. This feature makes it a great alternative to present fuels such as petrol, diesel, kerosene, CNG, LPG. The model in this research concentrates in the fire tube design improvement and also giving electrical control over the rate of wood gas produced by the use of electric blower for fluctuating load in demand. In this research paper the concentration for simple fabrication and compactness of the compact wood gas gasifier device along with electronically controlled inlet air rate is taken in and basic cost effectiveness are also taken into put where the cost of the whole device is taken down below **₹ 2000 ($30.76)** for material cost such that the possibility for rural area introduction of this device is more feasible. The present design with the prototype, a two burner stove normally used for LPG stove can work which makes it even simpler without any change in the present market availability also usability with an internal combustion engine is possible with change to a gaseous carburetor in generators, auto rickshaw, motorcycle(1-10 KW).

Keywords: Wood Gas Gasifier, engine, combustion, cost, wood, efficiency

1. INTRODUCTION

A wood gas gasifier is a device invented to produce a gaseous fuel (wood gas) from a solid fuel (wood) because of the flexibility of gaseous fuel uses. The present deign available for wood gas gasification is by the stratified downdraft gasifier, which lags a few restrictions such as in the case of compactness and high output and cost effectiveness .Energy access to rural areas is very worse with only 16% in biharand 800mil using biomass for cooking according to 2011 census. This shows the need for improvisation in the combustion process of wood gas. Efficiency of open chulha(stove) is inadequate with 15-30%, with air pollution to the women cooking in the open stoves; regular eye issues are common in rural areas. This project concentrates on removing these issues with the cost effective wood gasifier design. The design is good for the rural society where there is use of cow dung and timber wood for cooking their food and doing daily chores of heating water. The waste from farms can also be used, including harvest wastes. This increases the usability of poor fuels. And can be used in a nonpolluting way.

2. WOOD GAS GASIFIER

A wood gas gasifier is a device that works in the principle of incomplete combustion of biomass in the presence of restricted amount of air, due to which complex carbon compounds break down into CO & H_2 and Minor amount of CH4. The design in this project is a stratified downdraft wood gas gasifier which is improvised in the field of fire tube design and inlet blower design. The intake air is pumped in the starting through the inlet air blower, (which also works as the lid for putting wood through by opening the whole blower since it is attached with a hinge mechanism). The air then rushes through the wood chips or any other biomass used of the size of 1X1X1 cm minimum to 2X2X2 cm maximum to the steel dome. The air forced in reaches the fire tube where a fire is started through the “ash cleaning port/starter lighting port” where using large newspaper or any waste paper a fire is started. Once the fire starts releasing enough smoke to light a match stick, the lid of the port is closed and the blower speed is increased now. The combustion process starts, due to which incomplete burning of the wood starts and smoke is released. The gas released, passes through the perforated net cover (but keeps the burning charcoal intact in the fire tube and stops them from falling till it is converted into fine ash powder, which finally falls into the base of the gasifier, routine cleaning is required during continuous use). The gas so produced travels up to the outlet tube; during which it heats the steel dome and hence helps to warm the wood inside the do me to dry the wood chips (This process makes the wood chips more combustible). The gas then travels to the filter into which it is bubbled through the water bathand solid particles present in the gas makes a suspension in the water and tar also cools down and floats above the water bath. The gas next goes to the upper part of the filter and travels through the fuel pipe to the stove where in presence of more air complete combustion takes place and heat is produced(If used for internal combustion engine the fuel pipe is fed to gas carburetor). Due to the controlled combustion of wood, there is no smoke release to the environment and the combustion process is very nonpolluting and extremely efficient combustion process.

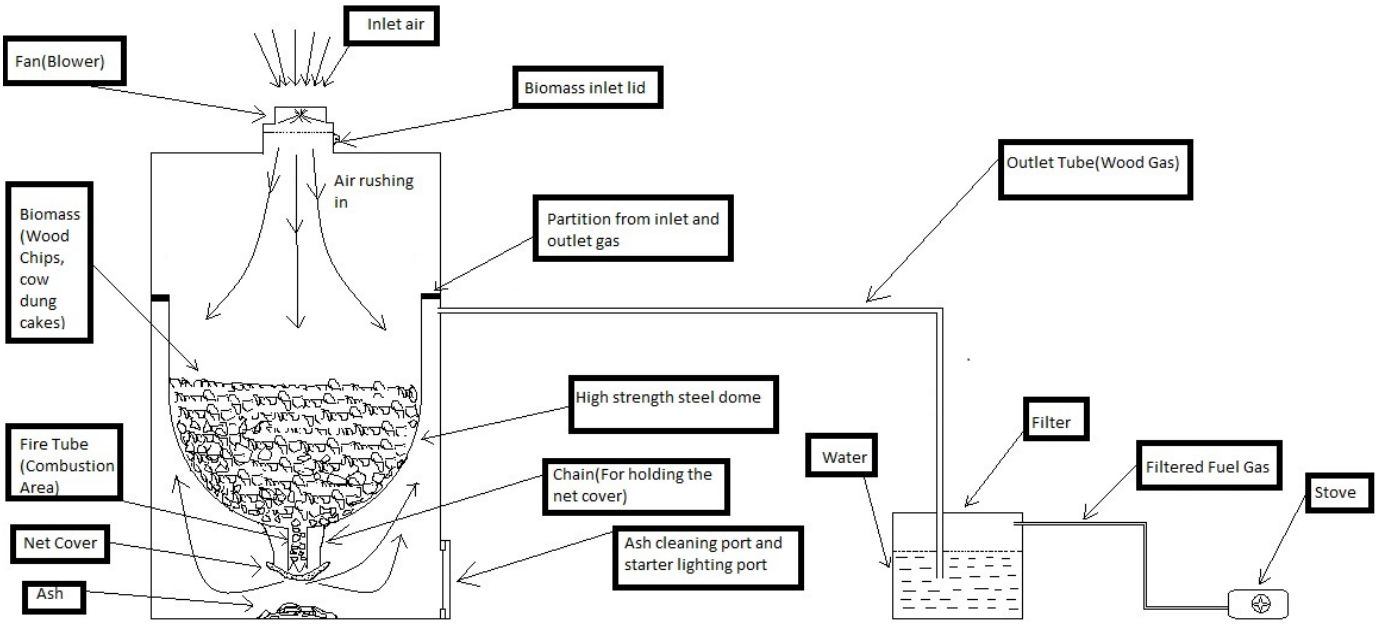

Figure.1. Working of the Wood Gas Gasifier

Figure 2.Cylindrical Dome and Fire Tube Of the Gaifier

3. WORKING OF THE WOOD GAS GASIFIER

The Chemical process behind the working of the wood gas gasifier is the pyrolysis process. The chemical breakdown of oxygen and carbon compounds due to combustion releases carbon dioxide and water; these molecules react further with the charcoal formed while the wood burns to produce

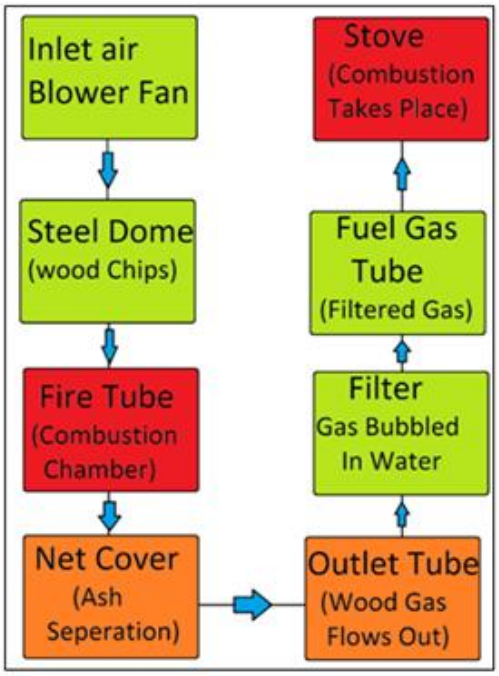

Figure .3. Block Diagram of the Wood Gas Gasifier

Carbon monoxide and hydrogen gas, which is the wood gas. In this process atmospheric nitrogen stays almost inert with minimum nitrogen oxide formation and around 4% methane gas is also produced (CH_4).

I. $(C_6H_{10}O_5)_n + O_2 \rightarrow CO_2 + H_2O$

Cellulose+Oxygen→Carbon Dioxide+ Seam

II. $CO_2 + H_2O + 2C \rightarrow 3CO + H_2$

III. Carbon Dioxide+Steam+Charcoal→ Carbon Monoxide+Hydrogen Gas

IV.

V.

VI. $C+2H_2 \rightarrow CH_4$

Charcoal+Hydrogen Gas→Methane

(Reaction only for understanding purposes, not all are chemically balanced) The CO and H_2 formed is taken forward to the cycle of convection of the cylindrical dome and next travels to the outlet tube and hence filters to be used in the complete combustion process with presence of air.

$$CO+H_2+O_2 \rightarrow CO_2+H_2O$$

Fuel Gas+ excess air→Carbon dioxide+ Steam

The initial *incomplete combustion* takes place in the *fire tube* and the *complete combustion* takes place in the *stove*. For increasing the production of wood gas, simply increasing the power to the 220V AC blower is increased and the wood gas production increase can be seen in the stove.

4. FABRICATION

Mechanical components

I. Support Mounting
II. Cylindrical Dome
III. Fire Tube
IV. Perforated Net Cover
V. Outlet Tube
VI. Filter
VII. Filtered Gas Outlet Tube
VIII. Stove

Electrical Components

I. Blower Fan
II. Design Consideration

5. DESIGN CONSIDERATION

The design consideration for the wood gas gasifier includes manufacturability, cost, durability, assembly and disassembly process, sealing, compactness and weight and material used.

Manufacturability – The design is rethought to improve the manufacturability with cheap materials and less amount of material with available materials.

Cost–the combined price of the gasifier can be decreased if proper consideration is taken to judge the component design, and the material cost has been taken down below **₹ 2000 ($30.76),** with only welding cost left.

Durability- The gasifier must be durable enough to withstand the intense heat in the combustion area because of which steel dome and tube is used in which high temperature tolerability is there with the option of applying a layer of POP if necessary on top of the steel.

Assembly and dis-assembly- many micro components constitutes the gasifier. However a quick water jet washes with shampoo water inside shall be enough for yearly maintenance and servicing. Few considerations are given.

Sealing- suitable sealing is applied to ash cleaning port and outlet port is welded shut and filter is kept airtight, but efficiency can be increased with proper sealing and regular tar cleaning through the pipes.

Compactness – The design is made in a cuboidal shape for easier transportation and placement with the inside cylindrical; the filter position can be improved with the different area demand and requirement.

Weight And Material Used- The steel dome is made from an old LPG 5kg cylinder cut in half and every other item is available in the common market with usual steel pipes and steel sheets and rods.

6. CALCULATION

TABLE.I. DIFFERENT METHODS USED TO BOIL 1LITREOF WATER TO COMPLETE VAPORIZATION

Sl No	Method Used	Fuel Used	Time taken
1	Open Wood Fire	1KG	23MINS
2	LPG gas stove	0.45KG	35MINS
3	Wood Gas Gasifier stove	0.7KG	30MINS

Hence,

Ratio of Efficiency of each process

Method Used=Time Taken/Fuel Used

Open wood Fire =23/1 =23

LPG Gas Stove =35/0.45 =77.77

Wood Gas Gasifier Stove=30/0.7 =42.85

We Know,

Efficiency of regular LPG Stove =**48%**[1]

Hence,

Efficiency of open fire=48*23/77.77=14.19%

Efficiency of LPG Stove is=48%

Efficiency of the Wood Gas Gasifier=48*42.85/77.77=26.45%

Hence,

Efficiency= 26.45%

7. CONCLUSION

This paper elaborates the design and construction of the compact wood gas gasifier model .After designing the model which produces the gas as illustrated in the previous sections. We can conclude that the design is simple and efficient enough for rural purposes and will be very helpful for the society. It is not a modern design by any chance but the improvements ininduction and material cost effectiveness will make it very much popular among the society. The design can be further automated in the startup and maintenance part of the working of the model and further improved versions can be expected once it moves forward from prototype stage to a production model.

8. SCOPE AND FUTURE ASPECTS

The introduction of this model of wood gas gasifier in rural areas will decrease wood consumption .The use of other renewable energy sources. Use of cow dung, grass pellets, every type of solid biomass can be used by pellet formation .The introduction of this model will decrease hazardous environment normally

experienced by women cooking in tradition open wood fire. This model can also be used for the carburetion of spark plug engines with proper filtering of the wood gas for tar and soot. This will result in renewable source of energy to automobiles and also running cost of vehicles will decrease to minimum. Since it is a carbon neutral method of energy production finally it will help the environment.

9. REFERENCE

[1].Jagruti R. Surange, Navneet K. Patil, Akhilesh V. Rajput*"Performance Analysis of Burners used in LPG cooking Stove-A Review"* Volume 3, Special Issue 4, April 2014 by S.S.B.T., C.O.E.T., Bambhori, College/ university, Jalgaon, MH, India.

[2]. *2011 Census*, Office of the Registrar General & Census Commissioner, India

[3]. AnjireddyBhavanam and R. C. Sastry" *Biomass Gasification Processes in Downdraft Fixed Bed Reactors: A Review"* International Journal of Chemical Engineering and Applications, Vol. 2, No. 6, December 2011

[4]. DebajitPalit and Sanjay Mande, "*Biomass Gasifier Systems for Thermal Applications in Rural Areas*", The Energy and Resources Institute (TERI), Darbari Seth Block, IHC Complex, Lodhi Road, New Delhi 110 003, India.

[5]. Krishna Prasad K "*Wood stove compendium"* in 1981(Netherlands: Eindhoven Univ. of Technology)