ANALYSIS OF CALORIFIC VALUE OF ANIMAL MANURE BY MAKING FUEL PELLETS OF DIFFERENT COMPOSITES

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ABSTRACT

Every year millions of tons of agricultural and animal waste are generated which are either destroyed or burnt inefficiently in loose form causing air pollution. The use of agricultural and agro-industrial waste as biomass fuel for power generation like briquettes or pellets can be an alternative solution to the problems related to their disposal & pollution. Clean and dry residue pellets are an ideal fuel for combustion in small scale installations. This project aims at finding the best substitute of wood, so that it can be eco-friendly. In this project we have tried to make pellet machine aiming to frequent generation of pellets and also tried to generate different composites of different biomass materials to make manure pellets by using biomass materials like wheat straw, dry leaves, groundnut shell, rice husk, saw dust and animal manure. After preparing pellets, we let them dry completely in sunlight. Then the analysis of the calorific value of pellets produced of different composition is done by determining their fixed carbon percentages. At last, the calorific values of prepared pellets are compared with the calorific value of wood.

Keywords: *Pellets, animal manure, calorific value, agricultural waste, biomass material, wood*

INTRODUCTION

Energy sources are the significant components of sustainable economic growth of any country. Energy is the key aspect which helps to accomplish & retain the economic and social escalation. The rapid population growth in the world makes the trouble worse owing to sharp increase in demand in all the sectors of society consequently put burden on the existing fossil fuels which were the leading energy sources since last five decades. These are of non-renewable nature & require millions of years for their replenishment but their limited reserves are running down quickly which make it difficult to keep balance between the existing reserves & consumption. [7]

The economic viability of the biomass as energy source can be better explored because of abundant availability of biomass residues in entire world. A large variety of agricultural residues e.g. wheat straw, wheat husk, mustard straw, paddy straw etc. are available all over the world in abundant quantity which can be efficiently utilized as raw material using different conversion techniques of gasification & combustion. Agro-industry by-products e.g. Paddy husk & bagasse are also valuable biomass residues. [7]

The small-scale bioenergy systems are expected to proceed at a faster pace due to the lower investment level. Today bioenergy is the second largest commercial renewable energy source. Current total biomass use for energy is in the range of 12% of world primary energy consumption, mainly in traditional applications for cooking and heating in developing countries. Also in some industrial countries, the interest in using wood for heating purposes is increasing. Domestic wood-burning appliances include fireplaces, pellet stoves and burners, central heating furnaces and boilers for wood logs and wood pellets (IEA Bioenergy, 1998; Janssen et al., 2002). [5]

Biomass can be converted into energy (heat or electricity) or energy carriers (charcoal, oil, or gas) using both thermochemical and biochemical conversion technologies. Combustion is the most developed and most frequently applied process used for solid biomass fuels because of its low costs and high reliability. [5]

During combustion, the biomass first loses its moisture at temperatures up to 100°C, using heat from other particles that release their heat value. As the dried particle heats up, volatile gases containing hydrocarbons, CO, CH4 and other gaseous components are released. In a combustion process, these gases contribute about 70% of the heating value of the biomass. Finally, char oxidizes and ash remains (IEA Bioenergy, 2002). [5]
Among the uses of biomass the wood pellet is also included. New techniques are available to turn wood and crop residues into standardized pellets that are environmentally safe and easy to handle (Obernberger & Thek, 2004; Petersen Raymer, 2006; Ravindranath et al., 2006). In the production of fuel pellets and briquettes, the feedstock has to be mill, pulp and steam before being transformed into a denser product. Itis a pure powder form refined wood or crop residues that have been put under high pressure so as to be formed into small cylinders of various sizes. Given the pressure, in the phase of its production, and its reduced humidity, the energetic density of the wood pellet is approximately double than that of the wood. [5]

Size reduction is an important treatment of biomass for energy conversion. Particle size reduction increases the total surface area, pore size of the material and the number of contact points for interparticle bonding in the compaction process (Drzymala, 1993). Owing to the binding capacity of lignin, a natural substance found in firewood, there is no need to add any type of chemical additives. Cellulose crystallinity reduction is required for bioconversion of lignocellulosic feedstock (Schell & Harwood, 1994). A number of properties are commonly known to affect the success of pelleting, including: heating value, moisture content of the material, density of the material, particle size of the material, fiber strength of the material, lubricating characteristics of the material, and natural binders. Ebeling & Jenkins (1985). [5]

Determined the heating value and performed fuel proximate analysis for 62 kinds of biomass. Samson Etal. (2000) were studied combustion characteristics of pelleted switchgrass. They compared the combustion quality of switchgrass pellets with coal and natural gas. They reported that carbon dioxide emission from switchgrass pellet was very much lower than the fossil fuel. [5]

DESIGN AND FABRICATION OF PELLET MACHINE

Basically, these days everyone seeks to have less human effort requirement for any task. So our pellet machine is also designed keeping this factor in mind. But we have prepared it at a smaller level i.e. by some rejected mechanical components to reduce human efforts so that one can easily work on that machine. Therefore, machine comprises of components like two hydraulic jacks (2 ton, 3 ton), solid cylinder (die steel), hollow cylinder (die steel), 6 small bearings, filler gap for input, stopper lever, 4 small helical springs, mixing chamber, stand pipe, frame angles.

This design is fabricated as shown in fig.

PREPARATION OF DIFFERENT COMPOSITES

To prepare different composites of cow dung & other different biomass materials we have taken some fixed amount of cow dung & biomass materials like wheat straw, rice husk, dry leaves, saw dust, groundnut husk .By using these ingredients we have prepared different mixture composites. By these mixtures, we have prepared different pellets of different composites.

In this what we did, first of all we took 400gm of cow dung & thoroughly mixed with biomass materials (rice husk, wheat straw, dry leaves, ground nut husk, saw dust) in different proportions to prepare pellets of various compositions like mixing of 15gm,25gm,35gm,45gm etc. of biomass material to get its most appropriate calorific value. Now finally, samples prepared, let those samples dry for two to three days in sunlight so that no moisture content left in it & can be burnt easily with less fumes.

CALCULATIONS

To determine the higher heating value or calorific value of the prepared composites we have used the formulae given below:

$$HHV = (0.196*FC) + 14.119$$

Where, FC is Fixed Carbon Percentage of various biomass components used. Their fixed carbon percentages are given below:

Table: - Various biomass materials used & their fixed carbon percentages

Biomass material used	Fixed Carbon Percentage
Wheat Straw	19.8%
Rice husk	17.17%
Groundnut Husk	22%
Dry leaves (Neem)	11%
Saw dust	29.85%

The above biomass materials were used in the proportions such that in 400gm of cowdung 15gm, 25gm, 35gm, 45gm etc. were mixed as per their densities or binding properties with cow dung & with that pellets are drawn out from the machine. And higher heating value or calorific value of animal manure is taken as **13.40 MJ/kg**. After drying of pellets the weight of each pellet we found are given below:

Table: - Sample v/s dried pellets weight

Wheat Straw		Rice husk		Groundnut husk		Dry leaves (Neem)		Saw dust	
Sample(gm)	Weight(gm)	Sample(gm)	Weight(gm)	Sample(gm)	Weight(gm)	Sample(gm)	Weight(gm)	Sample(gm)	Weight(gm)
15	85	15	85			25	80	25	105
25	105	25	90	20	95	35	100	35	110
35	105	35	100			45	95	45	110

RESULT & CONCLUSION:

After calculation of calorific value of different pellet the results found are given below:

Table: - Sample v/s Calorific Value of Pellets

Wheat Straw		Rice husk		Groundnut husk		Dry leaves (Neem)		Saw dust	
Sample (gm)	CV (MJ)	Sample (gm)	CV (MJ)	Sample (gm)	CV (MJ)	Sample (gm)	CV (MJ)	Sample (gm)	CV (MJ)
15	1.2079	15	1.20026			25	1.1438	25	1.5712
25	1.5219	25	1.30810	20	1.3736	35	1.4406	35	1.7039
35	1.5679	35	1.48295			45	1.4024	45	1.7696

At last we are comparing the common sample that is 25 gm sample of each composite with **EUCALYPTUS GLOBULES WOOD** which has the calorific value of **19.23 MJ/kg**

Table: - Composites v/s Percent difference in Calorific Value w.r.t. Eucalyptus Globules Wood

Composite	Percentage Difference in CV (%)
Wheat Straw	24.62
Rice husk	24.41
Dry Leaves (Neem)	33.91
Saw Dust	25.15
Groundnut husk	24.81

CONCLUSION

Finally, from the above tables & calculations we had concluded that all the composites are on an average 26.58% less in calorific value as compared to Eucalyptus Globules Wood as depicted in table.

From the above result we can easily conclude that it will be a wise decision to use such pellets compared to wood as Fuel pellets, which would be more beneficial for environment & will help us to reduce "Pollution & Deforestation".

REFERENCES

1. VIJAY KRISHNA MOKA, NIT ROURKELA, "Estimated the calorific value of biomass from its elementary components by regression analysis".
2. Riya Roy M.Sc. (Environmental Science), Asutosh College, University of Calcutta, Kolkata, West Bengal, India. "Production and evaluation of briquettes made from dry leaves, wheat straw, saw dust and cow dung as binder".
3. Pravin Kumar Sahu, Patel School of Studies in Environmental Science, Pt. Ravishankar Shukla University, Raipur, India, "Combustion Characteristics of Manures of different animals".
4. C Venkatasubramanian et al 2017 IOP Conf. Ser.: Earth Environ. Sci. 80/01/2012, "Experimental studies on effect of cow dung ash (pozzolanic binder) and coconut fiber on strength properties of concrete".
5. Ioannis Gravalos, Technological Educational Institute of Larissa, Faculty of Agricultural Technology, Department of Bio systems engineering, "The study on calorific energy values of biomass residue pellets for heating purposes".

6. Ayhan Demirbas¸ and A. Hilal Demirbas, "Estimation of the Calorific Values of Lignocellulosic Fuels".
7. Harmandeep Singh, Pawan Kumar Sapra, "Evaluated and Characterized different Biomass Residues through Proximate & Ultimate Analysis and Heating Value".
8. Institute of Energy, University of Dhaka, Dhaka, Bangladesh, "Feasibility Study of Pellet (Saw Dustand Rice Husk) in Bangladesh".
9. Wikipedia, "https://www.wikipedia.org/".
10. Youtube, "https://www.youtube.com/watch?v=MU3PJb2Ngqs".