

PLASTIC PELLET MACHINE

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ABSTRACT

The high level of uncontrolled biodegradable waste constantly dumped in our surroundings on a daily basis constitutes nuisance in urban communities in India. This necessitated the need for a detailed design and construction of a compact pelletizing machine. This machine is important in the recycling process because it can be used to reduce the size and bulk density of waste plastic materials for ease of transportation and processing in the industry. The pelletizing machine was designed and constructed with a screw thread conveyor in a barrel to convey molded plastic. The screw thread is driven by a belt drive. The barrel was constructed to sear low density plastic at a temperature of 80°C. The waste polythene was fed through the feed hopper and extruded through a nozzle. The output becomes useful raw material for plastic industries. The machine developed would be useful in plastic waste management in urban cities in India. The pelletized materials will generate income as it serves as raw materials to polythene industries and provide employment opportunity for youths.

Keywords: barrel, conveyor, hopper, palletizing machine, Polythene

INTRODUCTION

We are working together to find ways to work with plastic waste. By now plastic has become a threat to entire ecosystems and societies. It is deteriorating our planet and people's lives. It is a problem. A material made to last hundreds of years that is only used for minutes, a fraction of its possible lifespan, and quickly discarded.

All plastic laying our around is a resource, not waste. A material with great potentials, mostly intact qualities and a sea of opportunities waiting to be discovered. If treated correctly, this resource can become the beginning of something new. For you, society and the planet at large. This resource, laying around everywhere, can become a source of income or an educational tool for our community.

The extrusion machine is a very powerful machine it can create unique products and can run continuously. Technically, if you have enough plastic and a well-streamlined process you could be recycling 24/7. With the extrusion machine you can create filament, granulate or get creative working with mould. This machine is also great for educational purposes as the process is very straightforward and easy to understand. This technique nicely blends differently colored plastics together and outputs a homogeneous and smooth color, for example, if you mix black and white plastic together you will get a nice and smooth grey output. You can use this feature to your advantage in your designs.

NOMENCLATURE RELATED TO MACHINE**PLASTIC PELLET MACHINE NOMENCLATURE**

Motor: 2HP AC Supply Voltage 220V, Speed-1400rpm

Gearbox: Gearbox ratio-1:20

Table: L-960mm, b-500mm, h-830mm, Material-Iron

Temperature Controller: PID Temperature Controller, RX-100, **Range:**0-1200c*

Thermocouple: Thermostat or Thermocouple (K Type)

Barrel: 1x Machined Barrel with welded brackets and BSPP threads.

Size: 25mm (internal diameter) X 530mm (length +5mm tolerance)

External diameter: 35mm

Material: ST-52 Steel

Nozzle: Customized Nozzle

Heater: Heater coil-3.

Hopper: Dimension L-263mm, B-236mm, Angle-60^*

Screw: Dia 26mm(customizable)& Length-588mm, EN 41B MUSCO, Screw profile made on special thread milling machine with the help of advance measuring instrument. The screw is highly mirror polished by special purpose polishing machine



| Description | Material | Details | Quantity |
|----------------------|----------|--------------|----------|
| Machine parts | | | |
| Strip | Steel | 30x3MM | 10cm |
| Round bar | Steel | 30MM | 5.5cm |
| Round bar | Steel | 25MM | 800cm |
| Square tube | Steel | 30x30x3MM | 53cm |
| Tube | Steel | 34x26x4MM | 32cm |
| Angle profile | Steel | 30x30x3MM | |
| Sheet metal | Steel | 1mm | 1 |
| Motor | - | 1 | 1 |
| Bearing | - | 1 | 1 |
| Drill | - | 26 x 600 MM | 1 |
| Electronics | | | |
| PID Controller | - | 0-400 Degree | 2x |
| SSR | - | 2-24 V | 2x |
| Thermocouple | - | Type K | 2x |

| | | | |
|---------------|-------|------|----|
| Band heater | | | |
| Power switch | Metal | 220V | 3x |
| Led indicator | Metal | 220V | 3x |
| Power cord | | 5m | 3x |

The development of plastics has evolved from natural plastic materials to completely synthetic molecules (e.g., epoxy, PVC). Parkesine (nitrocellulose) is considered the first man-made plastic (1856). After World War I, improvements in chemical technology led to an explosion

of new plastics, with mass production beginning in the 1940s and 1950s. World War II led to greater research and development into plastic and the discovery of many new plastic types with different properties and applications. As the war ended, these new plastics made their way into society through a multitude of consumer goods.

METHOD AND HOW IT WORKS

Process:

Plastic is inserted from the hopper, gets transported along the barrel by a big screw towards the end where heating bands are placed. The heating from the bands and the mounting pressure inside of the barrel bring the plastic to a melting state (liquid). Once sufficiently melted the plastic can eventually get out through the nozzle in the form of a continuous thread. The plastic thread is then treated differently depending on the wanted outcome.

Create: -

Once the extruded thread exits the nozzle it can be treated in a number of ways in order to get the desired results. For the sake of this publication, we will only describe the process using the provided mould, other ways to create filament for 3D printing or pellets can be found online. When the plastic comes out of the nozzle it is still semi-liquid (and very hot!), this gives us a few seconds to shape it around our mould. The fresh hot thread coming out of the nozzle is placed around the mould over and over until a new object is created. Hot new plastic and previously layered threads will melt together to create a new solid material. Repeat this process multiple times around the mould and you'll get a new product. While very straightforward at first, this process requires a bit of experience and good hands-on approach but anyone should be able to make some cool objects after a few attempts.

Moulds: -

With the lamp mould from our technique videos you can make a lamp, it is simple and straight forward for anyone to understand how it functions. It is made with steel and can be reproduced by any metal worker around the world. An important aspect to keep in mind is to design the mould with convex walls (not completely straight) to help release the final product. Technical drawings for this mould are available online.

Temperature: -

You can set the temperature from the controllers on the electronic box. The heating elements are wired into two groups (Nozzle and Barrel marked on top of the controllers) first three elements (Barrel) should be set at slightly lower temperature than the last one near the nozzle. This is to make sure the plastic gets a last boost of heat right before it comes out. Below you can find a diagram with the best settings for this machine based on our experiments (tip: you could make one of your own to see what works best for you). The optimal temperatures

below are drawn using a motor turning at 70rpm. If your motor turns faster you would need higher temperature as the plastic flows faster through the barrel and has less time to melt, vice-versa if the motor is slower. How to operate the extrusion

Startup: -

1. Heat the machine to the desired temperature.
2. Wait 20 minutes.
3. Add desired plastic in the hopper.
4. Turn on the motor.
5. The material that comes out of the machine for the first 2 minutes is to clean the machine from old plastics from previous sessions.
6. The machine is now ready for production.

Production: -

1. A plastic string is now flowing out of the extruder, this cannot be easily stopped, so know what you want to make before you start extruding.
2. The flow and pressure of the extrusion can be adjusted by turning the screw at the nozzle (more flow equals less pressure).
3. Remember that it takes roughly 2 minutes for the plastic to reach the nozzle from the hopper.
4. Keep enough plastic granulates in the hopper while extruding to reduce chances of bubbles in the extruded plastic.

Cooldown: -

1. When cooling down the machine let the machine turn until there is no more material coming from the nozzle.
2. First stop the motor than the heating.

Trouble shooting: -

The most common problem with the extrusion is having an output that is not uniform. There are a few reasons why this could happen.

1. The plastic can be dirty clogging the nozzle and making it difficult for the plastic to get out.
2. Two different types of plastic are mixed together, common causes for this can be contamination in the sorting stage or plastic left in the barrel from previous activity. In this case, one plastic type melts while the other doesn't obstruct the plastic flowing through the nozzle.
3. The temperature is not high enough and the plastic in the barrel does not manage to fully melt.
4. You can solve the above problems by checking the integrity and purity of the raw material or by high ring the temperature. Upon adjusting your process make sure to empty the entire barrel before attempting to make a new product.

CALCULATION

POWER calculation; Power (kW) = Torque (N.m) x Speed (RPM) / 9.5488

1.RPM: Directly calculated with the help of DIGITAL TACHOMETER

2.Pitch: $\tan\alpha \times [D]$

$$\alpha = \tan^{-1}(\text{pitch}/[D])$$

METHODOLOGY

Screw Nomenclature

P is the screw pitch, distance between the center of two adjacent flights.

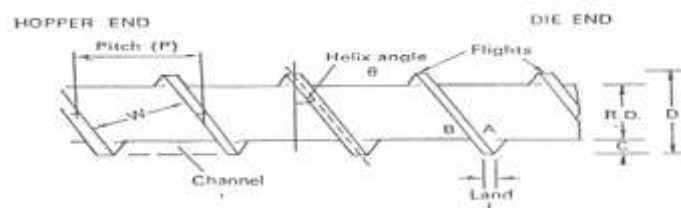
W is the channel width

L is the land width is the helix angle, defined as an angle between the flight to the transverse plane of the Screw axis.

D is the screw diameter, developed by rotating the flight about the screw axis.

R. D is the root diameter Flight is the helical metal thread of the screw.

C is the channel depth of radial distance from the bore of the barrel to the root



Extrusion:

Continuous Process

In principle, the plastic raw material is plasticated by means of a screw plastication unit and the molten material is continuously pumped out through a standard orifice (die) in order to take the shape and then the shape is set by cooling/sizing system.

Example: Film Pipe, Tube, Profile, Monofilament, Box Strapping etc.

Cast In-Heaters:

The insulated heating elements are cast into semi-circular or flat aluminum blocks, which are machined to match the surface to be heated

RESULTS AND DISCUSSION

| Trial | Procedure | Temp | Result |
|-------|---------------------------------------------------------------------------|------|------------------------------------------------------------------------------------------------------|
| 1. | At room temperature the shredded polythene material was fed to the hopper | 25°C | There was free flow, the screw thread conveyed the material to the end of the barrel was not moulded |
| 2. | Barrel was heated and then the materials was fed into the hopper | 70°C | The material achieved molding but was too thick to escape the die |

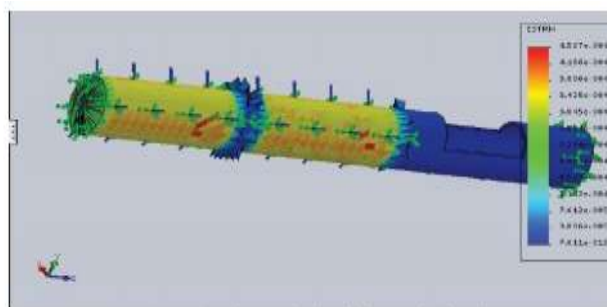
| | | | |
|----|------------------------------------------------------------------|-------|----------------------------------------------------------------------------------------------------------|
| 3. | Barrel temperature was reset to a lower temperature | 80°C | The material molded and flow through the die in lumps |
| 4. | Barrel temperature was reset and test carried out | 110°C | The material melted and it was observed that the polythene began to stick to the screw thread. (no flow) |
| 5. | Barrel temperature was increase and material was fed into hopper | 140°C | The material melted and polythene began to stick to the screw thread. (no flow) |
| 6 | After so much trial the temperature set at fix point | 170°C | The continuous flow of plastic in wired form drawn out. |

SIMULATION RESULT

1 Stress Analysis The von Mises stress plots of the extruder barrel analysis are given in Figure 4. The maximum stress at which it would fail is 182.852MPa.

2 Displacement Analysis The displacement diagram shows negligible displacement at the points in direct contact with the heater bands. However, there was induced displacement at the inner wall of the barrel opposite the heater band's location. The maximum displacement of 1.646×10^{-3} mm was observed at the inner wall and the space in-between the heater bands while the minimum displacement was 1.00×10^{-30} mm as shown in figure 5.

3 Strain Analysis From the strain plot in figure 6, we observed that the strain was maximum and minimum at the points that stress was maximum and minimum as shown in figure 4. The stress and strain plots follow the same pattern. The maximum and minimum strains were 4.567×10^{-4} and 7.611×10^{-18} , respectively.



CONCLUSION

A Polythene pelletizing machine capable of converting plastic waste (LDPE) into a molded state was designed, fabricated and tested, with the aim of converting the waste polythene materials into useful products by reducing the bulk density of the material to ease transportation to production facilities. The result obtained from the test shows that extrusion of waste polythene material could flow slowly in lumps through screw conveyor to the die at temperature of 800C. Other temperature values greater or lesser than 800C, (such as 1100C, 1800C or 250C,

700C) caused the material either to char, stick or not been molded. To obtain optimum temperature value of this material at the exit point of the barrel and the extruder, further work is recommended. This work has demonstrated that the production of a locally, easily accessible and operated polythene pelletizing machine is possible for urban communities in India.

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