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## EXTERNAL HEATING DEVICE TO FACILITATE UNPACKING PROCESS IN POWDER PROCESSING STATION

HP INC

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External heating device to facilitate unpacking process in powder processing station

**Abstract**

This disclosure relates to the field of 3D Printing with Thermoplastic Polyurethane (TPU) material. The process to print parts using this material has very strict timing constraints.

An accessory is disclosed that provides the user more flexibility by preventing the loss of temperature during the unpack process, leading to enhanced part quality. The system described can be assembled on the processing station and used during the unpack of TPU parts.

**Description**

First let's describe the end to end process that must take place to print with TPU material:

Load	Print	Annealing	Keep hot	Unpack	Load
Build Unit is loaded with powder. This is done in the processing station	Build unit then is introduced inside the printer and the job is printed	The job is kept several hours in the printer under temperature	This process is optional, and it gives the user some hours of margin to keep the build unit in the printer at temperature until they are ready for unpack process	Unpacking means removing the printed parts from the build unit. The excess powder is recovered and recycled for the next jobs. This also happens in the processing station.	Build unit can be loaded for next job.

TPU powder has one big disadvantage. If it is heated under pressure for a long time and left to cool down, the particles of powder stick to each other and they form chunks of material. This phenomenon is also known as "caking".

These chunks can lead to several problems:

- They cannot be removed from the final printed parts, resulting in bad parts that must be discarded.



Bad parts after cold unpack

*Figure 1: Final parts depending on unpack type*

- They cannot be recycled back in the system because they don't flow as well as free powder and can create hardware issues during the material feeding on the vanes or clogging the sieve.



*Figure 2: Powder agglomerations due to cold unpack*

This leads to lower recyclability rates and therefore higher wasted powder and costs.

Some 3D printing technology works by heating the material at a certain pressure and cooled down later. In order to avoid the formation of powder chunks during the cool down of the material, the powder must be separated while still being hot and stored as free flowing powder.

The current process to unpack the printed parts (after they have been printed under heat and pressure) is to conduct a so-called “hot unpack”: The build unit is sent to the processing station as soon as the printing and annealing is finished so the parts can be unpacked before the powder gets too cold. The unpack process then needs to be conducted quickly and the parts that are being unpacked need to be scrapped-off from any remaining of powder that they may have (specially in holes or cavities) so that the powder is not cooled down forming a chunk.

This process limitation:

- Forces the users to be dependent on the printing timings and to adjust their production to the timings set by the printers if they want a successful unpack.
- Requires customers to perform a quick unpack process if they want to be able to produce quality parts and recycle the powder that has not been used
- Can require more than 1 operator to ensure quick unpack leading to higher operating costs.
- Makes the process very operator-dependent with a long learning curve and risk when hiring new employees
- Leads to high variability of parts properties depending on the speed and skills of the operators performing the unpacks
- Requires to high intervention rates during load process due to frequently clogged sieve

Our solution is an accessory that consists of heating lamps that can be easily installed in the processing station, over the unpacking area. These lamps can produce enough heat to keep a constant temperature on the working area (the printing bed) so that the powder does not cool down as quickly during the unpack process.

This will provide the user flexibility during the unpack, prevent the formation of powder chunks and will allow the customer to recycle the unused powder back to the system no matter how long the operator takes to finish the unpack. For example, if the operator needs to attend to some important issue, go for a break or take care of an emergency, he/she will be able to leave the unpack unfinished without having the risk of losing both the powder and the parts for not being too quick.

The main advantages if this solution is:

- Wider window of operation for unpacking TPU powder
- Higher recyclability rates of powder
- Higher yield of good parts
- Only 1 operator required, leading to less labor cost
- Higher control of temperature providing flexibility of the unpacking process
- High uniformity of properties independent of the speed and skills of the operators performing the unpacks
- Nonoperator-dependent process: User friendly experience with more robust results
- Lower intervention rate during load due to avoiding sieve clogging

The solution that we present has 4 parts:

-The structure: A trapezium shaped metal structure that is assembled to the processing station and holds the weight of the lamp's module

-The lamps module: 4 heating lamps placed in parallel on the higher part of the structure. They are facing down to project heat to the surface of the build unit.

-Thermostat: A simple device to control the power of the lamps. It measures the temperature of the working area and controls the power of the lamps to adjust the temperature to the desired level.

-Electronic circuit: it is connected to the Processing Station and has a PCA and a servo. The input of information comes from the thermostat and the output is the power control of the heating lamps

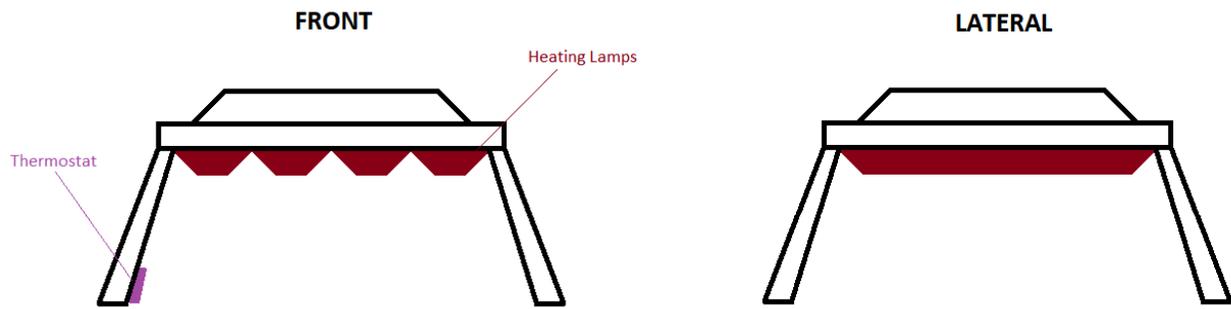


Figure 3 Heating lamps accessory

The way of using this accessory is very simple. First it is installed over the unpacking area inside the processing station (View Figure 1). When starting the unpack, the lamps will be turned on providing enough heat to keep the material at a safe Temperature. The accessory is constantly reading the temperature with a thermostat and adjusting the power of the lamps

There will be 2 working modes that the operator can choose:

- Working mode: Used while doing the unpack at a safe temperature
- Standby: Used if the operator leaves the unpack process and the printing bed needs to be kept hot

This accessory can be removed at any time for maintenance purposes or if the customer does not need it.

***Disclosed by Authors: Armero, Miguel, Urbistondo, Ainhoa and Vega, Miguel, HP Inc.***