Performance Study on Plastic Recycling Machine: HDPE

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Abstract- *Plastic is enormously used all around the globe. Use of plastic in day to day life is rising and it's wastages creating a major issue in terms of pollution. This project will help to resolve the plastic wastage problem effectively. To solve this issue there already exists numerous machines which are operated at high levels that makes it very costly. So, the main purpose of developing this machine is to make it cost effective and portable for recycling process. This machine will be used for cutting the plastic into considerable tiny chips and convert them into some useful products by melting and molding and mainly using HDPE . The machine will have three stages of attachment i.e. shredding, melting and product development.*

Keywords- HDPE, LDPE

I. INTRODUCTION

Plastic waste is one of the major issue in the past decade. Day to day popularity of plastic is rising gradually. Actually we are surrounded with plastic world. From packaging to product development the plastic creates a remarkable era of utility. People chooses plastic because of following reason-

a. Cost effective.
b. Light weight.
c. Chemically stable.
d. Corrosion Resistance

So we chose to do this project because use of plastic cannot be stopped suddenly instead of this we can find some alternative solution for the waste. Plastic Recycling is one of the wastage management solution.

The similar project idea already has been implemented but modification of our project is to development of some portable and low cost recycling machine, so that the machine can be install everywhere and easily Recycling process can be done

The another motivation to do this project is only 10% of plastic are going to recycled and rest of 90% of plastic can not get attention for the disposal or recycle. These huge amount of wastes increasing pollution gradually

1.1 Objectives

- To utilize the plastic from domestic and industrial waste to reproduce useful components like washers and bushes.
- To reduce the solid plastic waste.
- To make an innovative use of scrap machinery.
- To reduce soil and water pollution.
- To start Social awareness on wastages.
- To modify the raw plastic into composite material.

II. LITERATURE REVIEW

Bebetto sabu et.al (2017): Bebtto sabu et.al did the similar study what we have done. According to them they faced problem with managing plastic pet bottles. The environment is littered by plastic wastes especially bottles it causes the pollution and health hazards .So they found a solution with A e-eco bin. It is A device that accepts plastic pet bottles and rewards. When a user throw a plastic bottle inside the bin a candy is automatically rewarded the user. The inserted bottle will be crushed into minute granules. The output of the e-eco bin can be used for recycling, road making etc.

C.C. Ugoamadi et.Al (2011): This research involves the design and construction of A plastic recycling machine. That minimizes the limitations of the already existing technology of recycling. The results of experimental analysis showed that for every used plastic fed into the hopper, about temperature of 200 degree centigrade is required to melt and has a recycling capacity/throughput of about 265 kg/hr which translates to a significant time. Experiments also show that for a batch process, power requirement of the machine is proportional to the time in process.

Kamesh B. Vaidya et.Al (2017): The main purpose of their study is to design and fabricate cost effective plastic recycling machine for granule products for plastic industries. Machine works on combination of three processes to fulfill

requirement. First step is to separation of waste plastics according to classification of plastic. In second step separated plastic feed to crusher in which plastic dissect are formed. In third and last step the crushed plastic feed in to the extrusion hopper and then it feed in to barrel by using extrusion shaft as a feeding mechanism. Barrel is provided with heating elements which gives required heat to barrel to form mold and whose temperature is controlled by universal temperature controller as per type of plastic. Mold further feed in to cavity to form required product

III. METHODOLOGY

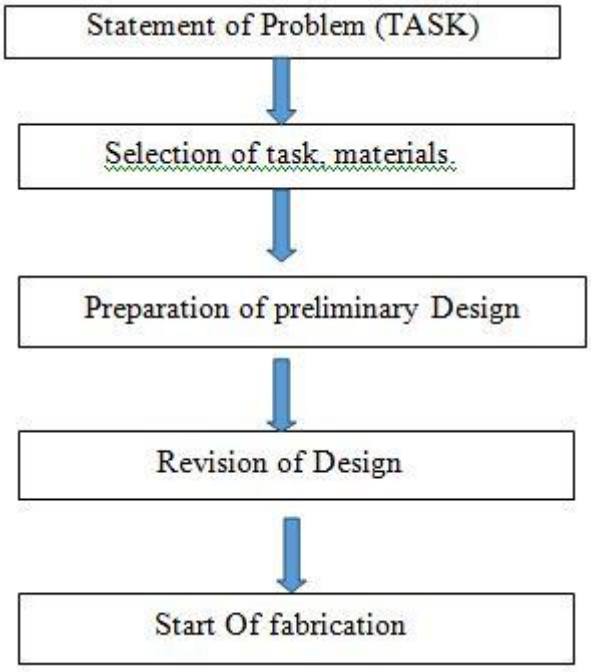

Fig: 3.1 Methodology

3.1 Statement of the problem:

As the usage of the plastic is rising since the past decade. It is being used because of its light weight and attractiveness. But these enormous usages have become problem in terms of pollution to the society because of its non-biodegradable property. Therefore, its wastages cannot decompose and is harmful for the environment. However, we cannot stop using plastic since we are surrounded with the plastic world.

3.2 Selection of the task and material:

Due to the non-biodegradable nature of the plastic, some other ways have to be carried out in order to minimize the wastage problem. One aspect can be considered by developing a machine that can be helpful in recycling the waste plastic rather than throwing the plastic waste or used plastics in a barren place. So, our main task is to be developed such a recycling machine which would able to meet minimum cost of recycling and for that we have to choose such cost-effective materials to build the machine.

3.4. Preparation of preliminary design:

The preliminary design has been carried out with the help of AutoCAD software. This preliminary design gives us a clear picture how the proposed model looks and different parts of the model. On this basis a fair decision can be taken regarding the proper usage of the selected raw materials. And also, it will help to assemble the parts according to the position of the parts with accuracy dimensional tolerance.

3.5. Revision of Design:

After the preliminary design, and making it a cross check practically, if there is a need of any changes of the design or any part of the machine then there will be the necessary of redesigning the machine as per the requirement of the project model.

3.6. Start of fabrication:

This is the final step where the fabrication of the proposed model starts. In this step we need to carry out measuring the materials, cutting operation of the rods, shredder blades, welding operation, drilling, grinding operation, finishing operation. In this project welding operation is carried out by the arc welding machine, using the current range of 100amps, and electrode selected 6018 as we using mild steel material for frames.

IV. RESULT AND DISCUSSION

4.1 Proposed Model AutoCad Design

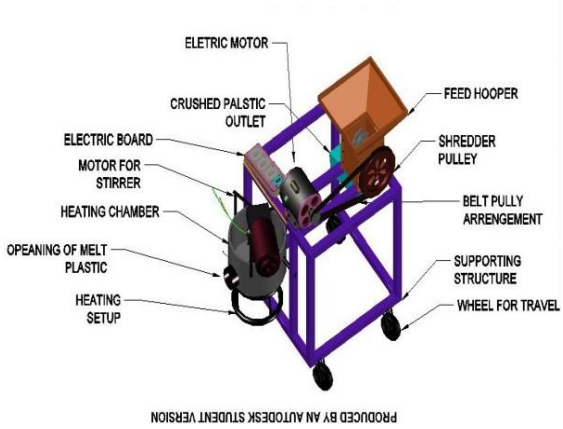

Fig: 4.1 CAD Model

4.2 Complete Model After Fabrication

Fig: 4.2 Fabricated Model

4.3.Calculations:

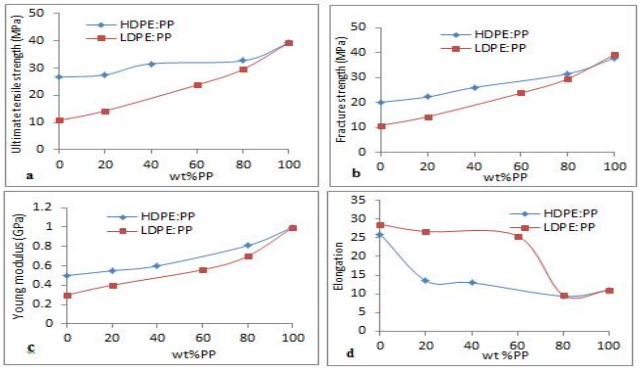

Fig.5.1: Mechanical Properties of HDPE & LDPE

4.3.1 Strength calculation for HDPE plastic:

From above chart we can say that average fracture strength for the HDPE plastic
σ = 26 MPa
Since 1 MPa = 1 N/mm^2

For cutting of HDPE plastic per mm^2 we need 26 N/mm^2 force.
The tip of the shredder blade is 5 mm.
Since three tips are working at same time.
So,
Cutting of 1 mm thickness HDPE plastic we will need-
Total tip area= 3x5 =15 mm^2
Again,
For cutting of 1mm^2 HDPE we need = 26 N/mm^2 of force.
Therefore,

Cutting of 1mm^2 HDPE by 1 blade tip = 26x5 = 130 N
Since three tips are working at time so the total torque needed for single cut = 130x3 = 390 N-mm.

4.3.2 Performance test on shredder machine:

a) Feeding capacity of hopper:

Volume of the hopper = Area of cross section of the hopper × Width of the hopper.

$$= \frac{1}{2}(A+B)H \times width$$
$$= \frac{1}{2}(150+160) \times 150 \times 250$$
$$= 5.8125 \times 10^6 \text{ mm}^3$$

Shredding or cutting capacity per minute = 0.280kg
Crushing per hour = 0.280x60 kg/h
=16.8kg/h ≈ 17 kg/h
Per day (i.e., 8 hour) capacity =16.8x8
=136 kg/8h

Torque of the working shaft:
Power consumption of motor, P = 370 watt.
Angular revolution of working shaft, $\omega = \frac{2\pi N}{60}$

$$= \frac{2 \times 3.14 \times 235}{60}$$
=104.71 rad/sec

We know that,
Power (p) = Torque (T) × Angular revolution (**ω**)
P =T×**ω**
T = $\frac{P}{\omega\eta}$
For choosing η value we have to followed the following table:
Percent efficiency of A typeV belt drive at 541.13 N tension-
$\eta = 97.3\%$
= 0.97
The torque of the working shaft T = $\frac{P}{\omega n} = \frac{370}{104.71 \times 0.97}$
= 3.64 N-m
Since the speed ratio, r = 4.25
Therefore,
The torque at the working shaft-
T = 3.64 × 4.25
=15.48 N-m

b) Determination of shaft diameter:

We know that

Torsion equation-

$T = \frac{\pi}{16} \times \tau \times d^3$

$15.48 = \frac{\pi}{16} \times 200 \times 10^6 \times d^3$

$d^3 = 7.33 \times 10^{-7}$

$d = \sqrt[3]{7.33 \times 10^{-7}}$

$d = 7.33 \times 10^{-2}$ m

Therefore, d= 7.33 mm

By considering factor of safety as 3.41, the shaft diameter-

$d = 7.33 \times 3.41$

d= 25 mm.

c) Cutting capacity of the machine:

For cutting of 1mm thick plate 390 Newton power required.

Toque at the output shaft of shredder machine is = 15.48 N-m

$T = 15.48 \times 1000$ N-mm

=15480 N-mm

Therefore, toque at the tip of blade, $T_p = \frac{\text{Torque at the output shaft } (T)}{\text{Radius of blade} \times \text{Total area of Blade tips gets contact at a time}}$

Here,

Torque at the output shaft, T = 15480 N-mm

Radius of blade, r = 60 mm

Blade thickness, t = 5 mm

No. of blade get contact with plastic at a time = 4

Therefore,

Total area of blade tips gets contact at a time = Thickness of each blade $\times$ no. of blade gets contact at a time

$= 5 \times 4$

$= 20$

Torque at the tip of blade, $T_p = \frac{15480}{60 \times 20}$

= 5160 N-mm.

Since, cutting of 1mm thick plastic needs 390 N-mm torque.

Therefore, 5160 N-mm torque can cut HDPE plastic by 4 tips of blades = $\frac{5160}{390 \times 4}$

= 3.3 mm

Hence, the machine can cut 3.3 mm thick HDPE plastic easily

V. CONCLUSION

From overview of study and the project, plastics have good properties which makes them useful in day to day life. But they are harmful for environment because they take lots of years to degrade. So recycling is one of the best method to reduce these plastic waste. So we need to develop awareness in people about recycling of plastic waste in order to secure our life. Thus the portable plastic recycling machine one of the important approach towards the achievement of plastic recycling in easy manner and in affordable cost. This project helps in minimizing the effect of plastic in the environment, by making the used plastic by recycling process into and useful product such show-cases, toys, casing. And this machine can recycle the HDPE plastic effectively. And HDPE plastic most widely and can be recycled easily.

VI. FUTURE SCOPE

- The recycled plastic can be used as composite material by adding PVC.
- In order to enhance strength in its mechanical properties, and also if automation used then the machine can be run remotely, and produce the product very quickly, and proper usage of the shredder blades with precise dimensions it can cut more effectively.

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