Sustainable Eco-Friendly Development of Plastic Shredding Machine from Recycled Plastic

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ABSTRACT

The use of plastic increases daily life in the current scenario, which a serious environmental problem, for this purpose we must make the environment ecological possible recycling of plastic waste. To solve this problem, there are already heavily used machines, but they are too expensive. The main goal of our study is therefore to design and manufacture efficient plastic shredder by the use of power supply and the multiple shaft mechanism that can be useful for micro, small and medium-sized companies. To implement this plastic concept implemented shredding machine, the mechanical and electrical components such Frame, hopper, electric motor, v-belt drive, shredder configuration. This machine is used for cutting the plastic into small pieces that can be irregularly shaped flakes processed recycle recovers raw material, which produces new plastic product. The recycled plastic parts are placed in an extrusion machine, where they can form wire plastic called filament and used in the 3d printing machine.

Keywords
Organizational cynicism, job performance, employee onboarding, Information technologyshredding machine, recycled plastic, Waste management, Reuse.

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I. Introduction

The recycling of plastics is a major problem in today's society and has gradually grown over the years as waste and threats to the environment and human health have increased. As technology advances, the amount of materials that can be reused or recycled also increases. Given the current population growth and the amount of waste produced, recycling and reuse must play a pioneering role in our daily life.Plastic recycling and reuse is an important issue for today.It has been observed that there are many resins and solutions which can be added to make it more sustainable.For this a rheological characterization has been done [1].For this the viscosity versus shear rate at different temperatures has been done.The use of plastics and its decomposition has o be given a proper attention and a good effort is required to maintain the environment from plastic waste. A functionality assessment of ecodesign support system has been initiated by Ewa Dostatni et al. in their paaper [6], where the ecological oriented product design has been initiated and resolved. Based on a number of recycling wastes and their usages and reusage, we can frame for many new design outreaches as described in the Handbook,[2].
We can focus mainly on the packaging industry and its effects on recycling. Because plastics are so widespread in the packaging / consumer industry, they have an impact on recycling rates. The growth of plastics can pose serious problems with waste disposal, which is almost all managed by local governments. As the landfill space becomes smaller and it becomes almost impossible to build new landfills, solid waste planners must consider other methods of waste management.Eco deisgn is a new approach to proct design ansd out reaches the envirpnmental impact associated with the design .[3].
The core objective of the sustainable design is the reduction in the negative environmental impact of all activities related to the production of a new product throuout its life cycle. The eco design of a products life cycle requires the following principles[11]:the saving of natural resources, extension of product life, design with reuse in mind, design considering recycled materials etc.There are various companies which lack in action plan proposing for the design of new products which affects and shatters the environmental performance[9], of products and making them rather unsuitable for the eco friendly judgement. It has also been noticed that the companies do not follow the eco design systematically and have no consideration for the ecocompatibility in their product design solution [4]

It has been observed that the Effective separation of raw material waste streams "at the source" and mechanical separation in waste sorting plants is an important element of the system which is favourable for the development of the plastics recycling sector.[8]. A polythene chipping machine was developed [5] using locally available materials via well structured designed and construction, and its performance was also evaluated. The machine has four major parts which include hopper, chipping chamber, delivery outlet and the frame. The machine was designed with an aim to use fixed and rotary blades which were primed by high-speed electric motor and wiould be able to shred pure water sachets in to flakes.

2. Objective of Project

1. Study of Shredder machine with Different elements like Blades, V-belt Drive, Single-Shaft, Frame.
2. Fabrication of Shredder in Compact Size
3. Less manufacturing cost with best output
4. Use of Machine at local recycle stations.
5. Development with Single Shaft

1.2 Project Scope:

This project is limited to the scope as follows;

- Research, Design and Fabrication of Mini Plastic Shredder Machine
- Test-run and verify the Machine.
- Research and suggest the safe protection during process.
- Reduce the plastic
- As a solution, a medium-sized machine has been developed.

3. Description and Operation of Shredder

The design of various components of a plastic shredder. Has been shown in [7]. In this design research, a 10-kW electric motor with a rotational speed of 500 rpm was chosen to drive the shredder. The designed plastic shredder must be portable. Therefore, we first selected the configuration dimensions, i.e. H. The capacity of about 2 PET bottles each, because PET is our main goal in crushing. The shredding box consists of 2 hexagonal shafts, on which 12 and 13 blades are mounted. All the designs today are CAD modeled and tend to apply the eco-designapproach [10], as life cycle assessment etc. With gaps between them. The blades have 3 hardened tips for cutting. They are made as a three-hawk claw model. The bearings carry the shafts that are forcibly mounted on the load-bearing walls. The side walls have welded guide vanes for a uniform cutting action by the blades and a separation of the flakes during operation. The motor is connected to a rotating shaft by connecting it via a gearbox via a flange coupling. Two spur gears are provided, one of which transmits the corresponding torque to the other corresponding shaft.

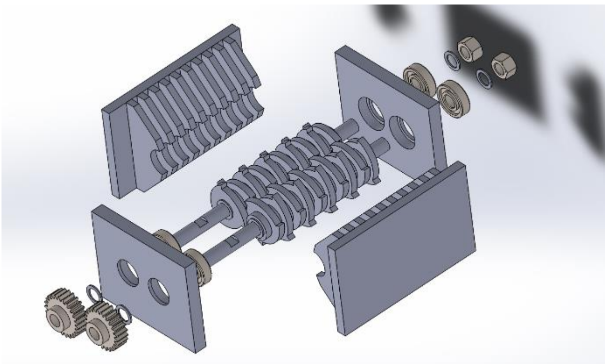


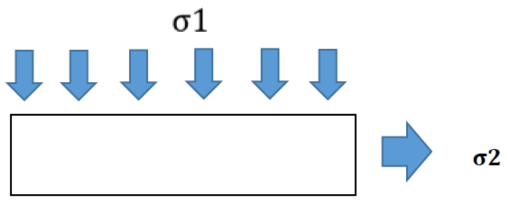
Figure 1-Plastic Shredding Machine

4. Design Procedure

After analyzing all the properties, we decided to stop working on the PP because it was difficult and few applications that we were targeting. We are now focusing

more on PET as it had a tensile strength of around 80 MPa. If we succeed in shredding PET, other bottles will obviously be shredded because they have less UTS values than PET. We have examined various theories of error; We were a little more confused between the two, namely the theory of the theory of maximum shear stresses, the theory of the energy of distortion and the theory of Von Misses.

In other investigations, we have found that the shredding processes are not a real case of shear failure, but rather a combination of bending, pressure and shear failure. With this information in mind, we chose the Distortion Energy Theory or the Von Misses Theory to discover the stresses and forces that we need to use to shred the plastic.



$$\sigma^2 = \left(\frac{1}{2}\right)[(\sigma1-\sigma2)^2+(\sigma2-\sigma3)^2+(\sigma3-\sigma1)^2]$$

Now we made certain assumptions that the stress acts along only 1 direction and hence equations changes to.

$$\sigma > \sigma sy$$

As we are dealing with the Plastic material, we consider Ultimate Tensile Strength for the calculations. Hence, we consider the UTS of PET as 80Mpa for the calculations. So, if we apply a force greater than 80Mpa then surely, we can cause the failure. Starting with the calculations,

$$\sigma = \frac{F}{A}$$

Now we studied various combinations of blades and found out that greater the blade contact area, greater is the force required to apply the Constant stress. We finally decided to go with the rectangular cross section of blade cutting area with the cross section of 100mm.

$$\sigma > 80 \text{ Mpa}$$

$$\sigma = \frac{F}{100(mm2)}$$

$$F > 80 \text{ x } 100 \text{ N}$$

$$F >= 8000N$$

4.1 Power Calculation. Electric motors are usually chosen from the Power requirements and the Speed.

$$P = \frac{2\ X\ \Pi\ X\ N\ X\ T}{60}$$

$$T = F\ X\ R$$

$$T = 8000\ X \frac{5}{100}$$

$$T = 400N\text{-}m$$

$$P = \frac{2\ X\ \Pi\ X\ 60\ X\ 400}{60}$$

$$P = 2513.27\ Watt$$

$$P = 3.36\ HP$$

4.2 Shaft calculations

Max Bending Moment (Mb) = 1.3 X 106 N-mm was recorded.

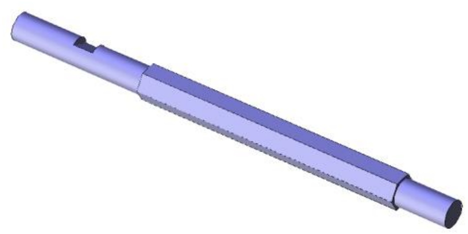


Figure 2- Shaft Design

Max Torque of (T) = 0.4 X 106 Nm was recorder Using Max Shear Stress Theory of Failure,

$$Te = ((M)^2 + (T)^2)^{0.5}$$

$$Te = 1.85\ X\ 10^6\ N\text{-}mm$$

$$D^3 = \frac{(16\ X\ Te)}{\Pi\ X\ \tau}$$

Substituting in the above equation,

D=40mm

4.3 Bearing Calculation

L10= 72 million revolutions

P =8000 N

C (dynamic loading capacity) = 33,281 N

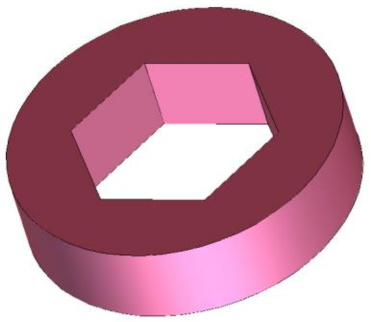


Figure 3-Bearing Design

Gear Specifications
Module = 8mm
Face width (b) = 64mm
Sb = 30984.33 N
Fs = 1.5
Sw = 32000 N
Zg = Zn =10
Hardness = 240BHN
Starting Torque = 600N-m
A = 80mm

5. Analysis

5.1. Blade Analysis. Thanks to a detailed analysis of the blades in Ansys Workbench, we exerted a force of 10,000 N on the blades and a firm support inside the blades on which the shaft rests. We found the following results, we chose mild steel as the blade material. Von Misses Stress was found around 300MPA, which was below the yield strength of the steel. Steel. The highest tension was found at the root of the blades, suggesting that we should choose steel made of high carbon as possible relative to the material of the blade with hardening on the surface of the blade to make it more resistant and more resistant to damage or scratches. A deformation of approximately 0.03 mm was tolerable and an FOS of approximately 1.5 was observed.

Figure 4-Blade Design

5.2. Shaft Analysis.

Max Stress Using Von Misses Lowest Factor of safety is 1.5

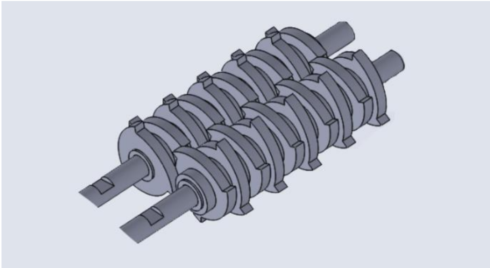


Figure 5- Shaft and Blade Configuration

Required force for failure is 135 Mpa, so Shaft is Safe.
Using the Max, Shear Stress Theory, and Max Stress is 78 MPA which is less than the Max Shear stress limit of Structural Steel.

6. Result

The fabricated material of shaft and blade prototypes is C45, but ideally it can be stainless steel as both have equivalent use according to required calculations. The shaft can sustain up to 67million rev. as per dynamic loading capacity. Hence, we can consider that the life of the shredder is 6 years. But for blades considering wear, the blades should be replaced after 1.5 year (according to industrial wear standards). Thus, the average life of the shredder must be 5 years considering FOS. The total weight of the prototype is 70kg which can be reduced by using Stainless Steel (except for gearbox and motor). The developed shredder has volume 400×240×160 mm^3.

7. Conclusion

The paper is an attempt to show that a successful plastic waste management system can be set up. The design of a proper shredding machine has been presented which can be used for shredding the used-up plastic for recycling and reuse. The system is a sustainable product for balancing the environment from various pollutants and harm to the nature through waste plastic. This prototype is efficient on domestic as well as industrial scale (due to its compactness). From the recycled thermoplastics 5mm to 7mm size flakes can be produced which can be further remolded and used for variety of applications. The prototype has guaranteed safety for assembly and has easy operation for usage.

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