

Plastic Recycling and Its Applications

Krishna Murthy M¹, Shankar shrestha², Pravin Buka³, Akhila C A⁴, Balesab⁵

¹(Mechanical engineering, Asst Prof, Bangalore Technological Institute, India)

²(Mechanical engineering, Bangalore Technological Institute, India)

³(Mechanical engineering, Bangalore Technological Institute, India)

⁴(Mechanical engineering, Bangalore Technological Institute, India)

⁵(Mechanical engineering, Bangalore Technological Institute, India)

Abstract: The main objective of the project is to recycle plastic waste into final product and reduce plastic in waste streams by some fraction. The entire work will be developed at a minimum affordable cost with minimal parts, possess durability, easy to operate, and safe operating condition, which is the main aim of the current work. At first plastic will be sorted based on its type. After, sorting mini shredding equipment is fabricated for converting plastic into miniaturized pallets. Then injection molding machine will be fabricated. The shredded plastic is melted as per its melting point without fumes on injection molding machine. At last, molten plastic is injected into molding unit for useable application.

Keywords: Shredder Machine, Injection molding machine, Coil, Plastic, Fabrication

I. INTRODUCTION

Plastic is widely used materials which is generally made from petroleum and its byproducts. Plastic is the general term for a wide range of synthetic or semi synthetic polymerization products. They are composed of organic condensation or addition polymers and may contain other substances to improve performance or economics. There are few natural polymers generally considered “plastics”. These polymers are broken in presence of suitable catalyst, into monomers such as ethylene, propylene, vinyl, styrene and benzene. These monomers are chemically polymerize into different categories of plastics. Plastic is any synthetic or semi synthetic organic polymer. In other words, while other elements may be present, plastics always include carbon and hydrogen. While plastics is made from any organic polymer, most industrial plastic is made from petrochemicals. A plastic shredder is a machine used to cut plastic into smaller pieces for granulation. Unlike plastic granulators, shredders are designed specifically for larger plastic waste, like car bumpers, pipes, drums, and other items too big for granulators. Plastic shredder is a machine that reduces used plastic bottles to smaller particle sizes to enhance its portability, easiness and readiness for use into another new product. The design principle of this machine was got from the ancient tradition method of using scissors to cut materials into reduced form and scratching used by rabbits when digging or tearing. These two traditional methods were applied in the design of the machine by fabricating cutting blades to cut the waste plastic while some of the cutting blades have sharp curved edges to draw-in the plastic into the cutting blades teeth. The waste plastic shredder comprises of four major components, namely; the feeding unit, the shredding unit, the power unit and the machine frame.

II. REFERENCE

Yassin et al. [1], Concluded that number of environmental concerns are associated with co-incinerating Plastic Solid Waste (PSW), mainly emission of certain air pollutants such as CO₂, NO_x and Sox. The combustion of PSW is also known to generate Volatile Organic Compounds (VOCs), smoke (particulate matter), particulate-bound heavy metals, Polycyclic Aromatic Hydrocarbons (PAHs), Polychlorinated Dibenzofurans (PCDFs) and dioxins. Carcinogenic substances (PAHs, nitro-PAHs, dioxins, etc.) have been identified in airborne particles from incineration or combustion of synthetic polymers such as PVC, PET, PS and PE. Capture and removal of flue gases in thermal (in general) and combustion processes (in particular) is a major issue dealt with by ammonia addition to the combustion chamber, flue gas cooling, acid neutralization, activated carbon addition and filtration.

Schoenung et al. [2], Suggested number of techniques that have been developed in order to separate and sort PSW. In the recycling industry, sorting and identification is to done within a short time to positively affect a recycler’s finances. Both fast and accurate identification of the primary plastic contained in a particular item, followed by some type of manual or automated sorting are essential. In the case of plastic bottle, sorting, automated techniques do exist but are not always applicable due mainly to a difference in shape and size, or the

existence of paint and coating which delays the analysis technique, etc. Another way of sorting (common in Asian recycling lines) is density sorting. The Density sorting methods are not particularly helpful, because most of the plastics are very close in density (HDPE = 0.941, LDPE = 0.915–0.925, 0.94, PP = 0.96 g/cc). In the case of rigid PSW resulting from electronic parts, a heavy medium separation is usually applied. This can be done by adding a modifier to water or by using Tetrabromoethane (TBE). However, this is a costly process and can lead to contamination of the recovered plastic. To enhance the effectiveness of density separation, hydro cyclones are commonly used. Hydro cyclones, which use centrifugal force, enhance material wettability. Some of the factors affecting liquid separation of a given material are its wettability, its variation in density (from porosity, fillers, pigments, etc.), shape factors of size-reduced particles, and its level of liberation from other materials. Even surface air bubbles, which can attach to plastics as the result of poor wetting or surface contamination, can cause an individual flake of material to float in a solution less dense than that of bulk material.

Zia et al. [3], Studied the process of recovering Plastic Solid Waste (PSW) for the re-use in manufacturing plastic products via mechanical means. It was promoted and commercialized all over the world back in the 1970s. Mechanical recycling of PSW can only be performed on single-polymer plastic, e.g. PE, PP, PS, etc. The more complex and contaminated the waste, the more difficult it is to recycle it mechanically. Separation, washing and preparation of PSW are all essential to produce high quality, clear, clean and homogenous end-products. One of the main issues that face mechanical recyclers is the degradation and heterogeneity of PSW. Since chemical reactions that constitute polymer formation (i.e. polymer addition, polymerization and poly-condensation) are reversible in theory, energy or heat supply can cause photo-oxidation and/or mechanical stresses, which occurs as consequence. Length or branching of polymer chains can also occur from the formation of oxidized compounds and/or harsh natural weathering conditions. Due to the previously stated reasons, it is very important to have a customer ready to purchase the product to achieve a sensible economic and environmental practice. Nevertheless, mechanical recycling opens an economic and viable route for PSW recovery, especially for the case of foams and rigid plastics.

III. INDENTATIONS AND EQUATIONS

The design of shredder machine is done as per the procedure. The shredder uses a mode of shear to cut material, which is a perpendicular force, applied to a material. In this case 2 perpendicular forces that are equal and opposite in direction. The two perpendicular forces are parallel to each other but opposite in direction. The design procedure is followed for the calculation of power requirements and torque. Following are equations used for calculation of power requirement and torque. The torque developed on a shaft is given by

$$T = F \times r$$

Where, T = Torque in Nm

F = Force in N

r = Distance of blade end from center of shaft

The force required to generate a require torque can be calculated using following

$$F = \frac{2\pi m N r}{60}$$

Where, N = Speed of motor in rpm

m = Mass of shaft in Kg

r = Distance of blade end from center of shaft

The power requirement of the motor is calculated using following

$$P = \frac{2\pi N T}{60}$$

Where, T = Torque in Nm

N = Speed of motor in rpm

Observations

The standard specifications of motor are as following:

Speed of motor = 1440rpm

Power of motor = 1hp

Diameter of smaller pulley

(d1) = 4cm Diameter of larger pulley

(d2) = 17.5cm

Calculation of Speed of Shredder Shaft

Let, N1 and N2 be the speed of the motor and the Shaft respectively.

Let, Assume, N1 = 1360 rpm

Relation between speed ratio and diameter ratio of pulley is given

$$\frac{\text{OutputSpeed}}{\text{InputSpeed}} = \frac{\text{SmallerDiameter}}{\text{largerDiameter}}$$

$$N2 = N1 \times \frac{d1}{d2}$$

$$N_2 = 1360 \times 47.5$$

$$N_2 = 725.33 \text{ rpm}$$

Therefore, the output speed of the shaft for the belt driven machine is 725.33 rpm.

Calculation of Torque From Newton's second law of motion,

$$F = m \times vt$$

Where, Linear velocity, $v = \omega \times r$ m/sec

Angular velocity, $\omega = 2\pi N/60$ rad/sec

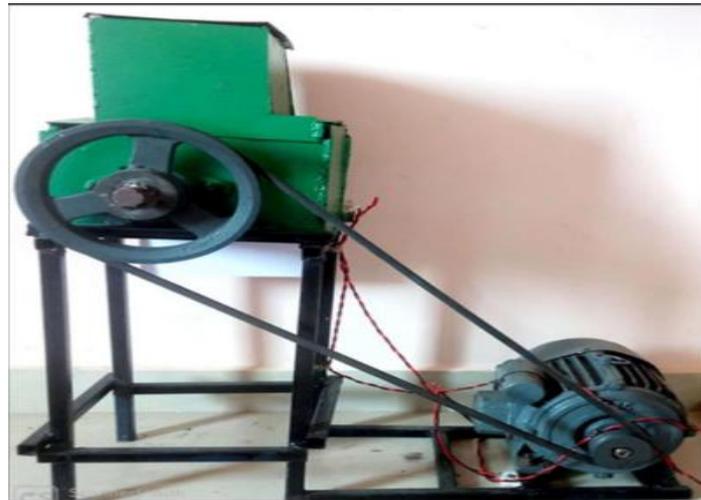
From the above formulas, we can find the torque from

$$T = F \times r$$

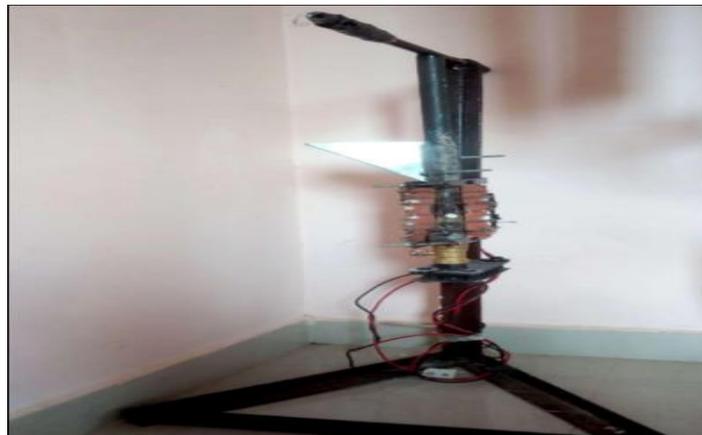
Where, F= Force N

r= Distance of blade end from center of shaft in meter

IV. FIGURES AND TABLES



Model of Shredder Machine



Assembly of Injection Moulding Machine

V. CONCLUSION

There are various conclusions obtained after finishing this project. Some of them are listed below.

- A simple in construction, easy to operate and highly productive plastic recycling equipment is designed and fabricated as per the model diagram with some modification.
- The fabricated shredder produces miniature pellets.
- Waste plastics HDPE is successfully recycled into new product and used in desired application based on the requirements.
- Fabrication is done at minimum cost.

Advantages

There are several advantages of the current work. Some of them are listed below:

- Waste plastic can be easily recycled into useful products like door handles, furniture, floor mats, and domestically for bowls, cloth hangers, toys, etc., and so on.
- Economical as compared to industrial recycling machine.
- Easy to operate.
- Maintenance free.
- Affordable to the middle class people.
- No need of skilled operator.

Disadvantages

Only disadvantage in current work is preparation of waste plastic before processing which will consume time. To overcome this drawback additional equipment's are to be fabricated such as washing machine, drying machine etc.

Applications

There are many applications of plastic recycling. First of all, it helps in reducing plastic solid waste by some fraction which helps in cleaning the environment. As we know that plastic have become most useful material in present world. Some of the application where plastic is used are as following:

- Used as insulator in electrical appliances.
- Used in making cups, buckets, bottles etc.
- Used for making door, frame of electrical devices like mobile, television etc.
- Making plastic bags, taps, rope, toys etc.

ACKNOWLEDGEMENTS

An acknowledgement section may be presented after the conclusion, if desired.(8)

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