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Design, Fabrication of Solar Operated Biomass Pelletizing Machine and Study of Biomass Pellet Samples

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Abstract - *The pelletizing machine is mainly found in production industries, railway/coal corporations and steel industries. The design & Optimization of pelletizing machine which will operate on solar energy for the production of pellets from a mixture of Biomass. The process of producing pellets for the purpose of strength measurements of powder agglomerates/pellets for good handling of waste materials for usage. The machine consist a mixer. As this machine will operate on solar energy the cost will be reduced and further the optimization of biomass pellets mixture will be studied. The project is of benefit and as a teaching aid. Consequently, from this benefit, the machine is recommended to manufacturers for usage.*

Key Words: **Biomass pellet machine, Biomass pellets, Design of machine, Fabrication of machine, Proximate analysis, Renewable energy, Global warming, Biomass fuel.**

1. INTRODUCTION

"Energy is everything" as said by James Maxwell. Energy is necessary for daily survival. Future development crucially depends on its long-term availability in increasing quantities from sources that are dependable, safe, and environmentally sound. At present, no single source or mix of sources is at hand to meet this future need. Concern about a dependable future for energy is only natural since energy provides 'essential services' for human life, heat for cooking, and manufacturing, or power for transport and mechanical work. At present, the energy to provide these services comes from fuels - oil, gas, coal, nuclear, wood, and other primary sources (solar, wind, or water power) that are all useless until they are converted into the energy services needed, by machines or other kinds of end-use equipment, such as stoves, turbines, or motors. In many countries worldwide, a lot of primary energy is wasted because of the inefficient design or running of the equipment used to convert it into the services required though there is an encouraging growth in awareness of energy conservation and efficiency.

Today's primary sources of energy are mainly non-renewable: natural gas, oil, coal, peat, and conventional nuclear power. There are also renewable sources, including wood, plants, dung, falling water, geothermal sources, solar, tidal, wind, and wave energy, as well as human and animal muscle-power. Nuclear reactors that produce their own fuel (breeders) and eventually fusion reactors are also in this category. In theory, all the various energy sources can contribute to the future energy mix worldwide, but each has its own economic, health, and environmental costs, benefits, and risks factors that interact strongly with other governmental and global priorities. Choices must be made, but in the certain knowledge that choosing an energy strategy inevitably means choosing an environmental strategy.

Considering that the major component of greenhouse gases (GHGs) is carbon dioxide, there is a global concern about reducing carbon emissions. In this regard, different policies could be applied to reduce carbon emissions, such as enhancing renewable energy deployment and encouraging technological innovations. In addition, supporting mechanisms, such as feed-in tariffs, renewable portfolio standards and tax policies, are employed by governments to develop renewable energy generation along with implementing energy use efficiency for saving energy. Many countries have started to install facilities that use renewable energy sources for power generation. The importance of alternative energy sources comes together with climate change challenges associated with the excessive use of fossil fuels. There are three primary motivators that stimulate the growth of renewable energy technologies: energy security, economic impacts and carbon dioxide emission reduction. The term "alternative energy" refers to any form of energy other than the conventional sources of energy, including hydropower. In recent years the focus has been on renewable energy sources.

1.1 CURRENT NON-RENEWABLE ENERGY SCENARIO

Coal is a combustible black or brownish-black sedimentary rock with a high amount of carbon and hydrocarbons. Coal is classified as a nonrenewable energy source because it takes millions of years to form. Coal contains the energy stored by plants that lived hundreds of millions of years ago in swampy forests. **[63]**

The plants were covered by layers of dirt and rock over millions of years. The resulting pressure and heat

turned the plants into the substance we call coal. Coal was the source of about 30% of the electricity generated in United States in 2016. Power plants make steam by burning coal, and the steam turns turbines to generate electricity.

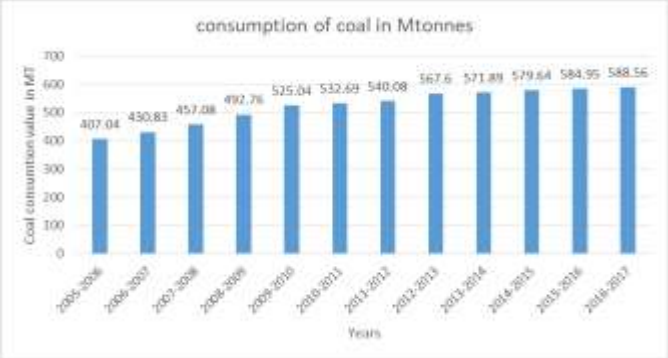

Chart 1 - Duration in year's vs coal consumption **[53]**

1.2 RENEWABLE ENERGY SOURCES AS A SUBSTITUTE [11]

Taking into account of the current energy scenario, where energy demand is second to none the need for switching over to alternative (Renewable) sources of energy has become mandatory for the industries to sustain.

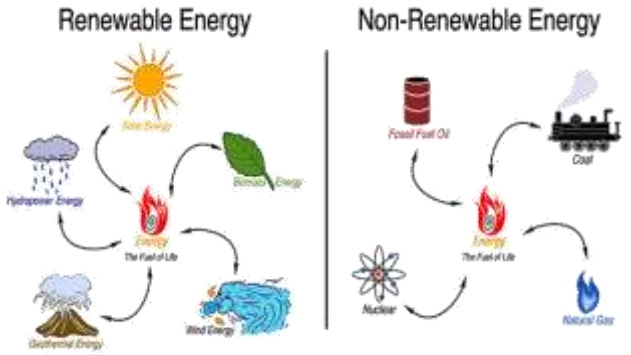

Fig 1- Renewable & non renewable energy sources

Renewable energy uses energy sources that are continually replenished by nature—the sun, the wind, water, the Earth's heat, and plants. Renewable energy technologies turn these fuels into usable forms of energy most often electricity, but also heat, chemicals, or mechanical power. Today we primarily use fossil fuels to heat and power our homes and fuel our cars .It's convenient to use coal, oil, and natural gas for meeting our energy needs, but we have a limited supply of these fuels on the Earth. We're using them much more rapidly than they are being created. Eventually, they will run out. And because of safety concerns and waste disposal problems, the United States will retire much of its nuclear capacity by 2020. In the meantime, the nation's energy needs are expected to grow by 33 percent during the next 20 years. Renewable energy can help fill the gap. Even if we had an unlimited supply of fossil fuels, using renewable energy is better for the environment. We often call renew-able energy technologies "clean" or "green" because they produce few if any pollutants. Burning fossil fuels, however, sends greenhouse gases into the atmosphere, trapping the sun's heat and contributing to global warming. Climate scientists generally agree that the earth's average temperature has risen in the past century. If this trend continues, sea levels will rise, and scientists predict that floods, heat waves, droughts, and other extreme weather conditions could occur more often. Other pollutants are released into the air, soil, and water when fossil fuels are burned .These pollutants take a dramatic toll on the environment and on humans. Air pollution contributes to diseases like asthma. Acid rain from sulfur dioxide and nitrogen oxides harms plants and fish. Nitrogen oxides also contribute to smog. Renewable energy is plentiful, and the technologies are improving all the time. There are many ways to use renewable energy. Most of us already use renewable energy in our daily lives. **[1]**

1.3 BIOMASS – THE RENEWABLE FUEL AND PELLETIZATION MACHINE

Biomass has always been an important energy source for the country considering the benefits and promises it offers. It is a carbon neutral fuel source for the generation of electricity; and apart from providing the much needed relief from power shortages, biomass power projects could generate employment in rural areas.

As many research are going on solar energy, hydro energy, and wind energy in India and worldwide but one important sector in which the focus must be given is nothing but biomass sector and technology related to it, hence biomass palletization is the technology which I have studied.

Pelletizing machine is specialized equipment. It is used for pelletizing of powder materials into pellets. It is original and peculiar with large scale disc-pellet machine and designed on the basis of the large scale disc pellet machine that is used in industries like iron and steel industry, chemical industry, pharmaceutical industry, cement industry, ceramics industry, railway corporations seen in metallurgical workshops and related industries. This machine adapts to pelletizing many kinds of powder material provided it is mixed with a particular solvent. Also the palletizing machine must be useful to rural area so the import of the machine will be decrease and the economy of nation also can be increase. **[20]**

Pelletizing machines are of different kinds and forms ranging from its sizes, shapes, method of operation (manual or automatic), capacity, function, etc. **[60]**

1.3.1 TYPES OF PELLETIZING MACHINE

- Pelletizing machine (Balling disc): Balling disc machine is mainly used for production of balls and agglomerates pellets.Disc balling machine is suitable for mixing material pelletizing equipment with nutrient. **[24]**It has the following advantages:

  i. High balling rate

  ii. Big roundness intensity of particles

  iii. Visual operation and easy for maintenance

- Floating feed pellet machine: This type of pelletizing machine is used for production of feed for animals. The floating fish feed making machine is used to make the pellet from the grain, the soybean, the cereal, or other materials. The pellet floats on the water at least about 12 hours.

- Wood pellets machine: This type of palletizing machine is used for making pellets of wood, plastics etc. Wood pellet fuel, as an alternative for fossil fuels, has a more competitive and stable pricing than does kerosene and natural gas in many countries. Supported by the green tax policy, wood pellet fuel is encouraged to be used as a countermeasure against global warming, energy security and rise of oil prices.

- Biomass pellet machine: biomass pellet fuel, has competitive and stable pricing, is clean burning and produces little pollution. The moisture content can be easily controlled during the production process. The raw material sources are very wide, such as wood waste (residual sawdust, wood shavings, wood peelings, etc.), yard debris (grass, leaves, tree sticks, forsythia, wisteria, woody bushes, etc.), farm waste (corn cobs, corn stalks, straw from plants, etc.) and other residues biomass waste. We can recycle energy from the above materials. **[24]**

Fig -2: Balling disc pelletizing Machine [54]

Fig -3: Wood pelletizing machine [55]

Fig -4: Floating feed pelletizing Machine [56]

Fig-5: Biomass elletizing machine [57]

2. LITERATURE REVIEW

Ayue ozyuuran et al. **[2]** studied different biomass material and calculated the colorific value of every material, as calorific value is the key factor for biomass fuel, also they characterize the different biomass material by proximate analysis.

Tawanda Mushiri et al. **[3]** fabricated biomass palletization machine, the main aim of developing machine is nothing but to produce 900 kg of pellet per hr. Generally in the boiler wood chips are used for the combustion some time there is shortage of wood chips and therefore plant gets breakdown for many hours. To overcome this issue there must be supply of some extra fuel, and the author have chosen biomass pellet as fuel and he designed and fabricated this machine who can produce 900kg/hr. of pellets.

Bobde, Saurabh A et al. **[4]** studied, today in the world fuel prices rises day by and the pollution may also. To control this pollution and to save the petroleum product and bio product this project is design and developed. This system requires heavy initial investment but it gives the energy output for life time with low maintenance etc.

Nilesh R.Pathare1 et al. **[5]** fabricated machine where the pellets can be produce and this biomass pellet will be useful for boilers and stove for burning, he also clarified that the pellets are mostly ask by people rather logs as it pellet burns quickly as compared to logs.

Maria Puig Arnavat et al. **[6]** finds two important factors in palletization one die temperature and other friction over the entire study they found that friction decreases with increasing die temperature.

R.Cengiz et al. **[8]** made one pelletizing test device where researchers have scope to study the die temperature "force-displacement curve", "force-time curve" and "strain curve", "density increase ratio" and ''durability'' of densified biomass can be introduced, according to him it will be easy for the research scholar to correlate above factors with good densified biomass pellet.

O.A. Olugboji et al. **[9]** designed and fabricated poultry feed pellet machine with locally available material,

the machine is electrically operated with two Hp electric motor the capacity of machine also tested with 5 kg /hr. of speed.

After doing this research the main aim of Theresa K et al. **[20]** was to discourage the importation of similar manually operated fish feed pelletizing machine from other country and it is recommended for rural and urban fish producer .As it is portable it can be use anywhere and also it easily operated manually.

Harmandeep Singh et al. **[21]** done the characterization of different biomass sample like white husk, rice husk and more .The study of characterization done on proximate and ultimate analysis basis, where he created three model i.e.mode1 (on ash basis) model 2 (on fixed carbon \basis) and model 3 (on ultimate analysis basis), with these three model he calculated the heating value of fuel and he finds the differences with the experiments in these models.

Ikebudu Kingsley Okechukwu et al. **[24]** design one balling disc machine from which he can produce pellets of powder form so that the handling of pellet can be easy during transportation, he comes to the conclusion that well form pellets are in between 6-25 mm diameter.

Wolfgang et al. **[31]** examined the pelletizing pressure required with raw material type, pellet length, temperature, moisture content and particle size, he comes to the conclusion that the pellet pressure increases with pellet length and decreases with increasing temperature of raw material during palletization also it increases with decreasing particle size.

3. OBJECTIVES

1. To fabricate the solar Energy operated Biomass Pelletizing Machine.

2. To calculate the power required to run the motor.

3. To compare the electricity cost required for working of machine between non renewable And solar energy resource.

4. To analyze the biomass pellet fuel parameters.

5. Study the optimum combination of biomass pellets mixture.

4. FABRICATION OF PELLETIZING MACHINE

As we know whole world is suffering from energy crises, and many machines of industry are running on conventional electricity which is too costly in both terms machining cost and electricity bill. Hence to overcome this issue if we substitute the conventional electricity with the renewable energy it will advantageous to global warming issue as well .Hence we are designing solar operated biomass palletization machine.**[5]**

4.1 MATERIAL SELECTION

One of the basic factors that affect the choice of a project is the availability of materials, selection of materials, and the cost of the materials for the design or fabrication of the project. Following are the materials which are going to use while fabrication of material.

Table-1: Name of material

SR.NO	NAME OF MATERIAL	SR NO	NAME OF MATERIAL
1	M ANGLE	3	ROUND HOLED PLATE
2	SHAFT	4	BEARING
5	M.S PIPE	6	ALLUMUMINUM CONTAINER
7	V-BELT PULLEY	8	V BELT
9	D.C MOTOR	10	SOLAR PANNEL
11	SOLAR CHARGER	12	BATTERY
13	BOLT	14	FLAT PLATE

4.2 DESIGN OF MACHINE

Using the Pro Engineer software I have made the following design of machine which we are going to fabricate, following figures will show all the views of machine. [9]

Fig -6: Front view of machine

Fig -7: Isometric view

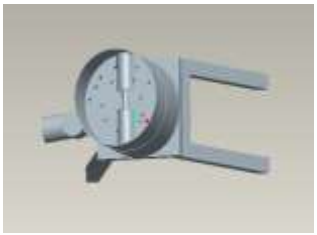

Fig -8: Top view of machine

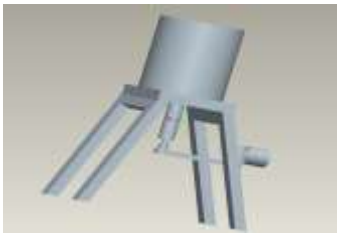

Fig -9: Inclined view of machine

4.3 ASSEMBLY AND FABRICATION PROCESS

A. Marking out -The first stage of this fabrication is the marking out of the required dimensions of the sheet metal and the angle iron together with the square iron bars.

B. Cutting process - The second stage after the required dimensions is marked out the cutting out of the required length from the main material will take place on cutter machine, lathe machine.

C. Welding Process- After the first two processes is carried out, the materials are joined together by means of the joining process called "welding". This involves the welding of the various parts of the frame together using the electric arc welding process.

D. Coupling Process -This comprises the coupling of the various parts of the machine which include the induction motor, aluminum container, roller crusher, the shaft etc.[24]

Following are the different views of solar operated biomass pelletizing machine.

Fig -10: Inclined view **Fig -11:** Front view

Fig -12: Top view

5. EXPERIMENTAL WORK

Selecting the single phase induction motor with a speed of 500 rpm, having a power of 0.25hp (187.5 watt).

5.1 TORQUE CALCULATION

Dimensions of the mild steel bar

Height (h) **= 260 mm**

Radius(r) **= 25 mm**

Density **= 7850 kg/m^3**

Selected motor speed (n) **= 34 rpm**

Acceleration due to gravity (g) **= 9.8 m/s2**

1) Volume of cylinder **= π*r2*h**
=3.14*0.0250^2
***0.260**
= 5.1025*10-4 m3

2) Mass of the blade **= Density * volume**
= 7850 * 5.1025*10-4
= 4.0054 kg

3) Weight of Blade (W) **= mg**
= 4.0054*9.81
= 39.29 N

4) Angular velocity of the Blade (ω)= 2 π n/60
=2*3.14*32 rad/sec
= 3.34 rad/sec

5) Torque (T) **= R * W**
= 130 * 39.29
= 5107.7 N-mm

6) Power(P) **= T * ω**
=107.7*3.34*10-3
= 17.05 watt

5.2 CALCULATION FOR SELECTION OF SOLAR PANEL

As the required power is 17.05 watt based on this we will select the power which gives the power more than 17.05 watt. Here are the reading selected solar panel.

Fig -13: Current reading **Fig -14:** Voltage readings

From this reading we can calculate power ratings output of solar panel,during the experiment Power rating were as follows.

$$P = 0.58*19.8$$

$$=11.484 \text{ watt}$$

But this power will not be sufficient to rotate the motor due to cloudy environment.Hence we will select the the solar pannel which have the power output more than 20 watts. We have choosen solar pannel of 50 watts.Two batteries of 12 v and 7.5 amp currernt are used to store and to transmit a power from solar panel to motor.

6. BIOMASS FUEL AND PELLETIZATION PROCESS

Biomass is renewable in nature, carbon neutral and has the potential to provide large productive employment in rural areas. It is considered as one of the promising sources for generation of power or energy using commercially available thermal and biological conversion technologies. Considering the importance of biomass power, the Government of India and various states with high biomass power potential are trying to promote biomass power through various policies, programs and financial assistance. Despite huge efforts, the biomass sector is still not able to tap the potential available optimally. The sector faces immense barriers and challenges in enhancing this vast scattered renewable energy resource. **[58]**

As the biomass waste is available everywhere in India which is free of cost like tree leaves, husk material and shell material. This material can be used for biomass pellet production which is environmental free and also rural employment will be increase with this employment problem of India can be reduced to some extent. **[4]**

Hence in my project study we have selected following biomass material.

1. Rice husk
2. Waste by product of rice in powder form
3. Wood husk
4. Waste forest leaves
5. Garlic cover leaves **[10]**

Hence the pellet of individual above mentioned biomass material is being produced conventionally. Instead of doing this method we are going to use the combination of two biomass material. **[14]**

We have tested two samples of combination as follows:

- Sample 1 – Rice husk + powder form of waste product of rice mill + Wood husk
- Sample 2-Garlic leaves + waste forest leaves + wood husk

6.1 PROCESS OF PELLETIZATION

1) Sample one and sample two are passed individually through roller of machine.**[13]**

2) The gap between roller and holed round plate is about 5 mm.

3) Hence due to compression pressure the biomass material is pressed.

4) The pressed material then converted into pellet form as it passed through the disc hole.

5) The produced pellets are then dried naturally to remove its moisture. **[36]**

Fig -15: Manufactured sample of biomass pellet

Hence to overcome this environmental problem, global warming, pollution problems etc. Biomass fuel can be stored. The problem may occur in collection for that the biomass material can be stored at district level and with the help of proper supply chain management this issue also can be resolve. **[29]**

6.2 STUDY OF BIOMASS PELLET FUEL QUALITY

After collecting samples of biomass it is passed through solar operated machine and the pellets are produced. The produced pellets has to go under analysis for studying the biomass quality and its proximate analysis. The pellet fuel quality and analysis is carried out by proximate and ultimate analysis.

1. Proximate analysis

Proximate analysis is used for calculation of chemical composition of the residue including Moisture content, Ash content, volatile matter & fixed carbon **[2].**

2. Ultimate analysis

This analysis is important for determining the elemental composition (C, N, H, S, O etc.) of the biomass fuels & is also useful for calculating their heating value. It was carried out by using CHNS analyzer. **[21]**

3. Heating value

Heating or calorific value of any fuel is the amount of the heat liberated by that under specific conditions of combustion. The heat value in a given fuel is mostly a function of the fuel's chemical composition. **[51]**

Bomb calorimeter is used to determine the calorific value of fuel by combusting a known quantity of the fuel under constant volume in bomb.

Therefore on this basis we have tested the two above mentioned biomass pellet sample. The output results of above parameters will be discussed in results and discussions.

7. RESULTS AND DISCUSSION

As the study is consisting mainly in two parts hence we will discuss the result and conclusion as follows.

- Fabrication of solar operated biomass pelletization machine.
- Analysis of Biomass pellets which produced by solar operated biomass pelletization machine.

7.1 FABRICATION OF SOLAR OPERATED BIOMASS PELLETIZATION MACHINE

By using Solar operated Biomass pelletizing machine the production cost may reduce and energy saved due to sustainable energy.

Solar operated Biomass pelletizing machine is eco-friendly operating with environment (solar energy)

The power rating of motor is **0.187 kwh**

Estimation of number of hours the motor is on per year

Considering our motor is turned on for 6 hrs. per day

No .of hrs. Per year = 365*6

= 2190 hrs.

The electricity consumption per year

= 0.187 kWh * 2190 hrs. /year

= 409.3 kwh/year.

7.2 COST CALCULATION OF ENERGY CONSUMPTION

For economic point of view it is necessary to find payback period. Payback period is nothing but time period after which we will get the returns of investment.

Table -2: Cost calculation of energy consumption

By conventional energy resources	By solar energy
Energy charges/ kwh = Rs 7.92	Solar panel cost = Rs 3000
Cost =7.92/kwh*409.3kwh/year =3241.65 Rs / year	Battery cost / year = Rs 2000 Maintenance cost = 1000 / year
Total = 3241.65 / year	Total = 6000 / year

Payback Time = Total System Cost ÷ Value of Electricity Generated ÷ Your Annual Electricity Usage [26]

= (6000 ÷ 7.92) ÷ 409.3

=1.84 years.

Hence we will get our returns of investment after 1.84 years. After that only maintenance charge of solar panel and machine will applicable, energy charges will be totally free as we are using natural energy resource which is freely available.

The idea of this machine came into mind by visiting bakery in my area which is located in rural area, Thane (India), this bakery was using coal and wood for combustion, the disadvantages of coal and wood combustion is explained above. Hence we can recommend the bakery management to use biomass pellets which is environmental free.

Based on machine manufacturing following are some areas where pelletization industry need to be concentrated.

1. The investment of machine will be one time investment so we suggest industry to buy this machine for life time, hence the dependency of purchasing high cost machine can be reduced.

2. Recently in the market all the machines which are running on non-renewable energy resources as we are using solar energy which is renewable energy and free of cost hence the energy bill of industry for pelletization will be completely zero.

7.3 ANALYSIS OF BIOMASS PELLETS WHICH PRODUCED BY SOLAR OPERATED BIOMASS PELLETIZATION MACHINE

As we know the fuel charges are increasing now at least in India hence biomass is best option to reduce global warming. In recent industry many biomass solid fuel are available but the problem regarding that is low heating value, to overcome this issue we have done some experiment by making combination of fuel as follows.

The two biomass sample 1 and sample 2 is tested in Bombay test house pvt ltd , vashi

- Pellet Sample 1 –Rice husk + powder form of waste product of rice mill + Wood husk
- Pellet Sample 2-Garlic leaves + waste forest leaves + wood husk

Generally the pellets and briquettes are made only of individual biomass material. Here we are adding different biomass material, with this addition the heating value of biomass fuel will definitely increase.

7.3.1 Proximate analysis of first biomass sample


ACCREDITED ISO 17025 NABL

BOMBAY TEST HOUSE PVT LTD

TEST REPORT

Date : 22 May 2018

Mr. Vipul Shardul
201/ H Wing, Ravindra Regency
Balyani Road
Tilwala (E) Maharashtra
E.mail: vashardul@gmail.com

Sample Name: Biomass
Batch No: 1
Description: Solid
Qty: 100 gm
Packing Details: Plastic Pack

Sample submitted by : Party
Received by us On : 19 May 2018
Analysis Started On : 19 May 2018
Completed On : 22 May 2018

Sr.No	Parameter	Test Method	Unit	Results
	Chemical & Physical			
1	Gross Calorific Value	By Bomb Calorimeter	Kcal/kg	5721.8
2	Moisture	IS: 13550(P-1):1994	%	8.69
3	Total Ash	IS: 13550(P-1):1994	%	9.01
4	Volatile Matter	IS: 13550(P-1):1994	%	78.01
5	Fixed Carbon	IS: 13550(P-1):1994	%	12.39

End of the test report

Checked By: Analyst

For Bombay Test House Pvt Ltd
Authorised Signatory

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Branch Laboratories : Salem (Tamil Nadu) | Vizag (Andhra Pradesh) | Ballari (Karnataka)

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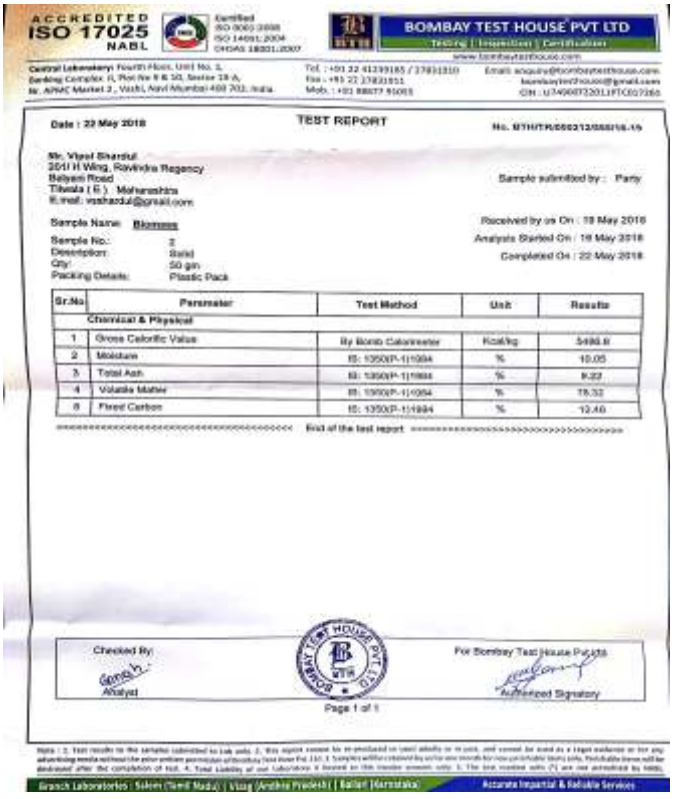
7.3.2 Proximate analysis of second biomass sample


ACCREDITED ISO 17025 NABL

BOMBAY TEST HOUSE PVT LTD

TEST REPORT

Date : 22 May 2018

Mr. Vipul Shardul
201/ H Wing, Ravindra Regency
Balyani Road
Tilwala (E) Maharashtra
E.mail: vashardul@gmail.com

Sample Name: Biomass
Sample No.: 2
Description: Solid
Qty: 50 gm
Packing Details: Plastic Pack

Sample submitted by : Party
Received by us On : 19 May 2018
Analysis Started On : 19 May 2018
Completed On : 22 May 2018

Sr.No	Parameter	Test Method	Unit	Results
	Chemical & Physical			
1	Gross Calorific Value	By Bomb Calorimeter	Kcal/kg	5486.8
2	Moisture	IS: 13550(P-1):1994	%	10.05
3	Total Ash	IS: 13550(P-1):1994	%	9.22
4	Volatile Matter	IS: 13550(P-1):1994	%	78.32
5	Fixed Carbon	IS: 13550(P-1):1994	%	12.46

End of the test report

Checked By: Analyst

For Bombay Test House Pvt Ltd
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After observing results of these two samples following are some important factors.

1. Calorific value

Biomass is one of the renewable and sustainable energy sources that does not lead greenhouse gas emissions. Efficient use of biomass energy will help to solve problems resulting from fossil fuels. However, the main concern relevant to use of this energy is mainly related to low calorific value of biomass. Therefore, calorific value is the key parameter to evaluate the fuel quality of a special biomass material in energetic applications. In this context, two biomass species that represent very wide range of biomass materials such as husks, and agricultural residues have been characterized by proximate analysis (moisture, volatile matter, fixed carbon, and ash contents). Then, various empirical equations which contain linear and nonlinear terms have been tested in order to predict the higher heating values (HHV) of full sample set from the proximate analysis results.

a. Heating or calorific value of any fuel is the amount of the heat liberated by that under specific conditions of combust.

b. The calorific value of sample 1 is 5721.8 kcal/kg and the calorific value of sample 2 is 5486.8.

c. Hence we will prefer sample 1 for the use of sample 1 pellet in industry as the heating value of sample 1 is greater.

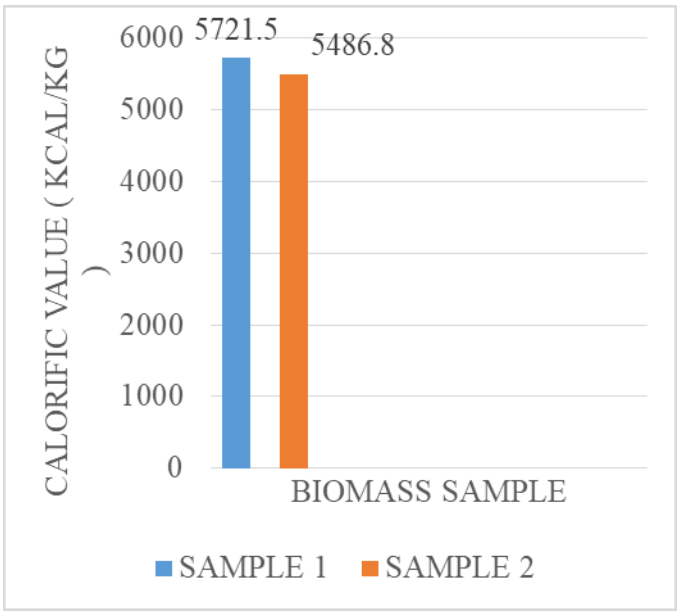

Chart -2 Gross Calorific Value Vs combined biomass sample

The other results like ash content, moisture content, fixed carbon and volatile matter also can be correlated.

With this result from the lab we have fulfilled all the parameter except ash content, therefore the sample 1 is considered as a best biomass fuel between two biomass fuel samples.

Therefore we can recommend the palletization industry to go for below combination of fuel.

➢ **Rice husk + powder form of waste product of rice mill + Wood husk**

8. CONLCUSIONS

As we have fabricated solar operated biomass palletization machine hence the energy will be saved as we are using renewable energy resources. The dependency or importation of machine will be discouraged as we have manufactured a simple machine. With this study we have created guidance base knowledge in solar and biomass fuel area. After the whole fabrication of machine we are able to develop a recommendations for the equipment designing, implementation and sizing. As we are facing climate change problem and also fuel crises problem therefore the use of renewable energy resources is mandatory and it's a need for future. Therefore we are using solar energy which is freely available.

In the second part of the project we have done the analysis of the biomass pellets .In this we are again using renewable energy resources. The use of biomass sample will definitely reduce the dependency of conventional fuel. We have used the combination of different biomass sample. In the recent pellet production only rice husk and wood husk are been used differently i.e. the pellet is produced individually. Hence sometime we can get the shortage of rice husk or wood husk to overcome this issue we have used the combination of biomass like.

➢ Pellet Sample 1- Rice husk + powder form of waste product of rice mill + Wood husk

➢ Pellet Sample 2 - Garlic leaves + waste forest leaves + wood husk.

Among these two samples sample 1 will be preferable as it is having comparatively greater calorific value. The main benefit of using the combination is that we are getting the calorific value more compared to individual produced biomass pellet by rice husk or wood husk. **[22]**

Following chart will show the calorific value of individual biomass fuel and combination of samples which we have tested.

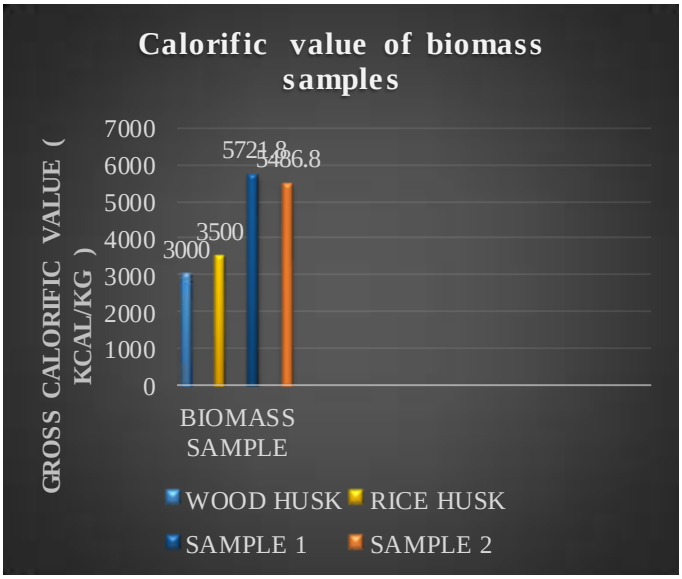

Chart -3 Gross Calorific Value Vs biomass sample

The heating value of our sample 1 and 2 are closed to the conventional fuel like coal **[61]**. As the coal produces pollution which is harmful to the environment therefore biomass is the alternative for coal.

8.1 FUTURE SCOPE

With this produced pellet we can work on the force required to produce pellet hence the force displacement curve can be drawn **[8]**

- Also the temperature of the die, durability of pellet, density increase ratio during palletization can be study.
- For the R&D in biomass field work we can make a sample of different biomass sample and calorific value can be calculated.
- There is scope for the biomass collection management related study, at rural level all taluka level. [44]
- For palletization rpm of motor must be high so this can be achieve by giving solar power of many watts.
- With advance machining technique we can fabricate the machine so that the machine can get the attractive look.

REFERENCES

[1] Rohan Patil et al. "Paper on Design, Development and Fabrication of Solar Operated Lawn Cutting Machine" International Research Journal of Engineering and Technology (IRJET) 2018

[2] Özyuğuran, Ayşe, and Serdar Yaman. "Prediction of Calorific Value of Biomass from Proximate Analysis." Energy Procedia107 (2017): 130-136

[3] Mushiri, Tawanda, Peterson Mugodo, and Charles Mbohwa. "Design of a sawdust pelleting machine." (2017).

[4] Bobde, Saurabh A., et al. "A Review on Solar Operated Agri-Cutter." International Journal for Innovative Research in Science and Technology 3.09 (2017).

[5] Pathare, Nilesh R., and C. K. Tembhurkar. "Fabrication of Pellet Making Machine."(2016)

[6] Puig-Arnavat, Maria, et al. "From a single pellet press to a bench scale pellet mill—Pelletizing six different biomass feedstocks." Fuel Processing Technology 142 (2016): 27-33.

[7] Taylor, Josh A., Sairaj V. Dhople, and Duncan S. Callaway. "Power systems without fuel." Renewable and Sustainable Energy Reviews 57 (2016): 1322-1336.

[8] Akdeniz, R. Cengiz, and Sina Haghighat Shishvan. "The requirement for new biomass pelletizing test device." Agricultural Engineering 19.2 (154) (2015): 25-34.

[9] Olugboji, O. A., et al. "Design, Construction and Testing of a Poultry Feed Pellet Machine."(2015)

[10] Niedziółka, Ignacy, et al. "Assessment of the energetic and mechanical properties of pellets produced from agricultural biomass." Renewable Energy 76 (2015): 312-317.

[11] Alam, Mehebub, et al. "Renewable energy sources (res): an overview with Indian context." International Journal Of Engineering And Computer Science 3.10 (2014)

[12] Segerström, Markus, and Sylvia H. Larsson. "Clarifying sub-processes in continuous ring die pelletizing through die temperature control." Fuel Processing Technology 123 (2014): 122-126.

[13] Zafari, A., and M. H. Kianmehr. "Factors affecting mechanical properties of biomass pellet from compost." Environmental technology 35.4 (2014): 478-486.

[14] Nunes, L. J. R., J. C. O. Matias, and J. P. S. Catalão. "Mixed biomass pellets for thermal energy production: A review of combustion models." Applied Energy 127 (2014): 135-140

[15] Nunes, L. J. R., J. C. O. Matias, and J. P. S. Catalão. "A review on torrefied biomass pellets as a sustainable

alternative to coal in power generation." Renewable and Sustainable Energy Reviews 40 (2014): 153-160.

[16] Kambo, Harpreet Singh, and Animesh Dutta. "Strength, storage, and combustion characteristics of densified lignocellulosic biomass produced via torrefaction and hydrothermal carbonization." Applied Energy 135 (2014): 182-191

[17] Yue, Dajun, Fengqi You, and Seth W. Snyder. "Biomass-to-bioenergy and biofuel supply chain optimization: overview, key issues and challenges." Computers & Chemical Engineering66 (2014): 36-56

[18] Agbor, Ezinwa, Xiaolei Zhang, and Amit Kumar. "A review of biomass co-firing in North America." Renewable and Sustainable Energy Reviews 40 (2014): 930-943.

[19] Ashrafee, Farin, Sayidul Morsalin, and Asif Rezwan. "Design and fabrication of a solar powered toy car." Electrical Engineering and Information & Communication Technology (ICEEICT), 2014 International Conference on. IEEE, 2014.

[20] Kaankuka, Theresa K., and David T. Osu. "Development of A Revolving Die and Roller Fish Feed Pelletizer." International Journal of Engineering Innovations and Research 2.1 (2013): 105..

[21] Singh, Harmandeep, Pawan Kumar Sapra, and Balwinder Singh Sidhu. "Evaluation and Characterization of Different Biomass Residues through Proximate & Ultimate Analysis and Heating Value." Asian Journal of Engineering and Applied Technology 2.2 (2013): 6-10.

[22] Sharma, Bhavna, et al. "Biomass supply chain design and analysis: basis, overview, modeling, challenges, and future." Renewable and Sustainable Energy Reviews 24 (2013): 608-627.

[23] Yılmaz, Sebnem, and Hasan Selim. "A review on the methods for biomass to energy conversion systems design." Renewable and Sustainable Energy Reviews 25 (2013): 420-430.

[24] Okechukwu, Ikebudu Kingsley. "Mechanized Balling Disc Machine (Pelletizer) for Industrial Development in Nigeria." Proceedings of the World Congress on Engineering and Computer Science. Vol. 2. 2012

[25] Zafari, Abedin, and Mohammad Hosein Kianmehr. "Effect of temperature, pressure and moisture content on durability of cattle manure pellet in open-end die method." Journal of Agricultural Science 4.5 (2012): 203.

[26] Williams, A., et al. "Pollutants from the combustion of solid biomass fuels." Progress in Energy and Combustion Science38.2 (2012): 113-137

[27] Lim, Jeng Shiun, et al. "A review on utilisation of biomass from rice industry as a source of renewable energy." Renewable and Sustainable Energy Reviews 16.5 (2012): 3084-3094

[28] Carroll, John P., and John Finnan. "Physical and chemical properties of pellets from energy crops and cereal straws." Biosystems Engineering 112.2 (2012): 151-159.

[29] Karkania, V., E. Fanara, and A. Zabaniotou. "Review of sustainable biomass pellets production–A study for agricultural residues pellets' market in Greece." Renewable and Sustainable Energy Reviews 16.3 (2012): 1426-1436.

[30] Saidur, Rahman, et al. "A review on biomass as a fuel for boilers." Renewable and sustainable energy reviews 15.5 (2011): 2262-2289.

[31] Stelte, Wolfgang, et al. "Fuel pellets from biomass: The importance of the pelletizing pressure and its dependency on the processing conditions." Fuel 90.11 (2011): 3285-3290.

[32] Nilsson, Daniel, Sven Bernesson, and Per-Anders Hansson. "Pellet production from agricultural raw materials–A systems study." Biomass and Bioenergy 35.1 (2011): 679-689.

[33] Panwar, Varun, B. Prasad, and Kailas L. Wasewar. "Biomass residue briquetting and characterization." Journal of Energy Engineering 137.2 (2010): 108-114

[34] Sultana, Arifa, Amit Kumar, and Don Harfield. "Development of agri-pellet production cost and optimum size." Bioresource Technology 101.14 (2010): 5609-5621.

[35] Shuit, Siew Hoong, et al. "Oil palm biomass as a sustainable energy source: A Malaysian case study." Energy 34.9 (2009): 1225-1235.

[36] Samuelsson, Robert, et al. "Effect of biomaterial characteristics on pelletizing properties and biofuel pellet quality." Fuel Processing Technology 90.9 (2009): 1129-1134.

[37] Kaliyan, N., et al. "Roll press briquetting and pelleting of corn stover and switchgrass." Transactions of the ASABE 52.2 (2009): 543-555.

[38] Chen, Longjian, Li Xing, and Lujia Han. "Renewable energy from agro-residues in China: Solid biofuels and

biomass briquetting technology." Renewable and Sustainable Energy Reviews 13.9 (2009): 2689-2695

[39] Hepbasli, Arif. "A key review on exergetic analysis and assessment of renewable energy resources for a sustainable future." Renewable and sustainable energy reviews 12.3 (2008): 593-661.

[40] Arshadi, Mehrdad, et al. "The influence of raw material characteristics on the industrial pelletizing process and pellet quality." Fuel Processing Technology 89.12 (2008): 1442-1447.

[41] Bergström, Dan, et al. "Effects of raw material particle size distribution on the characteristics of Scots pine sawdust fuel pellets." Fuel Processing Technology 89.12 (2008): 1324-1329.

[42] Niedziółka, Ignacy, et al. "Characteristics of pellets produced from selected plant mixes." TEKA Kom. Mot. Energ. Roln.–OL PAN 8 (2008): 157-162.

[43] Mani, Sudhagar, Lope G. Tabil, and Shahab Sokhansanj. "Effects of compressive force, particle size and moisture content on mechanical properties of biomass pellets from grasses." Biomass and bioenergy 30.7 (2006): 648-654.

[44] Mani, Sudhagar, et al. "Economics of producing fuel pellets from biomass." Applied Engineering in Agriculture 22.3 (2006): 421-426.

[45] Heller, Peter, et al. "Test and evaluation of a solar powered gas turbine system." Solar Energy 80.10 (2006): 1225-1230.

[46] Rhén, Christofer, et al. "Effects of raw material moisture content, densification pressure and temperature on some properties of Norway spruce pellets." Fuel Processing Technology 87.1 (2005): 11-16.

[47] Friedl, Anton, et al. "Prediction of heating values of biomass fuel from elemental composition." Analytica Chimica Acta544.1-2 (2005): 191-198.

[48] Daud, Abdel-Karim, and Marwan M. Mahmoud. "Solar powered induction motor-driven water pump operating on a desert well, simulation and field tests." Renewable Energy30.5 (2005): 701-714.

[49] Ståhl, Magnus, et al. "Industrial processes for biomass drying and their effects on the quality properties of wood pellets." Biomass and Bioenergy 27.6 (2004): 621-628.

[50] Sokhansanj, Shahab, Janet Cushman, and Lynn Wright. "Collection and delivery of feedstock biomass for fuel and power production." (2003).

[51] www.nzdl.org/

[52] http://bisyplan.bioenarea.eu/ash_appendix.html

[53] https://beeindia.gov.in/

[54] https://hndongfang.en.made-in-china.com/product/pvaETbYXRArP/China-Good-Quality-Disc-Balling-Machine.html(balling disc machine)

[55] http://www.smallpelletmachines.com/news/small-wood-pellet-machine.html

[56] http://www.longerinc.com/longer/Product/Feed_Pellet_Machinev/312.html

[57] http://www.biomasspelletplant.com/news/how-to-test-the-pellet.html

[58] https://biomasspower.gov.in/

[59] http://www.bombaytesthouse.com/

[60] http://drtlud.com/BEF/biomass.htm

[61] http://briquette.ronakbriquetting.com/dawnloads/pdfs/RONAK%20AGROTECH%20CALORIFIC%20VALUE%20CHART.pdf

[62] https://www.irjet.net/archives/V5/i2/IRJET-V5I279.pdf

[63] https://eia.gov/kids/energy.php?page=coal_home-basics

[64] http://mahadiscom.com/tariff/Tariff-Booklet-aug-2012.pdf

[65] https://www.wholesalesolar.com/solar-information/return-on-solar-investment#simple-solar-payback