Heat Block Assembly and Evaluation Procedure

SAFETY NOTE: DO NOT PLUG ANYTHING INTO AN ELECTRICAL OUTLET UNTIL INSTRUCTED TO IN THE DIRECTIONS

1. Place the AC adapter on the table so that you can read the Kastar Label. Plug the end adapter into the wire on the right-hand side. Plug the three-pronged plug into the small power strip on the INKBIRD controller.
2. Take the white temperature controller chip. Insert the exposed silver end of the black wire into the left-side slot of the green adapter. Insert the end of the red wire into the slot on the right-hand side of the green adapter. Secure the wires with a small piece of electrical tape.
3. Slide the white chip with the letters side up into the slot underneath the aluminum block.
4. Plug the INKBIRD plug into an electrical outlet.

Setting the target temperature

Before beginning, set the temperature readout to degrees Celsius:

The display on the temperature controller should read degrees Celsius (°C). If it is reading in degrees Fahrenheit (°F), use the following directions to change the display units (if already reading °C, go directly to Step 1 below):

- Press and hold the "Set" button for 3 seconds (the bottom number will flash when it has been long enough). Press the "Set" button three more times. The top display should now read "CF." Use the arrow keys to change from °F to °C. Once the bottom display reads the correct unit, press, and hold the "Set" key for another 3 seconds and proceed to Step 1 below.

1. Press the "Set" button on the Inkbird controller and hold for 3 seconds. The top display should change to read tS1 and the bottom number will flash.
2. Use the arrow keys to change the setting to the desired temperature.
3. Press the "Set" key again once (don't hold down). The top display should read dS1 and once again, the bottom number will flash.
4. Use the arrow keys to change the setting to "0.5." (Note that the dS1 setting controls how much the temperature is allowed to vary before the heater starts heating again.)
5. Press and hold the "Set" button for 3 seconds. The bottom display will show your target temperature and the top display will show the temperature being measured by the temperature probe. This will report the temperature of your heat block when the probe is inserted into the center hole in the heat block.

After assembling heat block prototypes, they were tested for time to reach target temperature, ability to maintain the target temperature, and cooling time, as described in the following procedures. For each test, temperatures were measured with a Vernier temperature probe connected to a LabQuest 2 controller. Three trials were conducted for each test and the results averaged. Results are shown in Figure HB-05.

Ability to Achieve the Target Temperature

This tests the duration of time the heat block will take to reach a predetermined temperature.

1. Set the target temperature to 37°C.
2. Leave the temperature probe outside to measure room temperature. Record room temperature.
3. Place the temperature probe into the center hole of the heat block. Record the temperature every 30 seconds for 360 seconds (about 6 minutes).

Heat Block Consistency

The second test investigated the ability of the heat block to maintain a set temperature.

1. Set the heat block to the target temperature of 37°C.
2. Insert the temperature probe in the center hole.
3. Once the target temperature is achieved, record the temperature of the heat block every 30 seconds for 360 seconds (about 6 minutes).

Cool Down Time

The third evaluation procedure tested the effectiveness of the heat block's ability to cool down from its target temperature.

1. Record room temperature.
2. Set the target temperature to 37°C.
3. Insert the temperature probe in the center hole of the heat block.
4. Once the target temperature is reached, allow the block to remain at that temperature for 360 seconds (about 6 minutes).
5. Unplug the power supply and turn on the fans.
6. Record the temperature every 30 seconds for 360 seconds (about 6 minutes) or until the heat block reaches the recorded room temperature.

Results and Reflection:

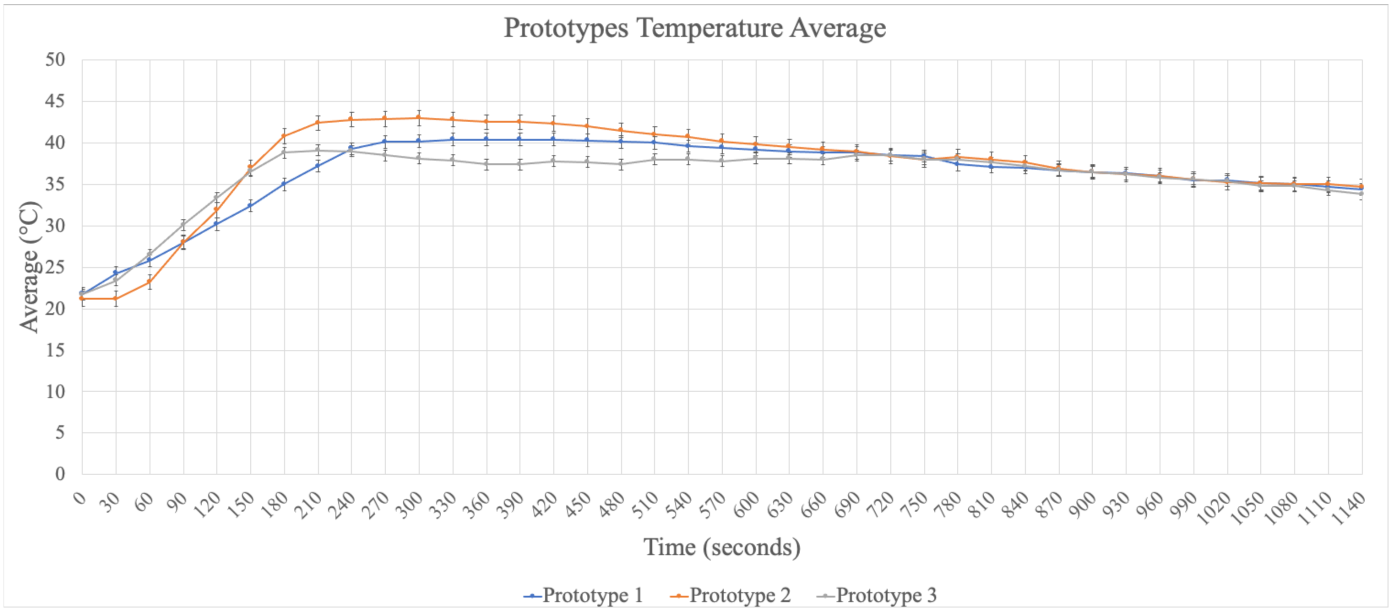

Figure HB-05. Heat block prototype evaluation results. The ability to achieve and maintain a target temperature is shown for the three heat block prototypes evaluated.

Developing Prototypes

The development of prototype 1 was inspired by the SUNY Oneonta team 2020 design. Each prototype originated from the base model but with some form of modification. Modifications or replacements were made to produce desired performance improvements.

The second prototype has the same structure as the first, but the Peltier chip was switched to a different model. The second Peltier chip (Part #14) is significantly smaller size when compared to the first Peltier chip (Part #6). The second chip was incorporated into the design in hopes of reducing the amount of heat transfer, therefore reducing the chance of the device overshooting the target temperature.

The third prototype was comprised of every part of the first prototype, but a heat sink is incorporated (Part #11). The recycled heat sink is included in the prototype to draw heat out of the system. This would reduce the chances of the device overshooting and keep the temperature consistent.

Results

Prototype 1 (blue line) took the longest to achieve a stable target temperature, but the temperature remained relatively stable. The system did not cool down once turned off in the desired amount of time.

Prototype 2 (orange line) reached the target temperature the quickest but overshot and took a long time to cool down to 37°C. This prototype reached the highest temperature compared to prototype 1 and 3. The system took longer than desired to cool down.

Prototype 3 (grey line) reached the target temperature quickly and maintained the stable temperature for the length of this test. When compared to prototype 1 and 2, this prototype is the most consistent to the target temperature. The system cool down time was still longer than desired.

Future Development

Further efforts to develop and improve our heat block prototype is needed. Incorporating new parts and designs will allow for more consistent average temperatures. For example, a Raspberry Pi device was developed to replace the aquarium temperature controller, but we did not have time to characterize its performance. In addition, we continue to research part sourcing and whether higher quality items can be purchased at an affordable price. Exploration into incorporating computer and small electronic parts will allow more creativity during the design process.

Future implementation of this device in an outdoor farm setting must be conducted. One of the primary requirements for this heat block is its ability to be operated in the field. There is a possibility of new challenges arising when this device is tested outside a lab environment. This can be tested by conducting a focus group of farmers and individuals who are our target audience for this product.

An additional consideration for the heat block is the need to educate farmers on how to effectively use the device and the purpose of this device in our genetic testing system. One way this could be done is to create a YouTube walkthrough video that will demonstrate how to set up and use the device. An informative pamphlet could also be developed and included with the device. The pamphlet would include a detailed list of steps for using the device properly and section for commonly asked questions.

Reflection

Throughout the process of creating, developing, and testing our heat block we were able to expand our knowledge on the principles of innovation and design. Each failed attempt was approached as an opportunity to learn and critically think of innovative solutions.

One aspect of the design process we expanded upon was creative “out of the box” thinking and problem solving. The team was encouraged to research parts in assorted products and appliances that could be incorporated into the design. An array of parts from computers, refrigerators, incubators, microwaves, and animal habitats were considered when developing new prototypes.