

Plastic Waste Utilization

Abhishek Pandey^{1a}, Shubham Yadav¹, Vicky Vishwakarma¹, Vishal Yadav¹, Sudheer¹,
Prof. Shyam Bihari Lal²

¹⁾ U.G. Student [B.Tech], Department of Mechanical Engineering, Buddha Institute of Technology, GIDA, Gorakhpur, Uttar Pradesh, India, 273209

²⁾ Assistant Professor, Department of Mechanical Engineering, Buddha Institute of Technology, GIDA, Gorakhpur, Uttar Pradesh, India, 273209

Abstract - 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 collector. In conventional way of recycling, plastic waste were first packed and then transport to the local processing unit or power plants, so, the process of packaging and transportation is much costlier and also the available machine used to recycle the waste is also costly. So our intension behind this project to make a machine which process the plastic waste as cheap as possible at the initial stage of plastic pollution. It will reduce the labor work and transportation cost which result cost reduction. A cutting machine is designed to reduce large solid material into smaller volume and then extruded into billet by melting and molding. This machine will be the solution of the problem of space and transportation

Key Words: Plastic waste, shredder, extruder, billet, moulding, recycling.

1. INTRODUCTION

Since the invention of plastic, we have depended on it as an affordable, versatile and durable material. Six decades ago, mass production of plastics began; accelerating so rapidly that it has created 8 billion tones of plastic and over 86% of it isn't recycled. As of 2018, approximately 380 million tons of plastic is produced worldwide each year and yet only 1 quarter of it is recycled. That plastic has to go somewhere and it's continuously either dumped carelessly on land or in rivers in developing countries. The $\frac{3}{4}$ waste that isn't recycled enters our ecosystem, polluting our oceans and causing damage to our environment.

Plastic waste or plastic pollution is defined as the aggregation of plastic objects e.g.: plastic bottles, packaging materials etc, in the Earth's environment that adversely affects nature, animals and humans.

2. RECYCLING

Recycling is a very complex method of plastic waste management, which is used to reduce the raw materials consumption and decrease of waste quantity. Recycling always becomes the only reasonable method of the plastic waste management when consider waste formation in the End of Life.

2.1 Method of plastic waste management

The most Accurate and valuable way of waste problem solution is avoidance of plastic waste formation. Good waste treatment promotes 5R principle.

1. The first principle is Reduce,
2. The second one is Reprocess,
3. The third principle is Reuse.
4. The forth principle is Recycle
5. The fifth principle is Recover

2.2 Process of plastic recycling

The recycling of plastics is carried out in a six step

- Step 1- Plastics collection
- Step 2 - Manual sorting
- Step 3 - Chipping or Shredding
- Step 4 - Washing
- Step 5 - Melting and extrusion
- Step 6 - Molding and Pelletizing

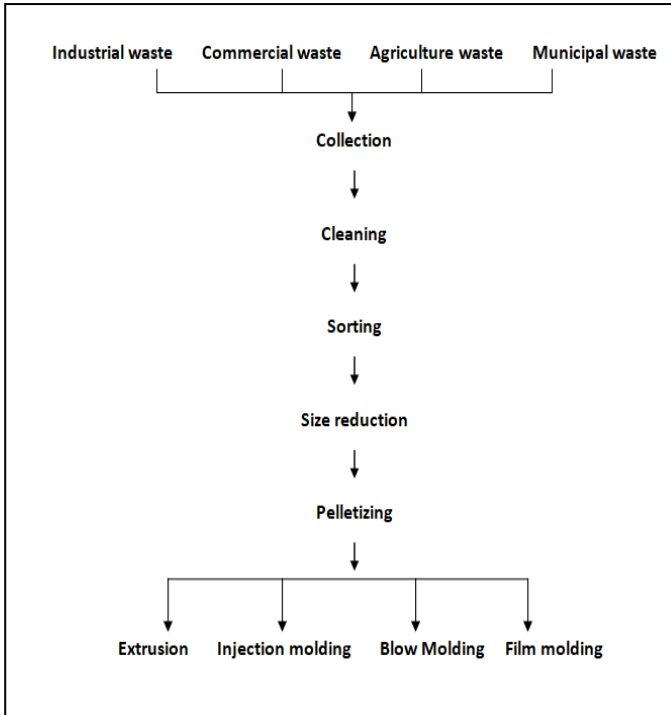


Chart.1: Process of plastic recycling

Plastics are organic artificial materials made by polymerization. They have high molecular mass and may contain some alternative substances to enhance performance or cut back prices. There are mainly two varieties of plastics first is “Thermoplastics” and second one is “Thermosetting” polymers.

Thermo plastics can soften and melt for many if enough heat is applied and hardened on cooling,

Thermosetting or Thermo set plastic will only soften and take form once. They’re not appropriate for perennial heat treatments; therefore when they need coagulated, they keep solid.

3. Literature review of the machine

On the basis of working process, this machine can be divided into two parts for better understanding of working of this machine. The first part is called shredder and second part is called extruder. Shredder is used to reduce the large chunk of plastic into small and even pieces. And Extruder is used to mix, melt and cast the plastic in the form of billet.

3.1 Principle of Shredder

Plastic have more volume compared to its weight. Due to this plastic waste take more space than other scrape so scrape collector avoid taking plastic waste. Shredder reduces plastic waste for better handling and inventory control. Designing of shredder depends on strength and hardness of the material. There are three possible zone can define i.e. feed zone, cutting zone, screening zone.

1. Feed zone: it is use to feeding the material to the cutting zone. It is basically a hopper by which material is feed to the cutting blade.

2. Cutting zone: it has rotary shafts which support a set of cutting blade. Shaft is powered by the motor by pulley and a set of gear. The cutting blade is rotate along with a set of fixed blade to perform the shearing action. Plastic goes through this and cut into pieces. Size of the pieces depends upon depth of cutting edge and the rotation speed.

3. Screening zone: it insures that the size of shredded plastic is between the desire and even size.

Table -1: Part List and Material of Shredder

| Sr. No. | Part Name | Material | Quantity |
|---------|----------------|-------------------|----------|
| 1 | Casing | Mild steel | 1 |
| 2 | Hopper | Mild steel | 1 |
| 3 | Shaft | Mild steel | 2 |
| 4 | Cutting blade | N8 Cast Steel | 12 |
| 5 | Strips | N8 Cast Steel | 12 |
| 6 | Gear | N8 Cast Steel | 2 |
| 7 | Pulley | Cast Iron | 2 |
| 8 | V-belt | Synthetic Leather | 1 |
| 9 | Bearing | Stainless Steel | 4 |
| 10 | Frame | Mild Steel | - |
| 11 | Electric motor | | 1 |
| 12 | Hopper cover | GI Sheet | 1 |

3.2 Principle of Extruder

In the Extrusion process material is forcedly passed through the die after melting the material to the plastic state. It forms the desire shape and size. For the plastic waste material melting temperature keeps low and for the continuous flow single or twin screw extruder is mainly use. The main function of extruder is uniform melting and mixing of plastic and finally generates the enough pressure to push the material to the die. It can define by the ratio of screw length and its diameter (L/D). Generally L/D ratio is used as 24:1, but it may increases to 32:1. It can also divide into three zones i.e. Feed zone, mixing and Melting zone, and Metering zone.

- 1. Feed zone:** In this zone Shredded plastic enter in the extruder barrel and the channel depth is constant here. Now screw pushes the material to the melting zone.
- 2. Melting zone:** In this zone a heating element is situated. It gives the desire energy which require for the melting process. Screw continuously mixed and pushes the plastic to the end.
- 3. Metering zone:** In this zone, mixed and molten plastic forwarded to the die at uniform pressure and temperature.

Table -2: Part List and Material of Extruder

| Sr. No. | Part Name | Material | Quantity |
|---------|-----------------|-----------------|----------|
| 1 | Barrel | Aluminum | 1 |
| 2 | Screw | N8 steel | 1 |
| 3 | Pulley | Cast iron | 2 |
| 4 | Bearing | Stainless steel | 2 |
| 5 | Heating element | Tungsten Alloy | 2 |
| 6 | Hopper | Mild steel | 1 |
| 7 | Die | N8 steel | 1 |

3.3 Design of shredder

We use C40 steel for the shaft. It has shear stress of 65 N/mm², length of drive shaft is 470mm and length of cutting shaft is 350mm, both shafts has diameter of 30mm supported on four bearing blocks. 12 cutting blade, made of N8 high carbon steel are welded on the cutting shaft. Each blade has diameter of 120mm and thickness of 11mm, it has three cutting edges. Cutting shaft is connected with drive shaft with a pair of gear ratio of 5:1.the shredder box made of 10 mm thick mild steel plates and its dimension is 310×310×290 mm.

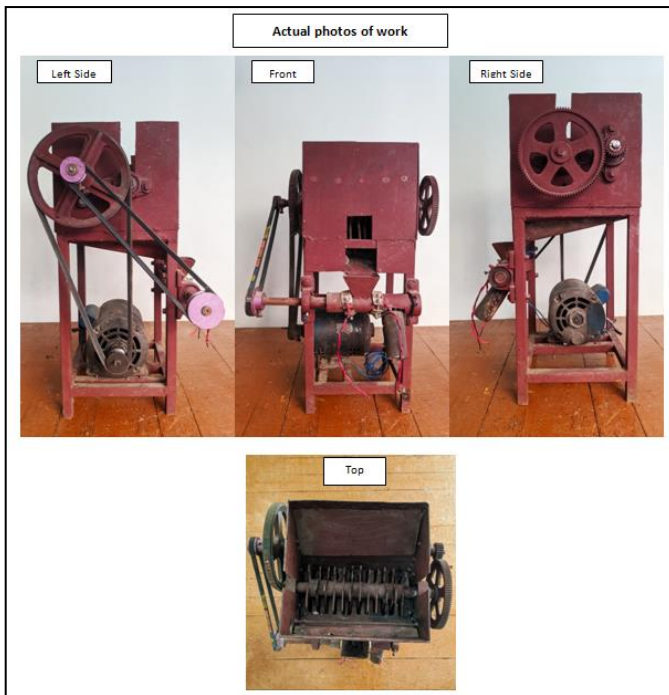
3.4 Design of Extruder

The barrel is made of Aluminum and the screw is made of N8 steel. This screw is connected with the drive shaft through belt and pulley. Diameter of drive pulley is 50mm and driven pulley is 70mm. This whole arrangement is supported by two bearing block. At its end there is a mounting for the die by which melted plastic goes in the mould. Two mica based heating element of diameter of 30×40mm are situated on the outer side of barrel. It has specification of AC 220V tail output, 300 watt power and temperature varies from 0 - 400°C.the pulley

3.5 Construction of Frame and Drive system

We use a 1.5 HP, 2800 rpm electric induction motor for powering the machine. It transmits rotation and torque to the drive shaft through the pulley. Diameter of driver pulley is 40mm and driven pulley is 225mm. and for the belt we use a leather V-belt.

All the arrangement of shredder, extruder and motor are supported by the frame, made of Mild steel. Its length and width is same as shredder casing and its height is 460mm without the height of shredder casing. Motor frame is 50mm up from the feet of the frame. So the total height of the machine is 800m



4. CONCLUSIONS

Based on our limited amount of use of this machine and analysis of working, several conclusions can be made

1. Firstly Recycling is very complex method of plastic utilization so it has its own complexity of collecting and separating the waste
2. The large particle of plastic had to be broken down into small particle for the smooth flow in extruder
3. Because of low density of plastic, the flow rate of melted plastic is high
4. Mass flow rate increases with the increasing of speed of motor.
5. Because of less manufacturing cost and small in size it reduce the general costing of recycling process and labor work and there is no requirement of skilled labor.

ACKNOWLEDGEMENT

I would like to express my special thanks of our group mentor Mr. Shyam Bihari Lal sir who gave me opportunity to do this project on Plastic Waste Utilization. And I would also like to thanks and acknowledge the HOD and the Staff of Mechanical Engineering department of Buddha Institute of Technology, for helping to construct this project.

REFERENCES

- [1] World Academy of Science Engineering and Technology International Journal of Industrial and Manufacturing Engineering Volume 10, No 11, 2016
- [2] International Journal Of Research, Paper on Fabrication of Paper and Plastic Shredder Machine, International Conference on Innovation and Research in Engineering Science and Technology, 24 Feb 2018.
- [3] International Journal of Waste Resources, Paper on Development of Plastic Bottle Shredding Machine, N.D Jadhav, Maharashtra, India.
- [4] Research Paper on Design and Fabrication Recycling of Plastic System Published in International Journal of Scientific and Engineering Research, Volume 7, Issue 5, May 2016 ISSN 2229-5518. Design Consideration of Plastic Shredder in Recycling Process
- [5] International Journal of Plastic Waste Shredder Machine, Research Paper on Design and Fabrication of Plastic Waste Shredder Machine, SNS College of Engineering, Coimbatore
- [6] Kiran N. Pyrolysis of Virgin and Waste Plastics and Characterization of Involved Products, PhD Thesis. Istanbul: Bogazici University, 1998.
- [7] Shilpi S (2013) Eco architecture: PET bottle houses. Int J Sci Eng Technol 2: 1243-1246.
- [8] Howell GS. A ten year review of plastics recycling. J Hazardous Materials 1992; 29:143 - 64.
- [9] Radusch HJ Future perspectives and strategies of polymer recycling, in: Akovali G, Bernardo CA,
- [10] Leidner J, Utracki LA, Xanthos M, editors. Frontiers in the Science and Technology of Polymer Recycling, NATO-ASI Series, Series E: Applied Sciences, vol. 351, no. 6. Kluwer Academic Publishers, Dordrecht, Netherlands, 1998: 451 - 467.
- [11] John W. sons, Principles of Polymer Processing. Tadmor and Gogos, 2006.
- [12] The NEED Project's free online Info Books at: 1TUhttp://www.need.org/Guides-Title.php
- [13] Mr. V.B.Bhandari, "Design of machine element", Tata Mc- Graw Hill Publication, 3rd Edition 2010.
- [14] Czvikovszky T., Nagy P., Gaál J.: A polimerteknika alapjai. Műegyetemi kiadó, Budapest, 2000. 240-289.
- [15] Rauwendaal C.: Polymer Extrusion. 4th ed., Hanser Publications, Munich, 2001. 6-8.
- [16] Harold F. G., John R. W., Eldridge M. M.: Extrusion The definitive processing guide and handbook. Plastics Design Library, New York, 2004. 13-21.
- [17] Sophie van den Berg (2009) Technical brief of recycling plastic.

- [18] Sonkhaskar YM (2014) Design and development of plastic bottle crusher. Int J Engg Technol Sci Res 3: 10.
- [19] Darshan R, Gururaja S (2017) Design and fabrication of crusher machine for plastic wastes. Int J Mec Product Engg 5: 10.
- [20] Elias HG (2003) An introduction to plastics.
- [21] R. J. Crawford, *Plastics Engineering*, 3rd Edition. 1998, p.245-250.
- [22] Instruction manual. CBW Granulators. Models 1012, 1018 and 1024 P. 11-36.
- [23] Kirubel Bogale. Simulation and Design of Extrusion Dies, Degree Thesis *Plastics Technology* 2011 P. 32-44.
- [24] Kikuchi R Jan K, Raschman R "Grouping of Mixed Waste Plastics According to Chlorine Content." *Separation and Purification Technology* (2008) 61: 75- 81.