The International Journal of Multi-Disciplinary Research

ISSN: 3471-7102

Design and Fabrication of a Manually Operated Briquetting Machine

(Conference ID: CFP/247/2017)

MAINZA CHILANGA

SIN: 1301345086

INFORMATION AND COMMUNICATIONS UNIVERSITY

Zambia Research and Development Centre (ZRDC)

Department of Engineering, School of Engineering,

P.O Box 30226, Lusaka 10101, Zambia.

SUPERVISOR: DR OLIVER SILUMBE

***ABSTRACT**: A ten (10) tonnes capacity agro waste manual briquetting machine have been designed and fabricated using locally available materials. The machine principal parts are made of frame, compaction chamber and base plate. Compaction chamber contains twenty (20) moulding dies each having transmission rod, piston and ejector. The machine can produce twenty (20) briquettes at a time of about 50mm length and 28mm diameter. The compaction pressure and force was determined to be 17.5 KN/m^2 and 215.3N respectively. It is hoped that machine will be very useful for small and medium scale briquette manufacturers.*

***Keywords**: Briquetting, design, fabrication, agro waste, manually operated.*

ISSN: 3471-7102

INTRODUCTION

Briquetting is defined as the densification (agglomeration) of an aggregate of loose particles into a rigid monolith. (Mordi, 2007).A briquette can thus be defined as a product formed from the physico-mechanical conversion of dry, loose and tiny particle size material with or without the addition of an additive into a solid state characterized by a regular shape.

Briquetting was first proposed in Russia by a Russian inventor F.P Veshniakov (Prokhorov, 1982). Veshniakov developed a method of producing briquettes from waste wood, charcoal and hard coal. The most important advantages of briquette are its low sulphur content, relative freedom from dust, ease of handling and high calorific value (Osarenmwinda and Imoebe, 2006).

Briquette machines have been in existence and used for sawdust and waste materials in Europe, Asia, and America (Kishimoto, 1969; ASTM, 1951). Saglam et al.(1990) reported that a briquette machine was designed and used for the briquetting of lignites using calcium and ammonium sulphite liquor. Afonja (1975) had earlier reported on a specially designed briquette machine for briquetting sub bituminous coal. Ilechie et al,2001, designed a moulding machine to produce briquettes from palm waste.Inegbenebor,2002, developed a five (5) tones capacity briquetting machine for compressing agricultural and wood waste that can produce six briquette at a time. This work focuses on preliminary design and fabrication of a ten (10) tonnes manual briquetting machine capable of producing twenty (20) briquettes at time which is of higher capacity than of the produced by Inegbenebor (2002).

In developing countries like Zambia, the direct burning of loose agro waste residues like rice husk, palm kernel shells, and groundnut shells in a conventional manner is associated with very low thermal efficiency, loss of fuel and widespread air pollution. When they are made into briquettes, these problems are mitigated, transportation and storage cost are reduced and energy production by improving their net calorific values per unit is enhanced (Grover et al, 1996). The briquetting machine we seek to produce will help minimize the environmental hazard from agro waste. This machine it is hoped will be useful to small and medium scale briquette manufacturers.

ISSN: 3471-7102

DESIGN CONSIDERATIONS

The manual briquetting machine was designed to produce twenty (20) briquettes at a time. Total area which pressure act = number of mould die x cross sectional area of die

$$20x \quad \frac{n}{4} d2$$

Where d = diameter of moulding die = 28mm = 0.028m, number of mould die=20, π=3.142

Mass of one pressure transmission rod used = 450grams. Number of pressure transmission rods = 20.Total mass of 20 transmission rods = 450x20 = 9000g = 9kg. Mass of ejecting piston = 100g. Total mass of 20 ejection piston= 100x10 = 2000g= 2kg

Mass of the base plate = 4.5kg

Maximum mass of one wet briquette sample = 50g.

Thus, Total mass of briquette samples = number of briquette sample x mass of one sample

= 20 x 50

=1000g

Therefore = 1kg.

Total mass to be lifted by hydraulic jack is = total mass of transmission rod + mass of base plate + total mass of ejection piston + total mass of briquette samples = 9kg + 2kg + 4.5kg + 1kg = 16.5kg

Assume g (acceleration due to gravity) = 9.81 Weight to be lifted = 16.5x9.81 = 161.87N

A 10 tonnes (10,0000N) hydraulic jack was used to lift the machine components and compress the briquettes.

The hydraulic jack used was obtained as a bought out item. The compaction force was calculated using the pressure. Pressure read from the pressure gauge connected to hydraulic jack (Compaction Pressure) =17.5KN/ m2 (Ihenyen 2010).

$$\text{Pressure} = \frac{force}{area}$$

Let FC = Compaction Force, and PC = Compaction Pressure and AC = Total Compacted Area.

Thus $Fc = Pc$ + Ac

Where Ac = Number of Briquette produced at a time x cross sectional Area of briquette sample

Thus, Ac =20x $\frac{n}{4}$ d2

Where d = diameter of briquette sample = 28mm = 0.028m, π=3.142

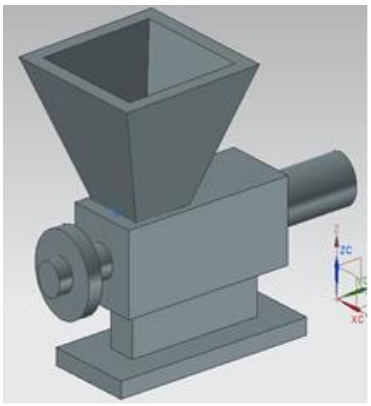
Ac = 20x $\frac{3.142}{4}$ x0.028 = 0.0123m2

Fc = 17.5 x 0.0123 = 0.2153KN = 215.3N

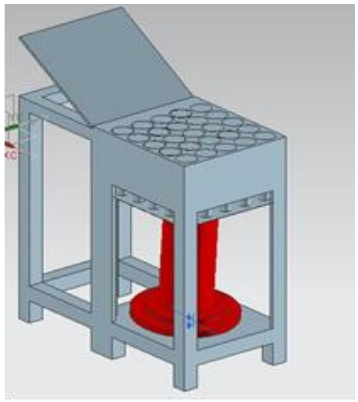
MACHINE FABRICATION

The briquetting machine fabricated is shown in Fig.1. Fig. 2 shows the isometric view of the briquetting machine. The Parts of the manual briquetting machines produced are the main frame, the compaction chamber and base plate.

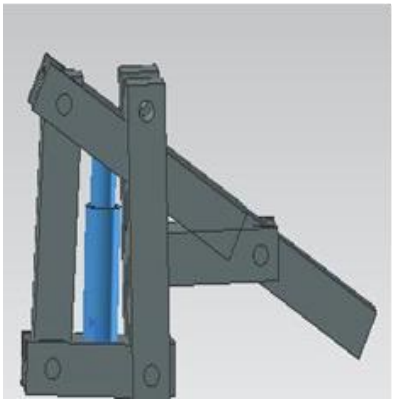
For the purpose of this study, mild steel was used for the construction of the machine. Mild steel plates and rods were bought from a local mild steel market.



Conceptual design 1



Conceptual design 2



Conceptual design 3

The Main Frame:

The main frame houses and support the other parts of the machine. The main frame was made from mild steel angular iron bars.

The Compaction Chamber:

The compaction chamber was made with mild steel block. Base Plate: The base plate of the machine is made from mild steel and is housed within the frame of the machine just beneath the compaction chamber. Twenty pressure transmitting mild steel rods are welded to the baseplate of the machine, and these rods go into holes rods made at the base of the machine to support the ejection piston

Operation and Cost of the Machine:

The palm kernel (other agro waste can be used) granules was mixed with starch binder and feed into the dies in the compaction chamber and rammed until they are full. The lid of the machine was then closed and screwed to position. The ten tonne (10 ton) hydraulic jack which was under the base plate was used to lift the plate assembly carrying the transmission rods, which then pushes the piston against the mixture inside the various dies of the compaction chamber. The mix is thus compacted against the lid of the machine, and the reading on a pressure gauge attached to hydraulic jack is recorded. The mix was then left to set for about five

ISSN: 3471-7102

minutes after which the lid of the machine is opened and the briquettes were then ejected .Some of the produced briquette are shown in Fig.3. The briquetting machine performance was found to be satisfactory. (Ihenyen, 2010).

CONCLUSION

The design and fabrication of a ten (10) tonne capacity manual briquetting machine that can produce 20 briquettes at a time using locally available material have been achieved. Differet agro-waste can be used to produce briquette using this machine. It is hoped that this produced manually operated briquetting machine will be useful to small and medium scale briquette manufacturers. Further studies is recommended in other to introduce heating elements in the machine to enhance drying of the produced briquette and make it electrically operated.

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