Temperature and Humidity Regulation in the Work-Area of 3D Printer

Degree programme: BSc in Micro- and Medical Technology | Specialisation: Medical technology
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New printable materials are constantly being developed, especially for medical technology, and frequently require adaptation of the 3D-printing processes and environment. This project focused on environmental control in the printing area to allow reproducible prints with temperature- and humidity-sensitive materials and processes.

Motivation

In order to advance research into new printing material and processes, precisely controllable and reproducible ambient conditions should be achieved during the printing process. This would allow longer and more complex printing processes. New experiments are also conceivable with adjustable climate conditions.

Objective

An existing prototype generated 100% humidity thanks to a piezo nebulizer. The saturated air was blown into the printing area without temperature adjustment using a frame placed on the machine work-area. The goal of this Bachelor project was to incorporate control units allowing adjustable humidity between room humidity and saturation and to adjust the temperature from room temperature to 40°C. Based on experiments with the newly built laboratory setup, it was established how such a closed loop regulation can be practically implemented.

Approach

To control the humidity, a mixing valve was developed and built which mixes room air and saturated air in variable proportions with the help of a servo motor (Fig 1).
To regulate the temperature, an air heating system was conceived and built. For this purpose, heaters were used and controlled by NTC temperature sensors and a microcontroller. In order to prevent the heated air from being cooled down again by the water temperature during air humidification, a heater was also built in the water reservoir according to the same principle (Fig 2).
The regulation was implemented by PID controllers.

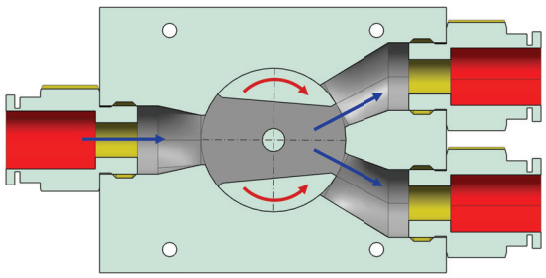

Fig 1: Mixing valve for humidity regulation with a servo. blue: air flow, red: regulation by rotation.

Results

First results showed that the temperature is strongly influenced by the length and thermal conductivity of the air tube. Therefore, the next steps will focus on a tube trace heating and an insulation of the air heater to reduce the loss of thermal power in the hose.
The air humidification by the nebulizer resulted in a mist which was deposited and accumulated in the tube, at the sensor and in the printing area, therefore an alternative humidification variant based on the gas washing principle will evaluated.

Outlook

In order to test the controller under changing environmental influences and to ensure that the regulation is constant over the entire printing process, measurements will be performed in a climatic chamber.

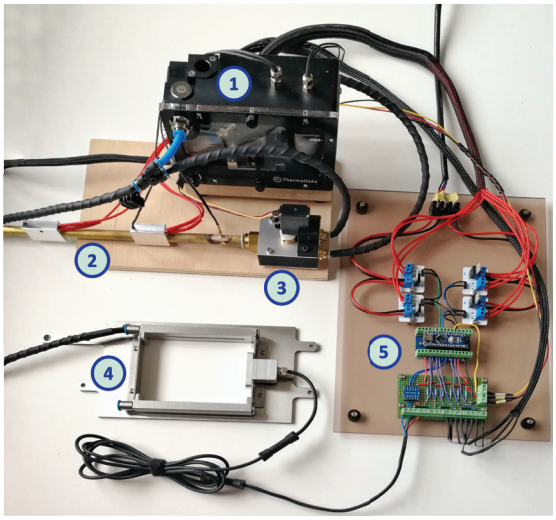

Fig 2: Controlling setup. 1: water reservoir with heating, 2: air heating, 3: mixing valve, 4: frame, 5: control unit.

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