

Development of Plastic Bottle Shredding Machine

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Abstract

The available machines used to recycle this waste are very costly. They pack this waste and give them to the local processing plants. So the process of packaging and transporting is much costly. So our intension behind this project is to process the plastic waste as cheap as possible by cutting where it is made for reducing of labour work which results in cost reduction. A cutting machine is designed to reduce large solid material objects into a smaller volume or small pieces. In this project there describes about the experimentation of plastic bottle cutting machine and analysis of mechanism used in machine. Plastic bottle cutter is a machine used for cutting the plastic in small pieces to make waste management easier. We are making this project model for recycling of plastic wastage in domestic area; industries as well as it can be useful to the scrap collectors. This machine is solution on the problem of space.

Keywords: Shredder; Plastic bottles; Hopper; Cutting tools; Electric motor

Introduction

Waste is now a global problem, and one that must be addressed in order to solve the world's resource and energy challenges. Everything we consume becomes waste including plastic bottles. Plastic is most commonly used material in the world today [1]. They come in five major categories, the Polyethylene terephthalate (PET), High density polyethylene, Polyethylene (HDPE), the polyvinylchloride (PVC), the polypropylene (PP), Low density polyethylene [2]. The disposal of waste plastics (PET, PP, etc.) is a biggest challenge, as repeated recycling of PET bottles poses a potential danger of being transformed to a carcinogenic material and only a small proportion of PET bottles are being recycled.

Plastic are synthetic organic materials produced by polymerization. They are typically of high molecular mass and may contain other substances besides polymers to improve performance and or reduce cost. These polymers can be molded or extruded into desired shapes.

Plastic bottles are made from a petroleum product known as polyethylene terephthalate (PET), and they require huge amounts of fossil fuels to both make and transport them.

It's harder to recycle plastic bottles than you think. Some plastic bottles consumed throughout the world, most of them are not recycled because only certain types of plastic bottles can be recycled by certain municipalities. They either end up lying stagnant in landfills, leaching dangerous chemicals into the ground, or they infiltrate our streets as litter. There is a big disadvantage of plastic that is difficult to decompose. So we have to recycle the plastic and there are various methods for plastic recycling [3]. As well as the scrap collectors also avoid to taking the plastic bottles because of its high volume and less weight. Machinery available is costly, so overcome this problem it is need to develop a low cost cutting machine. The project is about development of plastic bottle cutting machine which would help to the scrap collectors to crush the used plastic bottles and would thereby help in waste management and disposal the transportation cost also reduces. A cutting machine is designed to reduce large volume into smaller pieces [4].

Cutting is a process of transferring a force amplified by mechanical advantage through a material made of molecules that bond together more strongly and resist deformation more, than those in the material being crushed do. The equipment mainly consist a cutter, whose basic

principle is to destroy the plastic bottle depend on the shear and impact strength [5].

Materials and Methods

Working principle

The plastic bottles have more volume compared with its weight, so due to this plastic bottles take more space than other scrape so the scrap collector avoids taking plastic bottles. If we crush or cut this plastic then it is convenient and economical to scrap collector to transportation and this cut plastic can be directly used for further processing. So we decide to make plastic cutting machine which is motor operated so it is affordable to the customer.

The bottle crusher is cutting the parts from the bottles with rotary cutting tool within a specified depth and the speed limit, then the two parts separately or it will be truncated. The machine is powered by motor. The principle of operation is a follows (Figures 1-3).

- Align the plastic bottle into the hopper.
- Cutter will rotate when the shaft is rotated after starting of motor.
- Bottle will cut when contact with the cutting tool.
- The scroll will fall in the collector provided.

There are steel structural bar of L shaped are used of 3 types. The steel bars were welded to form the base of the machine.

- Type 1 plate with 600 mm length with 4 nose.
- Type 2 plate with 450 mm length with 2 nose.
- Type 3 plate with 300 mm length with 2 nose.

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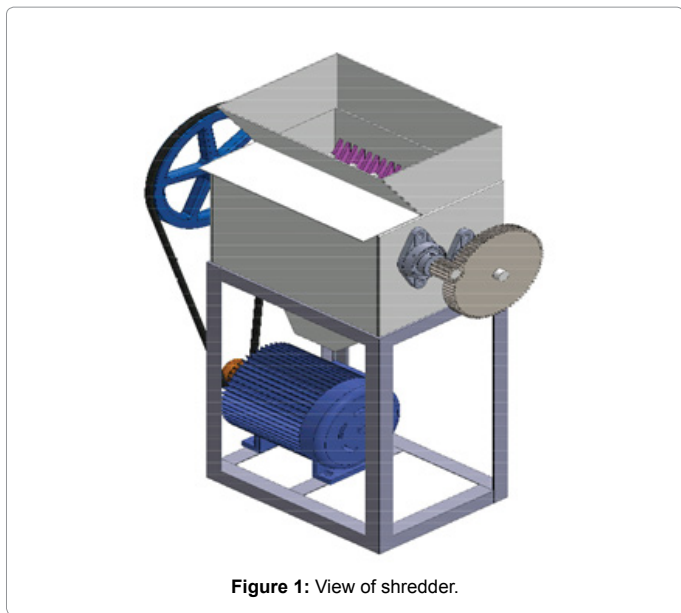


Figure 1: View of shredder.

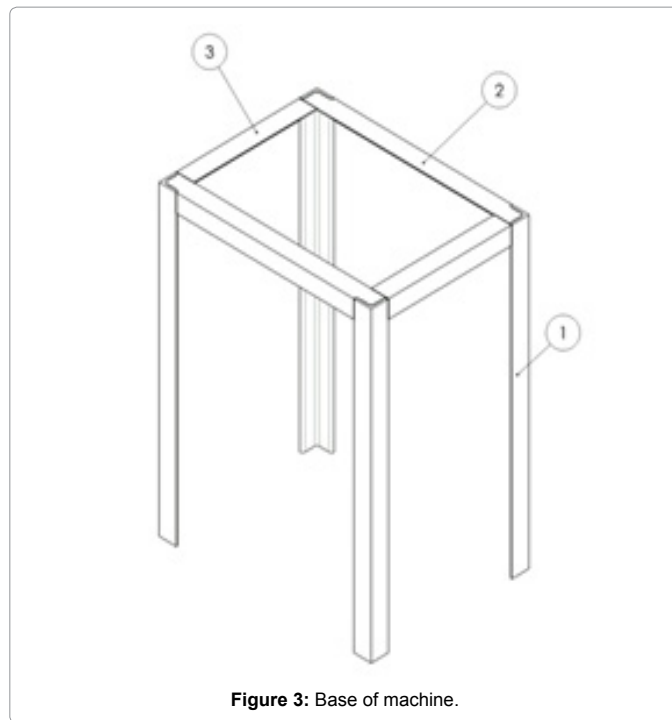


Figure 3: Base of machine.



Figure 2: Final model.



Figure 4: Cutter design.

Fabrication of cutting tool

There are 17 tools are mounted on shaft which are welded with shaft. The materials used for the cutter are spring steel. These cutters are made up of thin sheet of spring steel by laser cutting. The shape of the cutter is spiral so it is helpful to gripping and shearing (Figure 4).

Fabrication of cutter shaft

There are 17 cutting tools are welded on the shaft with equal space between them. Figure 5 shows all the design details. The material used for the cutting blades are mild steel. Both side of the shaft are mounted in ball bearing. Total length of the shaft is 595 mm with diameter of 45 mm. Figure 6 shows the final model after manufacturing.

Other Parts

An electric motor

AC motor with 1.5 HP power is used in the machine. Motor produces power and the power produced is given to the shaft. The motor has 1440 rpm speed and it is reduced up to 50 rpm on the main shaft [6].

Pulley

To transmit power from motor to the intermediate shaft pulley is

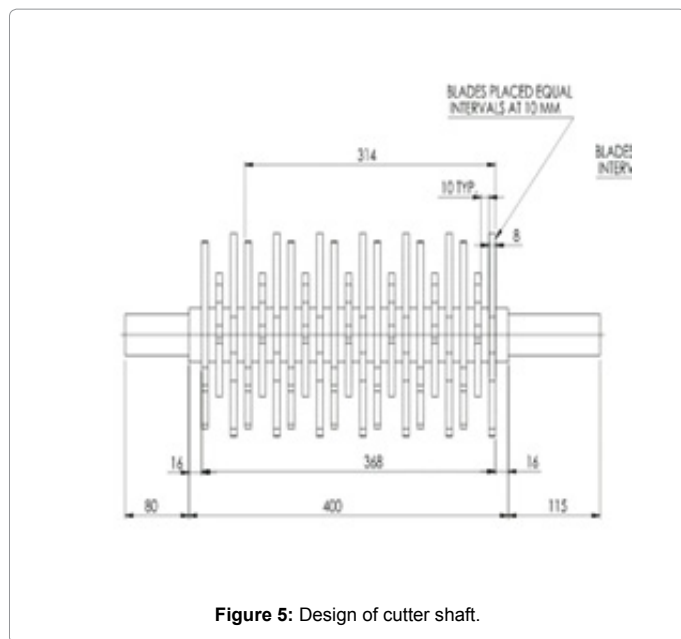


Figure 5: Design of cutter shaft.



Figure 6: Final view of cutting shaft.

used which is powered through the belt drive to reduce the speed of the shaft and to increase torque [7,8].

Bearing

Bearing used to permit constrained relative motion between parts. There are 4 ball bearings are used. Two bearing on intermediate shaft and two bearing on cutting shaft are used.

Hopper

Hopper is the upper part of the machine through which the plastic bottles are feeded in the cutting space.

Shredder box

Shredder box is the box made up of thick plates. All the assembly

Sr. No.	Brand of bottle	Initial Volume (m ³)	Final Volume (m ³)	% Reduction in volume (%)
1	Bisleri	0.0019	0.0009	50
2	Aquafina	0.0019	0.0009	50
3	Kinley	0.0017	0.0008	50
4	Oxyrich	0.0017	0.0008	50

Table 1: Percentage reduction in volume.

Maximum price of the machine	12500 rupees
Total life	60 months
Monthly depreciation	300 rupees
Monthly maintenance cost	200 rupees
Total cost	13000 rupees

Table 2: Cost benefit analysis.

like cutter shaft intermediate shaft is under the shredder box. Material used for the shredder is cast iron.

Gears

There are two spur gears are used. Smaller gear on the intermediate shaft and the bigger is on the cutting shaft. Due to which speed is again reduced on the main shaft.

Results and Discussion

The percentage of reduction in volume was calculated. For all the input Dimension and quality of plastic bottle, the volume of the bottle is 0.0019 m³. In the subsequent stage the percentage reduction in volume is calculated for all the crushed bottles. Reduction in volume is calculated with the help of following formula.

Percentage reduction in volume

$$\frac{\text{Initial Volume} - \text{Final Volume}}{\text{Initial Volume}}$$

Thus the initial and final volume was found out by the dimensions of the bottles that were measured. The following table shows percentage reduction in volume (Table 1).

Cost benefit analysis

Weight of one 750 ml plastic bottle is approximately about 20 gm and the market rate of the plastic is upto 40 rupees per kg. The cost of machine 13000 rupees and which can be recovered by shredding 435 kg of plastic bottle. Three bottles can be crushed at a time and in 3 minute of cycle. To obtain 435 kg of plastic 21750 plastic bottles should be crushed. As 3 bottles are crushed in one cycle, time required to crush the bottles is 21750 minute (21750/3 = 7250 × 3 minute= 21750 minute). Which is equivalent to 362 hours, considering one shift of 8 hours we can complete it at 45 shifts means 45 days. If working in double shift we can complete it at 23 shift. Thus cost of machine can be recovered in 23 days if working in 2 shift and can be recovered in 61 day if working in 1 shift only (Table 2).

Conclusion

The plastic bottle thus designed and fabricated is a unique, compact and portable plastic bottle shredder machine. The final machine is an outcome of a series of processes. The cutting force that is required to cut a plastic as found experimentally is well within the range of the force that can ergonomically be applied by an average human. In the next stage of processing testing is carried out on the machine. The

Machine thus designed has the ability to crush the bottle of different dimensions. On an average the machine reduces the volume of bottle to 50 percentage of the initial volume. It was found that the machine is capable of crushing bottles and cans also.

References

1. Sophie van den Berg (2009) Technical brief of recycling plastic.
2. Ayo AW, Olukunle OJ, Adelabu DJ (2017) Development of a waste plastic shredding machine. *Int J Waste Resour* 7: 281.
3. Faiyyaj MI, Pradip MR, Dhanaji BJ, Chandrashekhar DP, Shivaji JS (2017) Design and development of plastic shredding machine. *Int J Engg Technol Sci Res* 4: 10.
4. Sonkhaskar YM (2014) Design and development of plastic bottle crusher. *Int J Engg Technol Sci Res* 3: 10.
5. Darshan R, Gururaja S (2017) Design and fabrication of crusher machine for plastic wastes. *Int J Mec Product Engg* 5: 10.
6. Uzir AB (2014) The design and built of crusher machine plastic bottles. *J Mech Engg* 1: 2014 .
7. Shilpi S (2013) Eco architecture: PET bottle houses. *Int J Sci Engg Technol* 2: 1243-1246.
8. Elias HG (2003) An introduction to plastics.