The Preliminary Design and Fabrication of a Manually Operated Briquetting Machine

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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.

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 Imoeeb, 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).

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

\[ = 20 \times \frac{\pi d^2}{4} \]

Where \( d \) = diameter of moulding die = 28mm = 0.028m, number of mould die=20, \( \pi = 3.142 \)

Total Area = \( 20 \times \frac{\pi 0.028^2}{4} = 0.0123m^2 \)

Mass of one pressure transmission rod used = 450grams. Number of pressure transmission rods = 20. 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 set briquette sample = 50g

Thus, Total mass of briquette samples = number of briquette sample x mass of one sample = 20 x 50=1000g = 1kg

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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).

\[ \text{Pressure} = \frac{\text{Force}}{\text{Area}} \]

Let \( F_C \) = Compaction Force, and \( P_C \) = Compaction Pressure and \( A_C \) = Total Compacted Area.

Thus \( F_C = P_C + A_C \)

Where \( A_c = \text{Number of Briquette produced at a time} \times \text{cross sectional Area of briquette sample} \)

\[ A_c = 20 x \frac{\pi}{4} d^2 \]

Where \( d = \text{diameter of briquette sample} = 28mm = 0.028m, \pi =3.142 \)

\[ A_c = 20 x \frac{3.142}{4} x 0.028^2 = 0.0123m^2 \]

\[ F_C = 17.5 \times 0.0123 = 0.2153KN = 215.3N \]

**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.

_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 base plate 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 tonnes (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 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. The estimated cost of the machine was N16, 000 (Ihenyen,2010).
Conclusion: The preliminary design and fabrication of a ten (10) tonnes capacity manual briquetting machine that can produce 20 briquettes at a time using locally available material have been achieved.

Different agro waste can be used to produce briquettes 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 order to introduce heating elements in the machine to enhance drying of the produced briquettes and make it electrically operated.

REFERENCES