High temperature material extrusion guide

Filament Maker TWO

Introduction

This is a standard operating procedure on how to extrude high temperature materials with the Filament Maker TWO. The steps were tested and validated in-house with PEEK and the guide can be used as a general overview for transitioning up to and down from high temperature materials (extrusion temperature above 300℃).

It does not detail specific extrusion temperatures as the user is responsible for carrying out research into their selected high temperature processing material. If in doubt, please Contact Support at 3devo.

Materials

The materials needed to carry out the transition between low and high temperatures, purging, and ensure the safekeeping of the Filament Maker TWO.

- 3devo's HDPE for transition and safe material to be left in the machine after extrusion
- DevoClean MidTemp for purge
- DevoClean HighTemp for transition and purge
- high temperature material (of user's choice, also called *processing material*)

Safety

1. Carry out procedure with two persons!
2. Use a fume hood!
3. Do not leave any high temperature material, or HighTemp in the machine after shut down! It will freeze and clog the machine!

Guide

The guide table on the last page maps out the steps needed to transition up to and down from high temperature materials. However, it is essential to know that each **Step** includes multiple necessary actions, and these can take a long time before moving on to the next step.

An Example:

This is how Step 2 is visualized in the table.

Step 2	250	260	270	280	5 - 10	*HighTemp*

These are the actions needed to carry out Step 2:

i. **Change heaters** from the previous setting (from Step 1) to 250, 260, 270, 280. Hit confirm.
ii. **Wait for heaters** to meet set temperatures. This can take up to 20 minutes.
iii. **Add new material.** In this case, it is 200 grams of HighTemp poured into the hopper. If there is still HDPE (from Step 1) in the hopper, vacuum it out, before adding HighTemp in. This is to ensure a safe and efficient transition. See *Notes, b.*
iv. **Wait until material fully transitions and stabilizes.** from HighTemp to MidTemp, AND MidTemp is stabilized (there's no burning, dark materials, specs, or smoking). This can take up to 20-30 minutes. See *Notes, c.* and *e.*

So we see how a single step can easily take up to 45 minutes, when considering all the waiting time and monitoring.

Notes:

a. We extrude with a **temperature ramp of 10 degrees per heater.** We do this to ensure that the viscosity of the material gradually decreases, making it easier to push the material out and ensure a consistent extrusion.
b. Between materials, **always vacuum the previous material out of the hopper** before inputting the new one.
c. Only move to next step after temperatures are reached and a **clear transition has been made**.
d. We estimate the necessary **feed material for each step is 200g**.
e. We estimate the time taken for **materials to stabilize is between 10 to 30 min.**
f. During Step 2 and 5, when HighTemp first heats up, there may be some smoke and orange coloured extrudate with a caramel smell, but this is expected as we need to increase temperatures. A similar discoloration and light smoking might happen with MidTemp during Step 7.
g. If bubbles are seen in the filament, it is material degradation. This can be reduced by increasing the extrusion speed to reduce the residence time of the material in the barrel and therefore its exposure to heat. In general, it's always safe to **keep extruding and be patient!**

	Heater temperatures from hopper to nozzle ℃				Screw speed RPM	Input Material	
	Heater 1	Heater 2	Heater 3	Nozzle Heater		Only AFTER set temperatures are met	
Start							
	Transition up						
Step 1	190	190	190	190	5 - 10	*HDPE*	→
Step 2	250	260	270	280	5 - 10	*HighTemp*	→
Step 3	300	310	320	330	5 - 10	*HighTemp (no change)*	→
Step 4	choose extrusion temps based on material's TDS				5 - 10	*processing material*	

Extrude high temperature *processing material*, produce filament, and/or spool.

	Transition down						
Step 5	choose extrusion temps based on material's TDS				5 - 10	*HighTemp*	→
Step 6	340	340	340	340	5 - 10	*HighTemp (no change)*	→
Step 7	250	260	270	280	5 - 10	*MidTemp*	→
Step 8	220	230	240	250	5 - 10	*HDPE*	

Shut off