Analysis and Reduction of Pollutants by using a Bagasse as an Alternate Fuel

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Abstract: World is distributed into two region according to their development, they are Developed countries and developing countries. Energy is an important factor for any developing country. Developing countries consume more energy sources than developed countries because of their need of energy for industrial and economic growth. India is placed under developing countries list, so it needs of energy requirement for industrial and economic growth is high. Since sustainable development is also an important thing to maintain. We know that, Energy is a basic requirement for economic development. Every sector of Indian economy – agriculture, industry, transport, commercial and domestic –needs inputs of energy. Ever increasing consumption of fossil fuels and rapid depletion of known reserves are matters of serious concern in the country. This growing consumption of energy has also resulted in the country becoming increasingly dependent on fossil fuels such as coal and oil and gas. Rising prices of oil and gas and potential shortages in future lead to concerns about the security of energy supply needed to sustain our economic growth. Increased use of fossil fuels also causes environmental problems both locally and globally.

***Keywords* – Energy need to Developing.**

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1. INTRODUCTION

World is distributed into two region according to their development, they are Developed countries and developing countries. Energy is an important factor for any developing country. Developing countries consume more energy sources than developed countries because of their need of energy for industrial and economical growth. India is placed under developing countries list, so it needs of energy requirement for industrial and economical growth is high. Since sustainable development is also an important thing to maintain. We know that, Energy is a basic requirement for economic development. Every sector of Indian economy – agriculture, industry, transport, commercial and domestic –needs inputs of energy. Ever increasing consumption of fossil fuels and rapid depletion of known reserves are matters of serious concern in the country. This growing consumption of energy has also resulted in the country becoming increasingly dependent on fossil fuels such as coal and oil and gas. Rising prices of oil and gas and potential shortages in future lead to concerns about the security of energy supply needed to sustain our economic growth. Increased use of fossil fuels also causes environmental problems both locally and globally.

For efficient utilization of biomass, biogases based cogeneration in sugar mills and biomass power generation have been taken up under biomass power and cogeneration programmed. Wood and agricultural residues are major choices as feedstock for energy production and they can either be used directly as fuel or thermo-chemically converted. Most of these biomass materials are, however, not suitable for direct utilization, because they are bulky, heterogeneous in size and shape and might differ in density.

These differences not only make it difficult to handle, transport and store the biomass, but also to combust it, as most gasifiers cannot handle heterogeneous particle sizes. There are numerous ways to resolve these problems, of which briquetting and/or pelleting are the most commonly utilized technologies. Chemical composition, moisture content and final briquette density are the most important parameters affecting the combustion efficiency of any type of biomass. So Biomass energy is a one of the Green energy that has no or minimal negative environmental, economic and societal impact. And provide sustainable development to the nation.

2. METHODOLOGY

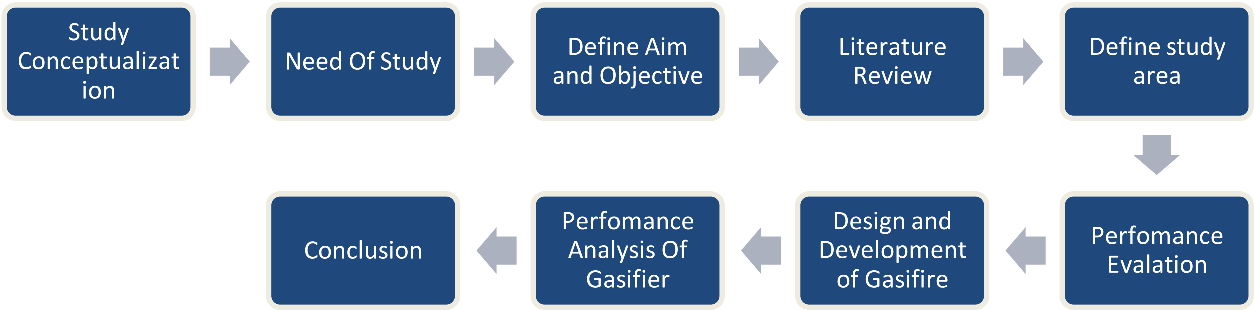

FIGURE 1 FLOW CHART OF METHODOLOGY

3. Material and Process Description

For solving Environmental and economical problems which generate from use fossil fuel. Analysis of different form of bagasse based biomass with their availability. Determination of proximate analysis (% moisture, % volatile matter, % ash and % fixed carbon contents) of bagasse based biomass. Characterization of bagasse biomass components for it ultimate analysis (carbon and hydrogen) Characterization of bagasse components for it energy values (calorific values).Compare performance of different form of bagasse thermally with their relevant phase of fossil fuel. Estimation of power generation potentials of it biomass species for a small thermal power plant on decentralized basis. Developing gasifier for ultimate conversion of energy from bagasse.

4. Experimental work

<u>Proximate composition of biomass:</u>

Analysis for moisture, volatile matter, ash and fixed carbon contents were carried out on samples ground to 72 mess size by standard method. The details of these tests are as follows.

Moisture Determination

One gram of air dried powdered sample of size 72 mess was taken in a borosil glass crucible and kept in the air oven maintained at the temperature 110˚C.The sample was soaked at this temperature for one hour and then taken out from the furnace and cooled in a dessicator. Weight loss was recorded using an electronic balance. The percentage loss in weight gave the percentage moisture content in the sample.

Volatile Matter Determination

One gram of air dried powdered sample of size 72 mesh was taken in a volatile matter crucible (made of silica) and kept in the muffle furnace maintained at the required temperature of 925˚C.The sample was soaked at this temperature for seven minutes and then crucible was taken out from the furnace and cooled in air. Weight loss in the sample was recorded by using an electronic balance having a sensitivity of 0.001grams.The percentage loss in weight – moisture present in the sample gives the volatile matter content in the sample.

Fixed Carbon Determination

The fixed carbon content in the sample was determined by using the following formula: [19]

Ultimate composition of biomass:

Ultimate analysis (analytical chemistry) is the determination of the percentage of elements contained in a different biomass. It's including different chemical components of biomass, which help in to find out different emission components generate after burning of biomass. Table 3.1 indicates ultimate analysis data of different biomass [16].

4.2.1 Carbon (C)

The C content in biomass varies in the interval of 42–71%. The extremely high C content is characteristicof some wood barks and high-ash greenhouse-plastic waste,chicken litter, meat-bone meal, and refuse-derived fuel.

4.2.2 Oxygen (O_2)

The O_2 content in biomass is mostly calculated by difference and varies in the interval of 16–49%. In contrast, the O_2 value in peat and coal is commonly in the range of 4–36%. The extremely high O_2 content is characteristic of pepper residues, coffee and soya husks.

4.2.3 Hydrogen (H)

The H content in biomass varies in the interval of 3−11%. In contrast, the H concentration in peat and coal is in the narrow range of 4−6%. The extremely high H content is characteristic of greenhouse-plastic waste, tamarack bark, mustard and cotton husks, meat-bone meal, refuse-derived fuel, and groundnut shells.

4.2.4 Nitrogen (N)

The N content in biomass varies in the interval of 0.1–12%. In contrast, the N value in peat and coal is in the narrow range of 1–3%. The extremely high N content is characteristic ofmeat-bone meal, chicken litter, sewage sludge, pepper residues, alfalfa and mint straws, palm kernels, and buffalo gourd grass.

4.2.5 Sulphur (S)

The S content in biomass varies in the interval of 0.01−2.3%. In contrast, the S concentration in peat and coal is in the range of 0.2−9.8%. The extremely high S content is characteristic of sewage sludge, meat-bone meal, chicken litter, biomass mixture, pepper residues, refuse-derived fuel, and Christmas trees.

4.2.6 Chlorine (Cl)

The Cl content in biomass varies in the interval of 0.01–0.9%. In contrast, the Cl value (db) in peat and coal is in the large range of 0.005–0.1%. The extremely high Cl content is characteristic of meat-bone meal, refuse- derived fuel, most straws (alfalfa, barley, corn, mint, rice, wheat), some grasses (bana, sweet sorghum), and chicken litter[19].

4.3 Calorific Value Determination:

The calorific values of the biomass samples were measured in a Bomb calorimeter apparatus by the method outlined in reference.[8]In this test an over dried sample briquette of weight 1gm (approx.) was taken in a bomb and oxygen gas was filled into this bomb at a pressure of 25-30 atm. The sample was then fixed inside the bomb and rise in temperature of water was noted with the help of Beckman Thermometer. The calorific value was calculated by using the following formula:

$$\textbf{Gross Calorific value} = (W.E \times T) / W_o - (\text{fuse wire + thread connections})$$

Where,
W.E = water equivalent of the apparatus

T = Maximum rise in temperature in ˚C.

W_o = Initial weight of briquette sample.

4.4 Ash Fusion Temperature Determination:

The ash fusion Temperature, softening Temperature, Hemispherical temperature and Flow temperature) of all the ash samples ,obtained from the presently selected non-woody biomass species were determined by using Leitz Heating Microscope (LEICA) in Material Science Centre of the Institute [1].

4.5 Briquette making from Bagasse in solid form:

Biomass briquetting is the densification of loose biomass material to produce compact solid composites of different sizes with the application of pressure. Three different types of densification technologies are currently in use. The first, called pyrolizing technology relies on partial pyrolysis of biomass, which is mixed with binder and then made into briquettes by casting and pressing. The second technology is direct extrusion type, where the biomass is dried and directly compacted with high heat and pressure. The last type is called wet briquetting in which decomposition is used in order to breakdown the fibers. On pressing and drying, briquettes are ready for direct burning or gasification. Some of the advantages of briquettes are given below:

1. This is one of the alternative methods to save the consumption and dependency on fuel wood.
2. Densities fuels are easy to handle, transport and store.
3. They are uniform in size and quality.
4. The process helps to solve the residual disposal problem.
5. The process assists the reduction of fuel wood and deforestation.
6. Indoor air pollution is minimized.
7. Briquettes are cheaper than COAL, OIL or LIGNITE.
8. There is no sulfur andfly ash when burning briquettes.
9. Briquettes have a consistent quality, have high burning efficiency, and are ideally sized for complete combustion.
10. Combustion is more uniform compared to coal.
11. Loading/unloading and transportation costs are much less and storage requirement is drastically reduced.
12. Briquettes are usually produced near the consumption centers and supplies do not depend on erratic transport from long distances.
13. The technology is pollution free and Eco-friendly.
14. Continuous burning and long burning duration.[4][5]

Characteristic of Bagasse

Bagasse is the crushed outer stalk material formed after the juice is squeezed from sugar cane, in sugar mills. Bagasse characteristics vary in composition, consistency, and heating value depending on the climate, type of soil, variety of cane, harvesting method, amount of cane washing, and the efficiency of the milling plant. In general, bagasse has a high calorific value 4000 Kcal/kg on a wet, as-fired basis. Most bagasse has moisture content between 45 and 55 percent by weight.

Bagasse if not managed properly (utilized /disposed) can lead to odor nuisance, dumping of bagasse on land can lead groundwater contamination, potential breeding ground for disease carrying vectors and reduces the aesthetic value of the neighborhood.

Table: 4.2 Comparison Table of fuels

Characteristics	Bagasse	Bagasse based Briquette	Coal
Calorific Value(CV)	4000 Kcal/Kg	4086 Kcal/Kg	4000 Kcal/Kg
Moisture content(M)	45-55 % by weight	2-5 % by weight	4-6% by weight
Ash Content(A)	2 – 10 %	2 – 10 %	25-30%
Cost(Rs.)	3000	4500	5000

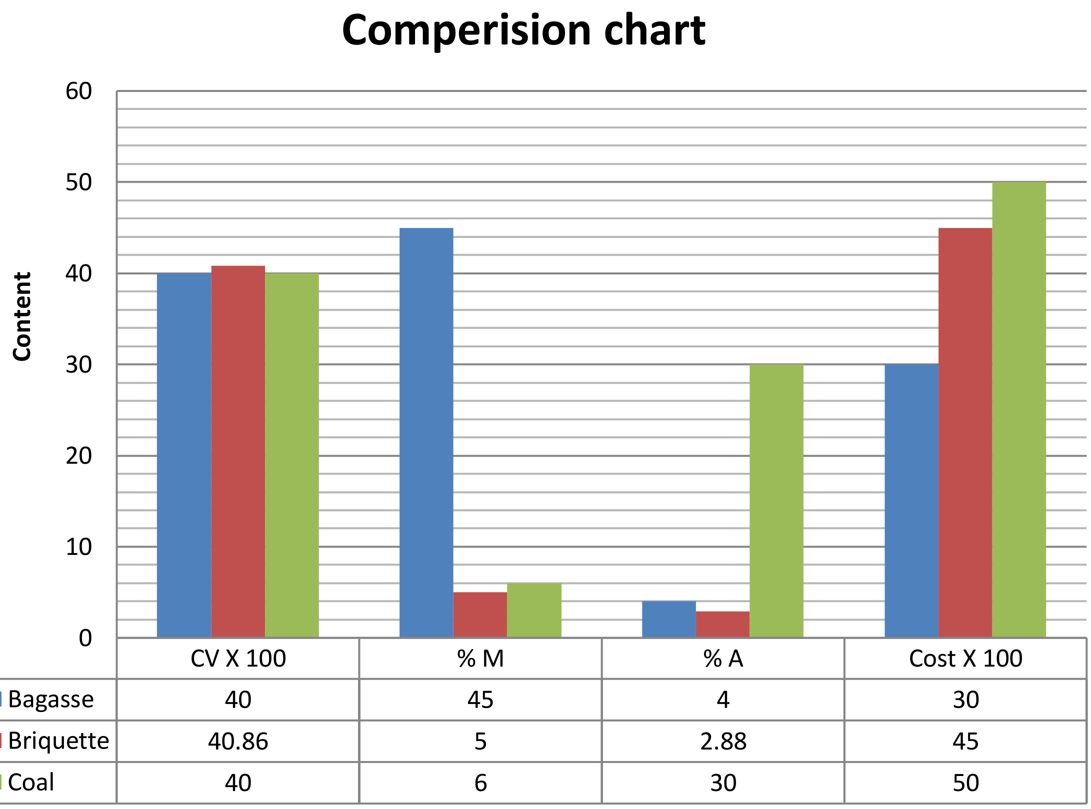

Fig. Comparison chart of coal, Bagasse, Bagasse based Briquette

Benefit of use of bagasse

The main benefits of using briquetted bagasse as a fuel are;

- Emissions of sulfur dioxide (SO_2) and nitrogen oxides (NOx) are lower than conventional fossil fuels due to the characteristically low levels of sulfur and nitrogen associated with bagasse.
- Helps in reducing the greenhouse gases (GHGs) in the atmosphere.
- Low ash content of 2-10% as compared to 20-40% in coal
- The indiscriminate disposal of bagasse and/or the disposal cost/fees areeliminated.
- Bagasse is a renewable resource can play a major role in substituting fossil fuelfor future power generation[6].

Briquetting technique is densification of the loose biomass; this is achieved by subjecting biomass to heavy mechanical pressure to form compact cylindrical form known as briquettes.Owing to high moisture content direct burning of loose bagasse in conventional grates is associated with very low thermal efficiency and widespread air pollution. The conversion efficiencies are as low as 40% with particulate emissions in the flue gases in excess of 3000 mg/ m³ In addition; a large percentage of unburnt carbonaceous ash has to be disposed off.

Following are the benefits of briquetting bagasse:

- High calorific value ranges between 3,500-5,000 Kcal/Kg
- Moisture percentage is very less (2-5%) compared to lignite, firewood & coal where it is 25-30%
- Economic to users compared to other forms
- Briquettes can be produced with a density of 1.2 g/cm³ from loose biomass of bulk density 0.1 to 0.2 g / cm³.
- Easy in handling and storage due to its size.
- Consistent quality[6]

Briquetting making Techniques from bagasse based biomass

The two techniques of briquetting bagasse/biomass are the binderless and charred binder briquetting techniques:
In the binderless technique the biomass is finely divided to uniform size and subject to heavy mechanical pressure to form briquettes. The *lignin* in the agro waste acts as a natural binder, there is no need to add chemicals or any other foreign substance to the process.

In the charred briquetting technique the biomass is finely divided and charred to increase the carbon concentration and reduce the moisture. The charred material is then subjected to heavy mechanical pressure to form briquettes. Due to the absence of the binding properties in char, binding agents like starch are added to form briquettes. Usually the binderless technique is used for commercial application of the briquettes (fuel for industrial boilers) the charred briquettes are used for domestic application.

4.5.3.1*Binding less techniques for briquette making*

In binding less technique there are main two type of briquette machine available.
Two main type of briquetting machines are:

1. The screw extrusion: The Prepared homogenous raw material is fed to briquetting press by screw conveyor for regular feeding. In briquetting press it passes through toper die and due to high pressure & heat, powder form is converted into solid cylindrical briquettes. Although both technologies have their merits and demerits, studies have shown that the screw pressed briquettes are superior to the ram pressed solid briquettes in terms of their storability and combustibility. However the screw extrusion machines have low production capacity (150 – 200 kg/hr) and high operational cost, due to the possibility of screw breakages.

   Processing of biomass using screw compaction involves the following mechanisms:

   a) Before reaching the compression zone (a zone usually formed by tapering of the barrel), the biomassis partially compressed to pack the ground biomass. It is during this first stage that the maximumenergy is required to overcome particle friction.
   b) Once the biomass is in the compression zone, the material becomes relatively soft due to hightemperature (200–250°C), and during this heating, the material loses its elastic nature, which resultsin an increased area of inter-particle contact. At this stage, local bridges are formed when the particlescome closer, and the interlocking of particles may also result. During its passage through the compression zone, the biomass absorbs energy from friction so that it may be heated and mixeduniformly through its mass.
   c) In the third stage, the biomass enters the tapered die, where the moisture is further evaporated due tothe prevailing temperature of 280°C, helping to better moisten the biomass and increase thecompression on the material.

d) In the final stage, the removal of steam and compaction take place simultaneously and the pressurethroughout the material normalizes, resulting in a uniform extruded log.

2. The reciprocating ram/piston press (briquetting press): Piston press (ram) machine has higher production capacity (above 1000kgs/hr) as compared to screw machines, the briquettes are completely solid and screw press briquettes on the other hand have a concentric hole which gives better combustion characteristics due to a larger specific area. The screw press briquettes are also homogeneous and do not disintegrate easily. Having a high combustion rate, these can substitute for coal in most applications and in boilers.

   The energy to the piston is transmitted from an electric motor via a high pressure hydraulic system. The throughput of a hydraulic press is lower than that of a mechanical press since the cycle of the cylinder is slower. In addition, the briquettes have a lower bulk density 6 (<1000 kg/m³) due to the fact that pressure is limited. However, these machines can tolerate higher moisture contents than the usually accepted 15% for mechanical piston presses Fig 4.4 represent making of briquette by hydraulic piston press machine.

   Another roll press type includes Densification of biomass using roller presses works on the principle of pressure and agglomeration, where pressure is applied between two counter-rotating rolls. Ground biomass, when forced through the gap between the two rollers, is pressed into a die, or small pockets, forming the densified product.Design parameters that play a major role on the quality of the densified product are the diameter of the rollers, the gap width, the roller force, and the shape of the die.

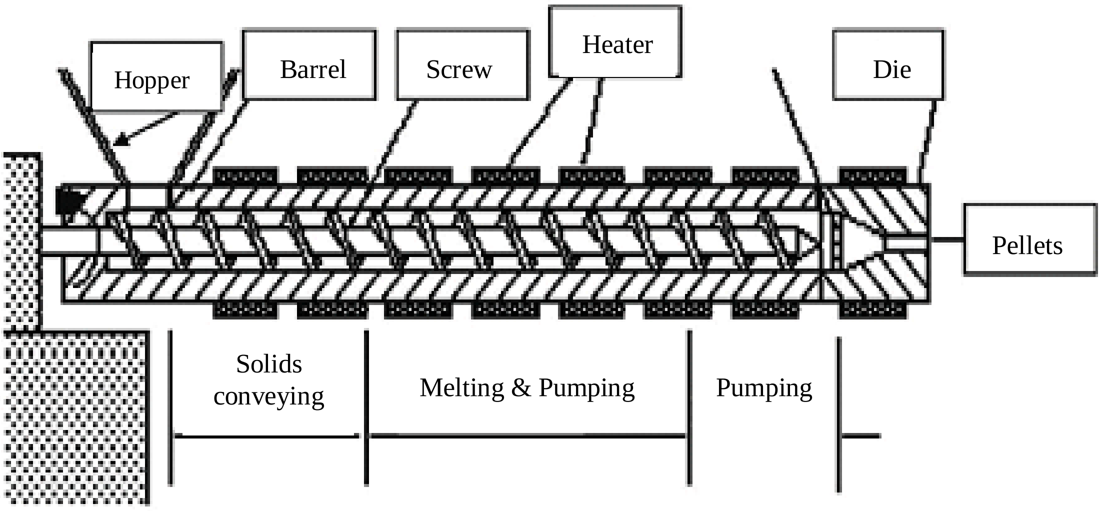

Fig.4.2 Representation of a screw extruder

Fig.4.3 Briquette made by screw extruder

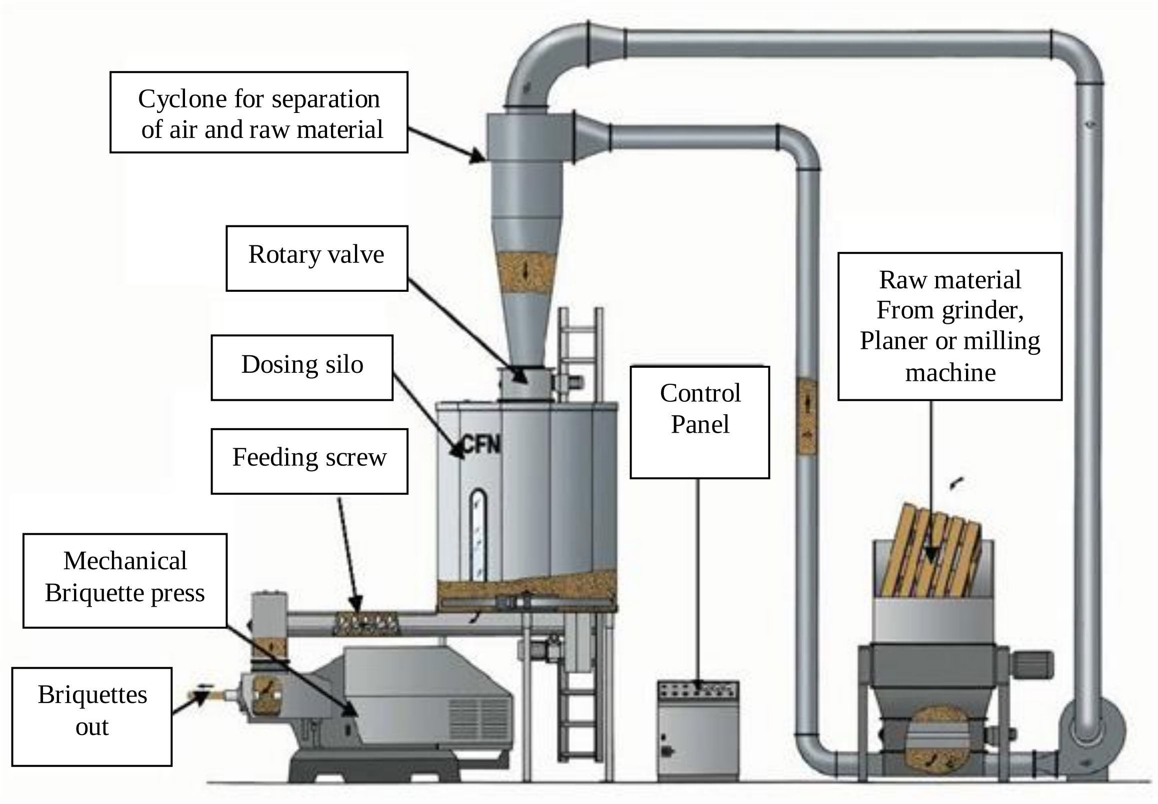

Fig. 4.4 Continuous piston press-type briquetting press

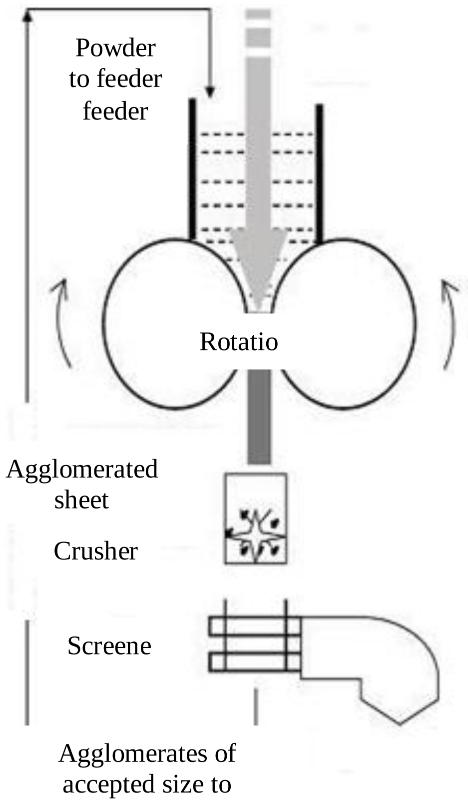

Fig. 4.5 Roller press for agglomeration of biomass

Fig. 4.6 Briquettes made by hydraulic press

In the case of agglomerate production, by using smooth rolls, the machine output can be a sheet having a specific thickness based on the gap provided between the rollers. The sheet produced is used to produce the agglomerates, as shown in Fig. 4.6 and the fines are again recycled back to the feeder.

Table: 4.3 Comparison of Briquette forming techniques

	Piston press (Ram)	Screw extruder
Optimum moisture content of raw material	10-15%	8-9%
Wear of contact parts	low in case of ram and die	high in case of screw
Output from the machine	in strokes	Continuous
Power consumption	50 kWh/ton	60 kWh/ton
Density of briquette	1-1.2 gm/cm³	1-1.4 gm/cm³
Maintenance	High	Low
Combustion performance of Briquettes	not so good	very good
Carbonization to charcoal	not possible	makes good charcoal
Suitability in gasifiers	not suitable	Suitable
Homogeneity of briquettes	non-homogeneous	Homogeneous
Economically feasible production capacity	Normally high (500 – 2000 Kgs/hr)	Normally low (100 – 250 Kgs/hr
Approximate cost of briquetting machine (with pulveriser and flash drier in India)	15,50,000INR (for an average capacity of 1200kgs/hr)	6,05,000 INR (for an average capacity of 200 Kgs/hr)

4.5.3.2*With Binding material techniques for briquette making*

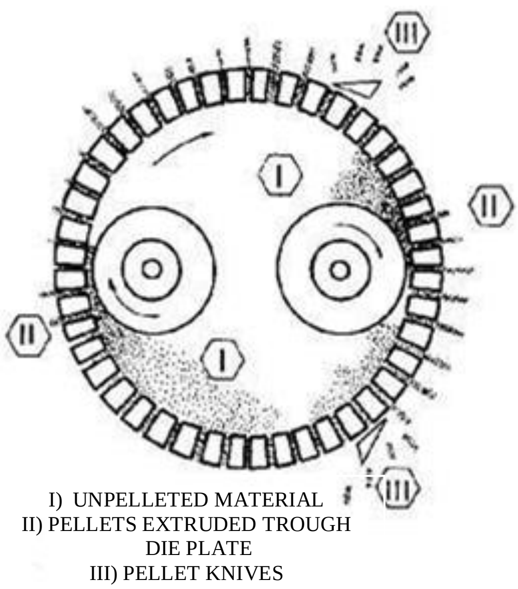

Fig. 4.7 Working process of dies

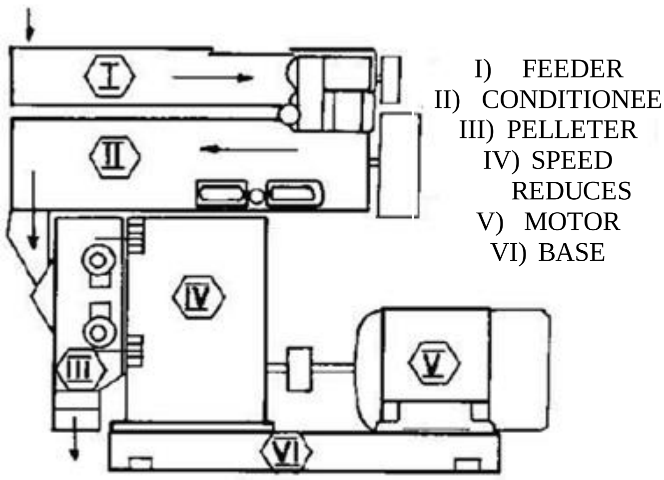

Fig. 4.8 Pellet mill components

Fig. 4.9 Bagasse in form of Pellet

Pelletizing is similar to briquetting except that it uses smaller dies (~ 30 mm) to produce smaller densified products called pellets.

Table: 4.4 Pellets properties

Size	6 to 12 mm Diameter with variable length of 10mm to 50mm
Ash contains	Max 8%
Moisture contains	Max 6%
Density	1150-1400 Kg/m^3
Bulk density	600-650 Kg/m stereo
Calorific value	4400+200 Kcal/Kg
Sulfur & phosphorus contains	Almost nil

There are two main types of pellet presses: ring die and flat die. In general the die remains stationary and the rollers rotate. However, some pellet mills have dies that rotate and rollers that remain stationary during production. The die of a pelletizer is made of hardened steel that is perforated allowing the biomass to be forced through by the rotating die or rollers. The various pellet mill components are shown in Fig. 4.7. Fig. 4.8 shows the dimensions of a commercial pellet mill die and Fig. 4.9 shows pellet make from bagasse. In principle, the incoming feed from the feeder is delivered uniformly to the conditioner for the controlled addition of steam or binders such as molasses to improve the pelletization process. Unlike piston or screw presses, commercial pelletizers are not restricted by the density of the raw material having capacities in the range of 200 kg/h to 8000 kg/h and power consumption in the range of 15-40 kWh/ton[21][22].

Table 4.5 Comparison of different densification equipments [22]

	Screw press	**Piston Press**	**Roller press**	**Pellet mill**
Optimum moisture content of the raw material	8–9%	10–15%	10–15%	10–15%
Particle size	Smaller	Larger	Larger	Smaller
Wear of contact parts	High	Low	High	High
Output from machine	Continuous	In strokes	Continuous	Continuous
Specific energy consumption (kWh/ton)	36.8–150	37.4–77	29.91–83.1	16.4–74.5
Through puts (ton/hr)	0.5	2.5	5–10	5

Density of briquette	1–1.4 g/cm^3	1.2 g/cm^3	0.6–0.7 g/cm^3	0.7–0.8 g/ cm^3
Maintenance	Low	High	Low	Low
Combustion performance of Briquettes	Very good	Moderate	Moderate	Very good
Carbonization of charcoal	Makes good charcoal	Not possible	Not possible	Not possible
Suitability in gasifiers	Suitable	Suitable	Suitable	Suitable
Suitability for co-firing	Suitable	Suitable	Suitable	Suitable
Suitability for biochemical Conversion	Not-Suitable	Suitable	Suitable	Suitable
Homogeneity of densified Biomass	Homogenous	Not homogenous	Not homogenous	Not homogenous

4.5.6 Performance comparison of bagasse briquette and different coals

Table: 4.8Different Fuels Calorific value

GCV of different feed stock	
Types of coal	**CV Kcal/Kg**
Indian coal	4000
Indonesian coal	5000
South African coal	6000
Anthracite coal	6200
Bituminous coal	4600
Lignite coal	3800
Bagasse	4000
Bagasse based Briquette sample	4086
Grade of coal	
A	6200
B	5500-6200
C	4900-5500
D	4200-4900
E	3300-4200
F	2400-3300
G	1300-2400

4.5.6.1 Proximate analysis

Table: 4.9 Proximate analyses

Element	Indian coal	Indonesian coal	South African	Bagasse	Bagasse based Briquette sample
FC	36.22	48.14	56.12	20.6	21.04
VM	20.04	28.37	22.78	31.4	69.84
M	4.60	9.49	5.87	45	5.42
Ash	39.14	14.00	15.23	4.0	2.88

4.5.6.2 Ultimate analysis

Table: 4.10 Ultimate analyses

Element	Indian coal	Indonesian coal	Bagasse(IIT)	Bagasse based Briquette sample
M	5.98	9.43	45	5.42
Ash	38.63	13.99	4.0	2.88
C	41.11	58.96	47.00	21.04
H	2.76	4.16	6.5	3.98
N	1.22	1.02	0.19	1.84
S	0.41	0.56	0.02	131ppm
O	9.89	11.88	42.54	37.78
Bulk density			74Kg/m^3	1110Kg/m^3

For performance evolution of biomass take some biomass element. Take example of boiler as a reference for performance comparison of different biomass from reference book.

EXAMPLE: - **Table: 4.11 Reference Data of coal fired Boiler [19]**

Type of boiler	Coal fired
Steam generation rate	28938.6 kg/hr
Steam pressure	58 kg/cm^2
Steam temp.	323˚c
Coal firing rate	6000 kg/hr
GCV of Coal	3600 Kcal/kg
Total surface area	80 m^2
Surface temp.	210˚ c
Wind velocity	3.9 m/s
Ambient temp.	32˚c
Humidity factor	0.021 kg/kg of dry air(R.F. chart psychrometry)

Feed water analysis

Feed water temp.	230˚c
TDS	200 ppm
PH	7.1

Ash Analysis

GCV of bottom ash.	700 Kcal/kg
GCV of Fly ash	200 Kcal/kg
Bottom ash to fly ash ratio	90 : 10

Ultimate Analysis of Fuel

C	H_2	N_2	O_2	Ash	Moisture	Sulphur
40%	3.1%	1.1%	14.4%	9.1%	30.9%	1.4%

(Re*f. Example:3.3 of energy conservation vol.2, Energy audit & Energy Management*)

By fixing other variable constant, just vary type of fuel to be used for producing steam in boiler. From Table: 1.4 we take some biomass as a fuel for producing steam from boiler.

Table: 4.12 Boiler Efficiency by burning of different biomass Fuel[25]

SR NO.	Type of Fuel	GCV of fuel(Kcal/kg)	Boiler Efficiency (η_{boiler} in %)
1	Coal	3600	74.60
2	Indian Coal	4000	79.06
3	Indonesian	5000	80.92
3	South African	6000	83.24
4	Anthracite coal	6200	83.61
5	Bituminous coal	4600	81.12
6	Lignite coal	3800	78.23
7	Bagasse	4000	71.91
8	Bagasse based Briquette sample	4086	80.65

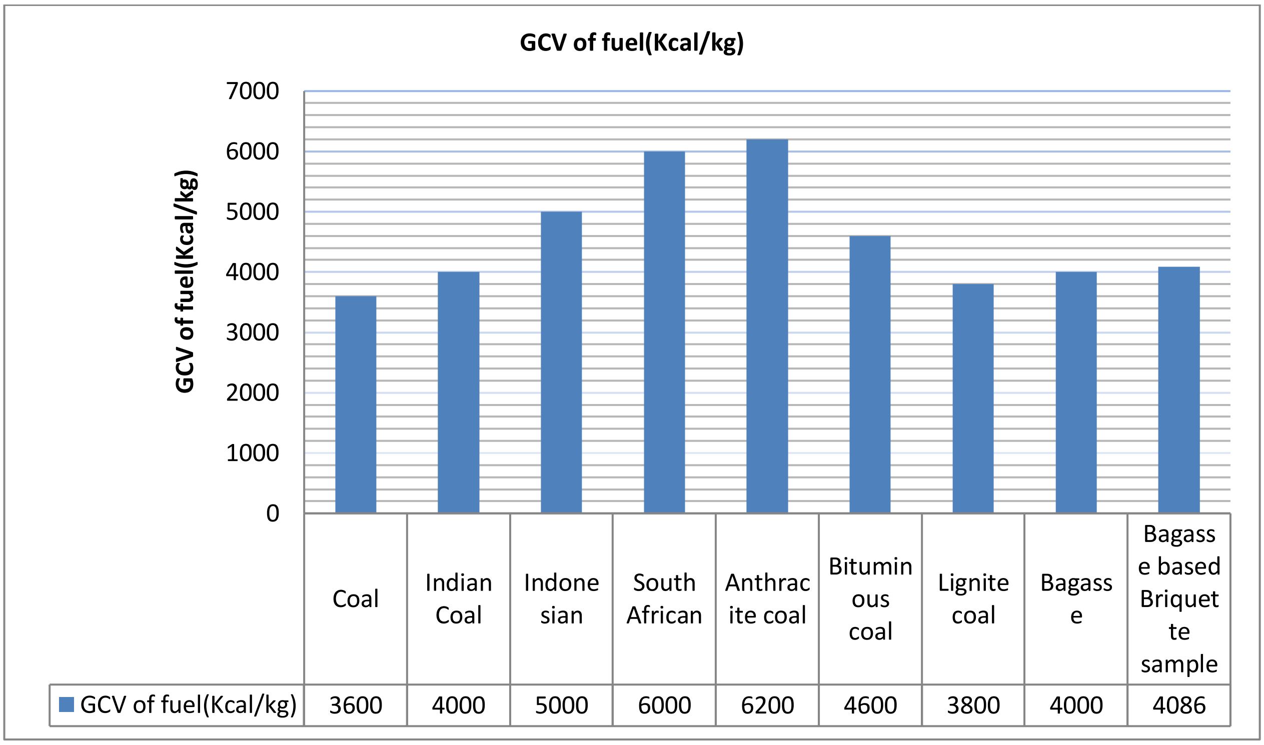

Fig. 4.11 Gross calorific value of fuels chart

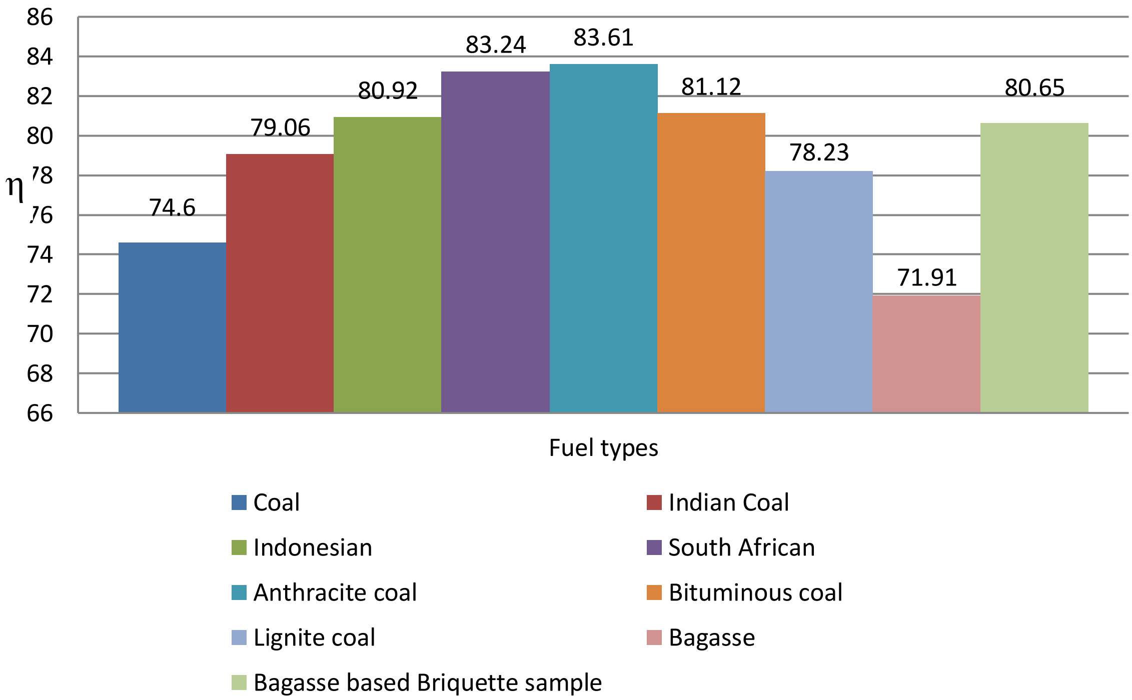

Fig. 4.12 Efficiency chart& Comparison of an Indian coal and bagasse based briquette

4.6 Co-firing method of generation of Heat:

Co-firing is combustion of two different types of materials at the same time. One of the advantages of co-firing is that

- An existing plant can be used to burn a new fuel, which may be cheaper or more environmentally friendly. For example, biomass is sometimes co-fired in existing coal plants instead of new biomass plants.

- Co-firing can also be used to improve the combustion of fuels with low energy content. For example, landfill gas contains a large amount of carbon dioxide, which is non-combustible. If the landfill gas is burned without removing the carbon dioxide, the equipment may not perform properly or emissions of pollutants may increase.
- Co-firing it with natural gas increase the heat content of the fuel and improves combustion and equipment performance. As long as the electricity or heat produced with the biomass and landfill gas was otherwise going to be produced with non-renewable fuels, the benefits are essentially equivalent whether they are co-fired or combusted alone.
- Co-firing can be used to lower the emission of some pollutants. For example, co-firing biomass with coal results in less sulphur emissions than burning coal by itself.

Two distinct techniques are available to co-fire bio-fuels in utility boilers:

5. CONCLUSION

In the present energy scenario, Bagasse different energy forms have been described for replacing fossil fuels. Bagasse as a biomass can be a nonconventional fuel by converting bagasse into different form by different techniques. Bagasse in solid Briquette form can be replace coal in thermal system for producing heat and briquette can also be used in co-firing system, which result in reduction of fossil fuel consumption. Bagasse in liquid form as a Bio-ethanol can replace petroleum products. Bagasse in a gasses form like H_2 and CH_4 gas production can reduce consumption of some of the Nature gas products. Bagasse gasification offers one of the most promising renewable energy systems for developing countries. A more extensive and attractive system could be a downdraft gasifier capable of generating sufficiently low tar content syngas for engine applications. Downdraft gasifier can ensure effective use of biomass and reduce emission in agro industries. The standardization of design and operating parameters of gasifiers, fuel processing and gas cleaning systems needs to be taken up to popularize small scale gasification systems for decentralized thermal and power applications. Result obtain from developed gasifier for bagasse and wooden chip feed stock are H_2 content 34.44 % is higher in bagasse than wooden chip as a feed stock. Calorific value of gas produced from bagasse is higher as 1.9% than wooden chip as a feed stock. But other very valuable gas composition CH_4 generated 50% less than wooden chip. Bagasse gasification gives some environmental benefit in form of production of harmful gases like CO_2 and CO less as 36.84% and 22.65% respective than wooden chip as a feed stock. Use of bagasse as energy source offers many economical, social and environmental benefits such as financial saving, conservation of fossil fuel resources, job opportunities creation and CO_2 and NO_x emissions reduction. It is providing sustainable development to the nation.

6. ACKNOWLEDGEMENT

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