OUR KILO

Creating filament from PET360 Festival cups

OURKILO REPORT

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SUMMARY:

This document shows the learnings in recycling PET cups used in the Bluegrass festival at the Pijnackerplein, that were collected during and after the event. The aim was to reuse the plastic material for 3D-printed objects. In this document, we explain the following steps to achieve a printable spool of PET using shredded plastic from beer PET 360 cups

RECYCLING PROCESS

We have received one type of plastic:

1) Transparent PET360 cups.

PET360 is a specific type of PET made by BORDEX, it has a clearer look and is 100% recycled already.

Picture 1: Example of shredded PET flakes.

PRE-TREATMENT:

All collected plastic has been cleaned by using the following process:

Step 1- separate the cups, we double checked that all of the cups were actually PET plastic, there were some collections that were not part of the main event, in this case usually not made of the same plastic.

Step 2- After the first separation, we cleaned them with the assistance of a restaurant. Using their industrial dishwasher.

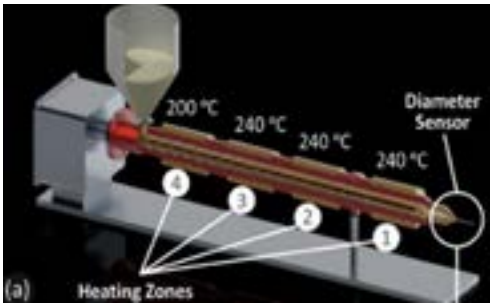
Step 3- Drying by leaving the cups outside in the sun to quickly get rid of the leftover liquid inside the cups.

Step 4- Shredding-PET is a very ductile material compared to other plastics such as PLA. This means that it takes longer to be granulated inside the machine. This means that the process takes longer and the machines cannot be fed too much at the same time, it would cause the shredder to stop due to accumulated material inside the granulator chamber.

Picture 1

CREATING THE SPOOL

Picture 2: A good example of spooled filament.



Picture 3: Model image of what happens in a mixing screw and the placement of the four different heating zones (H): source: Vidakis et al. (2022)

Go to link

Our definition of a good spool is achieving a spool above 300g in a single roll. Additionally, it should have a consistent diameter throughout the whole length of the spool, never going above 1.9mm or below 1.6mm.

Picture 2

The shredded plastic was processed in our designated PET filament maker machine at the following temperatures:

H4- 240° H3- 245° H2- 253° H1- 252°

PET plastic is very viscous and liquid, and the goal is to achieve a temperature setting that is able to push a constant stream of molten plastic out of the nozzle to create a filament thick enough to be used.

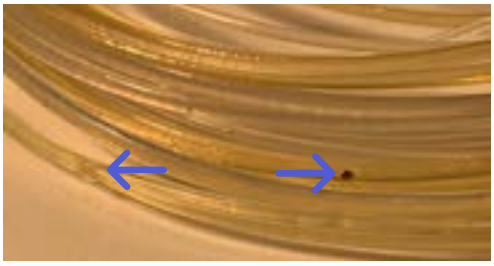
Picture 3

With the temperature settings mentioned above, you can get to that consistency. Going lower would cause the material to come out brittle and bumpy because it was not fully molten. At a higher temperature, the material would be too liquidy to spool with a round shape, and the strands of filament would come out flat and tiny which do not feed well into the printers.

CREATING THE SPOOL

Picture 4: Mixture of flakes and regrided spools.

Picture 5: Close-up of bluegrass spools.



Picture 6: A bad example of spooled filament. You can see a big blob of contamination in the middle of the spool, and towards the bottom, air bubbles trapped inside the filament cause bubbly plastic.

Picture 7: A good example of spooled filament. Consistent diameter and perfectly aligned.

To ensure the **constant stream of plastic** through the mixing screw, we have addeda step into our process:

OUR METHOD: Granulating a spool of PET to add granules to the plastic flakes

In this method, you regrind a made spool again. In this way, the same plastic gets shredded twice. It results in thicker flakes.

This method will result in a 100% recycled spool, only using own processed plastic.

Adding the regrind granules is done to increase the volume of plastic inside the machine and to help with the feeding of plastic. The round shape of the granules is easier to fall down into the hopper of the filament maker. Thus, adding granules to the flakes prevents them from grabbing onto each other and creating a hole in the hopper. If that hole occurs the machine will suddenly produce very thin filament and disrupt the process entirely so it is essential to avoid that.

Picture 4

The length of the spool

A commercial spool PLA usually contains 1 kilogram. With PET, we wanted to match this. We managed to achieve consistent spool weights of around 300 grams. This is equivalent to around 150 meters of plastic filament. This is because PET flows much slower than PLA, meaning the machine has to run for longer to get to the same length. Also, PET is much more hygroscopic than PLA, meaning it absorbs moisture and quickly has an effect on the diameter of the spool's filament. And lastly, PET is prone to have rat-holes in the hopper, meaning that there is air in between the screw and the rest of the plastic, causing the need to halt production.

Picture 5

Testing the quality of the spool

During the production process you need to continuously observe the spooling process, which can be done through the App from 3Devo, or by standing close to the machine. The main issues that need to be noticed are sudden drops or a raise in the diameter of the filament and/or contaminated material present in the filament. Once you have your PET spool checked you can proceed to print with it.

Picture 6, Picture 7

PRINTING WITH YOUR OWN CREATED SPOOL

Picture 8: Example of printing settings using a recycled spool.

Picture 9: A chunky look is achieved with a bigger diameter nozzle.

Picture 10: Picture showing an extreme amount of moisture trapped inside the print walls and lines of too little cooling.

We print our objects with a: 0.8 or 1mm nozzle

That is to achieve a chunky look but also to avoid impurities from clogging the nozzle. Clogging is a physical constraint, meaning either the filament was too thick to go through the heating element or there is a piece of alien material that does not melt and now is stuck inside the nozzle. A bigger hole in the nozzle means bigger particles can go through.

The BED has to be set at a minimum of 75° degrees to maintain adhesion to the PET and the nozzle set between 245° and 255° degrees to melt the plastic at the optimum rate for printing.

To facilitate the testing of the material, we operated with a printer that has a clog detector attachment (Clog Detector – Modix Large 3D Printers). This is a sensor that detects if the filament is still moving- if not the print is paused so that you can inspect it, remove the bad part of the filament and reload the plastic to continue printing.

Picture 8

IDENTIFIED ISSUES WHEN PRINTING:

In our process, we have identified a few issues that happen when printing with a spool that was not 100% consistent in diameter or free of impurities.

1) Stoppages-Due to Clogging: When printing with our spools, we observe that it is common to have a clog just before the filament gets to the nozzle. This happens because occasionally the filament gets too thick and cannot be pushed through into the nozzle. This causes the machine to stop and you have to remove the filament from the machine, cut the bad piece and return the filament back into the machine.

Due to insufficient feeding: The opposite can also happen, if the filament gets too thin the gears in the extruder cannot push enough filament into the nozzle, thus causing the clog sensor to be triggered and stop the machine. The process to restore the machine is the same as the one above.

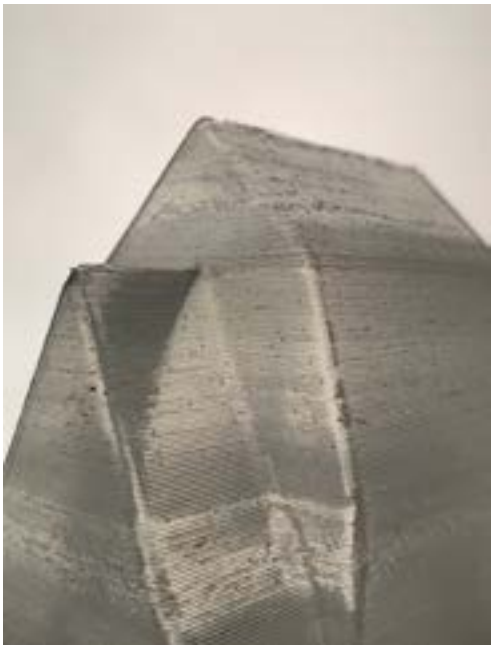
Picture 9

This can happen a few times per print depending on the size and duration of a print. We noticed that 30 minutes to an hour prints are the best size to avoid stoppages.

2) Print Quality-Crystallization and Cooling issues: Our PET plastic is good for printing simple shapes, usually printing spirally. This is because quick and short movements cause the crystallization of the material, with the nozzle moving quickly close to itself it causes the plastic to either not cool completely before being touched by the nozzle again which makes it look like the top of the ice cream below, or to cool too slowly which causes it to crystalize and become brittle, like the lighter tip of the icecream below. The previously mentioned PETG addition helps with this problem and stabilizes the material but does not solve it completely, complex shapes will still cause the nozzle to move too quickly near itself and crystalization happens once again

Picture 10

CONCLUSION



Picture 11: successfully printed small object (sand house 6.2x8.5x6.5 cm) from recycled 360PET

The PET collected from the Bluegrass was a successful attempt at transforming waste plastic into a 3D printing filament. The filament was a transparent glass-like look or a milky white appearance depending on the temperature. The spool is strong and useable as daily objects or sculptures. The recycling process, however, is very labor intensive, meaning you need specific environmental conditions (climate and moisture) as well as sterilized and clean handling of the plastic itself. This process is not a solution to return the plastic back into usable cups, we would recommend this as a creative way to reuse waste streams from festivals and big events. This process is great to turn into filament to be used in small design/art-related objects with household daily use or artistic purposes. We have managed to create around 5 spools up to 350 meters long. While this is a success in terms of production, the quality of these spools was not flawless, meaning printing requires extra attention to prevent or fix clogs in the 3D printers.

Picture 11

MORE INFORMATION