JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Conversion of 3D printer waste and plastic waste into useful filament

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ABSTRACT

In today's time, Plastic waste becomes one of the most critical issues. That's why our study is focused only on the recycling of different types of plastic waste. While studying the literature review, we noticed that a high quantity of plastic waste due to many types of failure comes from 3d printed waste and other resources like plastic bottles. First of all, we collected plastic waste from different Sources. After that our main aim is to convert plastic waste into a useful product. So, to make plastic waste as a useful we made a filament extruder. A filament extruder is a machine that converts plastic waste into 3D printer filament with the extrusion on process. After successfully making a filament extruder we produced three types of filaments. These three types of filaments are divided by their different colours Lime Green, Dark Green, and White. After that, we do some tests like the tensile test and Ductility test on filaments to know if they are better than available filaments in the market. When we compare the data of our Dark green filaments with purchased filament it is unbelievable because our filament is 5 times more ductile than the purchased filament.

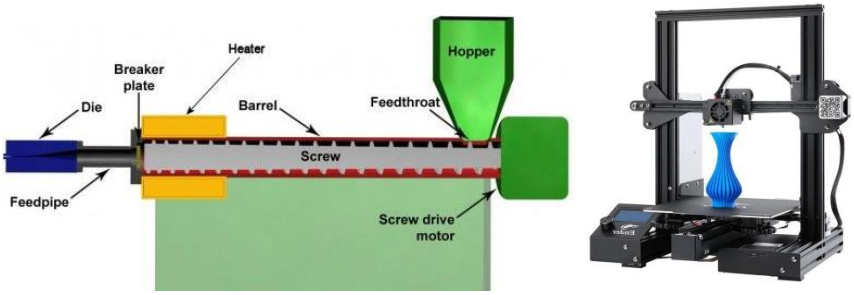
Keywords *– Extruder, Extrusion Process, Material Properties, Recycling plastic Waste, 3D Printer filaments.*

1. Introduction

In late times, the issue of plastic recycling has become one of the top issues of environmental protection and waste management. Polymer materials have been found utilization in many areas of daily life and industry. Opportunities for recycling polymeric materials offer a second life guarantee option and allow efficient waste utilization to be wasted. This research focuses on a review available of research on the production of filaments for 3D printers which are recycled from polymers as the opportunity to present an approach to the central selective collection of plastics. Recycling consumer plastic products is also very help full to saving the environment and it will be also another source of 3D printer filament. That's why recycling of 3D parts and 3D printed wastes again for the rest of their life is a very important issue to be discussed. The objective of this research is to fabricate and Test filament extruders for optimal utilization of material. This research aims to find an optimized material with a combination of different materials and recycle the available waste from 3d Printing.

1.1 Extruder and 3D Printer - A filament extrusion is a process in which a machine converts green plastic pellets into thread fibres. Failed 3D prints can also be shredded and reused as a substitute for these raw plastic pellets. And this is the best as well as most accurate method in these segments. 3D printer is a device or a machine in which with the help of 3D printing technique we

can create 3D solid objects from a digital file. In this process, we have to keep on layering the filament to make a solid object until a solid object is formed. And this process is called additive manufacturing A filament extruder and 3d printer shown in Figure 1.1



"Fig" 1.1 Filament Extruder and 3d printer

1.3 3D Printing Filaments - It is a special type of plastic which we also call thermoplastic which makes 3D printer filament. Firstly, heat the thermoplastic to the right temperature. So that it becomes flexible, after that the 3D printer makes an object from this filament, after cooling it becomes a solid object.

1.3.1 Different types of filaments are given below –

a) Acrylonitrile Butadiene Styrene Filament (ABS)
b) Polylactic Acid Filament (PLA)
c) (PETG) Polyethylene Terephthalate Glycol FILAMENT
d) (PETT) Polyethylene Trim ethylene Terephthalate Filament

2. Problem Formulation

According to the literature review 3D printing has some major problems like poor surface finish, Not Extruding at the Start of Print. Sometimes melted filament does not come out of the printer when the printer is initially used to print. Apart from this, many other errors are seen in it such as overheating, not sticking to the bed, the gap in the top layer, layer shifting, Stringing, and Under-Extrusion. Due to this lot of filament material gets wasted which causes plastic pollution. That's why recycling of 3D parts and 3D printed wastes again for the rest of their life is a very important issue to be discussed.

2.1 Wastage in 3d Printing (Disadvantages - Defects)

"Fig" 2.1 Waste Material

According to PEMRG (Plastics Europe Market Research Group), Globally there has been a huge jump in the production of plastic items in recent years. In recent years Global production of plastic-based goods has grown significantly. According to (Plastics Europe Market Research Group) PEMRG, global plastic production in 2019 amounted to 359 million tons, of which 17% in Europe and 51% in Asian countries. Each year, 4% of oil production (2.06683e+11L per year) is used to produce pure plastics globally.

3. Objectives

The Objective of this Research is to fabricate and Test filament extruder for optimal utilization of material. The aim of this research is to find a optimize material with combination of different materials and recycle the available waste from 3d Printing. There are several benefits of using composites materials in today's era. But the main Objective of the thesis as follows: -

- To fabricate a filament extruder that can able to convert waste plastic into useful filament.
- To determine the mechanical properties of the filament.
- To compare the properties of the existing filament with recycled filament made from plastic waste.

4. LITERATURE REVIEW

According to the literature review there is very little study has been done on reutilization of 3D printed waste material so this is the one of the major problems we are facing that 3D printed material having lot of (troubleshoot) problems which cause lot of waste of filament. This is very harmful for earth because plastic waste causes lot of pollution.

4.1 Oussai, Alaeddine 2021 - The most widely used 3D printing technology in today eras is fused deposition modelling. The process of creating an object without stopping till it is completed through layering is called the additive process. Whereas other similar processes to it are also used in it. In this research two different printed polyethylene terephthalate (PET) was analysed with the help of a tensile test. All 40 test pieces of PET were evaluated which were of both types. This new and old material was used in this process. Several tests were also conducted such as a comparison of values, the difference in stress incidence.

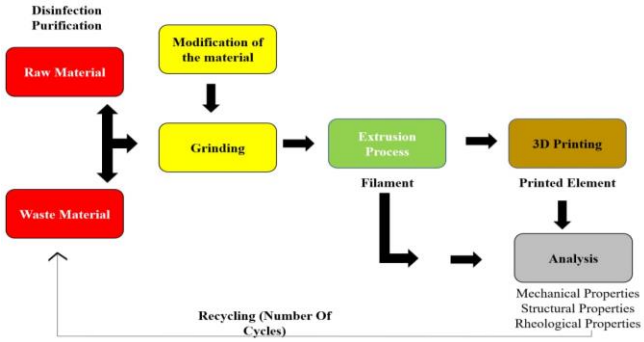
4.2 Mikula, Katarzyna 2020 - In the recent times, an issue is emerging a lot and this issue is about plastic recycling, in which there is a lot of pollution due to plastic in the environment. That's why it is being told as a big issue. Plastic waste has increased a lot because nowadays it is being used everywhere from domestic to factories. After that, when plastic was removed from use, it became an even more harmful waste. The process of reuse of plastic points towards a new direction. By recycling plastic, we can give it a new life.

4.3 Ruoyu Song, Cassandra Telenko 2017 - First, we needed some data to start this research, so to collect that data we chose someplace where 3D printing was done. All the people who used to work there, we told everyone that whatever waste will come out of the 3D printer due to different reasons, it has to be put in different dustbins. After that, we collect all waste and bring it in working place. After that, we characterizing those data well, the unsuccessful printers were divided into 9 types, and research was done on them. It was discovered that in open studios about 34% of the plastic is wasted.

4.4 Ruoyu Song, Cassandra Telenko 2016 - In today's era, if we do additive manufacturing, then the best and better name that comes out is that of fused deposition modelling (FDM). Additive manufacturing is a very good technology to reduce waste material. It is artisan as long as the waste released due to human error and machine error is less, but when the material waste becomes more due to human error and machine error than the total waste then this process is not an artisan. Additional failures can also be caused by improper geometry of parts, failures resulting from insufficient preheating time, user error, or printer malfunction.

5. Methodology

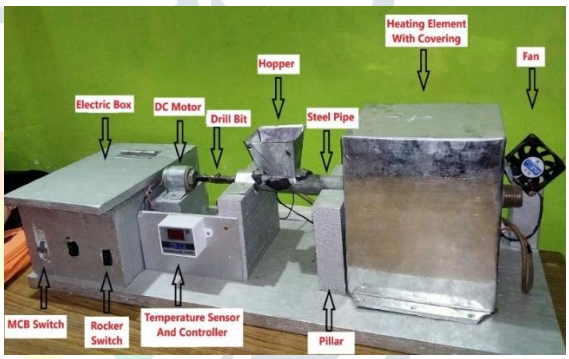
In this process FDM 3D printing method is used, a filament is required to print a layer over layer to make a 3D object. 3D Printing has many disadvantages (Troubleshoot) which cause many errors in the 3D printed parts already described in the introduction. This error creates many errors in 3D printed parts that create useless plastic waste and this plastic waste is a major cause of land pollution.



"Fig" 5.1 Working of Extrusion Process

The next step in our project is to collect plastic waste and separate the different types of a filament according to them. Gradually the separated plastic waste is grinded in a blender. The fine powder of this plastic is separated and collected. This composite plastic is called filament powder and this filament powder is poured into the extruder. The extruder is a soluble and pumping machine and converts powdered plastic into the same fibre. The heat is generated from the heating element and this heat transfer bar has enough heat to melt the material. This extruder is specially designed to turn this powder into useful fibers. We build the accurate base with all filament parts and fit them in their position. As you can see in the figure (5.3) the final filament extruder is ready and this all processes are done in our college lab.

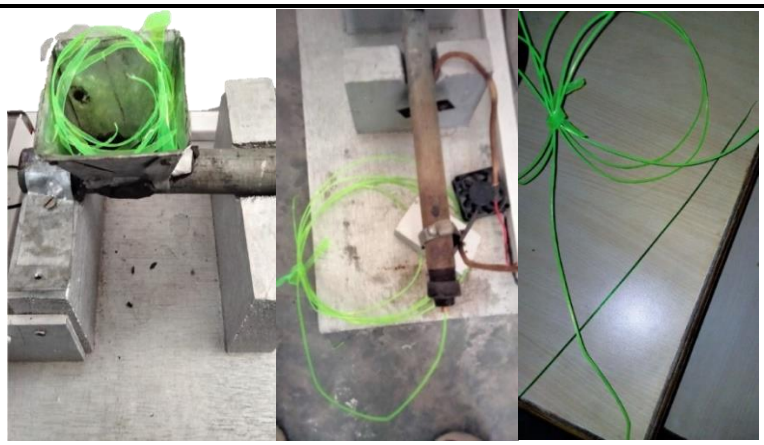
"Fig" 5.2 Extrusion Process



"Fig" 5.3 Parts name with location

6. Making of filament threads

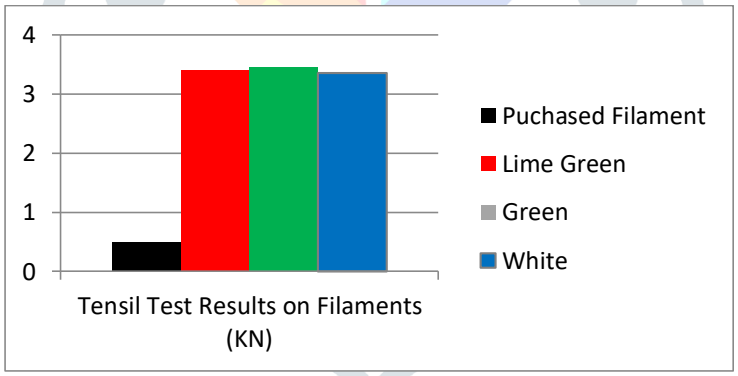
To make filament for the 3D printer from plastic waste, we collected plastic waste from different sources. And ground them into powder as you can see in figure (3.51). After grinding we feed powder in the Hooper. With the help of the extrusion process and heating of the raw material a filament is ready and comes out from the nozzle. Now our filament is ready for testing as you can see in the figure (3.52) a dark green colour filament is coming out from the nozzle.



"Fig 6.1" Grinded plastic wasters feeding in Hooper, Extruding filaments from nozzle

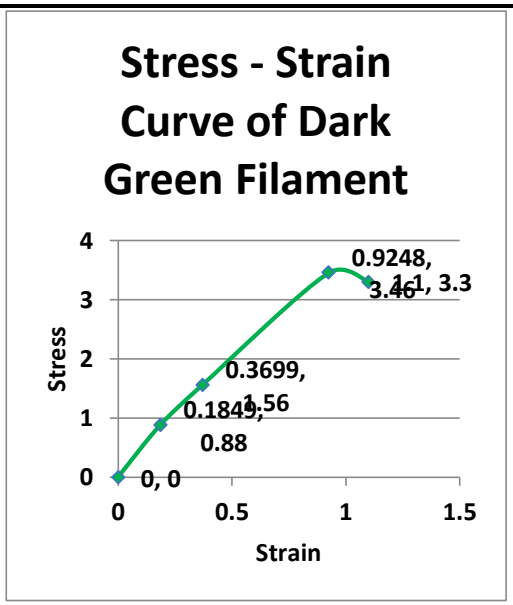
7. Result and Conclusion

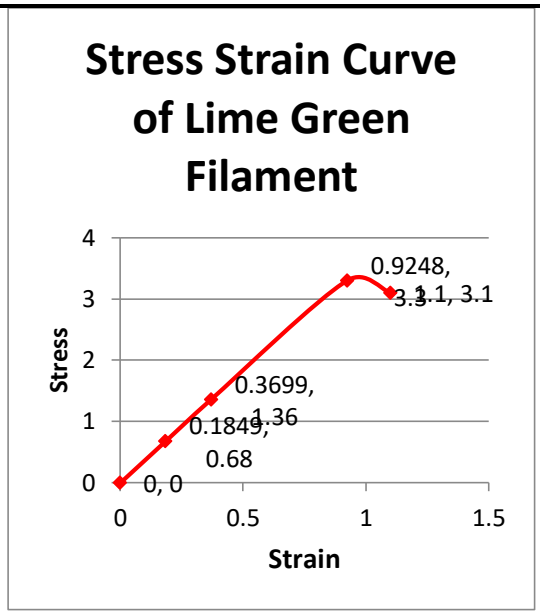
First of all, we collected plastic waste from many resources. After that our main aim is to convert plastic waste into a useful product. So, to make plastic waste useful we made a filament extruder. A filament extruder is a machine that converts plastic waste into 3D printer filament with the extrusion process. After successfully making a filament extruder we produced three types of filaments. These three types of filaments are divided by their different colours Lime Green, Dark Green, and White. After that, we do some tests like the tensile test and Ductility test on filaments to know if they are better than available filaments in the market. When we compare the data of our Dark green filaments with purchased filament it is unbelievable because our filament is 5 times more tensile and ductile than the purchased filament. The maximum Stress-Strain value of purchased filament is (0.8-0.27) and our filament Stress-Strain value is (3.46-1.1) which is 76% more than purchased filament. After that, we also compare our other two limes green and white filaments with purchased filament they also give very high stress-strain value as compared to the purchased filament. And the ductility of our filament is also more reliable than purchased filament. This all tests are done in our college labs.

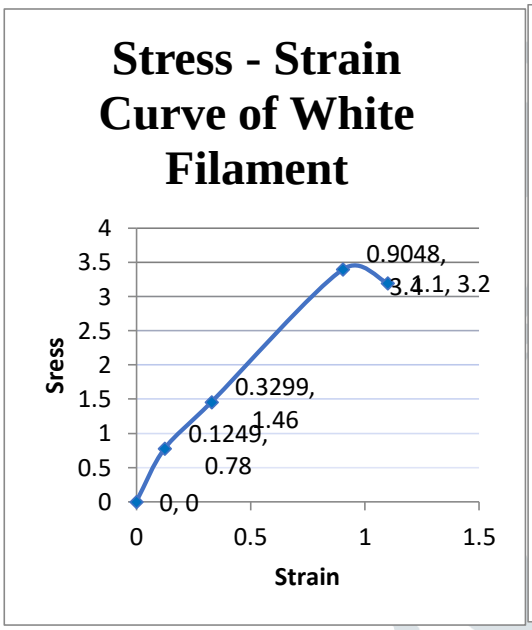


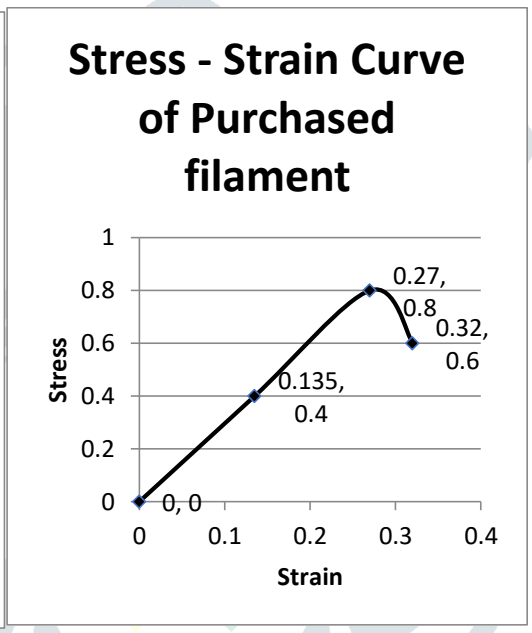
"Fig" 7.1 This Figure shows our new filaments tensile strength is much more than purchased filament. It is about 78.87% more than purchased filament.

This Stress-Strain Diagrams shows comparison between purchased filament and our three types of filaments (Dark Green, Lime Green, White)









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