

A REVIEW PAPER OF DESIGN AND FABRICATION OF PLASTIC SHREDDING MACHINE

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ABSTRACT

Today the world is facing a huge problem of waste management. Multiple industries like construction, manufacturing, medical, automobiles, food industry, packaging, etc. have plastic playing a vital role. Plastic is one of the most used materials due numerous advantages. But plastic has many serious disadvantages which can harm the ecosystem. Plastic if disposed unsafely, then it can lead to degradation in quality of soil, water, air and all the natural resource. Plastic waste has the highest percentage of non-biodegradable waste. The plastic waste cannot be incinerated as it will emit hazardous chemicals into the environment which lead to increase in environmental pollution. As the plastic waste does not decompose, it will require huge space for storage in landfills. This plastic waste is very difficult to store as it has large volume. Hence breaking down the plastic waste into very small piece can help the problem of storage. A shredding can be used for effective management of plastic waste. This paper gives information regarding design of shredding machine. This machine can be used for breaking down the plastic waste into small manageable size. The blades of shredder are designed in a way that they withstand the forces during cutting of plastic parts. These small flakes of shredded plastics then be recycled into numerous ways. The main consideration for this design is cost effective and efficient. Thus, the use of shredding machine can also reduce the labor cost. This will hence reduce the burial and dumping of waste in the earth.

Key Words: - Waste management, Shredding machine, recycle

1. INTRODUCTION

The consumption of plastic has increased in last two decades. This is because plastic is a material that can be easily formed into desired shape, size, finish etc. Also, plastic is way cheaper than most of the present materials. According to Dr. M. Muthukumaran [1], plastic takes up to 500 years to decompose. Still the designers and engineers choose plastic due to its formability. Plastic is lightweight and corrosion resistant. This makes it suitable for numerous applications [1]. Plastic is the most used material in the world [3]. The increase in production of plastic over past 50 years has been increased from 2 x 16 (Mt) in 1950 to 381 x 106 (Mt) in 2015. The production is anticipated to be doubled in next 20 years [4].

Plastics have high atomic mass and are created by polymerization. Generally, plastics have five common types – High Density Polyethylene (HDPE), Polyethylene terephthalate (PET), Polypropylene (PP), Polyvinyl Chloride (PVC) and Low Density Polyethylene (LDPE) [2]. The main types in which plastics are classified as are Thermosetting and Thermoplastics. Thermosetting plastics contain ester, melamine, epoxy formaldehyde, polyurethane etc. These are cross linked on curing and will not soften with heat to allow these to be formed into different shapes [5].

The plastic must be managed in a proper manner as it numerous disadvantages. Plastics are not suitable for heat treatment as it emits harmful gases. The only proper way of handling the plastic waste is by recycling it. Recycling of plastic will be help to reduce carbon dioxide emissions and consumption of natural resources. Recycling of plastic packaging is gaining importance and popularity over the last few decades [6]. The government has made it mandatory for separation of waste into wet and dry waste. This has helped in sorting of degradable and non-degradable waste. This initiative would result into reduction of waste in landfill and increase in recycling [6].

The plastic waste is generally in large volumes like, PET bottles, medical waste, automotive plastic covers, broken pieces of electric appliances, etc. Thus, these large volumes require more space for storage. Therefore, it will be easier to store these in the form of small pieces or flakes. The objective of this paper is to study the design of plastic shredder machine. The main consideration for the shredder design is to be cost effective and efficient.

1.1 Objective

The objective of this paper is:

- To understand method for recycling the waste
- To study the design procedure for shredder
- To study the ergonomic constraints for shredder

2. LITERATURE REVIEW

Recycling of plastic is the method of reusing the waste material and generate some new and useful product. A wide variety of products can be recycled from plastic like bags, decorative show pieces, window frames, lightweight doors, and many more [9]. The main purpose of shredding machine is the reduce the volume of plastic waste by cutting the waste into smaller pieces. As per ND Jadhav, [7] the existing shredders that are currently used to recycle plastic waste are very costly. The machine to be developed for reducing large plastic material to a smaller volume or small flakes should process the plastic waste as cheap as possible. Thus, the machine should reduce the labor cost. The machine should be made with locally available raw material which will result in low-cost production of machine. Also, the maintenance and service work for the machine can be easily done [8].

2.1 Design consideration

The MSW (Municipal Solid Waste) is generally sorted. Based on type of material, thickness and type of plastic the plastics are segregated. Then this waste is reduced in size by the use of shredder. The design for shredder assumes some information which is standard for some parts. Design considerations for the shredder are – safety, compactness, power consumption, shear strength, rigidity [11]. The parts are designed by thorough calculations. Material selection is done on basis of ease of availability of raw material, ease for fabrication, durability, efficiency and cost [10]. The design considers the safety of operator and there should be less or need for skilled operator.

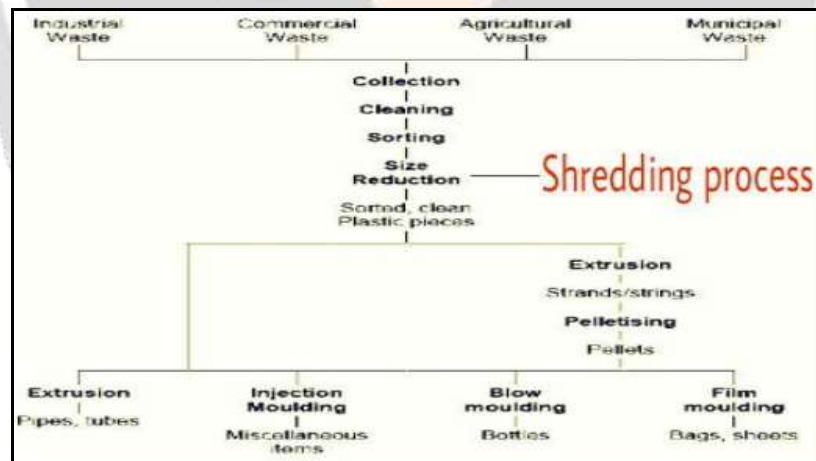


Fig. 1: Working flowchart [10]

2.2 Strength of Plastic material

As per the research carried out by Vaibhav Edke [10], the plastic used for the shredder is assumed to be PET.

Specimen: Bisleri bottle

EPET is a semicrystalline and colorless resin. The manufacturing procedure defines whether the material is rigid or semi rigid. This material is generally very lightweight [10].

Specification:

IUPAC name: Poly(ethyl benzene 1,4 dicarboxylate)

Chemical composition: $(C_{10}H_8O_4)_n$

Abbreviation: PET, PETE

Density: 1.38 g/cm^3 at 20°C

Youngs Modulus (E): 2800 – 3100 MPa

Tensile strength (σ): 55 – 75 MPa

3. DESIGN AND MATERIAL SELECTION

The plastic shredder machine is made of following main parts.

Table -1: Component list [6]

Sr. no.	Part name	Material
1.	Hopper	Mild Steel
2.	Shredding Chamber	Mild Steel
3.	Mesh	Mild Steel
4.	Electric motor	-
5.	Pulley	Cast Iron
6.	Belt	Leather
7.	Bearing	Stainless Steel
8.	Shaft	Mild Steel
9.	Blades	N8 Steel

3.1 Hopper

Hopper is made on 0.22 mm thickness plate of mild steel. This is the part of shredder where the waste is stored while the shredding procedure. The shape of hopper is truncated conical [12].

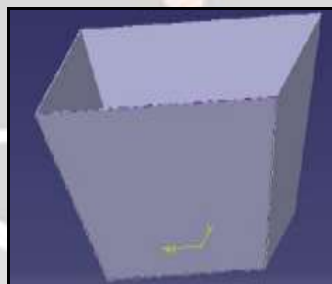


Fig. 2: Hopper Model [6]

3.2 Shredding Chamber

The chamber is where the actual cutting process takes place. This chamber is made with 0.610 mm thick plate of mild steel. All the plates of the chamber are joined by arc welding except a plate is kept bolted for ease of coupling and decoupling. This facilitates easy maintenance and servicing of blades. A mesh is attached below the chamber to regulate the size of shredded pieces [12].

3.3 Mesh

The mesh is placed at the bottom of the chamber. The function of mesh is to separate the small particles from larger ones. The small particles pass through the mesh and remaining larger ones are again shredded till the desired size is achieved. The mesh is made of steel wire [12].

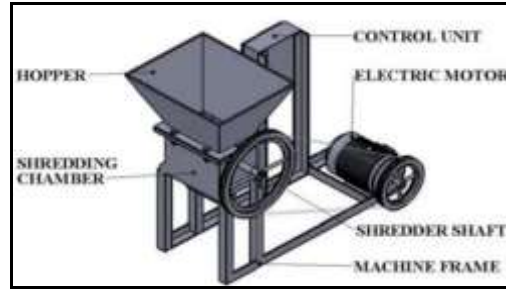


Fig. 3: Components of Shredding Machine [9]

3.4 Blade

In this project, the blade is used as a cutter for cutting the plastic waste. Blade is the tool that is used to cut the plastic into fine pieces. The blade is made using steel [1]. There can be blades with two, three or five cutters. Depending on the application and type material to be shredded, suitable blade is to be chosen.



Fig. 4: Four blade cutter [8]

4. WORKING PRINCIPLE

The plastic waste is sorted according to the size of shredding machine. As the power supply is switched on, the shaft starts rotating and therefore the blades also rotate. This rotation movement of blades shred the waste plastic. Plastic is fed to the cutter through the hopper. The shredded plastic material then falls on the mesh. Smaller pieces pass through the mesh and larger ones are again fed in through the hopper. Once the shredding procedure is complete, the pieces are then cleaned using chemicals and are reused for various applications.

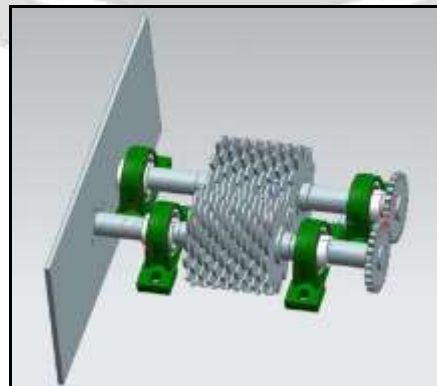


Fig. 5: Blade cutter Assembly [2]



Fig. 6: Shredded Plastic [11]

5. ADVANTAGES

From the research works of Prof. M. Deore [13], the shredder offers following advantages:

1. Initial cost is low as compared to industrial shredders
2. Maintenance and servicing cost is less
3. Construction and design are simple
4. The machine requires less space
5. Reduction in the labor
6. No need for skilled operator

5.1 Social Impact

1. The problem of waste plastic is reduced
2. Easy recycling of the plastic parts
3. Reduction in environmental pollution
4. Landfills will not be occupied with plastic waste

6. CONCLUSION

Plastic plays a vital role in the current scenario. It has become the irreplaceable due to its numerous advantages. But as plastic is non-biodegradable, it should be recycled and reused. The conclusion of this study is plastic waste can be effectively shredded using a shredding machine. The design procedure for this shredder is easy to understand and is also cost effective.

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