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Experimental Investigation of Biomass Briquettes from Agri waste and Forest Waste

M. Sriram, K. Vijay, T. Balamurugan, S. Sundaraselvan, K. Prakash

Arasu Engineering College, Kumbakonam – 612501, Tamilnadu, India.

*Corresponding author Email**:** thillaibala@gmail.com

Abstract: The project presents a detailed design study of the new briquetting machine called hybrid biomass briquetting machine. Briquetting of the saw dust represents one of the possible solutions to the local energy shortages in many developing countries. Briquetting of the saw dust represents one of the possible solutions to the local energy shortages in many developing countries. It constitutes a positive solution to the problem of increasing rates of desertification in many areas worldwide. The production cost was found to be lower due to the lower binder requirement for the new machine, which is lower by about 65%. The initial moisture content of the feed stock required for this machine is lower by about 30 % compared to the best alternative, which results in shorter drying time for the fuel briquettes produced. The quality of the produced briquettes was foundto be better and of lower smoke generation when burned due to the lower binder content. The device is simple and comfortable. Basic calculation, drawing, designing is included in the project. The salient features of our machine can be listed as the mechanism used is very simple, easy for operation; no skill is required to operate the machine to produce the briquettes low cost and an alternate solution to use the forest waste as a fuel for composition in boilers.

Keywords: Agro Waste, Biomass, Briquetting, Binders, Hybrid biomass briquetting machine.

1. Introduction

Utilization of agricultural residues is often difficult due to their uneven and troublesome characteristics. The process of compaction of residues into a product of higher density than the original raw material is known as densification or briquetting. The briquette machine can be used in producing high quality wood shaft with low cost sawdust, corn cob and peanut shell, cotton stalk, tree branch, etc. The final stick is with high density for the fuel. It is one of the newest energy recycle machine, which has important use for the energy Industry. This machine is used for making the briquette from the sawdust, straw, hulls, etc. its products density is high. It is best fuel and the feedstuff of animal. The briquette can be used as the burning material for the boiler or fire place for house warming. Many of the developing countries produce huge quantities of agro residues but they are used inefficiently causing extensive pollution to the environment. The major residues are rice husk, coffee husk, coir pith, jute sticks, biogases, groundnut shells, mustard stalks and cotton stalks, sawdust, a milling residue is also available in huge quantity. Apart from the problems of transportation, storage, and handling, the direct burning of loose biomass 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 addition, a large percentage of unburnt carbonaceous ash has to be disposed of. In The case of rice husk, this amounts to more than 40% of the feed burnt. As a typical example, about 800 tons of rice husk ash are generated every day in Ludhiana (Punjab) as a result of burning 2000 tons of husk. Briquetting of the husk could mitigate these pollution problems while at the same time making use of this important industrial /domestic energy resource. The hydraulic 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. Briquettes can be produced with a density of 1200 kg/m^3 from loose biomass of bulk density 100 to 200 kg /m^3 these can be burnt clean and therefore are eco-friendly. Due to their heterogeneous nature, biomass materials possess inherently low bulk densities, and uneven and troublesome characteristics thus, it is difficult to efficiently handle large quantities of most feed stocks. The process of compaction of residues into a product of higher density than the original raw material is known as densification or briquetting. By briquetting, voluminous biomasses are compacted and given a definite shape and size. Densification has aroused a great deal of interest in developing countries all over the world lately as a technique for upgrading of residues as energy sources.

2. Introduction The Basic Process of Briquetting

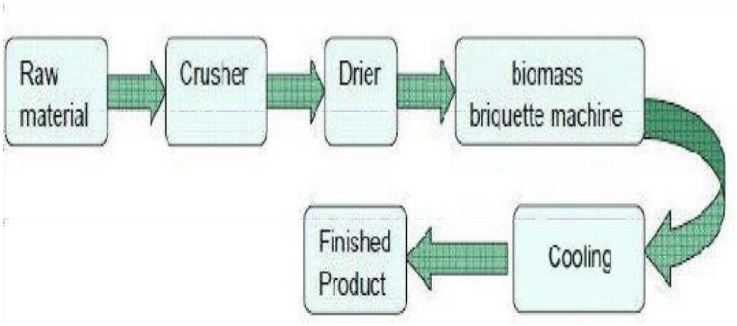

FIGURE 1. The Basic Process of Briquetting

The biomass briquette made through the densification of the agro-crop residues and biomass waste. They are used as a flammable material in bricks kilns, paper mills, chemical plants, pharmaceutical units, dyeing houses, food processing units, oil mills etc. It is commonly in shape of a square or rectangle. Biomass briquettes plant is one of the renewable sources of energy, through which we can reduce pollution. Biomass briquettes are made from the agricultural waste, forest waste and industrial waste. A briquette is a compressed block of coal dust or other combustible biomass material such as wood chips, peat or paper used for fuel and landing to start a fire. It is a block of flammable matter used as fuel. Briquettes are generally 50-80 mm diameter and 150 mm length of cylinders compressed at a high temperature, with a moisture content ranging between 10 to 20%. Other shapes, rectangular or prismatic, are also frequent, depending on the manufacturer. In some cases, they have holes in order to improve their combustion. Briquettes may be composed of crushed and densified wood or composed of crushed, dried and molded charcoal, under high pressure. Briquettes Making Process: Briquetting is process where some type of raw material is compressed under high presser to form a round or square briquette that can be used for heating purpose. If the raw material is wood waste or agro waste, the lignin content is liberated under this very high pressure thus binding the material into a briquette with high density. During the compression of the material, temperature rise sufficiently to make the raw material liberate various adhesive that will assist in keeping the particles together in the compressed shape. However, to make this process successful the moisture content of the raw material must be in the range 6-16%. Briquettes are made of combustible material obtained from agricultural, forestry waste, or coal dust. Briquettes are produced by the densification of these raw materials. The densification process is mainly composed of two parts:

1. Compaction (reduction of raw material volume)
2. Sealing (ensuring that the product remains in a stable, compacted state)

Current regulations allow the use of specific additives to enhance and maintain briquettes' compaction. These additives contain starch (rice flour, cassava flour, mashed sweet potato), or molasses and Arabic gum to give greater consistency to the resulting product. Biomass Densification: The production of a compacted solid out of loose granular material on an industrial scale is a nineteenth century technique first used to make a solid fuel out of peat. It has since become a widespread technology in many fields, for example animal feedstuffs, fertilizers and iron making. Fuel briquetting of peat and, particularly, brown coal is still practiced on a large scale. Biomass fuels are a potential source of renewable energy. One of the major barriers to their widespread use is that biomass has a lower energy content than traditional fossils fuels, which means that more fuel is required to get the same amount of energy. When combined low energy content with low density the volume of biomass handled increases enormously. Compaction or densification is one way to increase the energy density and overcome handling difficulties. This Factsheet examines the density properties of solid biomass and potential densification technologies. Bulk Density: Bulk density is defined as the weight per unit volume of a material, expressed in kilograms per cubic meter (kg/m^3) or pounds per cubic foot (lb/ft^3).Most agricultural residues have low bulk densities

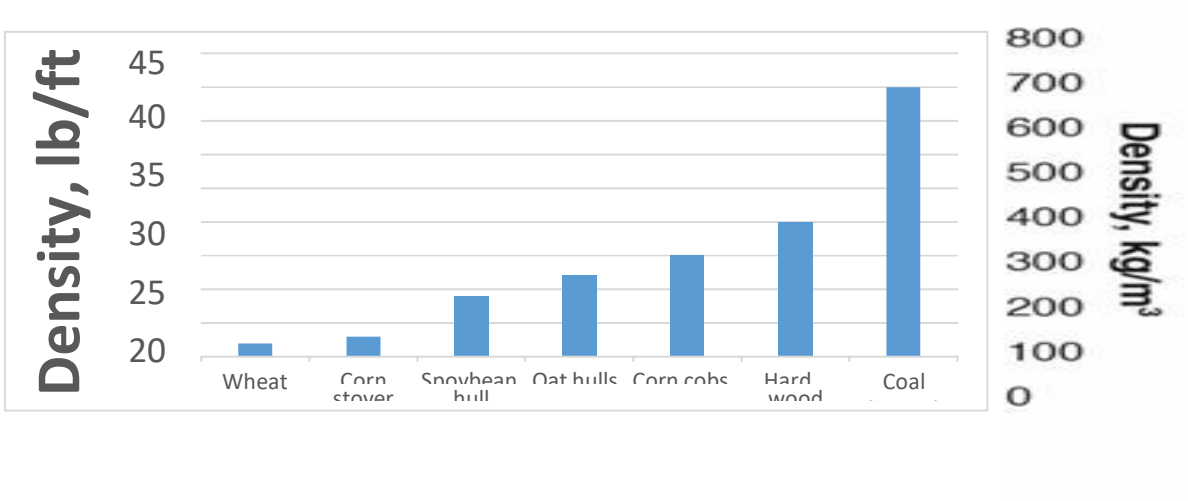

FIGURE 2. Typical Bulk Densities Of Unprocessed Biomass

Energy Density: Energy density is a term used to describe the amount of energy stored per unit volume, often expressed in MJ/m3 or BTU/ft3. Figure is a graphical representation of common volume ratios for unprocessed material, with the cubes representing the volume of material required for equal energy, 16:4:1 for straw to wood to coal.

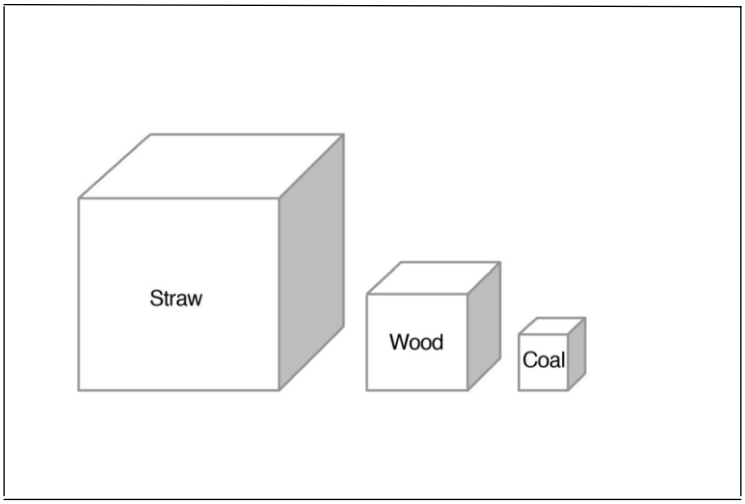

FIGURE 3. Equivalent Energy Content By Volume Of Unprocessed Materials

The main advantages of biomass densification for combustion are:

1. Simplified mechanical handling and feeding
2. Uniform combustion in boilers
3. Reduced dust production
4. Reduced possibility of spontaneous combustion in storage

3. Screw Press and Piston Press Technologies

High compaction technology or binder less technology consists of the piston press and the screw press. Most of the units currently installed in India are the reciprocating type where the biomass is pressed in a die by are reciprocating ram at a very high pressure. In a screw extruder press, the biomass is extruded continuously by a screw through a heated taper die. In a piston press the wear of the contact parts e.g., the ram and die is less compared to the wear of the screw and die in a screw extruder press. The power consumption in the former is less than that of the latter. But in turn is of briquette quality and production procedure, screw press is definitely superior to the piston press technology. The central hole incorporated into the briquettes produced by a screw extruder helps to achieve uniform and efficient combustion and, also, these briquettes can be carbonized

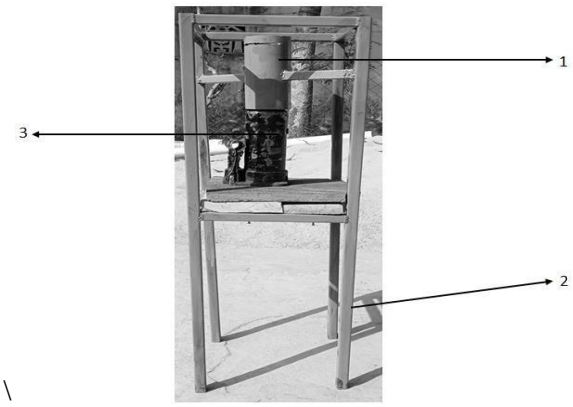

FIGURE 4. Components of Hybrid Biomass Briquette machine

FIGURE 5. Components of Hybrid Biomass Briquette machine

TABLE 2. Components of Hybrid Biomass Briquette Machine

S.NO	COMPONENTS
1	Circular Die
2	Base Frame
3	Hydraulic Jack
4	Saddle
5	Ram
6	Socket
7	Piston Assembly
8	Release Valve
9	Filler Plug
10	Extension Screw

Components of Hybrid Biomass Briquette: Circular Die: A circular die is a specialized tool used in manufacturing industries to cut or shape material using a press. Like molds, dies are generally customized to the item they are used to create. In this system a piston press is being used.

[Dimension of cylinder: Outer diameter = 3 cm
Inner diameter = 2.8 cmLength = 6.5 cm Material: Mild Steel with coating]
Base Frame: It is used to support the total load of the system comprising of various components like screw, barrel, screw housing etc. Frame is made by different size of angle bar and sheet metal. In the figure below a complete frame is shown. The function of the frame is to hold the motor. It also resists vibration during running. Hydraulic Jack: Hydraulic Jack Working is based on Pascal's principle. That is, the pressure applied to a fluid stored in a container will be distributed equally in all directions. The important components of a hydraulic jack are cylinders, a pumping system, and hydraulic fluid (oil is used

commonly). The hydraulic jack fluid is selected by considering certain fluid properties like viscosity, thermal stability, filterability, hydrolytic stability, and more. If a compatible hydraulic fluid is selected, it will offer maximum performance, self- lubrication, and smooth operation. The hydraulic jack design that will contain two cylinders (one small and another big) connected to each other using piping's. Both cylinders are filled partially using hydraulic fluids. Bottle Jack Saddle: Most bottle jacks have a serrated saddle that sits underneath the vehicle while it is being lifted. Serrated means it has a jagged edge, like a saw, for extra grip. Bottle Jack Ram: The ram extends when the jack is pumped, pushing the saddle against the underside of the vehicle to lift it. Socket: The handle socket is where the two piece jack handle will be inserted. Piston Assembly: The piston assembly consists of a pump piston and a cylinder. When the user lifts the jack handle, it lifts the pump piston drawing oil into the pump cylinder from the reservoir. Release Valve: When the release valve is partially opened, it allows pressure to be released, causing the oil to run back into the reservoir inside the bottle jack. This enables the jack to be lowered. When the release valve is closed, it is ready to be raised. Filler Plug: This plug can be removed to add hydraulic oil to the jack. Extension Screw: The extension screw can be extended for extra reach up to its maximum lift height. Turn the extension screw anti clockwise to raise, and clockwise to lower. Process of Making Briquette Machine: Development of Mould In order to perform the briquetting process, a cylindrical mold consisting of cylindrical die, piston and a base plate of required dimension was fabricated. The mold has a height of 430 mm and an inner diameter of 77 mm. The mold was made out of scrap materials such as G.I pipes, gear, rods, etc. from the basic workshop. A locking mechanism with the aid of nuts, bolts and washers were provided, to prevent slippage between the base plate and cylindrical die during the compaction process. Feed stocks Preparation And Characterization: Switch grass and prairie cord grass obtained from different local farms were ground in hammer mill using as sieve for densification. Similarly, corn Stover, pigeon pea grass, and cotton stalk were collected from experimental field at cholapuram, India. Sawdust was obtained from local sawmill located at cholapuram, India. The compositional analyses of the feedstock's and briquettes such as total solids, cellulose, hemicellulose, lignin, ash, and extractives content were carried out in triplicate as outlined by Slitter etc. Briquette Production: The entire processes involved in the preparation of composite briquettes from sawdust and forest waste. The feedstock materials were weighed according to the required proportion and mixed with fevicol which acts as a binding agent. The mixture was then fed into the cylindrical mould and briquettes were produced at the house. India by the process of biomass densification the process involved the use of high pressure with a dwelling time of about 5 min to prevent the spring back effect of the biomass materials. Briquette Consumption Equipment: Briquettes Can Be Used As Fuel for Several Types Of Heat Producing Devices: STOVES Stoves can range from 5 to 30kW of thermal output, and are usually wood, pellet or briquette powered. Such (small) power capacity is suitable for space heating of a single room, or several nearby rooms by using channeled exits. Apart from supplying heat, these stoves can also have a decorative use (figure 6).

FIGURE 6. Wood or briquettes stove

BOILERS: The principal components of briquette boilers are very similar to the systems described for automated stoves (Briquette feeding system combustion chamber control panel, ash collection container). Low power boilers: Boilers are used to generate heat that can then be transferred to a working fluid (typically water, in domestic premises) to supply space heating circuits and/or domestic hot water circuits. Low power boilers range from 6-60 kW and are recommended for single family houses or small buildings. The main benefit of these boilers is their reduced size, high efficiency and low cost. Medium power boilers: Medium power boilers range from 60-150 kW thermal output and are designed to supply heat to residential buildings (apartment blocks) or office buildings. High power boilers: High power boilers range from 200-800 kW thermal output and are designed to supply heat demands of industrial processes. Thermal power stations: Thermal power stations have capacities of 1 MW or above, and they are built to produce and supply heat to several nearby facilities or district heating networks.

TABLE 3. Heating Capacity Needs Conversion Coefficients (W/M2) - Good Or Medium Insulation Spaces

House/Room With Good Or Medium Insulation								
Orientation	South				North			
Flat in urban area	Between floors	Ground floor	Last floor	----	Between floors	Ground floor	Last floor	----
Detached house in rural area	----	Between floors	Ground floor	Last floor	----	Between floors	Ground floor	Last floor

Mild climate	66	68	70	72	72	74	76	78
Cold climate	69	71	73	75	75	77	79	81
Very cold climate	75	77	79	81	81	83	85	87
Extra cold climate	82	85	87	90	90	93	95	97

TABLE 4. Heating capacity needs conversion coefficients (w/m2) - good ormedium insulation spaces

House/Room Without Insulation								
Orientation					North			
Flat in urban area	Between floors	Ground floor	Last floor	----	Between floors	Ground floor	Last floor	----
Detached house in rural area	----	Between floors	Ground floor	Last floor	----	Between floors	Ground floor	Last floor
Mild climate	78	80	82	84	84	86	88	90
Cold climate	81	83	85	87	87	90	93	96
Very cold climate	87	89	91	93	93	95	97	99
Extra cold climate	97	100	102	105	105	107	109	111

4. Result & Discussion

Briquettes were produced from variety of feedstock's to compare their physical and chemical properties. Statistical analyses revealed the existence of significant changes in chemical compositions, differences in density, porosity, and durability. Correlation analyses confirmed the contribution of lignin, extractives, fines, and particle size towards durability. This study confirms that medium size feedstock with low moisture content and lignin content in the range of 21–25% would result in 2–11-fold increase in density with medium and high durability. Cotton stalk briquettes had a bulk density of 964kg/m3 witha durability of 0.923. In recent years, the use of biomass as a source of energy became of great interest world-wide because of its environmental advantages. The use of biomass for energy production (biofuels) has been increasingly proposed as a substitute for fossil fuels. Biomass can also offer an immediate solution for the reduction of the CO2 content in the atmosphere. It has three other main advantages: firstly its availability can be nearly unlimited, secondly it is locally produced and thirdly it can be used essentially without damage to the environment. In addition to its positive global effect in comparison with other sources of energy, it presents no risk of major accidents, as do nuclear and oil energy. Due to their heterogeneous nature, biomass materials possess inherently low bulk densities, and thus it is difficult to efficiently handle large quantities of most feed stocks. Therefore, large expenses are incurred during material handling (transportation, storage, etc.). As coal is a nonrenewable source of energy and is on the verge of extinction. Thus there is an immediate need of finding a substitute to it. The following table explains using of biomass briquettes as a substitute to coal in near future. Following pictures are the briquettes produced by hybrid biomass briquette machine.

FIGURE 7. Briquette

TABLE 5. Results Of Above Showed Briquette

Fuel	Density Kg/m3	Calorific Value	Ash Content (%)
		Kcal/Kg	
Coal	1300	3800-5300	20-40
Bio Mass Briquettes From:			
Sawdust	1100	4600	0.7

TABLE 6. Estimation And Costing

SI.NO	PARTS	UNIT PRICE (Rs.)
1	Base Frame	1000
2	Circular Die	250
3	Raw Material	500
4	Hydraulic Jack	2000
5	Welding Charge	350
6	Testing Charge	700
7	Travelling Charge	500
Total Cost		5250

5. Conclusion

A large volume of agricultural by products being generated in India and which constitute environmental hazards. Call for effective utilization of that high grade biomass material for solid fuel called briquette. Hence it can be concluded that the waste material like dry leaves, wheat straw, saw dust, etc. are feed stocks for the biomass briquette. Generally dry leaves and wheat straw are burnt to reduce waste, which causes several pollution to environment, but if wisely handled these wastes can then could be a better option for briquetting. Hence for an agricultural country like India that produces huge amount of agricultural waste every year, use of these waste as a briquette can be economically viable, sustainable and environment friendly solution. And also as machine concerned, it can be concluded that by using simple mechanism with widely available machine element the machine cost could be lowered and makes fabrication economical and portable.“Use chemical Free Briquettes to Solve Environmental Problem

References

[1].Oladeji, J.T.2010. “Fuel Characterization of Briquettes Produced from Corncob and Rice Husk Resides”. Pacific Journal of Science and Technology. 11(1):101-106.

[2].S. H. Sengar , A. G. Mohod , Y. P. Khandetod , S. S.Patil , A. D. Chendake, "Performance of Briquetting Machine for Briquette Fuel", International Journal of Energy Engineering, Vol.2 No.1, 2012, pp. 28-34. Doe: 10.5923/j.ijee.20120201.05.

[3].Olorunnisola “Production of Fuel Briquettes from Waste Paper and Coconut Husk Admixtures”. Agricultural Engineering International: the CIGR journal. Manuscript EE 06 006. Vol. IX. February, 2007

[4].Idah, P. A1, Mopah, E. J2 1,2Department of Agricultural and Bio resources Engineering, Federal University of Technology, P.M. B. 65, Minna, Niger State,Nigeria.

[5].Harshita Jain1 , Y. Vijayalakshmi2 , T. Neeraja3 1M.Sc. Scholar, Department of Resource Management and Consumer Sciences, College of Home Science, Hyderabad-500001, 2Associate Professor, Department of Resource Management and Consumer Sciences, College of Home Science, Hyderabad -500001, 3 Professor, Department of Resource Management and Consumer Sciences, College of Home Science, Hyderabad -500001,

[6].Daham Shyamalee 1, A.D.U.S. Amarasinghe 1, N.S. Senanayaka 2 1Department of Chemical and Process Engineering, University of Moratuwa Moratuwa, Sri Lanka 2 Department of Mechanical Engineering, The Open University of Sri Lanka, Nugegoda, Sri Lanka

[7].Riya Roy M.Sc. (Environmental Science), Asutosh College, University of Calcutta, Kolkata, West Bengal, India.

[8].Olawale J. Okegbile, Abdulkadir B. Hassan, Abubakar Mohammed*, Barakat J. Irekeola Department of Mechanical Engineering, Federal University of Technology, Minna, Nigeria

[9].Ogwu, I.Y1, Tembe, E.T2., and Shomkegh, S.A.3 1 and 2. Department of Forest Production and Products University of Agriculture Makurdi 3. Department of Social and Environmental Forestry University of Agriculture Makurdi

[10].Emerhi, E. A Department of Forestry and Wildlife, Delta State University, Awai Campus, Asaba, Nigeria P.D.Grover, Agriwaste feed processing for energy conversion”, Proc. International Conference 26-27, Bangkok, April 1996, 177-195.

[11].Khoa, TranMinh, S.C.Bhattacharya, Amur Ghulam Qambar, Study of agriwaste as a source of energy in Vietnam, International Energy Journal, 21, 1999, 69-75.

[12].N.P.Singh, Agriwaste programme in India: an overview Proc. International Conference, 26-27 New Delhi, February 1996, 65-72.

[13].S.C. Bhattacharya, R.Bhatia, M.N .Islam, N.Shah, Densified biomass 8, Thailand, 1985, 255-266.

[14].A.K.Tripathi, P.V.R Iyer., T.C Kandpal., Questionnaire based survey of agriwaste briquetting in India, MNES, International Journal of Ambient Energy 2(1) New Delhi, Jan 2000, 31-40.

[15].Filiz Karaosmanoglu, Biobriquetting of rapeseed cake, Energy Sources 22(3), 2000, 257267.

[16].P.D.Grover, S.K Mishra,., Regional Wood Energy Development Programme in India, Proc. International Workshop on Biomass Briquetting, New Delhi, April 1995.

[17].A Koopmans, Proc. of the International Workshop on Biomass briquetting 23 Bangkok, 1996.

