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RECYCLING OF PLASTIC THROUGH EXTRUSION PROCESS

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Abstract

This project deals with the design and development of plastic extrusion machines. The prime objective ofthis project is to recycle plastic waste bottles along with other plastic waste generated in various households. Plastic waste is generated on a very large scale in every household, college, and society. Decomposition of plastic takes around more than 100 years also it causes various kinds of pollution onavery large scale hence there is a need for the recycling of plastic. Our project aims at shredding plasticinsmall pieces and later melting that small shredded plastic to convert them into molten form and make other useful components. In our project, we have designed an extrusion machine for recycling plastic and later simulation will be done for doing stress analysis. Based on the result of the simulation we will fabricate the working model of the extrusion machine. After successful fabrication, testing, and working of the model will be conducted and shredded plastic will be melted using heating coils and molten plasticwill be forced into the mold for making wires, plates, paperweights, etc. In the project, we will be usingaPID controller for adjusting and controlling the temperature for melting various kinds of plastic. Therefore, this project will prove that plastic waste can be recycled & used in many ways. The extruder will also produce a filament that can be used for 3-D printing, as the dimension required for the printer ranges from 2-2.5mm. PET pellets were heated between 230 to 250 degrees Celsius and pushed through the nozzle. A filament of diameter ranging from 2 to 2.5mm is obtained without any air bubbles and roughness. As the efficiency of the machine is one of the important part , hence to also an attempt to improve the efficiency of the machine.

I INTRODUCTION

Recycling has been debated endlessly for many years now. There are two points of view regarding this issue. The argument in support of recycling concerns the negative impact of waste and emissions on our planet. The counter caseis that costs undertaken to recycle are larger than the revenue returns. India generates almost 1.7 million tons (MT) ofsingle-use plastic in the year 2020. Decreasing greenhouse gas emissions is also favorable to all for environmental reasons. The trend between the emissions and the cost can be deduced. It will be a strong, positive, linear correlation.The cost and the emissions can be kept low simultaneously using an increased recycling rate. The extrusion process produces thin filaments which are suitable for the 3-D printing process. In

the extrusion of PET plastic, raw PET material in the form of flakes is fed into the hopper mounted on the barrel of the extrusion machine. The PET fakes get transported by the action of gravity as it passes through the hopper. The flakes enter through the feed throat and come in contact with the screw. The screw rod is rotated using a motor at low rpm and the barrel chamber is heated by a ceramic heater for a temperature range of 230 to 250℃. The PET flakes as it passes through the screw rod gets heated and melted which then finally gets extruded from the nozzle designed for the size of the filament. Initially, in most of the processes, a heating profile is set for the barrel in which there are three heater zones that gradually increase the temperature from low to high. This allows the plastics pallets to melt gradually as they are pushed through the barrel and it will reduce the risk of overheating which may cause degradation in polymers. The basic mechanism involved in this process is a screw that transports the raw plastic pellets from a hopper through a heating metal pipe where the plastics are melted. The raw plastic pellets are fed into the screw from the hopper with the help of gravity. Then the molten plastic is forcefully passed into the pipe with the help of the nozzle at the end of the pipe to form thefilament. Finally, the extruded plastics which is drawn from the nozzle to determine the final diameter of the filamentwhich is drawn from the nozzle.

Unfortunately, the properties of plastic that make it so valuable also make its disposal problematic, such as its durability, lightweight, and low cost. In many cases, plastics are thrown away after one use, especially packaging and sheeting, but because they are durable, they persist in the environment. If plastic reaches the sea, its low density meansit tends to remain on the surface

Increasing attention has been paid to plastic waste by policymakers, scientists, and the media and probably one of themost influential factors was the discovery of the Great Pacific Garbage Patch by Charles Moore in the late 1990s. Thisis a layer of rubbish floating between California and Hawaii that has been estimated to span about 3.43 million km2 (the size of Europe). It is mostly plastic and contains everything from largely abandoned fishing nets to plastic bottlesto tiny particles of plastic (or 'micro plastics'). This type of mass in the seas can be known as 'plastic soup' and there are concerns that Europe hosts similar patches, in areas such as the Mediterranean and the North Sea. As such, marinelitter and plastic waste is a priority on the EU policy agenda.

II LITURATURE SURVEY

Design and Fabrication of Extrusion Machine for Recycling Plastics.

This paper gives a brief idea about the recycling of plastic and the product produced through extrusion for 3-D printing.

Ingeo Biopolymer 3001D, Nature Works LLC.

This paper focuses on the biopolymers as it designs for clear applications with heat deflection temperatures lower than 49ºC.

Design and Development of Single Screw Extruding Machine for Bio-Composites.

This paper gives a brief about the three main zones in the screw rod that is – compression, mixing, metering,of extrusion process. The main objective is to compact the size of the machine without harming its ability to extrude.

Screw design basics, The processor point of view, By- Andrew W. Christie, Optex process Solution, LLC.

The main objective is to compact the size of the machine without harming its ability to extrude, and to showthe absolute process and detail of single screw extruder.

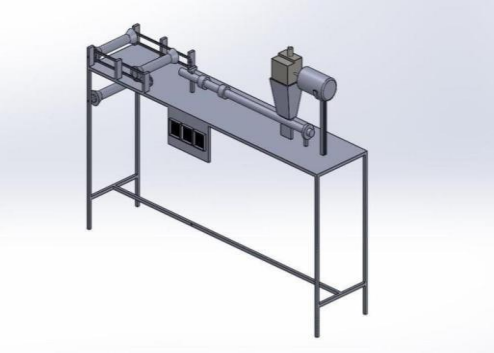
The Design of a Small-scale Plastic Extruder Machine

This paper discusses the design steps, working principle and structure of a small-scale thermo- plastic extrusion machine that will be used. In order to recycle plastic parts a grinding process is necessary, followed by extrusion. During the process the machine melts the polymer and extrudesa filament that can be converted into granulates or used as it is. The structure of the extrusion machine is rather similar to that of a commercial one, however it focuses on presenting the manufacturing principles and cost effectiveness.

III PROPOSED WORK

Experimental set up

The recycling line consists of a plastic shredder, an extruder, a granulate making machine, and an injection molding machine. The design of the extruder is very similar to extruders used in the industry.



3.1 HARDWARE REQUIREMENTS.

1) Hopper
2) Barrel
3) Screw rod
4) Nozzle
5) Heating band
6) Electric motor
7) Frame
8) Ball bearing
9) PID controller

IV WORKING

The recycling line consists of a plastic shredder, an extruder, a granulate making machine, and an injection molding machine. The design of the extruder is very similar to extruders used in the industry. The working principle of the designed extruder is as follows: 1) the extruder is fed through the hopper with the shredded plastic or the granulate, after which 2) is transported to the screw, plastic material into the barrel by the rotating

motion, 3) due to the heating system the thermoplastic material melts and is forced out on a die, generating a filament with 3 mm diameter cross-section. The die also contains a valve that can be used to increase the pressure in the barrel, thus increasing the homogenization of the melt, 4) the turning motion of the screw is ensured by an AC motor, that is connected to the screw with a special connector through the reducer.

V NUMERICAL ANALYSIS

a. The size of the machine had to be as much as an office table, which is 762 into 610 mm. Hence the Screw length was calculated as = 0.5(total length).

- The shank length of the screw was calculated as Sl = 0.2(Sc)
- Flighted length was calculated as L = Sc –Sl
- The Flighted length or the working length of the screw was found out to be
- L= 600mm. L/D ratio was chosen to be 12:1 and diameter was calculated using the ratio and Length Based on these dimensions other dimensions were calculated.

Feed section depth Hf, Metering section depth Hm, Land width e, Helix Angle ϕ, Channel width W, RPM wererespectively calculated using these formulae Hf = 0.2D, Hm = Hf / C.R, e = 0.1*D, Φ = tan-1 (p/πD),

W = (π*D*tanϕ-e) cosϕ, Rate = 2.3*D2*Hm*SG*N

Where D – Major Diameter; p – Pitch, N – RPM, SG- Specific Gravity, C.R – Compression Ratio.

b. Calculation for hopper

Calculation Volume = $\pi h/3\ (R^2+Rr+r^2)$

= $\pi*60/3\ (30^2+30*10+10^2)$

= 81681.4 m^3

VI RESULT AND DISCUSSIONS

Recycling and reusing those plastics by making some useful domestic products. There are lots of things wecan do with this machine. We can customize that machine to make products like below shown.

VII CONCLUSION

Melt Quality: of the extruder is nearly satisfactory. With a few changes in the design a better melt quality can be achieved.

Melt Viscosity: The viscosity of the is moderate, which suitable for the extrusion. Melt Flow: Melt flow has a satisfactory continuity.

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