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Design and Fabrication of Plastic Shredding Machine

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Abstract: ***Plastic is one of the most common used materials in the world today, but, they cause serious environmental pollution and exhaustion of landfill space. The recycling of waste plastic recovers the material, which can be used to make new plastic products such as containers, plastic lumbers and particle boards. For this to happen, the waste plastic will first be the effect of plastic waste is environment problems such as: chain food disturb, contaminate ground water, air pollution, extinction anima, poisonous soil, and act. One of the handling for plastic waste is recycling. It starts with separating plastic waste by kind of plastic. The next step is crush it until it becomes small flakes. The Small flakes can be directly used for making product such as pot, filler material for mixing with road asphalt or plastic granulate for making a product by injection mold or extraction. In order to handle plastic waste into small flakes, plastic shredder can be used to realize the making of prototype of plastic shredder machine. The concept design of the shredder machine that is currently available is fairly similar. The shaft and blades are the critical components in the shredder machine that determines its performance. The geometry and orientation of the blades that were fitted into the single or double-shafts were found to directly affect the shredding performance. Therefore, this article aims to review the various geometry and orientations of the blades that give direct effect on the shredding performance, as well as identifying the research gaps related to the shredder machine for plastic waste materials.***
Keywords: Shredding machine, Hopper, Jaw Type Coupling, Meshing Gears

I. INTRODUCTION

A plastic shredding machine is a mechanical device used to cut plasticmaterials into smaller pieces. The machine is designed to reduce the size of plastic waste and make it easier to transport and process for recycling or disposal. The plasticshredding machine works by using a series of blades or knives to shred the plastic intosmall pieces, which can be further processed into pellets or melted down to create newplastic products. Plastic shredding machines come in various sizes and designs, from small hand-held units to large industrial machines used in recycling facilities. Some shredding machines are designed to handle specific types of plastic, such as PET bottles, while others can handle a wide range of plastic materials. The benefits of using a plastic shredding machine include reducing the volume of plastic waste, saving space in landfills, and making it easier to transport the material for recycling. Shredding plastic waste also helps to prevent the release of harmful chemicals into the environment, as plastic waste can release toxic substances when left to decompose. The shredding process involves feeding plastic materials into the machine's hopper, where they are cut into smaller pieces by a set of rotating blades or cutters. The resulting plastic fragments can then be sorted, melted, and reformed into new products or used as a source of fuel. In summary, a plastic shredding machine is an important tool for reducing the volume of plastic waste and facilitating the recycling process. It is an essential component of any waste management system that aims to minimize the environmental impact of plastic waste.

Design of a plastic recycling machine which combined the principle of conveying and heating to effect shredding and melting of the plastic was however attempted, this machine was observed only suitable for domestic plastics of smaller units. Although optimization attempt was done for the heating process, the conveying unit and extrusion for efficient output need be thoroughly analyzed. The desired to package shredded waste plastic for foreign export as may be required for foreign exchange earnings should encourage stand alone shredding operation for such waste plastic management. Waste plastic shredder is a machine that reduces used plastic bottles to smaller particle sizes to enhance its portability, easiness and readiness for use into another new product. The design principle of this machine was got from the ancient tradition method of using scissors to cut materials into reduced form and scratching used by rabbits when digging or tearing. These two traditional methods were applied in the design of the machine by fabricating cutting blades to cut the waste plastic while some of the cutting blades have sharp curved edges to draw-in the plastic into the cutting blades teeth. The waste plastic shredder comprises of four major components, namely; the feeding unit, the shredding unit, the power unit and the machine frame. The machine can be powered by electric motor of 2 Hp.

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A. *Project Background*

The plastic shredding machine in this study is designed to apply sufficient amount of shredding force through a cyclic impact loading on the plastic waste material to be shredded. This induces adequate energy in the plastic material causing its molecules to separate or deform relative to each other. This type of machine is made up of five main parts namely: prime mover, hopper, shredding chamber, shredding shaft, and the collector bin. The prime mover is an electric motor which generates the torque needed to rotate the shredding shaft. The hopper is the part of the machine that empties the plastic waste into the shredding chamber. A chute located by the side of the hopper guides the plastic waste into the hopper. The top of the hopper is covered in order to prevent popping/flying plastic waste from escaping during operation. The shredding chamber is made up of a pair of static blades attached by the length of the inner wall and a mesh screen at the base. The mesh screen ensures that only shredded plastic particles smaller than the mesh size are allowed to pass through to the collecting bin. The shredding shaft is housed in the shredding chamber; as it turns, it shreds plastic waste caught between the blades on the shaft and the static blades by the sides of the wall. This action is carried out repeatedly until the plastic waste in the shredding chamber has considerably reduced in size and are no longer been trapped between the shredding blades

II. PROBLEM DEFINATION

A. *Problem Statement*

Plastic pollution involves the accumulation of plastic products in the environment that adversely affects wildlife, wildlife habitat, or humans. Plastics that act as pollutants of the prominence of plastic pollution is correlated with plastics being inexpensive and durable, which lends to high levels of plastics used by humans. It is slow to degrade in naturally. Plastic pollution can unfavourably affect lands, waterways and oceans. Living organisms, particularly marine animals, can also be affected through entanglement, direct ingestion of plastic waste, or through exposure to chemicals within plastics that cause interruptions in biological functions

B. *Objectives*

1) Study of Shredder machine with Different elements like Blades, V-belt Drive, Single-Shaft, Frame.
2) The scope of the project is to reduce the burning of plastic waste and control the environmental pollution.
3) To reduce plastic waste place into landfills
4) Fabrication of Shredder in Compact Size and less manufacturing cost with best output.
5) Use of Machine at local recycle stations and development with Single Shaft must be indented

III. METHODOLOGY

Since the shredding machine will be in constant friction from the cuts of the plastic material, it must be made of a durable material. For this, suitable materials were chosen for the mechanical assembly of the shredder. Aluminium, stainless steel and bearings are one of the major usage in shredding operation. Aluminum will be used for the case of the Plastic Shredding Machine, which is also a lightweight and durable material. The blades of the plastic waste shredding machine will be made of stainless steel to maintain the durability of the friction when making the cuts, the shaft that will hold the blades will also be made of stainless steel, which will be supported by rolling bearings for mobility shredding machine. To arrive at the result of the design that will be presented in the article, a preliminary study was made which consists of the durability of the product, its efficiency, and its sustainability over time.

A. *Shredding*

A shredder is a machine used for shredding (size reduction). Shredding systems are used to reduce the size of a given material. Industrial shredders are equipped with different kinds of cutting systems such as vertical shaft design, horizontal shaft design, single shaft, two shaft, three shaft and four shaft cutting systems, Biodegradable waste decomposes faster when shredded.

B. *Design Concept*

While designing this plastic shredding machine, some assumptions are considered which is standard for their parts. We made safe design for this machine by calculating the dimensions of each parts and considering formulations. Material selection based on availability, durability, cost and ease of fabrication were also considered. Shredding process is to reduce size of the plastic wastes into the small size. The plastic wastes are collected from the different kind of places. These are particularly sorted based on the thickness and the types of plastics. This separation is achieved by the use some grades of plastics. Once these processes are completed the plastic wastes are cutter into small scraps (i.e shred) by manually.

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C. Working Mechanism

Working principle gives us the functionality of the developed model. The developed model, acts as an electro mechanical which reduces the human effort as well as human intervention by utilizing the electrical motor for the cutting of leaves. The process is very much simplified as compared to the earlier processes. The machine is first connected to the 1-phase power supply. Cutters are mounted on dual shaft each shaft has 7 cutters. After that dry agro waste are fed through the hopper into the cutter assembly. As the coconut leaves moves towards the cutters, rotating at the speed of 550 rpm, the coconut leaves get chopped and chopped is collected on the other side of the machine.

D. Material Selection

Material selection based on availability, durability, cost and ease of fabrication were considered. The efficient performance of the machine and acceptability of the machine to the farmers and households who would be the user of the machine was profound to be the main focus. The cost of the machine is relatively low so that farmers can easily purchase. Also, it is easy to operate, even by non-educated farmers, if it needs to be. The following advantages were obtained from the design considerations: reasonable design, compact structure, safe and durable, only one motor drive, low noise, easy operation, compact layout, stable work, convenient to move, low energy consumption, high production efficiency, reasonable price.

E. Construction

Plastic shredding machines can vary in construction depending on their intended application, size and capacity. However, most plastic shredding machines share some common components, which include :

1) *Hopper:* This is a large opening located at the top of the shredding machine where plastic waste is fed into the machine for processing.
2) *Blades:* These are the components responsible for cutting and shredding the plastic waste into smaller pieces. They may be made of high-strength steel or other durable materials.
3) *Motor:* This is the power source for the machine and provides the necessary torque and speed to rotate the blades.
4) *Collection Container:* This is where the shredded plastic waste is collected and transported for further processing or disposal.
5) *Safety Features:* Modern plastic shredding machines, often come with safety features such as emergency stop buttons, interlocks and guarding to prevent accidents and protect operators.

F. Working

The working principle of a plastic shredding machine involves feeding the plastic waste into the hopper, where it is pulled down by a set of rotating blades or knives. These blades cut and shred the plastic waste into smaller pieces, which are then discharged through a screen or mesh. The size of the shredded plastic particles can be adjusted by changing the size of the screen or mesh, which controls the size of the openings through which the shredded plastic passes. Some plastic shredding machines also have additional features, such as a conveyor belt to transport the shredded plastic to a collection point or a granulator that further reduces the size of the shredded plastic particles. Overall, a plastic shredding machine is an efficient and effective way to reduce plastic waste and make it easier to recycle or dispose of.

IV. PARTS NAME

A. SHAFT

A shaft is rotating machine element, usually circular in cross section and which is used to transmit power from one part to another part or from a machine which is power producer to power machine, which absorbs power. The various members such as cutting blades, gears and pulley are mounted on it. Circular shaft is used with one keyway (square) has a circular cross section for cutting system. Material is used for shaft is EN31 steel



Fig 7.1 Shaft

B. Cutting Blades

Cutting system consists of the shafts, cutting blades, washers and gears. The cutting blade is round-shaped blade with 3 (three) cutting edges, given circle-shaped hole in the middle with keyway, mounted on the main shaft and main shaft move together]. We design the cutting system in such a way that angle between keyway of each cutter blade is 40 degree. And cutting blades are placed in such a manner that after first blade apart 40 degree from second blade. This concept used in shredder machine. Because of that, power which was requiring to rotate the shaft was large. Now that power to rotate the shaft is lesser than previous. Material used for cutting blade is mild steel.

Total deformation of cutting blade cutting forces.

Fc = (Ks*S)/G

Fc=cutting forces (kg)

Ks= tear strength (n)

S=max paper load

G=gravity (m/s2)

Fc= Fc*no. of blade



Fig 7.2 Cutting Blades

C. Motor

Electric motor is electrical device that converts electrical energy into mechanical energy. In certain applications, such as in the transportation industry with traction motors, electric motors can operate in both motoring and generating or braking modes to also produce electrical energy from mechanical energy.

Motor Specification:

1) Type-Single Phase Induction motor
2) Input power - 550 watt/1 HP
3) Input speed - 1405 rpm
4) Input torque - 3.738 Nm

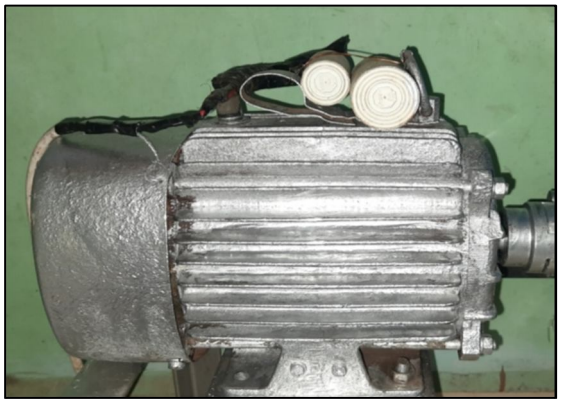


Fig 7.3 Motor

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D. Jaw Type Coupling

A coupling is a type of general purpose power transmission coupling that also can be used in motion control (servo) applications. It is designed to transmit torque (by connecting two shafts) while damping system vibrations and accommodating misalignment, which protects other components from damage. Jaw couplings are composed of three parts which are consisting of two metallic hubs and an elastomer insert called an element, but commonly referred to as a "spider". Considerations for elastomer selection include ability to dampen vibration, ability to handle misalignment, operational temperature range, speed of equipment, and chemical conditions. Jaw couplings are considered "fail-safe" because, should the elastomer fail or wear away, the jaw coupling hub teeth will mate, much like teeth on two gears, and continue to transmit torque.



Fig 7.4 Jaw Type Coupling

E. Bearing

A bearing is a machine element that constraint that constraint relatively motion to only the desired motion to only the desired motion and reduced friction a machine element that a bearing being a machine element that allows one part to bear another. UCF 205 bearing has been used in this case.



Fig 7.5 Bearing

F. Gears

Spur gears are a cylindrical shaped toothed component used in industrial equipment to transfer mechanical motion as well as control speed, power, and torque. These simple gears are cost-effective, durable, reliable and provide a positive, constant speed drive to facilitate daily industrial operations.

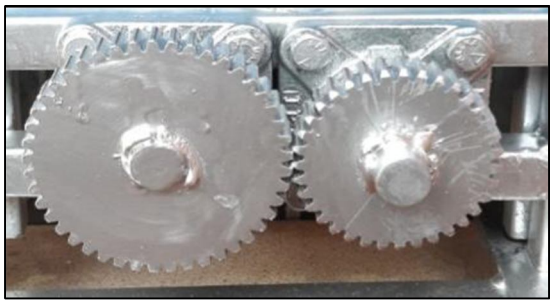


Fig 7.6 Gears

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G. Base Stand

Supporting stand is made up of mild steel with 1000 mm length and 500 mm breadth respectively. It actually consist for the support of overall model.

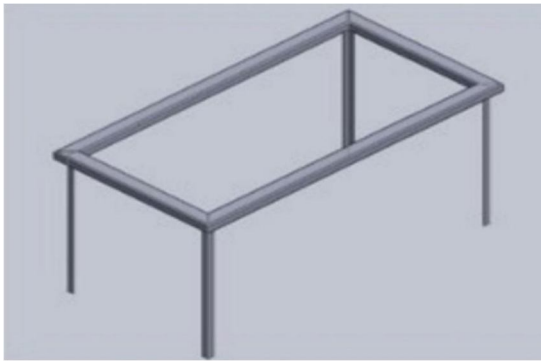


Fig 7.6 Base Stand

H. Hopper

The shredding mechanism handles small debris, such as grass and leaves. As material is being fed into the shredding machine hopper, it is shred by a separate array of hinged blades also known as hammers or flails. Some bigger shredding machines can manage small twigs.

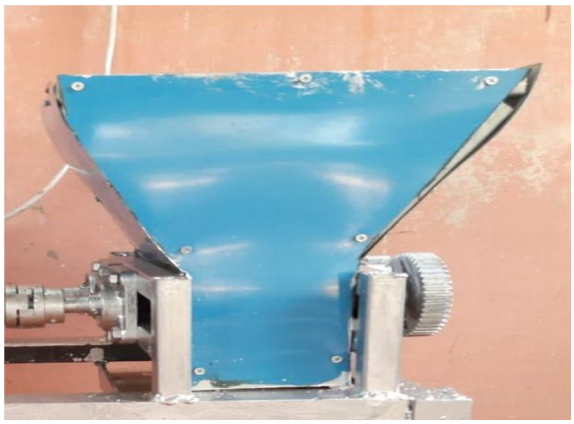


Fig 7.7 Hopper

I. Part List

Table 8.1 Name of the PARTS

Sr No.	Parts	Quantity	Cost
1.	2 HP Motor	01	3,800
2.	Coupling & Bearing	02	650
3.	Shaft	02	400
4.	MS Material	26.8kg	2000
5.	Bearing	03	750
6.	Blades	08	720
7.	Gears	02	720
8.	Nut Bolts	20	120
9.	Screw	24	30
10.	Plywood	01	180
	Total		9,370

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J. Actual Project Model



Fig 8.1 Actual Model Of Plastic Shredding Machine

V. CONCLUSION

A functional, easy to operate without the use of technically skilled labour due to its compact, less complex nature, low cost machine specifically designed for crushing of low-density nylon and plastics in preparation for recycling process has been developed. If the machine is well maintained, its durability is guaranteed and its maintenance cost is also lower when compared with existing imported machinery It is concluded that the plastic crushing machine works efficiently, this would confirm that the use of this system will help reduce the pollution generated by the plastic, since by crushing the plastic bottles it allows them to be recycled faster than traditional recycling.

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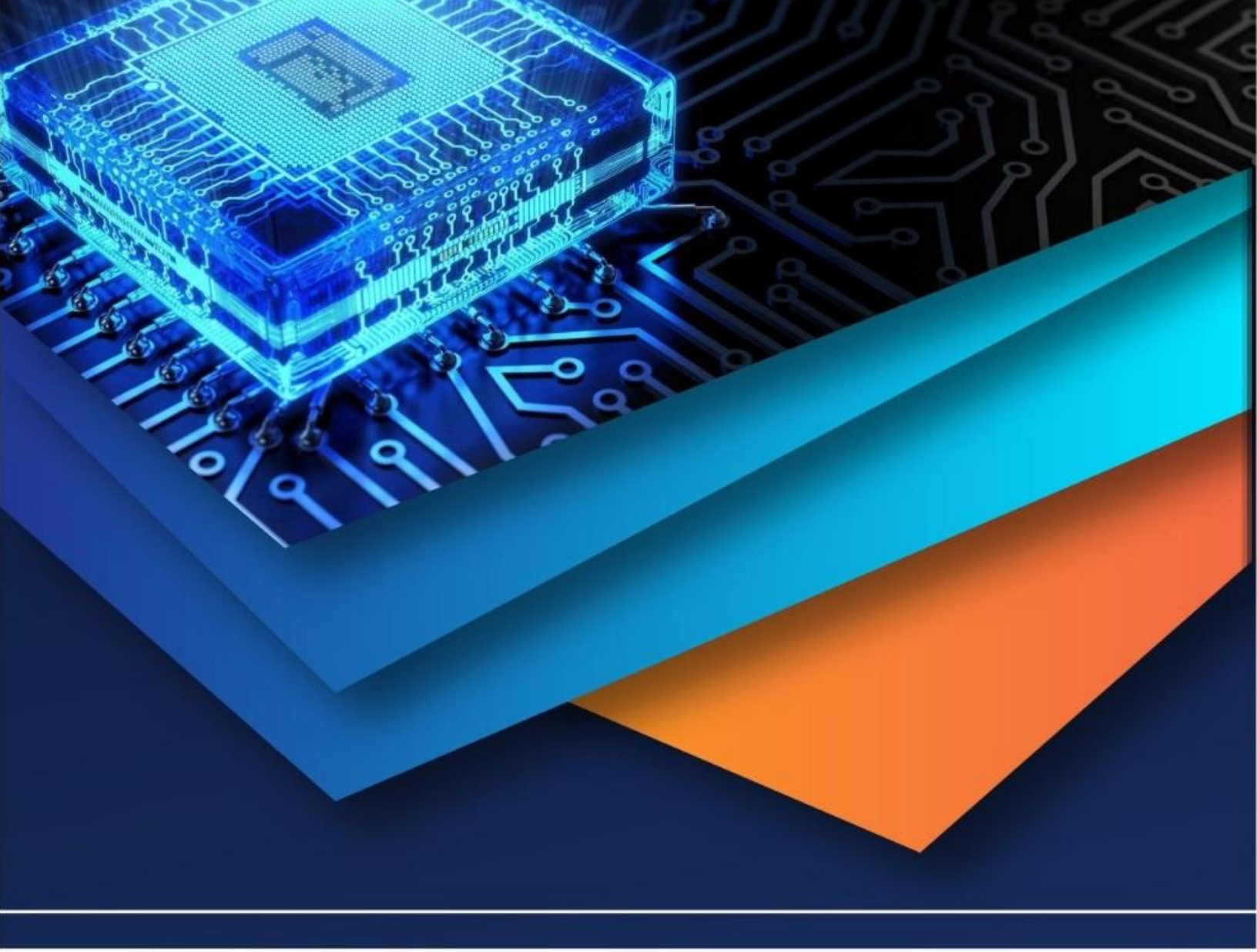
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