DEVELOPMENT OF A BRIQUETTE COMPRESSING MACHINE

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ABSTRACT

A low-cost agricultural and wood waste briquette compressing machine that can produce six (6) briquettes of about 300 mm long at a time was designed and fabricated for use in small and medium scale industry. The design was based on the principle of hydraulic pressure transmission (HPT) and the slider crank ejection mechanism (SCEM). The capacity of the machine which can be operated by two persons is about 1600 kg of briquettes per day.

Keywords:- Agricultural Waste, Wood Waste, Briquette, Slider-Crank Mechanism.

INTRODUCTION

Most fibrous waste compressing machines called balers are based on hydraulic principle. Balers collect hays and compact them into easily handled bales to be stored for stock feeding or bedding. Improvement in baler designs has resulted in more multiple uses. Different types of briquette machines, for compressing agricultural and coal field waste materials, are examples of products of such improvements in baler designs.

Briquette machines have been in existence and used for saw-dust and other 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 liquors. Afonja (1975) had earlier reported on a specially designed briquette machine for briquetting sub-bituminous coal. By 1995, a Seidner Riedlingen compacting Machine (Model SWP600) was reported to have been used as briquette machine to produce solid fuel briquettes from sugar-cane waste (Akpabio et al., 1995). Recently, Ilechie et al. (2001) designed a moulding machine to produce briquettes from palm waste.

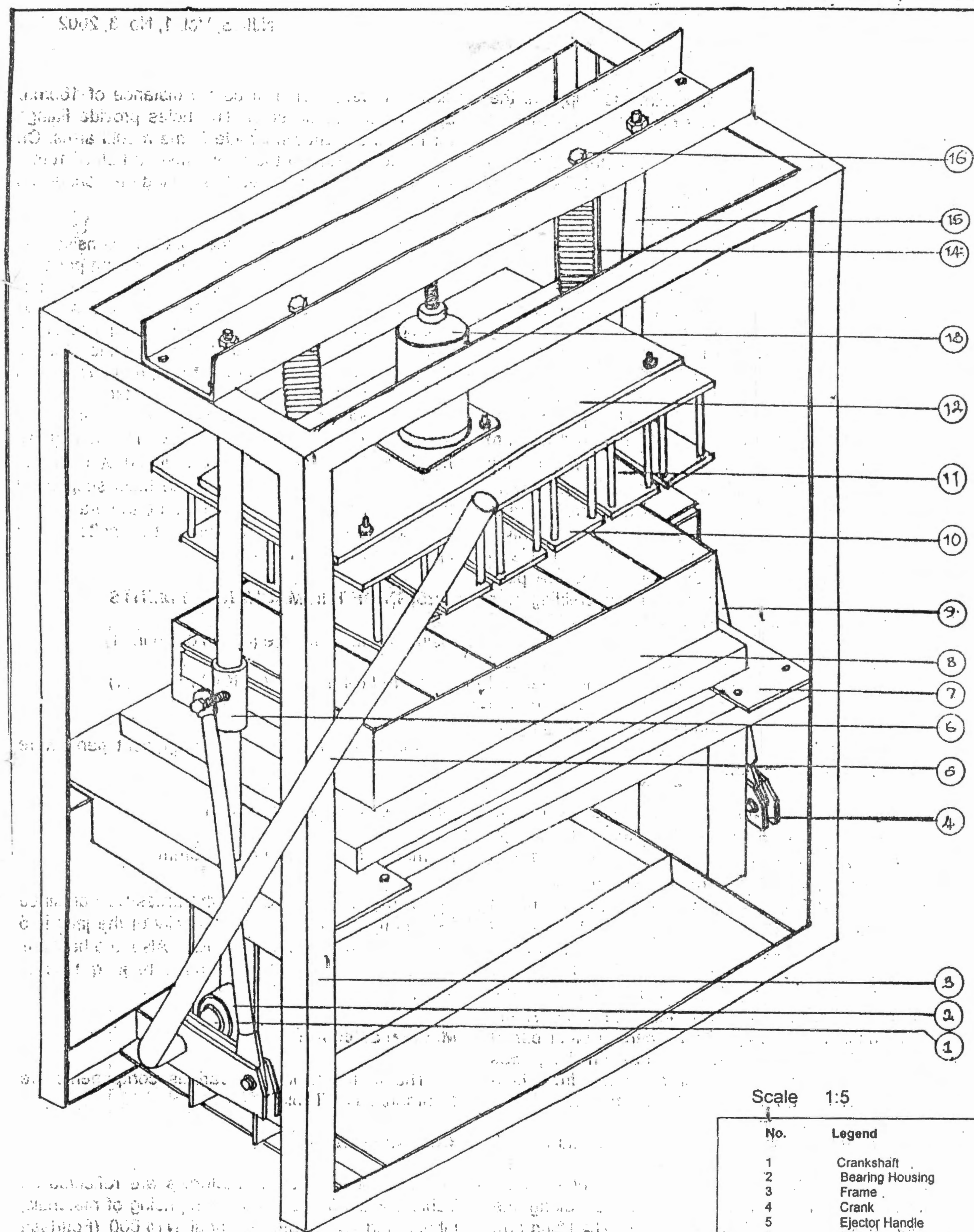
Though briquette machines have existed world wide for long, they are not common in the Nigerian markets. The major motivation for this work, apart from creating awareness of this important machinery, was to present a modified briquette machine which can produce fibrous briquettes from wood and agricultural wastes such as saw dust and rice husk.

Briquettes of wood and agricultural wastes from the machine can be used as an alternative to fuel-wood as the demand for the latter, especially in the developing countries continues to rise as a result of increasing population. Also, the problem of wood and agricultural waste disposal (such as saw dust and rice husk) is posing challenge to the farmer and to the general public as these wastes constitute a nuisance to the environment.

Designing and presenting a suitable machine that can compress agricultural and wood waste materials into briquettes which can be used as fuel material would therefore be a welcome solution to the problem of environmental resource conservation.

THE MACHINE DESCRIPTION

The design of the machine is based on hydraulic principles with incorporation of slider-crank mechanism (Mabbie and Ovevirk, 1967; Hall et al., 1987). The developed machine is shown in Fig. 1. consists of a frame which supports all the components of the machine.



Scale 1:5

No.	Legend
1	Crankshaft
2	Bearing Housing
3	Frame
4	Crank
5	Ejector Handle
6	Slider (Mould Lifter)
7	Pallet
8	Mould
9	Connecting Rod
10	Compactor
11	Spikes
12	Pressure Plate
13	Hydaulic Jack
14	Return Spring
15	Slider Guide Shaft
16	Spring Suspension Bolt

Fig. 1: Isometric View of Briquette Compressing Machine

The frame constructed of weldments supports the hydraulic press and the slider-crank mechanism.

The machine crankshaft, was constructed from a bar of high carbon steel of standard size 32mm diameter. The bar, 800mm long was turned to 30mm diameter at 200 mm from the handle end and 70mm from the other end. The stepped end of the shaft fitted into the bearings at 190mm and 60mm and into one pair of cranks at one extreme and into the second pair at 130mm from the handle end. The cranks were keyed into the shaft to allow for dismantling during maintenance (Deutschman et al., 1975). The compacting sets of the machine consist of pressure plates, spikes and compactors, all are joined by welding. The hydraulic press, was mounted unto a plate of section 120x100x6mm which was welded to the adjustment screw at the top of the jack. Four holes of 8mm diameter were provided in the plate through which it was bolted to the U-channel steel at the upper part of the frame. The base of the hydraulic jack which was made of cast iron was welded to the upper pressure plate using a cast iron electrode and the welding was carried out carefully to avoid cracking.

The bearing housings were made of mild steel tube each of bore 45 and 75 mm outer diameter and length 40mm. The bore was increased to 62mm diameter so that the bearings could fit tight into the hole. The bearing housings were welded to the lower portion of the frame.

The machine connecting rods were made from carbon steel bar of 20mm diameter, 330mm long and two pieces of plate section 30 x 20 x 8mm into one of the plates of the mould a 10mm diameter hole was drilled and into the other, a 13mm diameter. The plates are then welded to the ends of the bar thus giving a centre distance of 360mm between holes. The 13mm hole fits in between pair of cranks while the 10mm hole is bolted to the slider pin of the machine. The machine slider guide shafts were machined to 30mm from carbon steel bar of 32mm. The bar, which was 620mm long was threaded to 20mm diameter at 35mm from both ends. Thereafter, it was bolted to the frame.

The machine sliders of which the mould can be lifted consists of a short cylinder, a lifting arm and a bolt and nut. The cylinder of 30mm bore, 4mm thickness and 60mm long reciprocates along the slider guide shaft as it lifts the mould. The lifting arm which lifts the mould is made up of an angle steel 180mm long and 4mm thick. Two holes of size 8mm diameter were drilled at centre distance of 160mı apart on the angle steel. The holes provide fitting for the pins at the underside of the mould arms. O the opposite side of the angle steel, a bolt of 10mı was bolted to the cylinder thus linking the connectin rod to the slider.

The return springs of the machine consisted c two springs which were bent at the dividing points t form a hook, and the springs were connected i parallel on both sides of the hydraulic press. Tw bolts are provided for bolting each spring, one at th upper part of the U-channel steel and the other t the pressure plates. The machine spring suspensio consisted of four bolts, 20mm diameter, each and across which an 8mm diameter hole was drilled to allow for hooking of the springs. The hexagonal heads of the lower bolts were reduced by milling to prevent obstruction. Two of these bolts suspended the spring from the upper part of the frame (U-channel beam), while the other two bolts of the spring to the pressure plates.

DESIGN OF THE MACHINE ELEMENTS

Using ASME shafting equation given in (1)

$$d_{cr}^3 = 16\{(M_b K_b)^2 + (M_t K_t)^2\} / S_s \quad \dots (1)$$

the following dimensions of component parts were used:

Diameter of crankshaft = 30mm

Diameter of connecting rod = 20mm

The hydraulic jack used for the press was obtained as a bought out item. The capacity of the jack is 5 tonne force (approximately 5 KN). Also, the bearings selected are of single row bass bearing type of designation numbers ZZ6206.

Material Selection

The materials for the various components are summarised on Table 1.

Cost Analysis

The cost of the various materials are reflected on Table 1 while the total cost comprising of materials, labour and overheads is about N14,000 (Fourteen Thousand Naira Only).

Table 1: Material Selection & Material Cost

S/N	Component	Material	Dimension	Description or form	Qty	Total Cost (N)
1	Frame	Mildsteel	11/2"x6m	Angle Iron	2	1,100.00
2	Frame	Mild Steel	50x10x7mm 3mm long	U-Channel	1	1,400.00
3	Bearing housing	Mild Steel	45mm internal diameter, 75mm outer diameter	Tube	1	200.00
4	Crankshaft, Guide shaft and ejector handle	Mild steel	32mm diameter, 3m long	Bar	1	1,000.00
5	Bearings	Bearing Metal	30mm internal diameter,62mm outer diameter		1	300.00
6	Connecting Rods	Medium carbon steel	20mm diameter 800mm long	Bar	1	200.00
7	Spikes	Mild Steel	10mm diameter 3m long	Rod	1	500
8	Sliders	Low alloy Steel	30mm inner diameter,40mm outer diameter 60mm long	Tub	2	200.00
9	Hydraulic Jack (5 Tonnes)	Ferritic Stainless Steel		Weight Lifting	1	1,000.00
10.	Mould	Mild steel	1x1m^2,3mm thick	Sheet	1	1,000.00
11	Springs	Medium carbon steel	Wire diameter, 5mm,38mm mean diameter, 24 turns		2	250.00
12	Pressures Plates	Mild steel	300x450x4mm 200x450x10mm	Plate	2	100.00
13	Crank	Mild Steel	600x50x8mm	Plate	1	300.00
14	Pallet	Wood	500x35x30mm	Slab	1	150.00
15	Bolts	Mild steel or medium carbon steel			1pk	500.00
16	Electrodes		Gauge 12		1pk	500.00
17	Paints		30ml	Blue	2 tins	300.00
	Total					N9,680.0

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OPERATION AND PERFORMANCE OF MACHINE

With the pallet in position (under the mould) smeared with engine oil to prevent adhesion of fibrous waste to the pallet, the premixed fibrous waste of saw-dust with starch is fed into the mould through the space (70mm clearance) between the mould and the compactor. The machine is then operated by reciprocating the plunger up and down using the operating lever. With each stroke, the press displaces downwards, thus extending the spring and at the same time compressing fibrous waste material. After the compression, the ejector handle is then pulled (towards the operator), thus causing the mould to lift off the compressed briquette. The needle valve is then loosened by adjusting it in on anti-clockwise direction so that springs return the compactor to its position (upward). The compressed briquettes now moulded on the top of the pallet is then removed together with the pallet and kept aside to dry.

The machine was observed to produce 1,600kg of briquettes per working day of 8 hours. After drying, about 5.5% of the briquettes were observed to been defective. These defects include weal compaction and hair-line cracks. A possible reason for the dhair line cracks is that pressure was only applied to the top and bottom of the moulds during compaction, whereas additional lateral force could have contributed equal pressure from all directions thereby preventing the cracks. Similar hair-line cracks have been observed in briquetting sugar-cane waste by Akpabio et al (1995), and bituminous coal briquettes Rhys-Jones (1963).

CONCLUSION & RECOMMENDATIONS

A compressing machine for producing briquettes from agricultural and wood waste has been developed from locally available raw materials. The capacity of the machine is about 1600kilogram of briquettes per 8-hour working day. The machine could suitably be modified to produce small sized particle boards.

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