

# NUMERICAL ANALYSIS OF EXTRUDER SCREW & CONTROLLING THE DIAMETER OF PLASTIC WIRE IN EXTRUDER MACHINE

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**Abstract** - Nowadays, due to continuous flexibility and change in design the extruder machines are more compact. The plastic extrusion, 3D printing & extrusion is the most demanding sector in the automotive industry. By using the different diameter of the die the extrusion machines produce the different diameter of wires. The waste thermoplastic materials are input material for the extrusion process either in pellets or granules form. Heater is used to melt the plastic. Barrel screw is used to feed the raw materials. Screw consists of three zones: feed, melt, and transition zone. Maximum efficiency depends on the die heater. The temperature of heater is controlled by analog temperature controller. Die used extrudes the filament at the diameter of 1.75mm. Also by using DC-motor diameter of filament reduced. By adding additives to the input material mechanical and thermal properties can be increasing.

**Key Words:** Extrusion, Process efficiency, simulation of extruder screw, power consumption, Plastic materials, 3D printing, Recycling process, Plastic filament.

## 1. INTRODUCTION

Since its discovery, plastic is a very important part in modern society. From drink bottles to farming to even clothing, plastic has replaced a number of traditional materials. Plastic is durable and long-lasting, qualities of plastic which are perfect replacements of different heavy materials. In plastic industries the engineer Charles Hancock and his co-workers used the basic principle of plastic extrusion. The first screw machine was developed in the 1870s and commercial production started in the USA. This review is carried out on the optimization of the extrusion process and a low-cost 3D extruder machine, which is used to manufacture the objects by polylactic acid (PLA). Porosity and mechanical strength were analysed, and optimal process parameters were determined to ensure the best performance. This paper includes the process of extrusion where granules or pellets are used as input and this is melted by the heater. The screw is used to feed the input materials. There are feed, melt, and transition zones in the extruder. Maximum efficiency depends upon the die heater.

## 2. TRANSIENT THERMAL ANALYSIS OF EXTRUDER SCREW

The aim of transient thermal analysis of the screw is for calculating the total stress, deformation, and strain value at 190°C temperature. In the extrusion process, the temperature goes increasing from 0 to 190°C; therefore, heat is transferred slowly in the hole body of the extruder as well as the system of components. This analysis gives us temperature distribution and heat flux as well as to find out the behavior of the extruder at different temperatures.

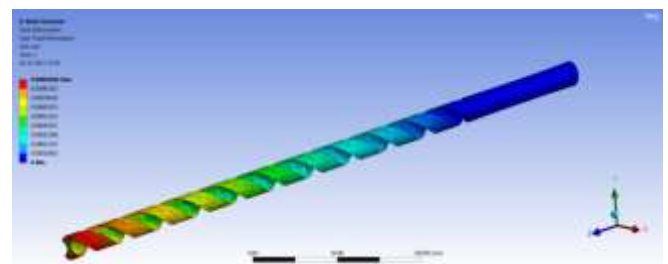


Fig 2.1 total deformation at 180°C

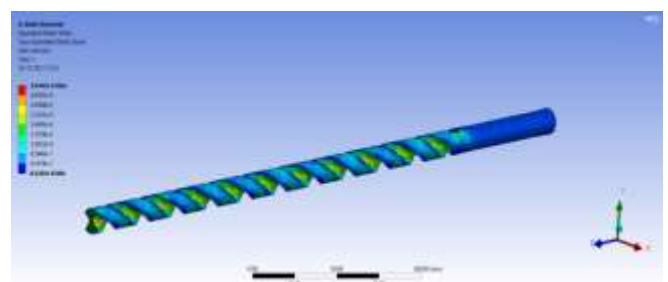


Fig 2.2 total strain value at 180°C

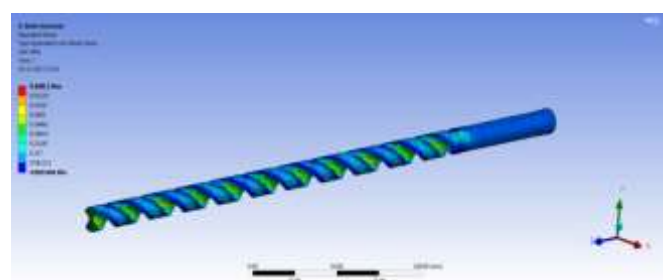


Fig 2.3 total stress value at 180°C

**Table 1-Numerical analysis values**

SR NO	total deformation [mm]	total strain [mm/mm]	total stress [N/mm <sup>2</sup> ]	Temperature [°C]
1	0.009596	0.6667	0.6881	180°C

From above table it is clear that all the values are under safe condition because the screw selection is under maximum pressure and maximum flow.at this condition there is no effect of temperature on a screw.

**3. COMPONANT USED**

by using a screw selection the following components are selected.

**Table 2- list of components**

Sr No.	List of components
1	Screw
2	Barrel
3	Die
4	Hopper
5	Temperature controller
6	Thermocouple
7	Motor

**4. OVERALL ASSEMBLY**

Extruder screw is kept inside the barrel. Barrel is mounted on the frame. Barrel is connected to the Motor and Extruder die is kept at the front of the barrel. Heaters are placed around the barrel and the die heater is placed around the die. Three phase AC supply is given for the heaters and single phase DC supply is given for the electric motor. Input plastic is given in the hopper which is attached to the barrel. Analog temperature controller is given to control the temperature of heaters used in the machine. Overall assembly of the machine is shown in the figure4.1

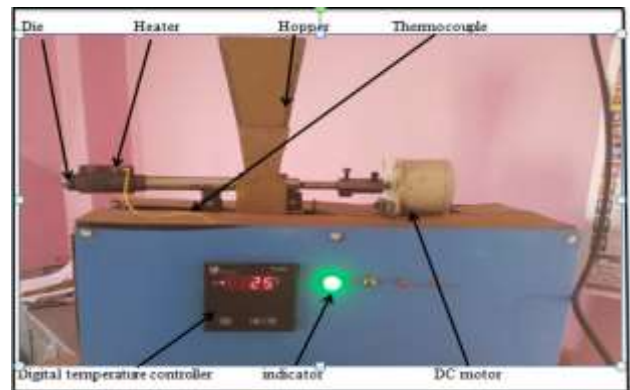


Fig.4.1- Actual prototype of extrusion machine

**5. RESULTS**

- 1. Material –High density polyethylene(HDPE)

Power consumptions /hour (Watt)- 265

**Table 3- Observations of HDPE**

Sr.NO	Melting temperature (°C)	Speed(RPM)	Diameter of wire (mm)
1	50	60	0.98
2	60	60	1.20
3	70	60	1.15
4	80	60	1.29
5	90	60	1.22
6	100	60	1.40
7	110	60	1.39
8	120	60	1.40
9	130	60	1.40
10	140	60	1.20

- 2. Material –Low density polyethylene(LDPE)

Power consumptions /hour (Watt)- 260

**Table 4- Observations of LDPE**

Sr.NO	Melting temperature (°C)	Speed(RPM)	Diameter of wire (mm)
1	50	60	1
2	60	60	1.20
3	70	60	1.15

4	80	60	1.39
5	90	60	1.40
6	100	60	1.38
7	110	60	1.26
8	120	60	1.22
9	130	60	1.22
10	140	60	1.20



Fig 6.2. LDPE

3. Material- Poly-lactic acid (PLA)

Power consumptions /hour (Watt) - 265 watt

Table 5- Observations of PLA

Sr.NO	Melting temperature ( °C )	Speed(RPM)	Diameter of wire (mm)
1	50	60	1.09
2	60	60	1.20
3	70	60	1.15
4	80	60	1.29
5	90	60	1.38
6	100	60	1.40
7	110	60	1.40
8	120	60	1.39
9	130	60	1.29
10	140	60	1.20



Fig 6.3- PLA

1. HDPE, LDPE and PLA plastic are the recycled plastic materials. During the extrusion process HDPE and LDPE are having a poor quality wire form which is given in fig.6.1 & 6.2 but we can use these materials directly into different types of die. We can develop different types of objects.
2. PLA plastic having good quality wire form which is given in fig.6.3.this wire we can use directly into the 3D printer for making a different types of objects.
3. Thus the plastic filament extruder is manufactured as per the design and with low cost . Plastic filament extruder , can be used to make filament from all type of thermoplastic materials except PVC. This machine will be used in small scale production. Produced filament can be used in the Rapid prototyping (FDM) and 3D-printing Machines.

6. CONCLUSIONS

During a operation material having a different type of wire form.



Fig 6.1- HDPE

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