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TITLE: DESIGN AND DEVELOPMENT OF PET BOTTLE RECYCLING MACHINE

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Abstract

plastic bottles end up in either in the ocean or in landfills. So it essential to recycle the plastic bottle in a significant way. So for recycling the first step is to collect the bottle and second is the transportation of the collected bottles to the recycling plant. This two process requires the high amount of money which increased the cost of recycling. Used plastic bottles are reused by some unauthorized company to get more profit which is illegal and unhygienic for human health. The basic aim behind our project is to reduce this cost of this and eliminate reuse of used bottle. Our machine will shred down the used bottle and then cut the pieces in very small pieces which are operated by pedestrians. So because of this the cost of the transport and collection will get reduce and the reuse of the bottle will get eliminated thus increases the hygiene.

Index Terms: *Types of Plastic, Plastic Waste, Shredding and Cutting, Machine Design, Transport and Collection, Waste Management, Pet Bottles, Electric Motor, Blades, Efficiency*

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1. INTRODUCTION

Recycling is a method of treating the waste material to reuse the product of the same and decrease the pollution caused by it. In our country and other developing country waste management is a difficult task because of huge amount of waste generated by huge consumption by citizens. Recycling is the only method which is used in waste management of plastic. It takes 400-500 years to naturally decompose.

Basically, when we visit any public places such as bus-stand, railway station, restaurants etc. we see lots of pet bottle laying inside or near the dustbin. It looks so dirty and unhygienic for human health.

For recycling of the plastic waste, it requires a collection of bottles, transportation of collected bottles to the plant and cutting of the bottle into the small pieces. This requires a huge amount of money. There are also lies many issues in transporting the bottles to the plant because the bottles are of different shape and sizes. The waste material must be in uniform shape or size for easy and effective transportation. Collection of the bottle requires human efforts and may generate health issues.

This paper helps in producing the shredder and crusher machine which would help in waste management. The machines available in the market recycle at a very high cost so our aim for this project is to develop a machine which will recycle the waste as cheap as possible by shredding and cutting. This machine will be used for cutting different sizes of plastic bottles. The other advantages of our machine are it will reduce the labor work which reduces the cost of recycling , it is compact and easily movable so we can move the machine to any place and fix it there, we can install it in places such as public sectors bus stand, railway stations, malls restaurants, school colleges etc. this machine will use the electric power to shred the plastic our future aim will be to use this machine on renewable sources.

2. PROBLEM STATEMENT

Plastic waste management is one of the most difficult tasks and very less efficient in a present situation most of the plastic waste goes to the ocean and the landfills. Now a days in every functions marriages and parties the drinking water has been served in plastic pet bottles of different shapes and size this pet bottles consume large space which usually overflow the dustbin and lay on the place near it this plastic bottles usually found laying on the street in the gutters and other places causing a serious environmental threat and chock up the sewage system several attempts were made by our government

to stop and reduce the use of plastic but no result came out of that because of the waste use of plastic in daily use.

3.LITERATURE SURVEY

1. DESIGN AND FABRICATION OF CRUSHER MACHINE FOR PLASTIC WASTES
Darshan &Gururaja S.
International Journal of Mechanical and Production Engineering (IJMPE) Volume-5, Issue-10
This paper is about the design of a Plastic Bottle Crusher which would help to crush the used Plastic bottles and would thereby help in waste management and disposal.
Conclusion: Our machine helps in increasing the volume of transportation by reducing the volume of plastic bottles by shredding them into pieces. This helps in reducing the emissions at the time of transportation and also used to recycle plastic wastes

2. DESIGN AND FABRICATION OF PLASTIC BOTTLE AND CAN CRUSHER FOR RECYCLING PURPOSE
SonaliDevmane& S.N. Aloni
International Journal of Mechanical Engineering (IIJME)
VOLUME 5, ISSUE 6, JUNE 2017
This paper describes the design of various components of can and plastic bottle crusher machine. This paper gives the general idea about all the calculations regarding the fabrication of the shredding machine.
Conclusion: From the design procedure they adopted for the fabrication of Automatic Can/Plastic Bottle Crusher machine which can crush both cans as well as the bottle. Thus, with help of this design and some other electronic components, we can fabricate an automatic can/plastic bottle crusher machine to simply reduce the volume of cans/plastic bottles as well as to reduce the human fatigue.

3. DESIGN AND DEVELOPMENT OF PLASTIC SHREDDING MACHINE
Rushabh Mete, Jaydeep Bhosale, & Suraj Jadhav International Journal of Engg. Technology Science & Research IJETSR Volume 4, Issue 10, October 2017 Our project is used for cutting and crushing plastic in small pieces to make waste management easier. We are making this project model for recycling of plastic wastage in the domestic area, industries etc. Our intention behind this project is to process plastic waste as cheap as possible by shedding. Benefits of this machine are the reduction of labor work which results in cost reduction
Conclusion: We can conclude that plastic is shredded with the help of plastic shedding machine hence we also design and manufacture plastic shredding machine. We studied how to design the machine from the literature review and we got many technical details about this machine this is very helpful to us

4. STUDY ON USE OF WASTE PLASTIC IN CONCRETE MIXTURE AS AGGREGATE REPLACEMENT
Zainab Z. Ismail
Waste Management
Volume 28, Issue 11, November 2008
They conducted a comprehensive study based on a large number of experiments and tests in order to determine the feasibility of reusing plastic sand as partial replacement of fine aggregate in concrete.
Conclusion: Replacement concrete which yields some good amount of strength as conventional concrete it can be used in construction purpose and structure made up of concrete. This replacement concrete will bring wide changes in the field of Civil Engineering.

4.PROJECT OBJECTIVES

1. To design and develop the machine at low cost
2. To reduce transportation and labor cost
3. To reduce the plastic pollution
4. To design machine according to the suitable aesthetics and ergonomics
5. To design the machine according to the drawing.
6. Manufacturing of required components of the machine
7. To assemble all the manufactured components
8. To run the machine and carry out required testing
9. Result and conclusion

5. SCOPE OF PROJECT

The machine will help the recycling of plastic waste bottle. It will reduce the space in trucks so that it can transport more waste and cost will also be reduced. It will also ensure the hygiene and reuse of the used bottle. The machine will cut the bottle in so small pieces so that recycling will be easy and less expenditure. The machine will be very simple and convenient to be used.

6. DESIGN AND CALCULATION

Table-1: Machine Components and Material

Sr. No.	Machine Components	Material	Quantity
1.	Pulley	C.I.	4
2.	V-Belt	Leather	2
3.	Pedestal Bearing UCB 204	--------	4
4.	2 HP Electric Motor	---------	1
5.	Flywheel	C.I.	1
6.	Crushing Tray	M.S.	1
7.	Square Pipe	M.S.	-
8.	Shredding Blade	M.S.	1
9.	Shaft	M.S.	2

6.1 Selection & design criteria

Selecting the proper design is very essential in all departments of engineering fields.
General Requirements of Machine Designs are:

- Low Cost.
- Simplicity of design
- High productivity
- Good Appearance.
- Safety and convenience of control
- Shape and size and also necessary surface finish.
- Ability to produce and provide required accuracy
- More durability

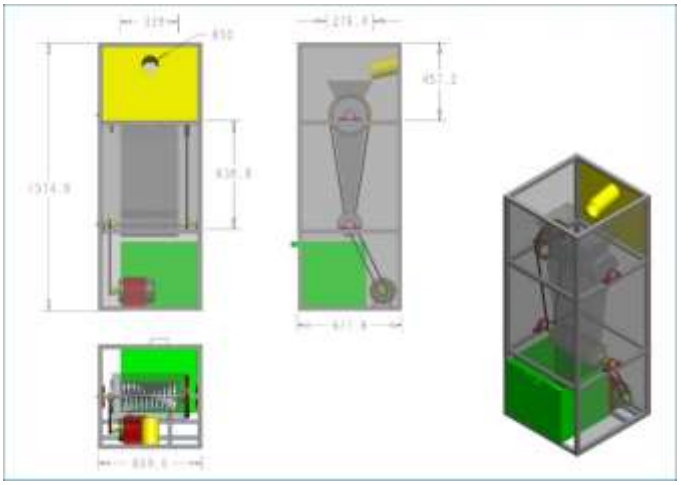

Fig 1 conceptual design

6.2 CALCULATION

6.2.1 SPEED CALCULATIONS FOR LOWER SHAFT

To calculate speed of lower shaft

$N1D_1=N_2D_2$ ……1

Where

N_1=Speed of motor shaft

D_1=Pulley diameter of motor shaft

N_2=Speed of lower shaft

D_2=Pulley diameter of lower shaft

Here to transmit equal amount of power the diameter of pulley on motor shaft and the diameter of pulley on lower shaft are same.

i.e $D_1=D_2$=2 inch

∴ N1=N2=1440 rpm

6.2.2 SPEED CALCULATIONS FOR UPPER SHAFT

To calculate speed of upper shaft

$N1D_1=N_3D_3$……2

Where

N_1=Speed of lower shaft

D_1=Pulley diameter of lower shaft

N_3=Speed of upper shaft

D_3=Pulley diameter of upper shaft

∴1440×2=N3× 12

N3=240 rpm

6.2.3 TORQUE GENERATED BY MOTOR, LOWER SHAFT AND UPPER SHAFT

Motor power=2HP=1492 W

We know

$$P=\frac{2\pi NT}{60}$$

Where

P=Motor power

N1=Speed of motor

T=Torque generated by motor

Fig 2. Motor

$$\therefore 1492=\frac{2\times\pi\times1440\times T}{60}$$

∴ T=9.89 N.m …… [Motor torque]

As the pulley diameter of motor shaft and lower shaft is same, neglecting losses equal torque is transferred to lower shaft.

Like motor power, we can calculate the torque on upper shaft.

∴ Torque on upper shaft:

T=59.36 N.m

6.2.4 TO CALCULATE SHEAR STRESS

A=B×H

Where

A=Area cutting section

B=Width cutting section

H=height of cutting section

$\therefore A=\frac{9.9\times7.3}{2}$

$\therefore A=36.6\ mm^2$

For plastic material poly-ethene terephthalate (PET)

Ultimate shear stress =55 mpa

$\therefore S_{us}=0.557\times S_{ut}$(for plastic material)

$\therefore S_{us}=0.577\times55$

$\therefore S_{us}=31.73$ Mpa

6.2.5 TO CALCULATE SHEAR FORCE F_{sh}

Induced shear stress

$\tau=\frac{Fsh}{shear\ area}=\frac{Sus}{F.O.S.}$

$\tau=\frac{Fsh}{36.6}=\frac{31.73}{FOS}$ $\therefore F_{sh}=580.66$ N

Fig 3. Shredding blade

6.2.6 TO CALCULATE CUTTING FORCE F_C

Yield strength for plastic (PET)=S_y=80 Mpa

$$\frac{Fc}{Area\ of\ crosssection}=\frac{Sy}{FOS}$$

$$\frac{Fc}{36.6}=\frac{80}{2}$$

Fc = 1464 N

Fig 4. Crushing Blade

WHY WE CHOOSE 2HP MOTOR

Force induced on cutting blades for sectional area

σ plastic=55 Mpa

$\sigma=\frac{force}{area}$

$55=\frac{F}{\pi\times r^2}$

$F=971.93\times10^3$N

Torque by shredder blade=force×perpendicular distance

$=971.93\times10^3\times0.075$

$=68.84\times10^3$N.m

Power required for shredder

$P=\frac{2\pi NT}{60}$

$=\frac{2\times\pi\times80\times08.84\times10^3}{60}$

=0.70 Hp

Power required for crusher diameter=7 inch

$\sigma=\frac{force}{area}$

$55=\frac{F}{\pi\times88.9^2}$

F=1365.67N

Torque by crusher blade=force×perpendicular distance

=1365.57× 0.08m

=109.25N

Power required for shredder and crusher

$P=\frac{2\pi NT}{60}$

$=\frac{2\times\pi\times80\times109.26}{60}$

p =915.25 W

=1.22 Hp

∴Total power required = (Power required for shredder) + (Power required for crusher)

=0.70+1.22

=1.98 Hp

6.2.7 PULLEY DESIGN

Centre distance between motor shaft and lower shaft

$C=2D_1+D_2$

D_1=2 inch…….driver pulley

D_2=2 inch…….driving pulley

∴C= (2×2) +2

=6 inch

Centre distance between lower shaft and upper shaft

$C=2D_1+D_2$

D_1=2 inch……driver pulley

D_2=12 inch……driving pulley

∴C= (2×2)+12

C=16 inch

Calculation for length of belt

$L=2C+\frac{\pi}{2}(D_1+D_2)+\frac{D1+D2}{4C}$

$=2\times 6+\frac{\pi}{2}(2+2)+\frac{2+2}{4\times 6}$

L=18.44inch

$L=2C+\frac{\pi}{2}(D_1+D_2)+\frac{D1+D2}{4C}$

$=2\times 16+\frac{\pi}{2}(2+12)+\frac{2+12}{4\times 16}$

L=54.20inch

WORKING

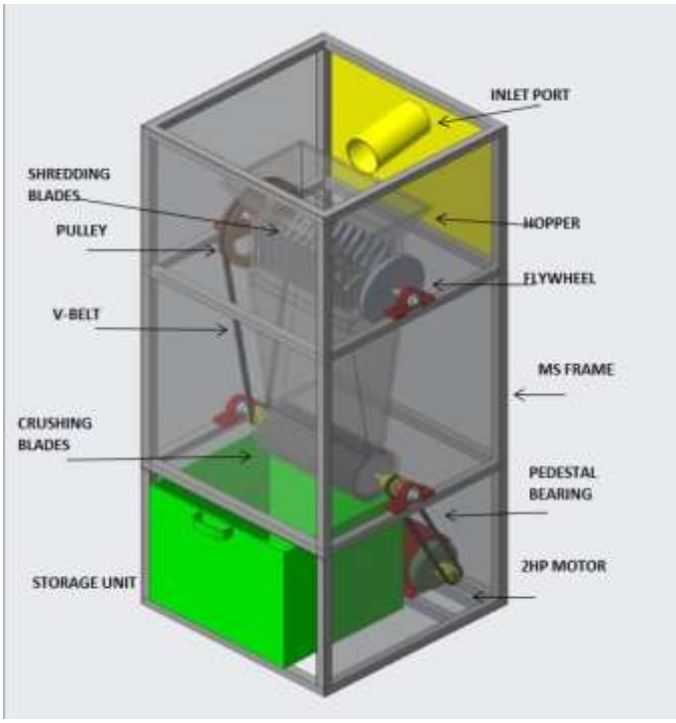

Fig.5 Complete Assembly

Our shredding and cutting machine has five main components feeding unit, shredding unit, cutting unit, power unit, and storage unit. Feeding unit consists of inlet port from which the bottle insert into the machine and hopper through which bottle guided into the shredding unit.it is made up of galvanized mild steel. The shredding unit consists of shredding blade (combination of rotating blade and fixed blade), 30 mm diameter shaft, pulley and a flywheel which is used to maintain uniform torque. The 14 mm shredding blades (10 blades) are uniformly placed between 12-inch shaft distances. The direction of rotation of the blade is clockwise. This complete unit is used for cutting the PET bottles into medium size pieces. Tapered guideway provided between shredding unit and cutting unit. This will ensure that the medium size pieces are guided into the cutting unit properly without deviating.

Cutting unit consists of 20mm diameter shaft, 2-inch pulley (2 pulleys), cutting blades (2mm thickness, 7-inch diameter, fixed in 12-inch length). Now finally this unit will cut down the medium size pieces into smaller pieces. Power unit consists of 2 Hp 3-phase induction motor which will generate about 9.801 N.m torque. Power is supplied to the blades through v-belt and pulley arrangement.

The last unit is the storage unit. It is made up mild steel sheet. It is the square removable box of 450×450 mm2.The small pieces will fall into the storage unit. Once the storage unit gets occupied with small pieces of plastic bottles it will be removed from the machine and send for the further recycling process.

7. CONCLUSION

The aim of this paper is to design and development of a plastic bottle processing machine to reduce its volume to very small pieces, the design is modified we studied various literature to design the machine and referred this to make the design more cost-effective the proposed design is able to do the job effectively and efficiently, the product will help in reduce the plastic pollution in various places. And these results in saving our environment from hazardous plastic waste to some extent.

8. REFERENCES

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