AN EXPERIMENTAL STUDY OF EFFICIENCY OF AGRICULTURAL WASTES (BIOMASS) FOR SUPPORTING GASIFYING TECHNOLOGY

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ABSTRACT

Agricultural wastes (biomass) gasifier for electrical power generation in duel fuel mode is a proven technology, yet there is scope for enhancing gasification efficiency at variable conditions. The present system was made with a Ministry of Non-convetional Energy ; MNRE sponsored ,a research gasifier named wbg-15 at "Ankur Scientific and Energy Technology (P) Ltd," Vadodara.

The objective of the study is to determine efficiency of biomass burned. The biomass were chopped in 2 to 4 cm length and sun dried to moisture content less than 20 %.Each treatment was replicated tree time. According to the result of the study ,the bulk densities of each biomass was 128 kg / m3 ,97 kg / m3, 273 kg / m3, and 274 kg / m3for coconut husk , stems of cassava , mulberry and cassia stamea respectively. The density of biomass was highest for the cassia stamea and lowest for cassava and coconut ,with an intermediate value for mulberry. Despite these differences in feedback density , there were no differences among sources of biomass in the operating parameters of the conversion of biomass to electricity , the energetic efficiency (Gasifier) The requirement of biomass in energy production in one hour is 9.06 kg, 9.63 kg , 10.32 kg , and 10.89 kg for coconut husk ,stems of cassava , mulberry and cassia stamea respectively . One kg of biomass density can produce energies as 1.11 kWh, 1.21 kWh, 1.18 kWh, and 1.27 kWh for coconut husk , stems of cassava , mulberry and cassia stamea respectively . Statistically , there is no significant difference between treatments , except bulk density of biomasses.

Keywords: Climate Change , Electricity, Mulberry, Renewable Energy, Woody Biomass Gasifier, Efficiency of Biomass, Agriculture Wastes Etc.

I. INTRODUCTION

The three components of the world crises – economic recession, global warming and resource depletion (especially fossil fuels) - presently facing humanity are closely inter-related. The gaseous emissions from the burning of fossil fuels are the major contributor to global warming; the apparently inexhaustible supply of fossil fuels facilitated the exponential growth of the world population during the past century and, more recently, the unsustainable indebtedness in the developed countries, which led to the present economic recession. In the past century, the needs for energy, and indirectly for food, of the expanding world population were provided by cheap oil. The inevitable process of adaptation to increasing cost and declining supplies of oil, will almost certainly change the future life style of the majority of the world's population.

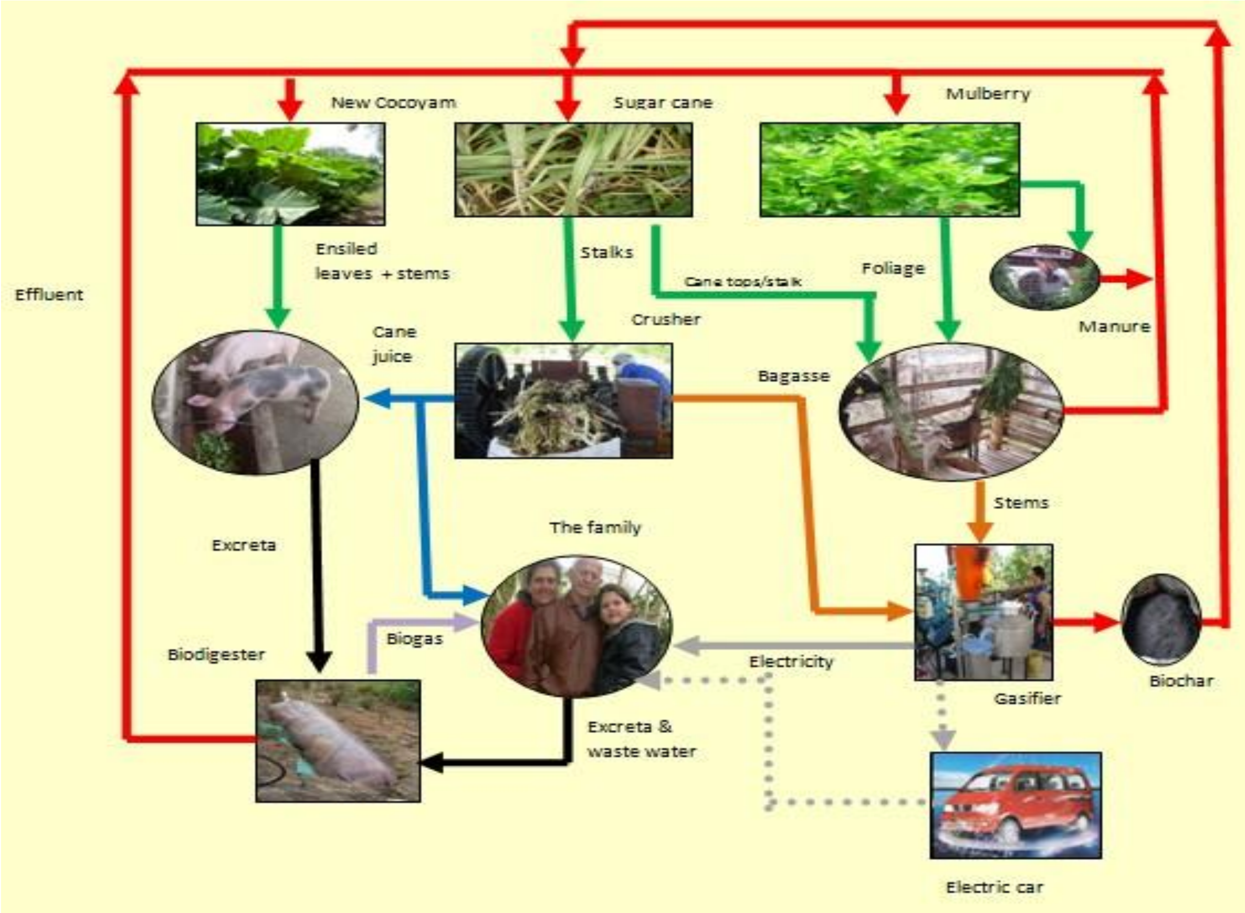

Fig. 1 Flow Diagram of the Principle Activities In The Agriculture Field

For the future, the only long term alternative to fossil fuel (as exo-somatic energy, that is energy not derived from digested food – muscle power) is solar energy, utilized either directly as a source of heat, or indirectly in solar-voltaic panels, as wind, movements of waves and tides, or in biomass produced by photosynthesis. Solar energy will also have to be relied on to produce food, in what must surely have to be rural small-farm systems, to support the largely urbanized population. The green revolution which dramatically increased food supplies during the last 40 years was a "fossil energy " revolution as it was energy in the form of oil and natural gas which facilitated production of fertilizers, especially nitrogen, pesticides and herbicides, and the mechanization and irrigation that permitted multiple cropping. Another "energy" revolution is possible but it will be based on making greater use of the energy derived daily from the sun. It must also produce both energy and food and have an EROEI (Energy Returned On Energy Invested) of at least 5 (Hall et al 2008a,b). It will also need the support of human energy and increased numbers of people working in rural areas. There are few difficult decisions about producing food by photosynthesis. By contrast, the ideas proposed for redirecting energy from the sun into potential energy to replace that of fossil fuels are many. The alternatives that are currently practiced commercially (although in most cases with a high degree of Government subsidy) can be divided into processes that depend on (i) the products of photosynthesis (e.g : ethanol produced by fermentation of sugars derived from cereal grains, cassava roots and sugar cane; and biodiesel from soya beans, rapeseed and oil palm);

or (ii) that use the physical qualities of solar energy directly (photovoltaic panels, solar water heaters, windmills and tidal barrages). Surprisingly, gasification which is a proven technology for using biomass as a source of fuel, and which was applied widely in several "oil-dependent" countries during World War II, has received little attention from policy makers and the media. Yet, as will be shown in this paper, it appears to hold real prospects of being especially applicable at the small, dispersed farm level. Gasification is a process for deriving a combustible gas by burning fibrous biomass in a restricted current of air. The process is a combination of partial oxidation of the biomass with the production of carbon which at a high temperature (600-800 C) acts as a reducing agent to break down water and carbon dioxide (from the air) to hydrogen and carbon monoxide, both of which are combustible gases. The advantages of gasification are that: the feedstock is the fibrous parts of plants which are not viable sources of food; the energy used to drive the process is derived from the combustion of the feedstock; there is minimal input of fossil fuel (mainly for the construction of the gasifier and associated machinery); the process can be de-centralized as units can be constructed with capacities between 4 and 500KW.

Fig.2 Chopped Dried Stem of Cassia Stamea

Fig.3 Chopped Dried Stem of Cassava

Fig.4 Chopped Dried Stem of Mulberry

Fig.5 Chopped Dried Stem of Coconut

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Therefore, the use of agricultural wastes for generating electricity is the main key to reduce expenditure on fuel which is better to left it abundant. Renewable energy will become a choice of future demand. Fibrous biomass can play an important role in the creation of renewable energy. The specific objective of the study was to compare the burning efficiency of different biomass. The type of gasifier investigate in this study was woody biomass gasifier(WBG-15) which was able to generate electricity with capacity of 7kw. The development of gasifier technology was the mix use of gasifier, generator and electric motor, etc; the fuel generator was completely converted to run by gas from burning of biomass. Four different types of biomass were used, including coconut husk, steam of cassava, mulberry, and cassia stamea.

II. METHODOLOGY

Materials

Type of raw materials (Biomass)

- Coconut husk was cut with 2*4 cm size and sun-dry up for 4-6days.
- Cassava steam was chopped in 2*4 cm size and sun-dry up for 3-4days.
- Mulberry steam was a part of plant which its leaves was used for animal feeding. The steam of the plant was cut in 1*4 cm size and sun-dry up for 4 to 5 days.
- Cassia stamea steam was chopped in 2*3 cm and sun-dry up for 5-6 days
- All raw materials were sun-dry up to get the moisture content below 20%.
- Particles were sieved off and the dried raw materials were stored in proper place to avoid moisture absorption.

III. FACILITIES

1. Hopper
2. Nozzle
3. Burning chamber
4. Ash collector
5. Gas cleaning tank
6. Gas filter tank 1
7. Gas filter tank 2
8. Flare pipe
9. Combustion engine
10. Electric motor

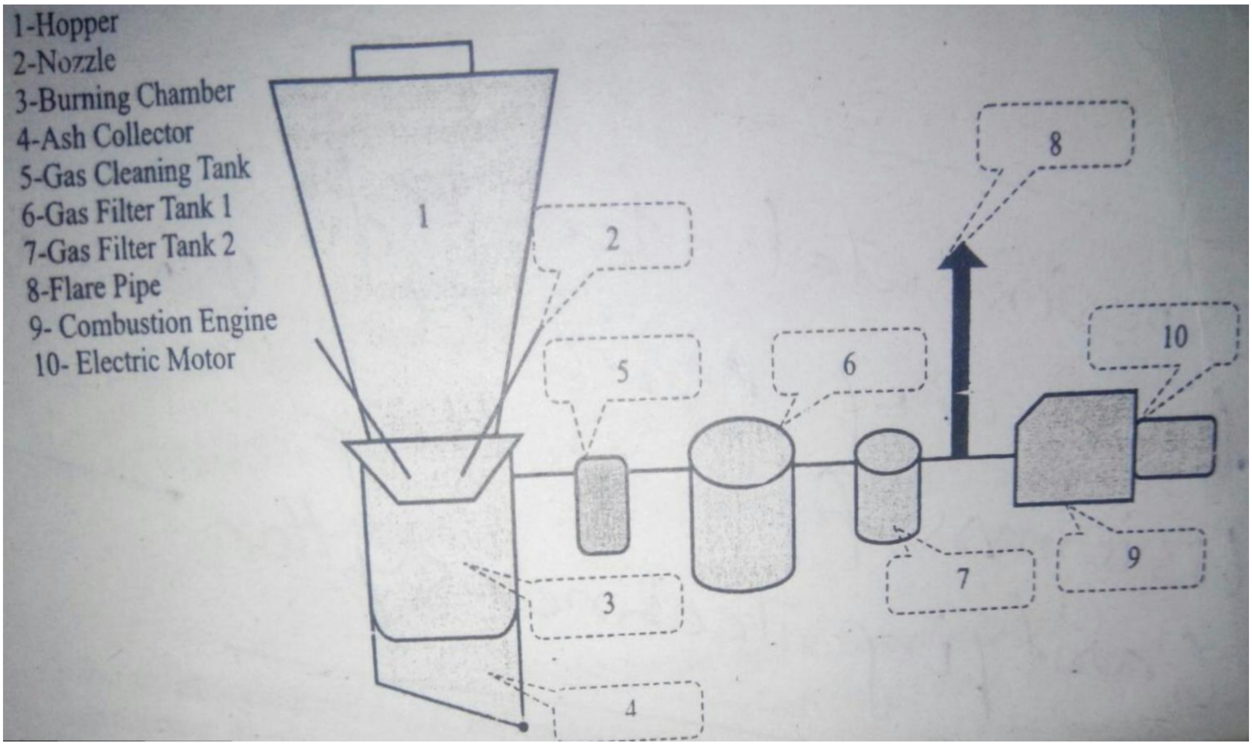

Fig .6 Schematic Drawing of Gasifer (WBG-15)

Method

Treatment determination

The experiment was conducted in 4 treatments:

- Treatment 1: Used coconut husk
- Treatment 2: used steam of cassava
- Treatment 3: Used steam of mulberry
- Treatment 4: Used steam of cassia stamea

Each treatment was replicated three times and each replication was used 40kg of raw material with the moisture content below 20%. Before place into gasifier the density of samples was measured.

Data recording

The key to be recorded include weight of raw material input (kg), moisture content of raw material (%), density of raw material (kg/m3), burning duration (h:min.),weight of ash (kg),electricity output(kWh).

IV. RESULTS AND DISCUSTION

The summery result is show in table.1 below:

Table 1 Summary Result

Biomass	Coconut husk	Cassava stem	Mulberry stem	Cassia stamea stem	Standard error	Probability
Weight of biomass consumption,(kg)	36.4	35.1	40	36.9	2.89	0.7

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Moisture content,(%)	14	12	16	14	1.31	0.27
Bulk density,(kg/m^3)	128	97	273	274	38.09	0.02
Burning duration,(min)	241	220	249	215	16.77	0.45
Weight of ash, (kg)	4.33	3.87	3.66	4.28	0.75	0.90
Electricity output,(kWh)	28.17	25.73	28.67	25.07	1.95	0.49
Requirement of dry mass per 1 kWh (kg DM)	1.11	1.21	1.18	1.27	0.05	0.28
Electricity output per 1kg dry mass,(kWh)	0.90	0.83	0.85	0.79	0.39	0.27

4.1 Biomass Consumption (kg)

According to table.1 weight of biomass consumption was 36.4kg, 35.1kg, 40kg, and 39.9kg for coconut husk, cassava steam, mulberry steam, and cassia stamea stem, respectively. This result shows that standard error was 2.89 corresponding to probability of 0.7. In statistically, when the probability bigger then 0.05, it can be concluded that it was no significant difference between different types of biomass.

4.2 Moisture content of Biomass (%)

According to table.1, the moisture of each sample was 14, 12, 16, and 14 for coconut husk, cassava stem, mulberry stem, and cassia stamea stem, respectively. It was some different in number, but in statistically, it was not significant difference, it was 1.31 which corresponding to probability of 0.27 which was bigger than 0.05. therefore, moisture content in each sample can be neglected.

4.3 Bulk density of biomass (Kg/m^3)

According to table.1, the bulk density of each sample was 128,97,273, and 274 for coconut husk, cassava stem, mulberry stem, and cassia stamea stem, respectively. Stem of cassava plant had the lowest density followed by coconut husk, while bulk density of mulberry stem and cassia stamea stem was almost not different.

The difference of bulk density between biomass could be related to the percentage of wood content inside, (mulberry stem and cassia stamea stem). Cassava stem and coconut husk had the lowest density which in fiber and spongy content was involved.

The value of standard error between all biomass was 38.09 which corresponding to the probability of 0.02. in statistically, when the probability less then 0.05, it could be concluded that bulk density of biomass was significant difference.

V. DURATION OF BIOMASS BURNING (MIN)

According to Table.1, the duration of biomass burning of each sample was 241,220,249, and 215 for coconut husk, cassva steam, mulberry steam and cassia stamea stem, respectively. The result show that burning of biomass was slightly different, but did not impact on gasifying process. Mulberry stem while cassia stamea stem could be burned out at the shortest period. The value of standard error between all biomass was 16.77 which corresponding to the probability of 0.45. In statistically, when the probability bigger then 0.05, it could be concluded that burning of biomass was not significant difference.

5.1 Ash output (kg)

According to table.1, the ash output sample was for 4.33, 3.87, 3.66 and 4.28 coconut husk, cassva stemea , mulberry stem, and cassia stamea stem, respectively.

Data on ash output was showed that coconut husk and cassia stamea stem had the highest output of ash, followed by mulberry stem and cassava stem. Respectively higher output of ash could be related to the spongy state completely burn, and fiber content.

The value of standard error between all biomass was 0.05 which corresponding to the probability of 0.90. In statistically, when the probability bigger then 0.05, it could be concluded that electricity produced from the four biomasses was not significant difference.

5.2 Electricity Output (kWh)

According to Table.1, the electricity output of each sample was 28.17, 25.73, 28.67, and 25.07 for coconut husk, cassava stem, mulberry stem, and cassia stamea stem respectively. It was showed that mulberry stem and coconut husk could produce the highest electricity output, followed by cassva stem and cassia stamea stem gave the range of electricity output in range as described. The highest electricity output of coconut husk be related to volume by mass and the duration of burning. On loop of that, spongy shape and higher fiber content also related to higher output of electricity. The value of standard error between all biomass was 1.95 which corresponding to the probability of 0.49. in statically, when the probability bigger than 0.05, it could be conclude that electricity produce from the four biomass but not significant difference.

VI. EFFICIENCY OF BIOMASS

Referring to the result of this experiment; coconut husk should be the best biomass use for gasifying technology. Allowed by mulberry stem and cassava stem while cassia stamea stem was not preferable .Coconut husk was useful and benefit this technology due to the duration of burnable and electricity output. Even thought, coconut husk was preferable in term of economic return and electricity produced, but is was also encounter some difficulties such a difficult in chopping; take time to dry up; while burning was not completed without more care and charcoal needed to add as burning catalyst; and continues feeding of husk. However, it was one of the excessive resources. Cassava stem was also abundant resources and easiest to chop, easy of dry up and could said to be a sustainable resource. Cassia stamea was fast growing plant, but it was not so being grown by community yet.

Comparing the residue of burned biomass, mulberry stem can be classified as the less residue produce giving. It was the completed burning. However, the viability of this kind of biomass not considered plenty yet.

VII. CONCLUSSION AND RECOMMENDATION

7.1 Conclusion

In generally, it was concluded that coconut husk gave the highest efficiency in term of duration of burning, energy conversion, and requirement of biomass and electricity production. Even thought, this technology adoption was still not countrywide due to some constraint accountable i.e. complexity and requires higher operation management.

7.2 Recommendation

The following are the key ides suggested to adopt this technology to rural areas of India.

- Should be extended this technology to rural community, which interest in rural electrification, generation from agricultural wastes (Biomass)
- Ministry of agricultural, forestry and fisheries; ministry of industry, mine and energy; ministry of rural development, ministry of environment and other related institution should pay more attention on this new technology, through conducting a cooperative research and extension on value of benefit of waste and to alleviate poverty of poor people, especially on the utilization on this technology to deduct problems, causing from using fossil oil and useless of wastes.

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