"DEVELOPMENT AND PERFORMANCE ANALYSIS OF GASIFIER FOR BIOMASS"

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ABSTRACT

Energy production, waste disposal, and the minimization of pollution are key problems that must be addressed for sustainable cities of the future. High agricultural productivities and subsequently the growth of green revolution has been made possible only by large amount of energy inputs, especially those from fossil fuels. Emissions from solid fuel combustion to indoor, regional and global air emission inventory largely depend on fuel types, combustion devices and other factors. Due to improper design of combustion zone and low thermal efficiency, it emits gaseous pollutants like CO, particulate matter, etc. In our project, we modified combustion chamber for complete combustion of biomass fuel. By supplying necessary amount of oxygen in combustion chamber with help of primary and secondary fans, great difference occurred in normal and modified working. From performance test results, it was found that gasifier cook-stove shows higher heat transfer efficiency. This indicates a better performance when compared with the average thermal efficiency value chulha. The gasifier gives 21.89 % of efficiency at full load while on medium load efficiency is 32.41 %. It improves the energy efficiency of biomass clean burning, which potentially offers a highly cost-effective alternative for easing the burden of buying fuel by urban poor as well as rural population.

(**Keywords:** Gasification, Biomass Fuel, Combustion Chamber, Pollution Control)

Introduction:

Modern agriculture is an extremely energy intensive process. However high agricultural productivities and subsequently the growth of green revolution has been made possible only by large amount of energy inputs, especially those from fossil fuels. With recent price rise and scarcity of these fuels there has been a trend towards use of alternative energy sources like solar, wind, geothermal etc. Properly applied biomass combustion, process releases carbon dioxide, which was removed from atmosphere by photosynthesis, and thus maintains an equilibrium level of carbon dioxide. Carbon dioxide is leading greenhouse gas and the use of biomass is a result neutral with respect to global warming potential.

Combustion is process by which more than 90% of world's primary energy supply is released in order to provide heat and energy services such as material processing including food preparation, space heating, steam and electricity generation etc. The combustion is an exothermic process in which the rapid oxidation of combustible elements of a fuel take place with release of heat energy. The combustion is called the complete combustion, when all the carbon present in fuel is burned to carbon dioxide, all hydrogen is burned to water vapour, all sulphur is burned to sulphur dioxide and all combustible elements are fully oxidized. Combustion in conventional way like in "Chulha" is incomplete combustion and generate lot of smoke.

"Thermal gasification" is a process which converts carbonaceous materials into combustible gases. Gasification is the partial combustion of solid biomass in presence of controlled air, which leads to generation of mixture of combustible gases hydrogen (H_2), carbon monoxide (CO), methane (CH_4), nitrogen

(N_2) and other gases. This combustible mixture is also called as producer gas which is a combustible gas. This producer gas is get combusted by controlled amount of oxygen and converted into carbon dioxide (CO_2), water vapour (H_2O) and we get heat for further application.

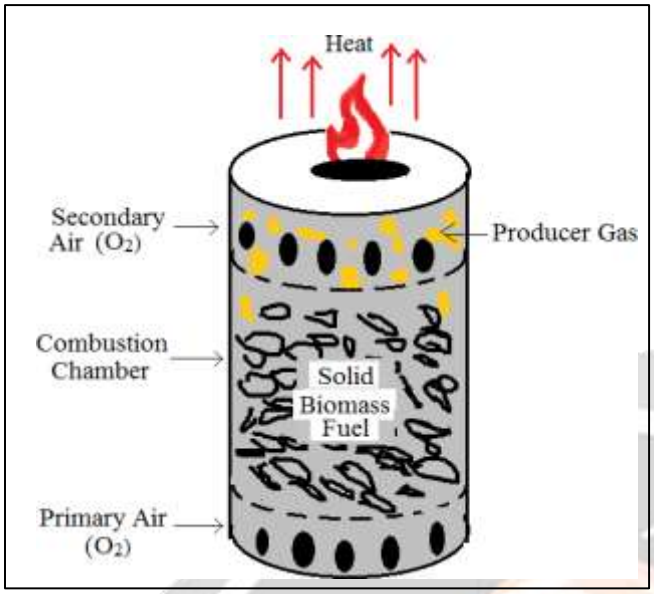


Figure :Basic Working Principle

Functions of Gasifier:

[1] To provide enclosed or partially closed chamber for controlled combustion of biomass.

[2] To increase speed of gas generation reaction.

[3] It allows to supply correct amount of oxygen to combustion chamber.

[4] To generate producer gas which can be further used for other application.

Necessity of Gasifier:

[1] It utilizes energy from waste biomass.

[2] It enables reduction in global temperature by reducing non-polluted gases liberated from incomplete combustion.

[3] It provides a less polluted and healthier kitchen environment.

Problem Definition:

Global warming, energy conservation and pollution control are the main crises that we are facing nowadays. According to the World Health Organization (WHO), combined effects of outdoor and household air pollution cause about 6.5 million premature deaths every year, largely as result of heart diseases, lung cancer, chronic respiratory diseases etc. More than 80% of people living in urban and rural areas that monitors air pollution are exposed to air quality levels that exceed WHO guideline limits.
Black carbon (BC), commonly known as soot, is particulate matter (PM) emitted from burning biomass and diesel fuel. This by-product of incomplete combustion contributes to climate change by increasing temperatures, increasing ice and snow melt, and changing precipitation patterns. When snow and ice are covered with BC, the additional absorbed sunlight accelerates melting. BC's light-scattering and radiation-absorbing effects alter the amount of sunlight that can reach the earth's surface, trap radiation in the atmosphere, and alter global temperature distributions.

So, the gasifier is best provision to reduce pollution by preventing harmful gases liberation into atmosphere.

Objectives of Research paper:

1] To provide controlled combustion process by supplying correct amount of O2. 2] To recover waste heat from flue gases.
3] Correct heat distribution.

4] To achieve desired temperature by generating right amount of draught. 5] To minimize refractory losses.
6] To control surface losses.

1.1 Basic Part Location:

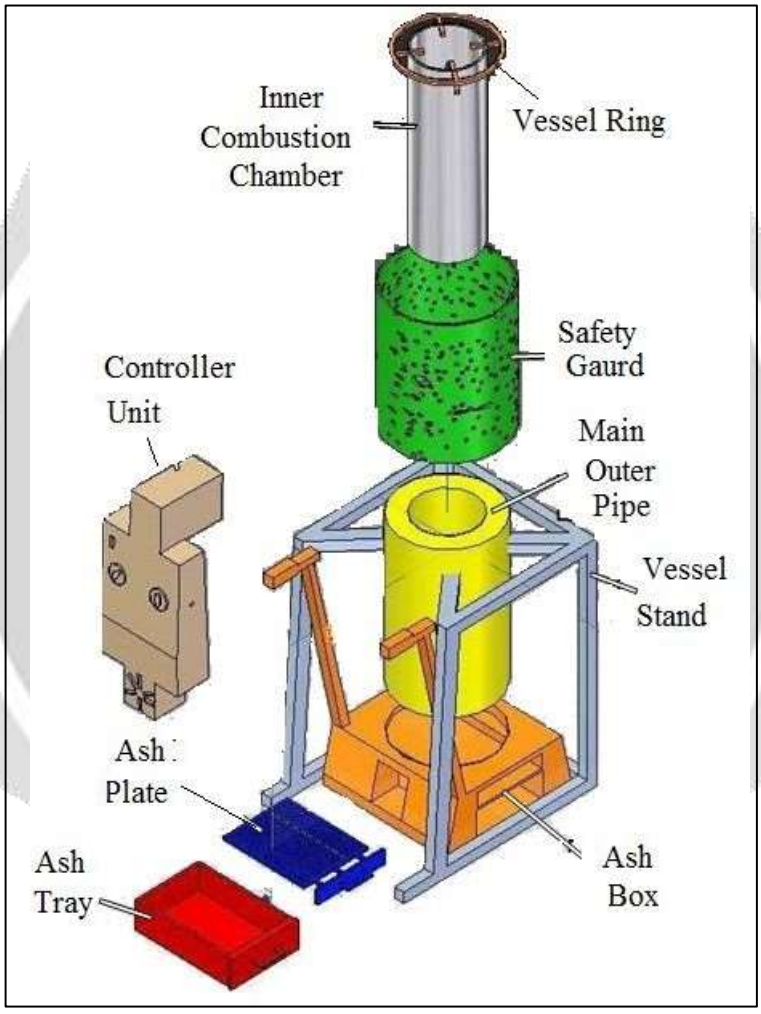


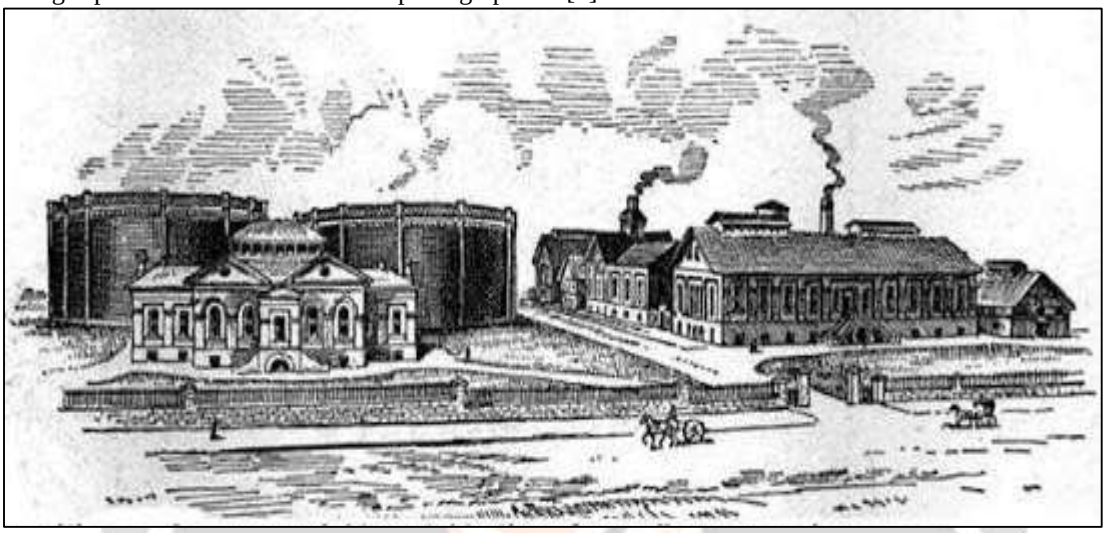
Figure: Extruded View of Design Model of Gasifier

LITERATURE REVIEW

Literature Review of Existing Work:

History of Gasification:

"Town gas", a gaseous product manufactured from coal, containing approximately 50% hydrogen, with the rest comprised of mostly methane and carbon dioxide, with 3% to 6% carbon monoxide. It supplied lighting and heating for industrializing America and Europe beginning in the early 1800's. The first public street lighting with gas took place in Pall Mall, London on January 28, 1807. Not long after that, Baltimore, Maryland began the first commercial gas lighting of residences, streets, and businesses in 1816. A typical town gas plant for the era is shown in photograph 2.1 [2]



Photograph:Baltimore's Bayard Station from "Progressive Age Magazine" of 1889 picturing plant prior to 1850

The first gasifier patent was issued in England at the end of the 18th century and producer gas from coal was mainly used as lighting fuel throughout the 19th century. The first commercial up-draft gasifier for continuous gasification of solid fuels with air was installed in 1839. Up-draft gasifiers were subsequently further developed for different fuels and were in widespread use in specific industrial power and heat applications up tothe 1920's, when their function was gradually taken over by oil fuelled engines and furnaces. In anticipation of unreliable petroleum supply, between 1920 and 1940, compact tar-free down-draught gasifier systems for automotive application were developed in Europe. During the 2nd World War, tens of thousands of those gasifiers were used in Europe. Shortly after the war, most gasifiers were decommissioned because of widespread availability of inexpensive liquid fuels.

The energy crisis of the 1970's brought a renewed interest in biomass gasification. A few developing countries including Philippines, Indonesia, Brazil and India started gasifier implementation programmes based on locally developed technologies. India is a leading country in the world both in terms of biomass gasifier research and development activities as well as their applications. [1]

Photograph : Car Powered by Biomass Gasifier during World War-II

Background of Biomass as a Fuel:

Renewable energy is derived from naturally replenishing resources such as the sun, wind, rain, tides and geothermal heat. About 81%, of energy produced today is fossil fuel based. Fossil fuels are intermittently distributed with many countries having little to no domestic fossil fuel resources. The wide variety of renewable energy resources are distributed much more evenly. Everywhere on earth will have regional access to at least some energy from these sources. [4] Biomass is a basic term for all organic biological material, is primarily composed of carbon, hydrogen, and oxygen. The food supply for humanity is essentially biomass converted to energy by the body. Therefore, from a sustainable standpoint, biomass for societal energy production needs to minimize overlap with the food supply. These markets should naturally balance based on supply and demand, but energy market is very unstable. This is why the main sources of biomass for energy used in descending order of usage are wood, agricultural by-products, dedicated energy crops, and municipal or industrial waste. [5]

Biomass has been used as an energy source by humans for heating, cooking, and lighting from ancient times. It acts as link in energy chain from producing renewable biomass to providing sustainable services in form of heat, shaft power and electricity. There are several broad categories of combustion applications such as heat for daily living use for cook, industrial use for both process heat and electricity production, forest industries etc. Properly applied biomass combustion, climate neutral with respect to greenhouse gas production. [4]

Finding from Literature Review:

Solid biomass fuels provide the largest part of renewable resources and are mostly used in private households for cooking and heating. Still there has been limited research on appropriate and technologically advanced cooking systems. A deeper understanding of the ongoing processes in such systems is needed for the optimisation of future designs. In order to achieve substantial health benefits, cleaner burning cook stoves than are currently in widespread use are needed. One type of cook stove that has been recognised as potentially able to achieve this goal are gasifier stoves. These use the thermochemical process of gasification to transform the fuel into combustible gases and burn them separately in time and location.

SYSTEM MODELLING

Working Principle of Gasifier:

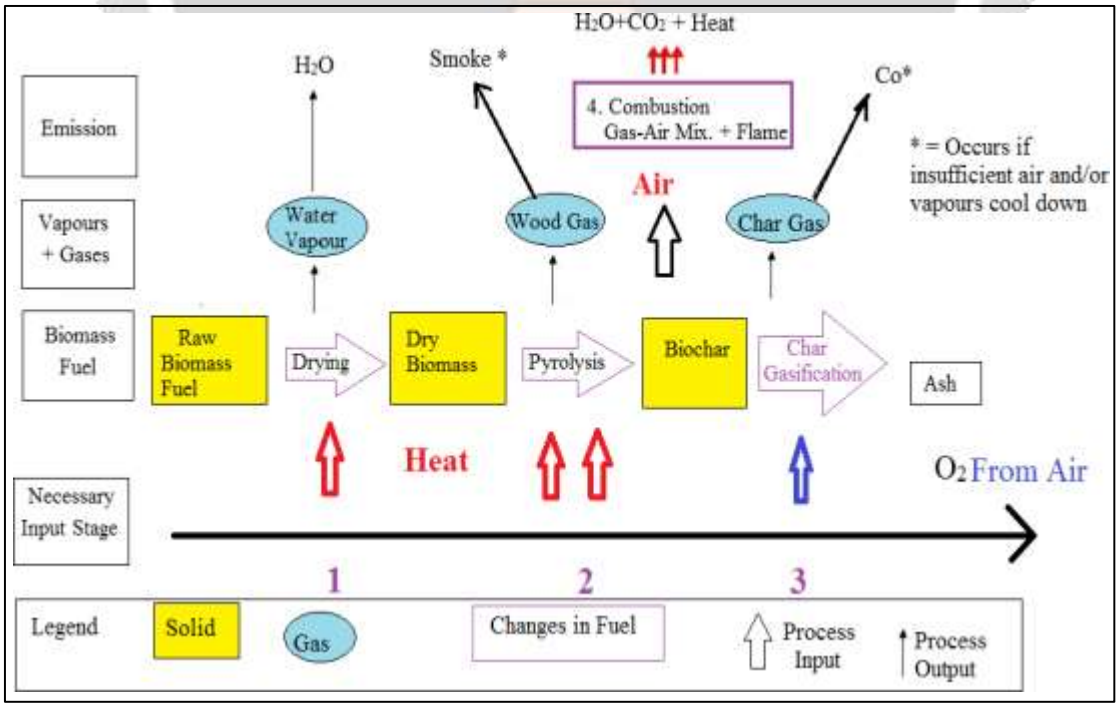


Figure: Working Principle of Gasifier

Following are processses that are normlly observed during gasification process:

PERFORMANCE ANALYSIS AND TESTING

Fuel specifications:

Wood pellets are biofuels made from compressed organic matter. They are made from industrial waste, food waste, agricultural residues, energy crops etc. Wood pellets are most common type of pellet fuel and are generally made from compacted sawdust and related industrial wastes from manufacture of wood products, furniture. They can be used as fuels for power generation, commercial or residential heating, and cooking.

Conclusions:

To conclude, we believe that a project was successful one since we could meet most of the targeted requirements with pleasant team management. The terms stated at beginning stage was accomplished with a simple design which maintain throughout the project. We hope that the experience learnt from project, including planning in designs and skills in utilizing different tools could help to develop our career path in future.

In upcoming days, this will prove a great boon to the world, since it will utilize a lot of energy generating from biomass. As conventional sources are depleting very fast, then it time to think of alternatives. Our gasifier reduces wastage of agricultural residues, waste of wood products. Most preferred fuels for gasification have been wood, pellet and coal also. However, biomass residues are the most appropriate fuels for on-farm systems and offer the greatest challenge to researchers and gasification system manufacturers. Now time has come to put forte this type innovative ideas, and researches should be done to upgrade their implication.

Advantages:

[1] Reduces disease and save lives by decreasing exposure to indoor air pollution.

[2] Reduces the time and cost of procuring fuel, thereby freeing individuals for other productive activities.

[3] Empower women and communities via engagement in the production, use, and distribution of cook stoves.

[4] Climate change by reducing greenhouse gas emissions, including black carbon.

[5] Reduces pressure on forests and other vegetation and facilitate sustainable harvesting of biomass fuels.

[6] Cleanly burn the wood gas in mainly smoke free combustion.

Disadvantages:

[1] It allows only one time feeding of biomass.

[2] We have not to switched off air controller fans till all biomass is get utilized for heat production, because if we switched off air controlling fan there are great chances of getting damage of electronic circuitry.

[3] Agricultural residues often require appropriate stoves to burn well, e.g. gasifier stoves.

[4] Storing of biomass fuel is bulky and storage requires more space.

[5] Residues are often limited to seasonal availability of crops.

[6] Agricultural residues may have a shorter burn time per volume/weight of fuel. For the same cooking task, more fuel is required as compared to wood.

[7] Poor reaction capability with heavy gas load.

[8] Affordable to pay.

Applications:

[1] It can be used in hotel, restaurant.

[2] In small size, we can also use at home for domestic cooking.

Future Scope:

In today's global market, due to industrialization, increased number of vehicles on road, advanced lifestyle leads to increase global temperature. On the other hand, biomass residues are the most appropriate fuels for on-farm systems. So this gasifier also can be used in mountain areas. The use of non-renewable sources of energy is high. These energy sources are going to extinct. Hence from now we must have to take step forward to face this situation. And thus with help of our gasifier we can also contribute to our nation.

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