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Development Of A Mechanical Wood Splitting Machine

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ABSTRACT: The wood splitting machine (WSM) was successfully constructed with locally sourced materials; it was tested, evaluated and compared with a crude hand splitting (HS) method. The machine was able to perform the specific function of splitting wood. It was able to split both dry and wet woods of different widths and sizes. The average throughput capacity of the wood splitting machine for dry wood was 423 woods per hour, while that of hand splitting method was 240 woods per hour; the average throughput capacity of the wood splitting machine for dry wood was 345 woods per hour, and that of hand splitting method was 210 woods per hour. This result suggests that the throughput ratio of WSM to HS was 1:1.7 for dry woods, and 1:1.6 for wet woods. Labor charge for hand splitting wood of the size used for this study was ₦ 5 per wood; while labor charge using the develop machine was ₦ 1 per wood; this implies that the labor cost of HS is five (5) times that of WSM.

Keywords: Development, MWS, HS, Wood, Split, Machine.

I. INTRODUCTION

Wood has always been an important material in the civilization of the world, and is still used today to make manufacture paper, furniture, buildings, as a source of fuel. There are various kinds of splitters available in the market, still there is a lot of scope and market area to be covered; people in rural areas are not used to machines for splitting wooden logs, rather they make use of traditional methods and manual energy like hand and axe (Karuna,1998). Most people use wood products every day; furniture, paper, plywood, building material, railroad ties, and news print are all made from wood. These last few years the forest resource is increasingly prized especially due to important needs in wood energy. Splitting the wood is the way to value this unused resource. Especially as splitting wood, allows fast and natural wood drying. It also gives to fire wood better quality and guarantees superior combustion. Splitting of logs using axe is a tedious job. Chain-saw, the process of cutting wood into smaller lengths has become easier and faster. But for length wise splitting of logs, chain-saw cannot be used when the log is for firewood. Cutting logs using chain saw makes the surface of wood smooth. Firewood surface should have sharp edges or splinters in order to catch fire easily. Hence if a machine has to be designed for log splitting, it should split log such that the effect is similar to that of splitting using axe

Common Splitting Methods in Nigeria

Manual method

Manual woodcutting tools include various saws, axes, chisels, gouges, bits, files, jointers, and manual smoothing planes. The construction of woodcutting machine tools is complex and depends on the type of mechanical woodworking method used: circular saws in rotary machines; planer knives in planers; form (profile) cutters and shank cutters in milling machines; and drills, countersink reamers (counter-bores), and bits in drilling machines.

Mechanical methods

Woodcutting tools are characterized by their cutting elements; their cutting angles and the shape of the cutting faces and blade. In addition, woodcutting machine tools have bracing parts, which come into contact with the corresponding parts of woodworking machines and lathes and serve to coordinate the position of the woodcutting tool in relation to the piece being worked and to transmit the cutting forces to the elements and units in the machines. The bracing parts vary for different woodcutting tools, but they all must provide safe operation and the necessary precision of operation Woodcutting tools whose cutting elements are equipped with hard-alloy blades are used for working cemented wood materials (plywood and fiberboards) and particularly

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hardwoods. During operation, woodcutting tools must produce high-quality working surfaces that meet predetermined requirements for both dimensional accuracy and surface roughness (Whitney et., al). This is achieved by precision manufacture of woodcutting machine tools, standardized heat treatment of the tools, precision grinding and sharpening of the cutting edges, balancing, and precise mounting in the machine. Automatic grinding machines, whose design requirements are determined by the type of tool, are used to grind woodcutting machine tools. Woodcutting tools differ from metal-cutting tools by their small angles of taper and cutting and high blade sharpness.

II. METHODOLOGY

The machine was designed to enhance the splitting of woods, both for commercial and non-commercial purposes. It aimed at avoiding the use of human labor, reducing the use of manual method in splitting of logs and improve log splitting operations in terms of timeliness and convenience.

The respective parts of the device were measured, cut, welded together, grinded to specification before assemblage. The performance test for the machine was carried out, results were recorded and evaluated.

Materials used for Fabrication

Some of the materials used for the construction of this machine include;

Welding machine Drilling machine grinding machine
Metal sheet Rod Cutting machine
Electrode Allen key and bolt Pipe bender
Angle iron

Design Consideration for Parts

The design considerations for the different parts of the machine were classified into two; design criteria and functional requirement.

Design Criteria

- The components were designed to ensure easy assemblage.
- The machine was designed for easy maintenance
- The machine was fabricated with easily accessible materials to ensure low cost

Functional requirement of the splitter

- The splitter should be able to split all kinds of logs (dry and wet).
- Skilled and unskilled farmers should be able to operate it.
- It should be more efficient than available manual methods available in the market.

Description of the Machine

The wood splitting machine was made up of the following components;

Electric motor

This was connected to an electric source; it transmits electrical energy into mechanical/ rotational force and transmits it through its pulley. A suitable 3-phase motor was placed on a motor plate belt for motor pulley and cutter roll pulley. The belt alignment and belt tension were adjusted.

To determine the force generated by the electric motor

P = 1520W, N = 1725rpm

V =

Therefore

(This is the force generated by the electric motor).

Table 1: Electric motor specification

s/no	Specification	Unit
1	Voltage	230 volts
2	Frequency	50/60Hz
3	Speed	1725rpm
4	Power	2 H.P

Drive mechanism ……. This device helps to regulate the speed transmitted from the motor through a belt and pulley combination. It transmits the regulated torque to the driving pulley which is connected to the splitter arm.

Splitter blade … High surface finish mild metal steel was used to design the blade at angle of 60^0 for high splitting purpose. The splitter was rigidly fixed to a shaft to avoid accidental failure of its assembly. It was made of a height 144mm and can conveniently split woods with height less than 144mm.

Pulley and belt

A pulley and belt mechanism was used to transfer torque from the motor to the shaft bearing the splitter. Three pulleys were used, one on the electric motor and two on the drive mechanism.

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The belt was ensured to be the suitable size for the pulleys. The diameter of the pulley on the motor was 75mm and transmits torque to the drive mechanism; a pulley of diameter 75mm and 100mm on the device mechanism were used to receive and transmit torque from the motor to the splitter arm. The variation in pulley sizes was to step down speed.

Motor seat …. The motor seat was designed based on the width and length of the selected electric motor. The dimension of the seat was to ensure that the electric motor was well fitted to avoid wobbling during usage. It had a length of 245mm and a width of 210mm.

Punch arm … this is the part that runs a punch (force) into the wood to be split. This was selected subject to the design of the drive way. It was designed to cover appropriate distance along the drive way to give allowance for the placement of the woods to be split. The arm was made of length of 730mm

Driveway …. The length and width selected was to ensure stability when the machine is running. It would also give the punch arm enough space to travel back and forth.

Arm-head …. This was an assumed dimension. But it was ensured it was wide enough to give proper covering against the woods to be split. A length of 200mm and height of 133mm was selected.

Plate 1: Pictorial side view of the fabricated machine

Plate 2: Pictorial rear view of the fabricated machine

Principle of Operation

Operation of the machine is easy and requires only one man to operate it easily. Splitting is accomplished by powering the electric motor. The motor transmits torque to drive mechanism through a belt and pulley connection. The drive mechanism regulates the speed to be transmitted to the punch arm, which punches the wood to be split against the splitter blade. The splitter blade is stationary hence splits the wood as the punch drives through it.

The following steps demonstrate the operating principle of the machine.

- Put on the engine from the main switch
- Ensure proper and smooth motion of the cutting arm.
- Mark the point to be cut on the work piece.
- Carefully position the work piece on the cutting spot when the cutting arm is away.

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- The arm returns and cuts the work piece smoothly in one stroke and returns for another stroke.

Performance Test

A performance test was carried out on the wood splitting machine (WSM). It was used to split wet and dry woods of various sizes. Wet woods had moisture content of 40% and above while dry woods had a moisture content of less than 25%. The respective woods were sawn to length 30cm and height 10cm. A performance test of splitting was carried out for 30 minutes, results were recorded and the procedure was replicated five (5) times. These results were compared to local method of hand splitting (HS), and evaluated.

Evaluation Parameters

The fabricated machine was evaluated considering the following factors;

Workability … this ascertains if the machine works, splits wet and dry woods and different sizes.

Throughput capacity … this is the ratio of the number of woods split to time.

Mathematically;

Splitting cost implication … this is the labor cost for splitting wood manually.

Mathematically

Where n … number of woods

c … cost of splitting per wood

III. RESULTS

Workability… the machine was able to perform the specific function of splitting wood. It can be easily assembled, modified, easily transported to different locations and the parts can be easily maintained or replaced.

Throughput capacity … table 2 and 3 shows the throughput capacities of the developed wood splitter and hand splitting method for dry and wet woods respectively. The average throughput capacity of the wood splitting machine for dry wood was 423 woods per hour, while that of hand splitting method was 240 woods per hour.

Table 2: Throughput capacity (dry wood)

Replicates	WSM (No per hr)	HS (No per hr)
1	**403**	**270**
2	**425**	**223**
3	**428**	**231**
4	**435**	**244**
5	**422**	**230**
Mean	**423**	**240**

The average throughput capacity of the wood splitting machine for dry wood was 345 woods per hour, while that of hand splitting method was 210 woods per hour.

Table 3: Throughput capacity (wet wood)

Replicates	WSM (No per hr)	HS (No per hr)
1	**348**	**215**
2	**351**	**198**
3	**349**	**221**
4	**331**	**212**
5	**344**	**205**
Mean	**345**	**210**

Figure 1 gives the graphical distribution of the respective throughput capacities of both the wood splitting machine and hand splitting method for both dry and wet woods. Result suggests that the throughput ratio of WSM to HS was 1:1.7 for dry woods, and 1:1.6 for wet woods.

Splitting cost implication … as at when this study was reported, labor charge for hand splitting wood of the size used for this study was ₦5 per wood; while labor charge using the develop machine was ₦1 per wood.

Therefore for a thousand woods, while WSM would cost ₦1, 000 as labor cost, HS would cost ₦5, 000, which is five (5) times the labor cost for WSM.

IV. CONCLUSION

The machine was successfully constructed and tested. Locally sourced materials were used.

The machine was able to perform the specific function of splitting wood. It was able to split both dry and wet woods of different widths and sizes. The average throughput capacity of the wood splitting machine for dry wood was 423 woods per hour, while that of hand splitting method was 240 woods per hour, while the average throughput capacity of the wood splitting machine for dry wood was 345 woods per hour, and that of hand splitting method was 210 woods per hour.

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