

“Design of Automatic Organic Waste Shredder for Composting”



Ashwini M. V., Robinson P., Nithin P. S., Seella Charan

Abstract: *Developing means of farming and agriculture is the reason humans live in the world they do today. It is a necessary means of survival, without which there would be famines all over the world. For thousands of years, agricultural was a natural process that did not harm the land it was done on. Environmental impacts caused due to the harmful effects of human activities are a worldwide problem causing global warming and climate change. Too much dependence on the usage of chemical inputs and the burning of farm wastes was identified as the major ones. Since this issues are threat to mankind and to the existing agriculture equipment's and the shredder machine is one among them. The machines available in the market are powered via fossil fuels which is also contributing to global warming, this directed the researchers to design and develop a Solar-Powered Shredder machine which can be efficiently operated using solar energy without the dependency on fossil fuel. This project aims at providing solar powered automatized vertical shredder machine to our farmers that is compact and can be operated by using solar.*

Keywords: *Solar energy, Shredder machine, Compost, Organic farming, Automatic.*

I. INTRODUCTION

To begin with, the earliest source of the pollution has been pesticides and fertilizers. Modern day pesticides & fertilizers have to deal with the local pests that have existed for hundreds of years along with the new invasive species. And so, they are laden with chemicals that are not found in nature. Once they has been sprayed, it does not disappear completely. Some of it mixes with the water and seeps into the ground. The rest of is absorbed by the plant itself. As a result, the local streams that are supplied water from the ground become contaminated, as do the animals that eat these crops and plants. Contaminated water used for irrigation is one further source of pollution. Much of the water we use comes from ground water reservoirs, canals and through the rains. While plenty of it is

clean and pure water, other sources are polluted with organic compounds and heavy metals. This happens due to the disposal of industrial and agricultural waste in local bodies of water. As a result, the crops are exposed to water which has small amounts of mercury, arsenic, lead and cadmium dissolved in it. The process of agricultural pollution becomes harder to fight when such water poisons the livestock and causes crop failure. Further problems are caused by soil erosion and sedimentation. Soil is comprised of many layers and it is only the topmost layer that can support farming or grazing. Due to inefficient farming practices, this soil is left open for erosion and leads to declining fertility each year. Whether eroded by water or wind, all this soil has to be deposited somewhere or the other. The resulting sedimentation causes soil build up in areas such as rivers, streams, ditches and surrounding fields. And so, the process of agricultural pollution prevents the natural movement of water, aquatic animals and nutrients to other fertile areas. Agriculture play's an important role in air pollution. The excessive use of pesticides contaminates the environment making it poisonous to in heal for the humans. Burning of crop fields also pollutes the atmosphere. India uses more than 4 billion liters of diesel (13% of total diesel consumption in India) and around 85 million tons of coal per annum (19% of total coal consumption in India) to support water pumping for irrigation .The use of diesel powered or other fossil fuel powered equipment's such as Tractors, SHREDDER, watering system, Rotator, Roller, Planter, Sprayers, and so on also pollutes the environment. The CO and NO₂ (carbon monoxide and nitrogen oxide) which is emitted by this equipment's get absorbed by the crops hindering the life of the plants and also effects the vegetation. Agricultural pollution is the main source of pollution in water and lakes. Chemicals from fertilizers and pesticides make their way into the groundwater that end up in drinking water. Health related problems may occur as it contributes to blue baby syndrome which causes death in infants. Oil, degreasing agents, metals and toxins from farm equipment cause health problems when they get into drinking water. Banned pesticides are now part of our diet, such as Cypermethrin, eptachlor, Quinalphos, Aldrin, Chlorodane, Dichlorvas, Cypermethrin. Some vegetables have been categorized as extremely harmful in terms of levels of pesticide these pesticides can seriously harm our health.

II. CONCEPT GENERATION

The concepts were generated on to provide our farmers a solar powered automatized vertical shredder machine that is compact in size, easy to operate, should be portable, reliable to maintain the machine and can be operated by using solar gird that has already been installed

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by the framers for the purpose of solar pump.

Concept 1: Horizontal Feed Conventional Organic Waste Shredding Machine

In this type of shredder machine (fig no:2.1) mainly consists of cutter, mounted on dual shaft, motor is attached at the base, and smaller pulley at the motor end gives drive with the help V-belt to bigger pulley which is connected to gear. One gear will give drive to other gear, and Barrel rotates in opposite direction with the help of these gears. Shaft it rotates at 520 rpm at this time organic waste is fed into the hopper for high rotational speed of cutter assembly were the Macro organic waste is converted in micro particles.

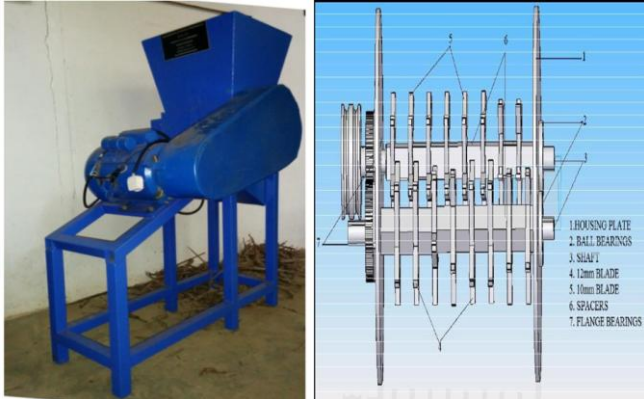


Fig: 2.1 Horizontal Feed Shredder Machine **Fig: 2.2 Horizontal Blade Setup**

Advantages

1. This is electrical powered.
2. The machine can handle bulk amount of organic waste.
3. Simple to operate.

Disadvantages

1. The machine is bulky and occupies more floor space.
2. Machine cannot be portable.
3. As the machine has more complex parts such as blade assembly as shown in the fig 3.2 Hence decreases reliability of the machine.
4. As the machine as more moving parts, the power requirement of the machine is more hence cannot be powered by solar power.
5. Noisy and vibrations while operating the machine

Concept 2: Solar Powered Automatic Vertical Feed Shredding Machine

The proposed design is a size-reduction apparatus, especially for leafs, stalks of trees, paper and food waste. The machine is provided with a loading chute (hopper), a chopping chamber having a chopping blade which rotates about a vertical axis, a shredding chamber having a cutting blade which rotates about a vertical axis, a feed tube which opens into the shredding chamber, commencing with the lower shredding chamber. An electric motor supported in the housing has its output shaft projecting into the shredding chamber and a respective discharge chute or conduit for each of the shredding and chopping chambers. The chopping chamber and the shredding chamber are disposed next to one another. The proposed design is very compact and can be easily portable.

Advantages

1. The machine make use of propeller grind (blade grind) mechanism which Makes the machine compact in size
2. The machine can be easily portable because of the compactness
3. The machine can shred very efficiently when compared to conventional Shredder
4. The power required to run the machine is very less when compared to Conventional machine has it as very less moving parts
5. The machine can easily powered by solar energy
6. The machine can be multi powered since it uses a BLDC motor
7. Easy to operate.

III. DESIGN FOR PAPER SHREDDING

From literature survey it is found that shear force (tearing force) required to cut the paper is 4N for single sheet or piece of paper, hence considering 15 sheets of paper so the force required to shear the paper by blades

$$F_c = (K_s * S) \\ = (4 * 15) \\ = 60N$$

Design for Plant Waste (Leafs, Stalks) Shredding

From literature survey it is found that shear force (tearing force) required to cut the Leafis is 3.36N-6N for different leafs considering an optimal cutting force i.e. 4.5N for a single leaf ,Hence considering 15 of papers so the force required to shear the paper by blades

Considering stalk the sheer force (tearing force) required to cut the stalk is 30-60N for smaller stalks for different plants consider an optimal cutting force i.e. 52.145(for mango stalk)

$$F_c = (K_s * S) \\ = (4.5 * 15) \\ = 67.5N$$

Battery Source Requirement

As the BLDC motor works only on DC current the voltage and current required for the selected motor is Voltage=48v Current =30amp The required battery power (wattage) to run the machine for 1.5 hours is Motor (power) Watt/hour=1125wh

Solar Power Requirement

The solar energy can be used to run the machine in 2 ways

- Direct use of solar energy to operate the machine without the use of batteries and other source of energy
- Solar energy used to charge the batteries and then used to operate the machine the power generation rating of a Solar panel is also given in Watts. In Theory, to calculate the energy it can supply to the machine or to the battery, you multiply Watts (of the solar panel) by the hours exposed to sunshine. The latitude angle of sun in Bangalore is =12.9716*(degree) The average sunshine in Bangalore is 9 hours Hence to find out the number of solar panels required to run the machine directly from solar energy can be calculated as given below

Required voltage, current and power (watt) to operate the machine is

$$\text{Voltage} = 48 \text{ v}$$

$$\text{Current} = 16 \text{ amp}$$

$$\text{Power (watt)} = 750 \text{ watt}$$

The available solar planes in market is

$$\text{Voltage} = 24v$$

$$\text{Current} = 11.6$$

$$\text{Power (watt)} = 325 \text{ watt considering the efficiency up to } 80\% = 260 \text{ watt}$$

The Number of solar panels required to run the machine directly from solar energy is Required load to run the machine for 1.5 hour is = 1125wh

$$\begin{aligned} \text{Number of solar panels (N)} &= \text{load (watt)/single solar panel watt} \\ &= 1125/260 \\ &= 4.326 \end{aligned}$$

Hence the number of 325 watt solar panels required to operate the machine directly using solar energy is $N=4.326= 5$ panels Now to charge the battery by solar energy and using it for future use can be calculate as Considering the availability of sunlight 8 hour per/day

$$\text{The wattage of the battery is } 1440w$$

If we consider the battery to be charged by 8 hours

$$\text{Then required wattage of the solar panel is given by (w) = wattage of battery/time in hours} = 1440/8$$

$$\text{Hence the required wattage of the solar panel considering the efficiency of solar panel to be } 80\% = 180/0.8=225 \text{ watt}$$

IV. WORKING PRINCIPLE

The working principle provides us the functionality of the developed model. The developed model acts as an electromechanical mechanism that reduces human intervention, along with human effort, by using electric motors to cut leaves. This process is much simpler than earlier procedures'. The design incorporates propeller grind mechanism in vertical direction where the motor is mounted in vertical position and the blades are mounted on the motor shaft. The input is feeded through a hopper in vertical direction on to blade setup which gets chopped or grinded and the output is pushed out .The design aims to promote an environment friendly machine for farmers to mitigate the possible effects of common agricultural practices to warming and climate change .Generally, the design focused on the automation of the shredder machine through engineering methods using arduino Uno microcontroller. To mitigate the factors of global warming in common agriculture practices through composting and the automation of the shredder machine was actually too general. It also promotes the use of solar power instead of using fuel engine oil or gasoline in powering the machine to mitigate the effect of greenhouse gases to global warming and weather condition may actually intervene the use of solar power. Electric AC grid power and battery source was also included as an alternative for solar power as a feature of the machine. Hence in the conducted research, the source was limited only to solar power energy. The automation process of the machine was not limited to biodegradable energy leaves which means that any material placed in the machine enabled the machine to operate thus, the ability of the machine to shred any material depends on the design and material of the blades.

The system consist of Arduino Uno microcontroller that controls the ultra-sonic sensor and verifies the data gathered and triggers the relay switch when input detected which runs the shredder blade of the machine making it operation mode. The machine must put in first in operation mode to the actual

feeding of the actual leaf to be shred so that full turning speed of the motor will be met and to avoid sudden change in voltage .relay shield was used to protect the Arduino Uno board and a relay switch will acts as the automatic switch off the system.



Fig: 4.1 Shredder machine.

V. RESULTS AND DISCUSSIONS

Testing Of the Developed Machine

Different performance measuring test where conducted and was compare with existing machine performance as shown

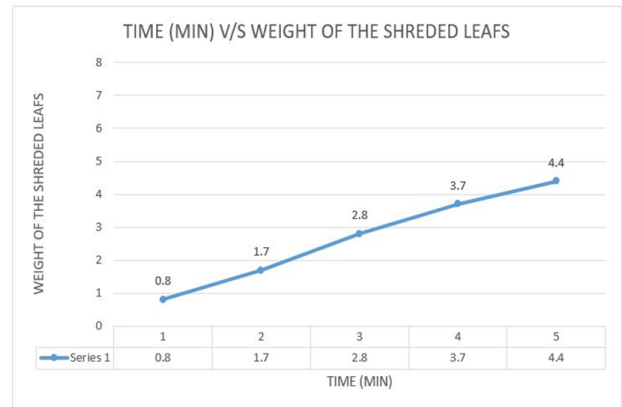


Fig: 5.1 Time (min) v/s Weight of the Shredded Leaves

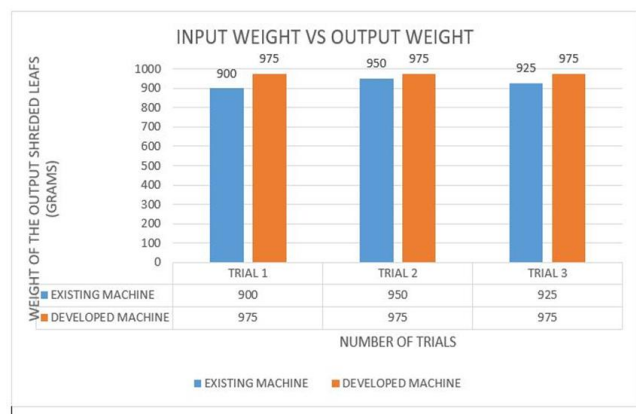


Fig: 5.2 Input Weight v/s Output Weight

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- By using “SOLAR POWERED AUTOMATIC VERTICAL SHREDDER MACHINE” farmers will be able to shred their agriculture waste by using solar power without the dependency on AC power supply which can be used for compost preparation.
- The developed machine is simple, efficient, requires less time, and cost effective when compared to existing machine. The overall performance of the shredder machine is satisfactory by considering the size of the shredded substance with respect to time.

VI. CONCLUSION

- By using this machine farmers can shred their agriculture waste using solar power without the dependency on AC grid power supply and can effectively shred depending on its required shape and size for compost preparation.
- Implementation of the battery and multipurpose capability enables the machine not only restricted to farmers having large solar grid but also to smaller farmers and general citizens to use the machine with a smaller solar grid or regular AC supply for the preparation of compost.
- The developed machine is simple, efficient, requires less time, and cost effective when compared to existing machine. The overall performance of the shredder machine is satisfactory by considering the size of the shredded substance with respect to time.

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Ms. M. V. Ashwini, Assistant Professor of Mechanical Engineering holds Master of Engineering Degree in Product Design & Manufacturing from East Point College of Engineering & Technology, Bangalore and Bachelor of Engineering Degree from M V Jayaraman College of Engineering, Bangalore. She served as an Assistant Professor in VTU affiliated Engineering college for 1 year. She has taught Manufacturing Technology, Kinematics of Machines and Elements of Mechanical Engineering. Ms M .V. Ashwini has attended many international conferences, has presented 11 papers in International & National conference. Ms. Ashwini has attended workshop on Finite element methods, Mechatronics. Her current areas of research interest are Product life cycle management, Product Design and lean Manufacturing..



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