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Biomass - An Endless Source of Renewable Energy

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***Abstract* - Energy demand in India is increasing continuously due to sharp growth in population and industrial development. Major demand of electricity is fulfilled by conventional energy resources like coal, oil, gas etc. About 13% of installed capacity in India is obtained from renewable energy sources. India being an agricultural rich country has a huge stockpile of biomass which can be used as a potential source to obtain renewable energy in the future for providing energy access to all. Biomass comprises of agricultural waste like woody waste, rice husk, cotton straw, industrial waste, household waste and human & animal waste. Present research work has been put forward to discuss about potential of biomass based power generation in India, different processes to obtain energy from biomass, future prospectus of biomass based power generation systems. Different slurry based and gasification system designs existing today are elaborated in this paper. These systems are energy efficient and environmentally & economically clean to generate heat and electricity. If used on a large scale these systems can solve cooking problems and may provide energy access in rural areas of India through distributed systems.**
***Keywords:*Biogas, Biomass, Gasifier, Producer gas, Renewable Energy.**

I. INTRODUCTION

Economic growth, development and any country's quality of human life can be judged through per capita consumption of electricity. Many environmental and financial advantageous are associated with renewable power generation. Biomass is one of the resources through which renewable power can be obtained. Using biomass methane or producer gas can be made which may be used for cooking purposes or to run dual fuel engines to produce power. Several researchers worked on these processes. Reference [1] shows anaerobic co-digestion of sewage and brewery sludge for biogas production and land application. Reference [2] shows co-digestion of food waste and diary manure for biogas production. Reference [3] shows performance evaluation of plastic bio- digester by designing and constructing a biogas digester and storage tank. Reference [4] shows anaerobic co-digestion of wasted tomatoes and cattle dung for biogas production. Reference [5] shows financial and environmental profiles of the electricity generation using rice husk as an alternate fuel in a dual fuel diesel engine. Reference [6] shows performance parameters of dual fuel diesel engine by using producer gas obtained by gasification of eucalyptus wood as a secondary fuel and diesel oil as a pilot fuel. Reference [7] shows assessment on cow dung to be used as a supplementary fuel in a downdraft biomass Gasifier. They suggested after doing an economic analysis that the cost per unit of energy available in the producer gas will be minimum when the presence of cow dung in the blend is 40-50% by mass. Reference [8] shows the effects of moisture content and air flow rate on biomass consumption rate and quality of producer gas. In this paper a detailed discussion has been made on biomass based power generation in India and different processes through which biomass can be used to produce energy.

II. DIFFERENT PROCESSES TO FORM ENERGY

A. Anaerobic Fermentation

With the increase in household waste a million folds during the last decade, waste management system will not only be a old school but comes out to be futile when energy incapacity is likely a solicitude, that's when household waste to energy conversion comes clever and handy in the form of biogas digester. It should be noted worth a while that organics are the chief components of household waste that could be easily converted into biogas for a clean energy. Biogas is primarily a mixture of CH_4, CO_2 and H_2S which are formed by anaerobic digestion of organic ingredients of household waste.

The chief processes of biogas formation include hydrolysis which can be construed as the disintegration of colonial complex substrate into single units called monomers. Acidogenesis which is a process of complete conversion of monomers into fatty acids which are volatile. Acetogenesis which includes conversion of volatile fatty acids (VFA) into acetic acid, H_2 & CO_2 and finally Methanogenesis which is complete conversion of CO_2, H_2 and acetate into CH_4 [9].

1. Types of Anerobic Biogas Digester

Different types of anaeobic digesters to form biogas are written below:

i. Fixed dome digester :

Such digesters are filled by the inlet pipe up to the bottom level of the expansion chamber. The produced biogas is accumulated and stored in the upper domed shape part of the structure called storage part. Fixed dome digesters developed in India are called Janta and Deenbandhu models. Disadvantages of Janta models such as short circuiting of slurry flow, escape of the undigested slurry at the top and low gas volume leads to the modified Janta model or

Deenbandhu model which consists of the upper sphere of small diameter which serves as the gas collector or storage unit and the lower sphere of bigger diameter which serves as the fermentation unit [9].

ii. Floating drum digester:

This type of digester includes an inverted drum which acts as storage tank and is situated on the digester which could move up and down depending on the gas accumulation hence the weight of the accumulator provides the necessary gas pressure required to run the pipes [9].

iii. Plug flow digester:

Portable plug flow or tubular models built over ground provides a suitable mobility and provides biogas at constant volume and variable pressure. The structure consists of a narrow and long tank like structure and Inlet and outlet which are located in diametrically opposite directions. The fresh substrate is added into the inlet while the spent slurry flows towards the outlet at the other end [9]. Figure 1-4 shows different types of digester

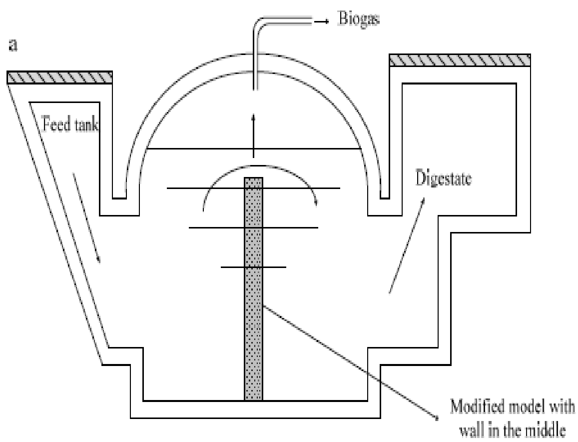

Fig. 1 Janta model fixed dome digester [9]

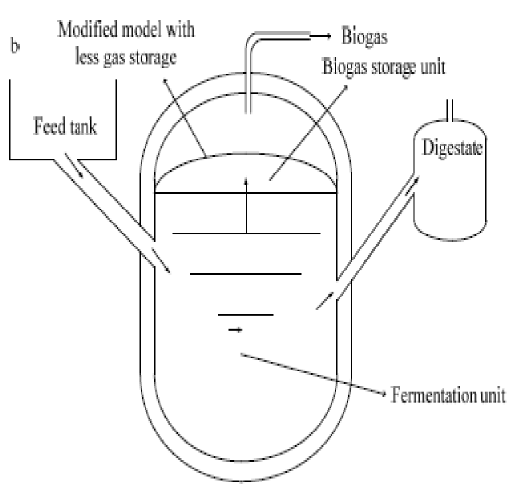

Fig. 2 Deenbandhu model fixed dome digester [9]

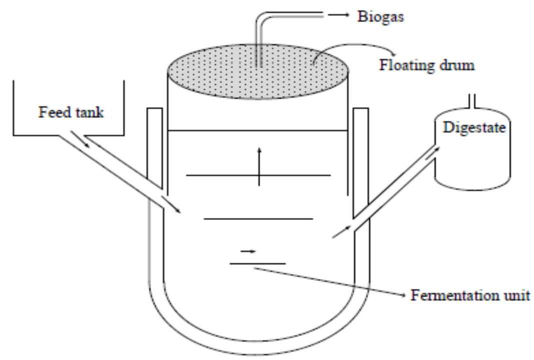

Fig. 3 Floating drum digester [9]

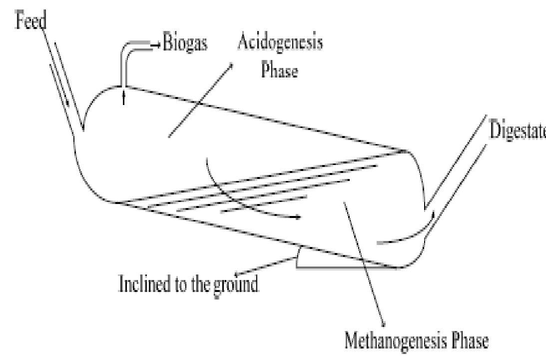

Fig. 4 Plug flow digester [9]

B. Biomass Gasification

Gasification is a process by virtue of which producer gas is formed from organic or fossil based carbonaceous materials. The producer gas mainly consists of CO, N_2 and H_2. Wide variety of bio-residues like saw dust, woody waste, rice husk and cotton straw etc. can be used as the feedstock to from producer gas which in turn is used for power generation purpose. The process of producing energy from biomass through gasification is not new and is in use for more than 180 years. The advantages associated with such systems are suitability in rural areas, distributed generation, carbon neutrality, large feedstock variety, reduction of methane content in atmosphere, low operating cost and ease of production. Gasifiers are the systems which are used to form producer gas through the process of gasification [10].

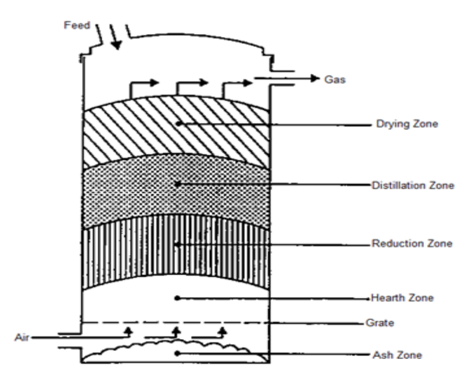

Fig.5 Updraft Gasifier [10]

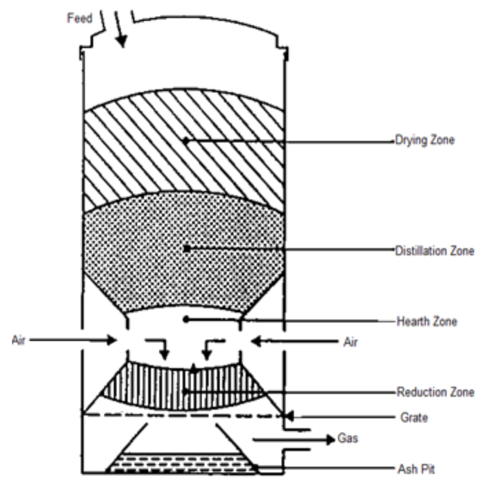

Fig. 6 Downdraft Gasifier [10]

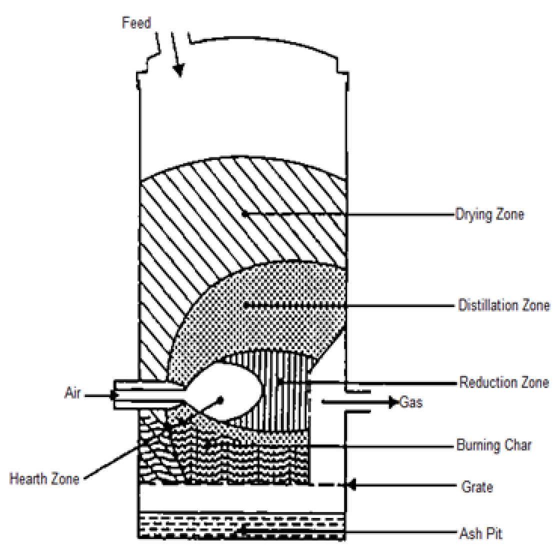

Fig. 7 Cross-draft Gasifier [10]

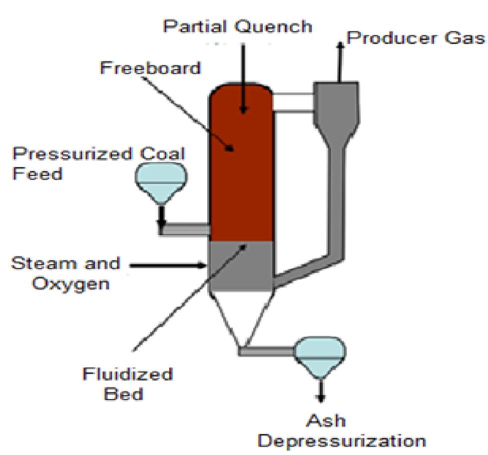

Fig. 8 Fluidized bed Gasifier [10]

Gasifiers may be of fixed bed or moving bed type. Fixed bed type Gasifiers systems are having a bed of solid fuel particles through which the Gasifying media and gas moves up or down. In the moving bed type configuration the bed is either entrained flow type or fluidized type. Updraft and downdraft type configuration are the most commonly used fixed bed type configurations. In updraft Gasifiers gas is drawn out of the Gasifier from the top of the fuel bed while the gasification reactions takes place near the bottom while in downdraft Gasifiers the gas is drawn out from the bottom and gasification reactions takes place near the top of the Gasifier. In contrast to down draft and updraft Gasifiers Cross-Draft Gasifier's reduction zone and fire zone are different and this limits the fuel usage. While distinctively air is blown with a sufficiently high velocity to make a feed particle suspension, the heated air thrusts Pyrolysis into feedstock almost instantaneously hence giving it a glaringly distinctive features of its own. Figure 5-8 shows different configurations of the Gasifiers. [10]

1. Different Zones of the Gasifier

Different zones of the Gasifier are as under:

i. Drying Zone:

In this zone the biomass is heated and dried. Moisture (if any) present in the biomass is removed. Temperature in this zone is usually in the range of 120-150^{o}C.

ii. Pyrolysis Zone:

The dried biomass from the drying zone now enters the Pyrolysis zone where the biomass is partially burnt with the existing air and results in the formation of Pyrolysis gas and charcoal.

iii. Oxidation Zone:

In this zone the output from above two zones react with the remaining char in the absence of oxygen at a temperature of around 800-900^{o}C.

iv. Reduction Zone:

In this zone the products (usually CO_2 and H_2O) react with carbon to form producer gas. Further the charcoal can be taken out from the bottom of the Gasifier [10].

In the total installed capacity of India 4545.63 MW is based upon bio power in which 4418.55 MW is obtained from Biomass power/Cogeneration sector and 127.08 MW is obtained by converting waste materials to energy [11]. Main companies dealing in building these gasification systems in India are Ankur, CGPL, OVN, SYNERGY, ARUNA, NETPRO, BETEL, ARRYA etc. [10].

III.FUTURE OF BIOMASS BASED RENEWABLE POWER GENERATION IN INDIA

India is very rich in three energy sources namely energy plantations, agricultural crop residue and municipal & industrial wastes. These energy sources have tremendous scope in the coming future. At present the total installed capacity of biomass based power in India is 4545.63 MW and according to some forecasting's this no. is going to increase to 35000 MW by 2035. But there are some barriers too in this field like gas cleaning systems are not robust with high maintenance required, power delivered by the gasification depends upon quality of biomass and so many variations are there, compatibility with IC engines needs to be studied further, storage and handling is difficult, tar generated during gasification is still not under control and it has been noted that very few systems have gone through life cycle operations and are having significant deficiencies in terms of designing operation and maintenance protocols [12].

IV.CONCLUSIONS

In this paper a discussion is made to explore biomass based renewable power generation in India. It has been found that India is having a large potential of biomass based power generation. Using biomass, energy access can be provided to all households in rural areas of India through distributed or off – grid solutions. Different processes and designs through which energy can be obtained from biomass are discussed in detail. At the end future prospectus of biomass based power generation and different issues are discussed. If these systems are used on a large scale they can impact large population of rural India solving cooking issues and may provide energy access to all households.

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