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Development of Solar Powered Shredder Machine for Waste Management

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Abstract: ***The scope of the project is to design and develop a focused shredder machine for crushing coconut leaves and betel leaves and making compost for shredded dry worms. The project started with the collection of information and data about the user's lifestyle and the current process of doing their work. The concepts were developed in the context of four different shredder machines and operating systems. Security factor The concept was developed with the customer operation environment and management in mind. A model has been developed keeping in view the needs and affordability of the customers. The machine consists of a single-phase motor, spur gear, bearing, structural frame, cutter and dual shaft. The frame of the machine is made of mild steel and tungsten carbide is used to prepare the cutter tip. The eight cutters are mounted on two shafts which are rotated parallel by a spur gear. The power from the electric motor is transmitted to the cutter shaft via a belt drive. The inside of the cutting house is cut due to the effect of tension, friction and impact during the cutting process. Cut the coconut leaves and collect the powder at the bottom.***

Keywords: Waste Recycling, Shredder Machine, Solar Energy, Waste Management etc.

I. INTRODUCTION

Traditional agro-waste disposal is the traditional and ancient method of disposing of waste in which agricultural waste is dumped as it decomposes at a specific location to decompose. Dumping garbage like this takes longer to decompose and causes environmental pollution. The goal of the waste shredder machine is to reduce agricultural waste and convert it into useful nutrient fertilizer. Agriculture is one of the most important sectors in the Indian economy. Coconut palm cultivation is one of the major sources of livelihood for farmers in Kerala and Karnataka. Awareness is expressed that large quantities of agricultural waste are not being utilized as there are difficulties in the management, storage and management of agricultural waste. This is due to their low bulk density and large area / volume for storage. Farmers in the fields burn most of this waste after harvest. This burning of agricultural waste is repeated every year. In order to use this waste for some economic purposes, it was felt that such a machine would be needed after shredding all types of agricultural waste that are economical and practical.

II. SCOPE OF SHREDDER MACHINE

Literary study is done on the basis of various existing shredder machines and it has been observed in the field survey that labor is widely used to shred agricultural waste and the existing machine price is also expensive. Overcome these difficulties by designing electric powered machines that increase human fatigue. Safety features such as belts and pulleys and gear coverings are also considered when designing the machine.

III. BLOCK DIAGRAM

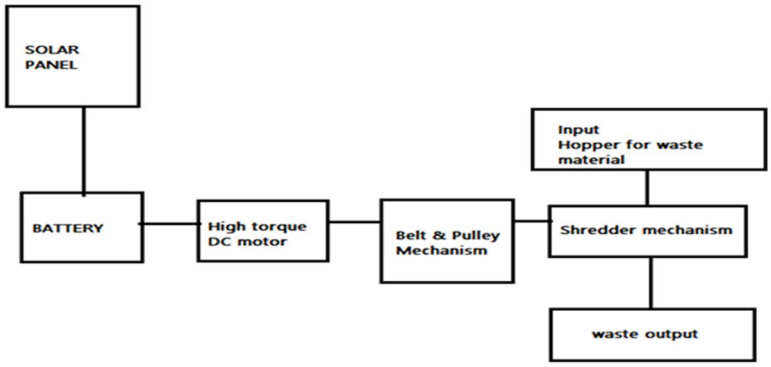


Fig. 1. Block diagram of the system

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Using an electric DC motor for the shredder, an electromechanically operating model was developed that minimized human effort as well as human intervention. The process is much easier compared to previous methods. The machine was first connected to a DC power supply. The cutters are mounted on dual shafts with cutters on each shaft. Dry farm waste is poured into a cutter assembly through a tank. While the coconut leaves are moving towards the cutter, in a rotating motion, the coconut leaves should be grated and cut on the other side of the machine.

IV. COMPONENTS

1) Frame Structure: size of 4ft*1.5ft*2.5ft with rectangle beam mild steel frame is used.
2) Hopper : 1.5ft*1ft*1ft with mild steel plates is used to construct.
3) Solar Panel: 12 v , 25 w is used.
4) DC high torque Motor : 60 kg torque , 500 RPM
5) Battery : 12V , 8 Amp is used
6) Shredder blade : mild steel thin sharp blade is used
7) Belt and pulley : 2.5 inch small , 4 inch big pulley with its belt arrangement.
8) Switches and wire
9) Collecting box
10) Other

V. FLOW CHART FOR WASTE SHREDDER MACHINE

Figure 2 shows the assembly process of the coconut leaf shredder. The quality of the material is checked at the collection stage in accordance with the design requirements. At this stage the skeleton of the section is made according to the dimensions specified by the design.

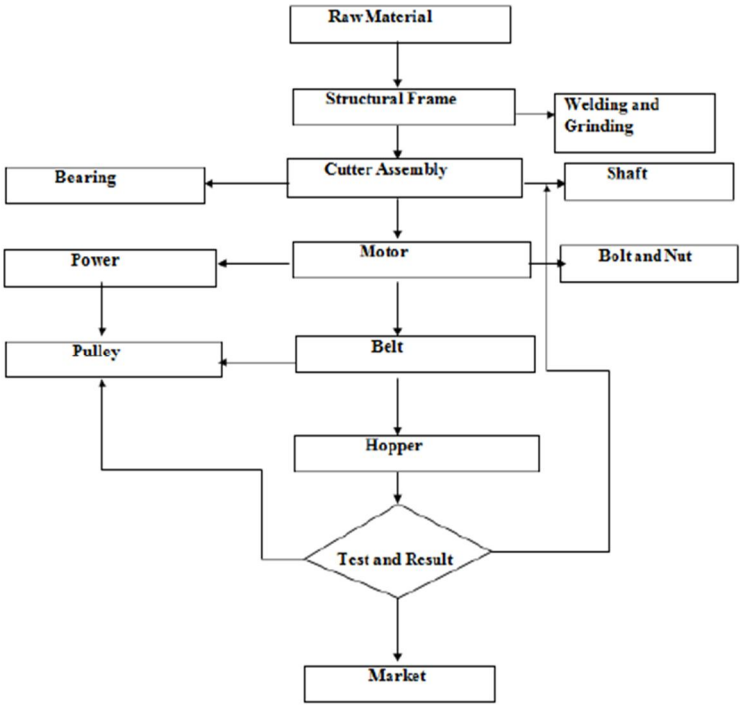


Fig 2. Flow Chart for Agricultural waste shredder machine

At this stage the flow chart of the section is prepared according to the dimensions specified in the design. The frame is made according to the specified design and material. After inserting the shaft go to the cutter assembly to assemble the cutter container, and then fasten the cutter with the key on the shaft and make sure all the cutters on the spacer are not otherwise the cutter may be damaged and this will also produce more noise. And vibration. The motor is mounted on the other side of the frame with the help of bolts and nuts. The tank can be mounted on a cutter assembly to properly feed the coconut leaves. Mount the pulleys and V-belts to set the belt to the correct tension, otherwise the belt will slip. Finally all the assembly work is done and the machine is ready.

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VI. EXPERIMENTAL DIAGRAM



Fig 3.Experimental Diagram

The model was developed, which works electromechanically, which reduces human effort as well as human intervention by using an electric DC motor for the shredder. The process is much easier compared to the previous methods. The machine was first connected to a DC power supply. The cutters are mounted on dual shafts with 5 cutters on each shaft. Dry farm waste is fed to the cutter assembly by tank. As the coconut leaves move towards the cutter, it rotates at a speed of 550 rpm and shreds the coconut leaves on the other side of the machine.

VII. CALCULATION

A. Solar Panel Calculation

Ipv, photovoltaic current = total current required to charge the battery from the solar panel
Ei= input energy to the battery
V = system voltage = 12V
H = peak sunshine hour, the average number of hours the solar energy can be captured. H = 5hrs.
Thus
Ipv=4395.06/ (12 x 5)
= 73.25Amperes.
In order to compensate for the losses due to the inefficiency of the solar panel,20% of Ipvis added so that
Ipv= 73.25 + (0.2 x 73.25) = 87.9A.
With a solar panel of the above rating, the peak or open circuit voltage, VP = 12V , 25w.

B. Cutting area made by edge of the blade

A= W × T
A= 2mm× 2mm
A= 4 mm 2. 7 mm
Where, A = cutting area made by edge of the blade.
W = width of cutting edge.
T = thickness of cutting edge.

C. Force acting on edge of the blade

Shear strength = 51.71 MPa.
Shear strength = Force /Area
51.71= force ÷ 4
Force = 206.78 N.

D. Torque exerting on the blade as well as shaft

Torque (T) = Force × perpendicular distance
Torque = 206.78 × 50×e-3
Torque (T) = 10339 Nm.

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E. Power Required

Required speed, N = 60 rpm
P = (2×Π×N×T) ÷ 60000
P = (2×3.143×60×10339) ÷ 60000
P = 64.92 w.
=>P = 1 HP (Aprox. DC power motor required).
Blade material: mild steel [ultimate shear strength = 580 Mpa]
Assume factor of safety [FOS] = 3
FOS = ultimate tensile shear strength ÷ working shear strength
3 = 580 ÷ working shear strength.
Hence design is safe.
i.e.; working shear strength = 193.33 Mpa > 51.71 Mpa.

F. Design of Hopper

Volume of the hopper = 1/3 [A1 + A2 +√(1 + 2)] × h
Where, A1= Area of top base
A2= Area of bottom base
h= Height of hopper
Volume of the hopper = 0.035625 m3

G. Determination of Shaft Diameter

$$d^3=\frac{1}{\pi}\sqrt{(K \times M)^2 + (K \times M)^2}$$

Where,
d = diameter of the shaft = 12 mm
Allowable shear stress of metal with key way = 40 × 106 N/m2
Mb = maximum bending moment = 25.61 Nm
Mt = torsion moment = 22.3 N
Kb = combined shock and fatigue factor applied to bending moment = 2.0 (sudden loading)
Kt = combined shock and fatigue factor applied to torsional moment = 2.0 (sudden loading)

H. Selection of Pulley and Speed of Shaft

By studying various research papers on design of plastic waste shredding machine we select the a speed of final output shaft, and the diameter of pulley. We assume that the input speed as per the motor specification which is mentioned as below.

We select the motor of ½ HP (dc high torque). and assume the motor speed is 300 rpm. The calculation for determination of pulley diameter and the speed of output shaft is given as below
Motor power = 1 HP (DC high torque)

= 0.372849 kW
Speed of the Motor = 300 rpm
Diameter of Pulley 1 = 30 mm (d)
Speed = 300 rpm (N1)
Diameter of Pulley 2 = 254 mm (D)
Speed (N2) =?
N2 = 35 rpm

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I. Cutting Blade

Total cutter on one shaft 5 and 4 cutter on other shaft
So that,
9 cutters divided in 2 set
Number of cutter=9
=9/2
=4.5 set distance
Power requirement by cutting system
Cutting forces
Fc = (Ks*S)/G
= (4*15)
Fc = 60N
Fc=cutting forces of paper (kg)
Ks= tear strength of paper (n)
S=max paper load (sheet)
G=gravity (m/s2)
Fc= Fc*no. of blade
= 60*9
= 540 N
D = Diameter of blade 6 inch=152 mm
T = Fc*D/2
= 540*152/2
= 41040 N.M

VIII. RESULT AND DISCUSSION

The development of solar powered shredder machine for waste management is in performance testing. Shredder machine performance is measured using the amount of shredded powder at different time intervals. The machine cutter assembly is capable of cutting 5-10 kg of organic waste, but manual cutting of organic leaves is very laborious and time consuming. Performance testing was performed on an advanced agricultural waste shredder machine to ensure its compatibility and working efficiency. The graph below shows the time V / s weight of the powder. The graph clearly shows the amount of waste collected over time. The test is performed at 4 different intervals.

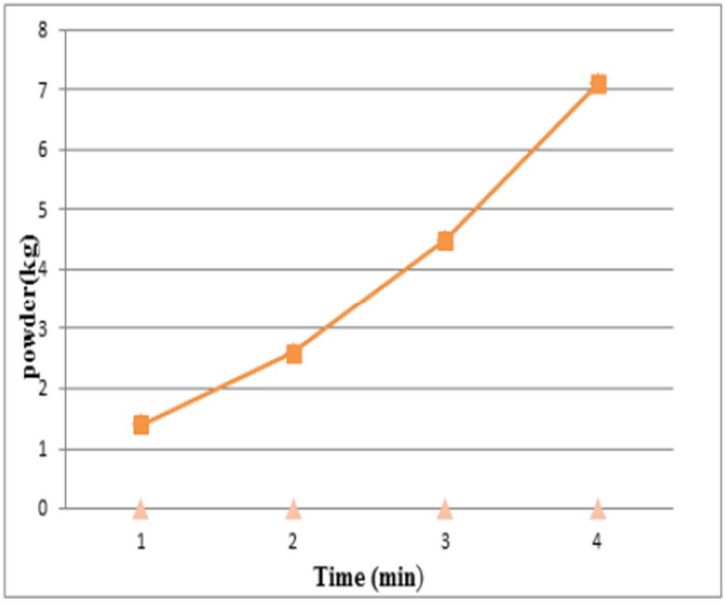


Figure 8: Graphical representation of time (min) v / s Dry weight (kg)

IX. CONCLUSION

Waste recycling is an effective way to improve environmental performance. With the help of this portable shredding machine, organic waste, paper, cardboard, lightweight plastics, cables, etc. can be wiped out. That is why we have designed and manufactured a solar powered portable shredding machine.

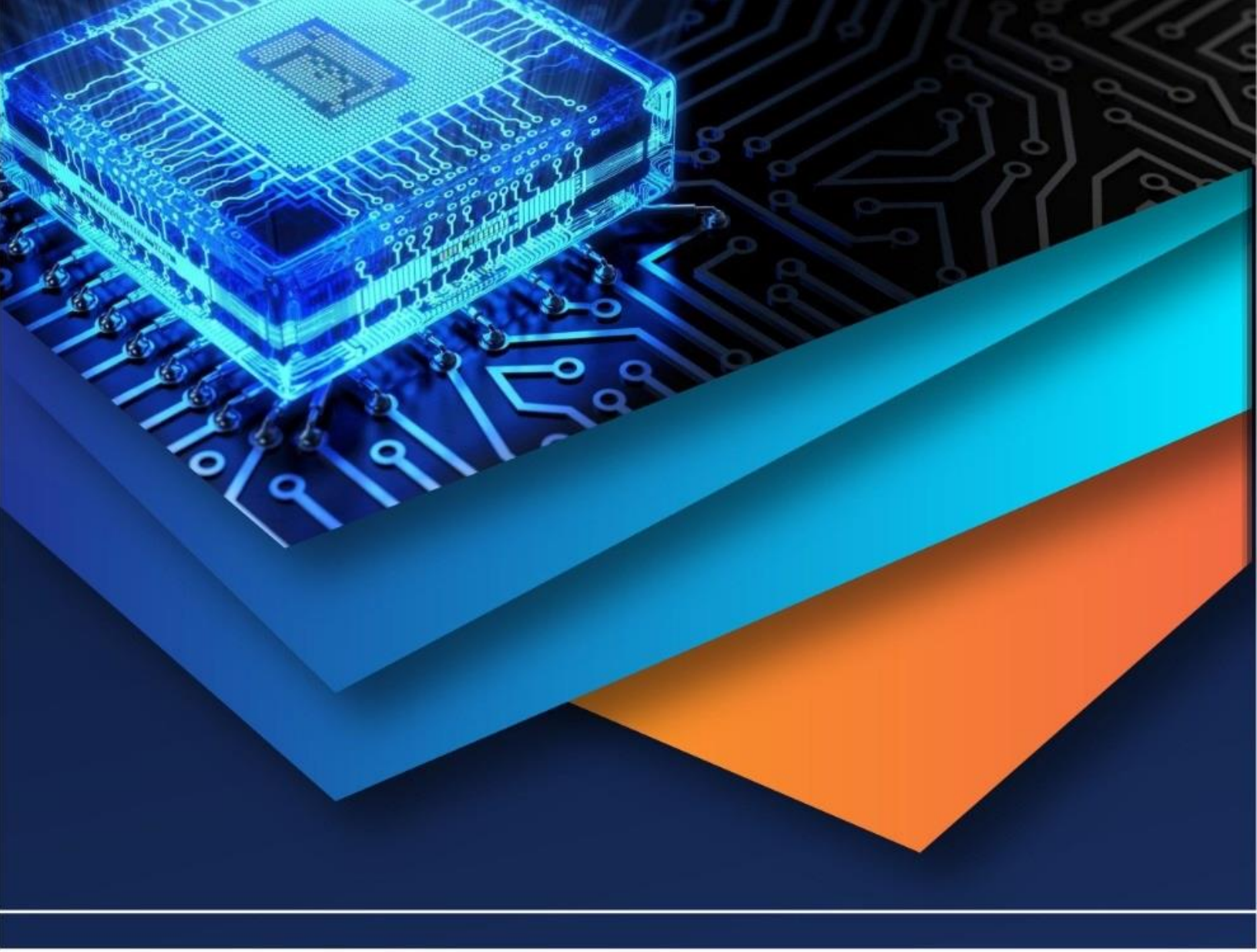
The following important points are incorrect from our project work

1) The developed model is simpler, more efficient, less time consuming and less expensive than the available models.
2) User friendliness and importance in operation is primarily given to security. Rotating elements such as belts and pulleys and gears are covered, so it is completely safe for the operator.
3) The assembly was checked for tightness and found to be reliable.
4) The overall performance of the shredder machine is satisfactory considering the amount of powder produced over time.\

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