

GNG 1103

Design Project User and Product Manual

ACCELERATED EROSION TEST SYSTEM

Submitted by:

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Table of Contents

Table of Contents	ii
List of Figures	vi
List of Tables	vi
List of Acronyms and Glossary	viii
1 Introduction	1
2 Overview	2
2.1 Conventions	3
2.2 Cautions & Warnings	3
3 Getting started	4
3.1 Configuration Considerations	4
3.2 User Access Considerations	4
3.3 Accessing/Setting up the System	4
Assembly of Divider, Plug, and Sample Containment	5
Insertion of Propellor into Lid	6
Preparation of Peltier Plate	7
Wiring of Motor	8
Wiring of Peltier Plates	9

Wiring of Temperature Sensor.....	10
Sample Insertion	10
Code Setup	11
3.4 System Organization & Navigation	11
Lid	11
Divider	11
Drain	12
3.5 Exiting the System	12
3.5.1 Physical Process to Exit the System	12
3.5.2 Software Process to Exit the System	12
4 Using the System	14
4.1 Collecting Results	14
Subsystems.....	15
4.2 Motor Control System.....	15
4.3 Temperature & Cooling System.....	16
4.4 Drainage System	17
4.5 The Filter System	18
5 Troubleshooting & Support	18
5.1 Error Messages or Behaviors	18
5.2 Special Considerations	19
5.3 Maintenance	19
5.4 Support	19

6	Product Documentation	20
6.1	Water Propulsion.....	20
6.1.1	BOM (Bill of Materials)	20
6.1.2	Equipment list	21
6.1.3	Instructions.....	22
6.2	Cooling	22
6.2.2.	Equipment list	23
6.2.3.	Instructions.....	23
6.3	Filtration	23
6.3.1.	BOM (Bill of Materials)	23
6.3.2.	Equipment list	24
6.3.3.	Instructions.....	24
6.4	Containment	25
6.4.1.	BOM (Bill of Materials)	25
6.4.2.	Equipment list	25
6.4.3.	Instructions.....	25
6.5	Testing & Validation.....	26
6.5.1.	Water Propulsion Testing	26
6.5.2.	Cooling System Testing.....	28
6.5.3.	Drainage System Testing	31
6.5.4.	Filtration System Testing.....	37
7	Conclusions and Recommendations for Future Work	40

8	Bibliography	42
	APPENDICES	43
9	APPENDIX I: Design Files	43

List of Figures

Final prototype on Design Day	2
Arduino connected to circuit to power motor	16
Peltier plate with heat sink	17
Sample containment unit attached to plug via chain	17
Plug to drain water post-filtration	17
Overhead view of filtration system	18
Wiring of small hobby DC motor	27
Two views of the motor circuitry	27
Circuitry to test temperature sensor	28
Testing setup of Peltier plate between two wooden rods with tinfoil insulation	30
Testing setup with three Peltier plates and other components	30
Iterations of drainage systems, filters, and plugs.	32
Printed drainage systems, filters, and plugs	33
CAD model of sample containment unit	34

List of Tables

Table 1. Acronyms	viii
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Table 2. Glossary	viii
Change in Temperature with One Peltier Plate.....	29
Table 3. Referenced Documents	43

List of Acronyms and Glossary

Table 1. Acronyms

Acronym	Definition
AETS	Accelerated Erosion Testing System(s)
CNL	Canadian Nuclear Laboratories

Table 2. Glossary

Term	Acronym	Definition

1 Introduction

This User and Product Manual (UPM) provides the information necessary for scientists to effectively use the AETS and for prototype documentation. The AETS was made to investigate the different rates that materials erode at, in a short time frame. This is done by subjecting a test material to a great amount of erosion, to simulate the wear it would experience over the time frame of years in use. This manual explains how the AETS works, its parts, any warnings or precautions, and all other pieces of relevant information. This manual is meant for those operating the system or to understand how the AETS functions.

2 Overview

CNL had a component that was subject to a great amount of erosion, and they needed to be able to test how materials hold up to great erosion, in a short time frame. They need this information as the processes they perform require a piece made of an erosion-resistant material. The product needs to be effective and hasty. This product is different because it spins the water, while the test material sits in the middle, to stimulate erosion.



Final prototype on Design Day

There are four subsystems: the drainage system, filtration system, cooling system, and water propulsion system. The drainage system allows the water to leave after the test, the filtration

system makes sure none of the test material debris is mixed into the water, the cooling system lowers the water's temperature, and the motor connects to a propellor to make the water spin. There is the AETS, which is the bucket that has been wrapped in aluminum foil for insulation, and the stand that it sits upon so that the plug at the bottom doesn't support the AETS.

2.1 Conventions

No conventions present.

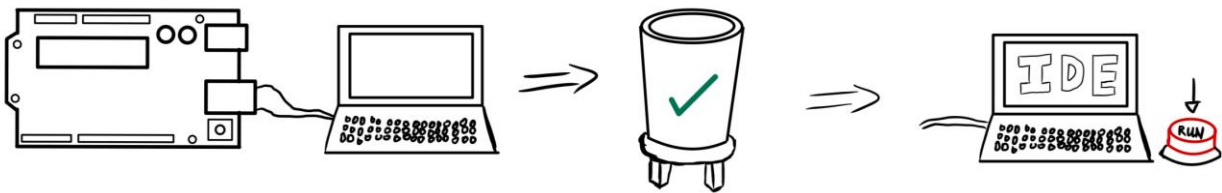
2.2 Cautions & Warnings

Keep items away from the motor. Peltier plates without a heat sink can overheat and melt/burn things. Keep liquids away from the Arduino as it is not waterproof/resistant.

3 Getting started

3.1 Configuration Considerations

1. Connect to the Arduino with a computer
2. Make sure the AETS is properly set up
3. Open the Arduino IDE and run the code



3.2 User Access Considerations

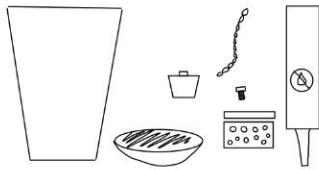
This erosion tester is for anyone who is interested in seeing how erosion works and for people who want to choose a material that does not erode easily. This can be done by testing various materials and seeing when the least amount of erodent is caught in the filter.

This system is not intended for children's use as components of the system may be damaged. Additionally, it is recommended to use it in a stable environment to avoid damage to some of the components.

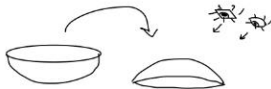
3.3 Accessing/Setting up the System

A series of diagrams will follow which visually explain the construction of the major subsystems.

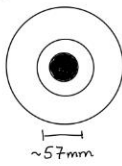
Assembly of Divider, Plug, and Sample Containment



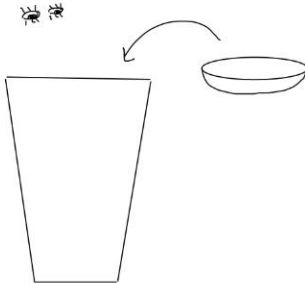
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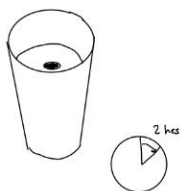
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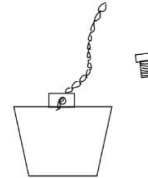
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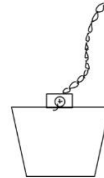
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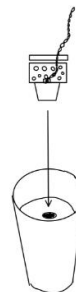
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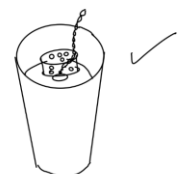
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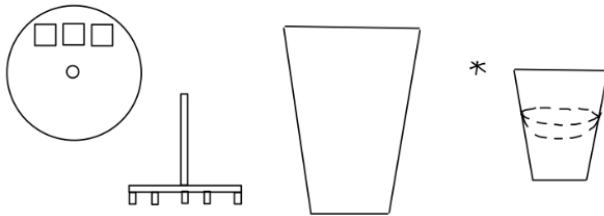
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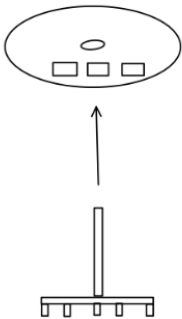
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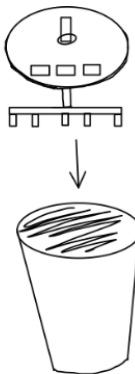
Insertion of Propellor into Lid



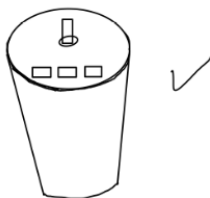
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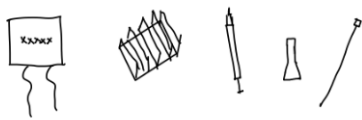
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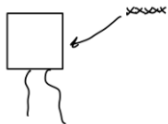
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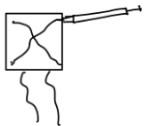
Preparation of Peltier Plate



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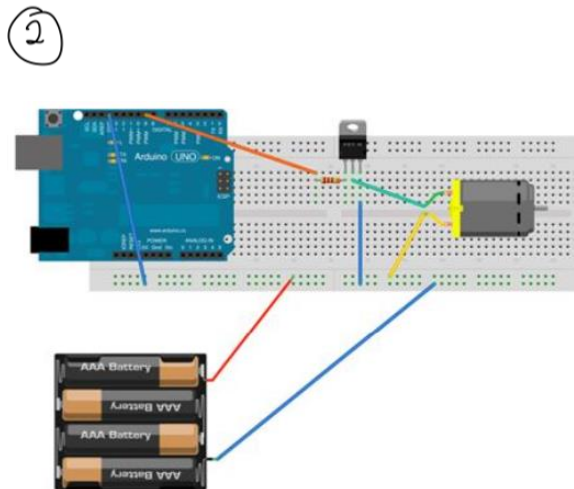
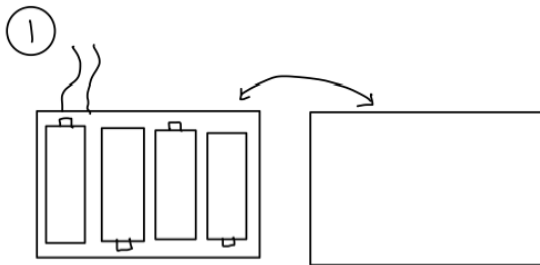
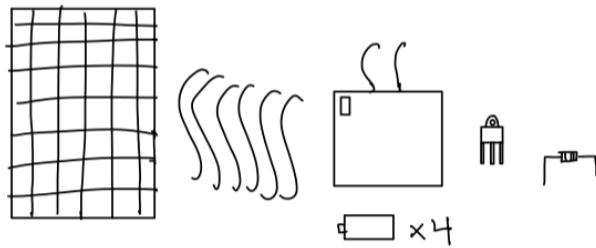
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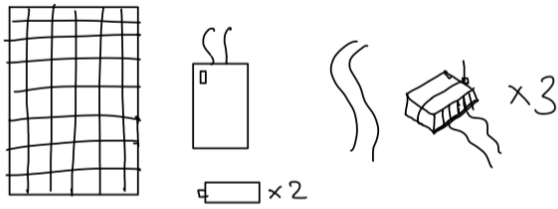
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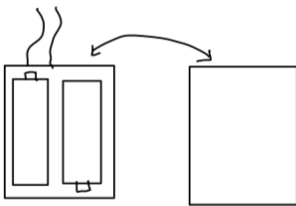
Wiring of Motor



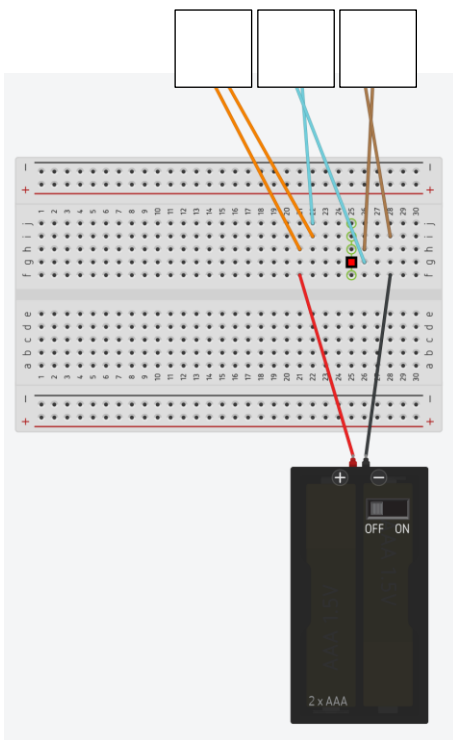
Wiring of Peltier Plates



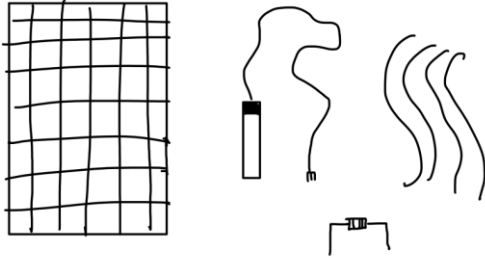
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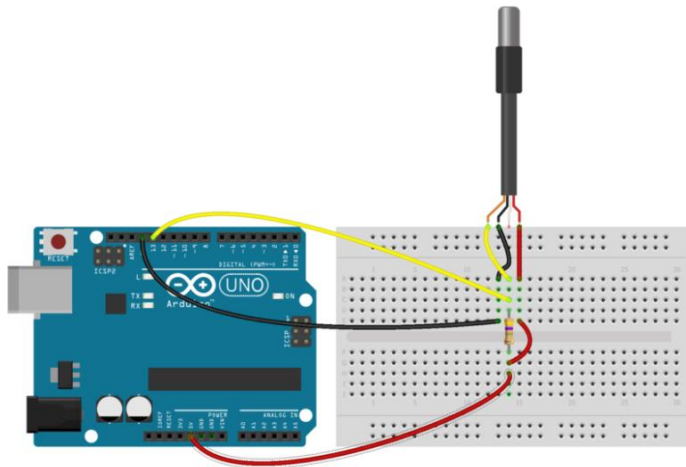
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Wiring of Temperature Sensor



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Sample Insertion

1. Take off the lid.
2. Take out the sample container (the white container with holes).
3. Open the lid and put in desired sample.
4. Close the lid.
5. Reinsert container, securely closing plug.
6. Reinstall lid on the bucket.

Code Setup

1. Connect Arduino to computer using an appropriate cable.
2. Open the Arduino IDE.
3. Change the “speed” variable to a value between 0 (no power) and 255 (maximum power).
4. Select the appropriate board (Arduino Uno) and port (depends on the computer being used).
5. Press the checkmark on the left side to verify the code.
6. Press the arrow on the left side to upload the code.

3.4 System Organization & Navigation

Lid

The Peltier plates and motor with respective breadboards, as well as the temperature sensor, are secured to the top of the lid. The Arduino and breadboard for the temperature sensor can be secured to the side of the container or the lid.

Divider

The divider has been designed so it fits precisely in the container without need for glue. It does have a layer of waterproof caulking around the outside edge and inside edge where the plug is located. For an extra waterproof seal, the plug has a layer of caulking applied precisely where it meets the divider. The plug fits into the hole in the divider so there is no need for additional adhesive; besides, it will need to be removed after the test is complete.

Drain

The primary drain consists of a plastic filter which is glued to the bottom of the divider. Prior to testing, a fibrous filter is inserted and then a thin mesh metal sieve on top. The latter will catch large particles and the former will catch all remaining debris to be dried and weighed. The water will also flow through here and into the secondary container. It will be stored here until it is at a safe temperature, at which point the secondary drain will be unscrewed from the bottom and the water will be released.

3.5 Exiting the System

3.5.1 Physical Process to Exit the System

1. Pull the chain to let the water drain through the filter.
2. When water has stopped flowing, open the lid of the container carefully.
3. Remove the sample containment unit and set it aside to dry.
4. Remove the metal filter and set it aside to dry.
5. Remove the fibrous filter and set it aside to dry.
6. Once the water at the bottom of the container has cooled to a safe temperature, twist open the drain.
7. Close the drain once all the water is let out.

3.5.2 Software Process to Exit the System

1. Turn off the Peltier plates by turning off the battery pack.
2. Turn off the temperature sensor and motor by entering any non-zero integer into the input terminal.

3. Disconnect the Arduino from the computer.
4. Log off the computer.

4 Using the System

Provide a detailed description of each user function and/or feature, explaining in detail the characteristics of the required input (push a lever, button press, etc.) and system-produced output. Each function/feature should be described under a separate sub-section header, 4.1-4.x, and should correspond sequentially to the system functions (e.g., order of actions or menu items) and/or features listed in certain sub-sections found in this document. Include pictures or screenshots as needed to depict examples. This section of the manual may also be tailored or customized based on defined user roles, if appropriate. The information in this section is specific to the user interactions with the system and is different than the prototype documentation section below.

4.1 Collecting Results

The following is a set of general instructions for collecting results from the AETS.

1. Insert sample in sample containment unit found in top half of the testing area and connect the container to the plug, then insert the plug in the hole in the divider.
2. Place a lid on the container and ensure the chain is placed on the outside of the container.
3. Have the batteries flipped to the “on” for the motor and the cooling plates.
4. Wait till test time has elapsed, then enter a non-zero integer on the computer when prompted to end the test.
5. Turn off the batteries and pull the chain up, until the plug is out of the divider.
6. Wait until all the liquid is drained out of the testing area.
7. Remove the sieve from the funnel and dry it along with the fibrous material.
8. Weigh the sieve and fibrous material and subtract the mass with that of the sieve and fibrous material.
9. Take the test system and open the funnel at the bottom of the test system to clear the liquid tank at the bottom of the test system.

Subsystems

The accelerated erosion testing system consists of four main subsystems/features, each one responsible for the collection of erodent material to aid in quantifying the erosion rate. The four main subsystems/features are:

1. Motor control system
2. Cooling system
3. Drainage system
4. Filter system

Each subsystem/feature of the AETS will be described in terms of the method of using it and its subfunctions. When using the system, follow the instructions provided to turn the motor on and the cooling system and follow the procedures for collecting data.

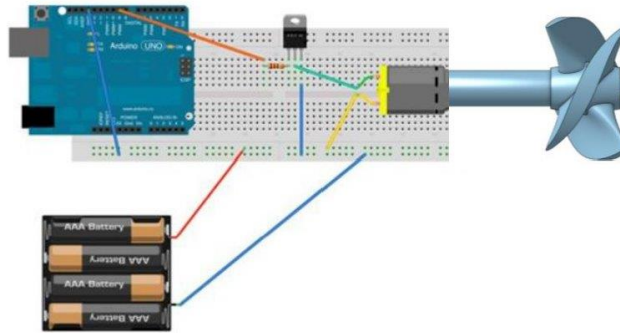
The following sub-sections provide detailed, step-by-step instructions on how to use the various functions or features of the AETS.

4.2 Motor Control System

Describe the specific system function or feature in detail and depict graphically by including pictures or screenshots and descriptive narrative as appropriate. Ensure each figure is captioned and has an associated tag providing appropriate alternative text. Provide information on functionalities that the user must master, expected behaviors, and any special instructions. Identify any caveats and exceptions that the user may encounter specific to the system function.

The motor control system consists of using an Arduino Uno, a brushed DC motor, and an external battery. The DC motor needs 6 V of power, which is supplied to it by the external battery. As a safety precaution, the battery has an on/off button for any emergency. The Arduino controls the flow of power supplied to the motor, which controls its rotational speed. To change the speed of the motor, the Arduino IDE can be opened on a computer, which is subsequently connected to the

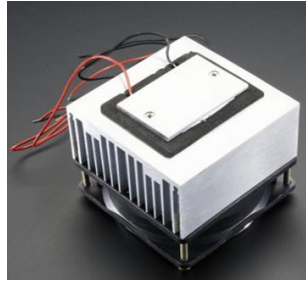
Arduino and alters the speed variable. The motor can also be turned off by inputting the kill code in the serial monitor of the Arduino IDE (the kill code is any number but 0). The user can input in Arduino code the time the test should run, which after which the serial monitor will output the prompt: "Do you want to continue test". If the code detects no input, it will continue to test normally and will prompt the user every 5 seconds if they want to continue the test. Therefore, the user must ensure they are there to enter a nonzero integer to end the test when prompted (or in case of emergency).



Arduino connected to circuit to power motor

4.3 Temperature & Cooling System

For cooling the liquid, thereby increasing the viscosity of the liquid, Thermoelectric Peltier Cooler devices were used (below is a picture of one plate). These plates get cold on one side, while the other gets hot. To avoid the plates from failing, we attached heat sinks to the hot side of the plate. The cooling system consists of three Peltier cooler plates, connected to a 5 V battery, which has an on/off button for emergencies. Connected to the Arduino Uno, there is a waterproof temperature sensor, that will record the temperature of the liquid used for quantifying data.



Peltier plate with heat sink

4.4 Drainage System

The drainage system consists of a ceramic divider, which separates the testing environment from the pocket to collect the liquid after the test is done. In the middle of the separator, there is a hole that has a water seal plug which is connected to a chain outside the system. Whenever a test is done, the chain is pulled, which removes the plug and drains the liquid down to the filter system, which subsequently filters the erodent material out of the liquid. The liquid is therefore stored in the pocket underneath the divider (below is a visual of the subsystem).



Sample containment unit attached to plug via chain



Plug to drain water post-filtration

4.5 The Filter System

The filter system consists of a funnel with stainless steel sieve, lined with a water-resistant fibrous material. When a test is done and the plug on the divider is lifted, the liquid with the erodent material will be drained into the sieve, which will collect the erodent material and filter from the liquid. The sieve will be collected after all the liquid is drained out (it can be detached from the funnel) with the fibrous material and after drying it, it would be weighed. Subtracting the weight of the sieve and the fibrous material, the mass of the erodent material collected is determined.



Overhead view of filtration system

5 Troubleshooting & Support

5.1 Error Messages or Behaviors

The Arduino IDE may sometimes fail to upload the code to the board, despite having the correct port and board selected. To resolve this, ensure the correct driver is installed and cables are secured or use a different cable, hardware adaptor, or Arduino board. If this fails, redownload the CH340G driver from the manufacturer and restart the computer. Failing this, reinstall the Arduino IDE on the computer.

Leakage at the plug (top half or bottom half) can be solved by an additional layer of caulking.

Ensure the caulking has two hours to dry before being exposed to water.

The motor circuit, temperature sensor circuit, and cooling circuit would be soldered securely and would ideally not come apart. If they do not work for this reason, the circuit diagram can be followed to resolder the connections.

5.2 Special Considerations

There are no special considerations since the general setup of most subsystems is straightforward.

5.3 Maintenance

To avoid total system failure, some maintenance is necessary:

- Replace motor when it is broken.
- Replace batteries when they die.
- Replace fibrous filter each test.
- Soldering of wires may be necessary if they get damaged or detached from system.
- Reseal bottom of container with silicon every 6 months to avoid leakage.

5.4 Support

If someone hacks into your code or your entire computer:

1. Disconnect the Wi-Fi
2. Take your device to a tech shop or a professional to see if they can resolve the issues.

The Arduino database provides troubleshooting support at

<https://www.arduino.cc/en/Guide/Troubleshooting>.

If you are facing problems with any other components of the system, email one of the following people for support:

- amusl039@uottawa.ca
- ggrew025@uottawa.ca
- loloz054@uottawa.ca
- smuta017@uottawa.ca
- yhasi055@uottawa.ca

6 Product Documentation

6.1 Water Propulsion

6.1.1 BOM (Bill of Materials)

Item	Link	Cost per Unit (\$)	Quantity	Subtotal (\$)
Arduino Uno Rev3	https://makerstore.ca/shop/ols/products/arduino-uno-r3-clone	15.25	1	15.25
12V DC Motor		1.99	1	1.99
Solderless Breadboard	https://makerstore.ca/shop/ols/products/breadboard/v/C005-HLF	5.00	1	5.00
Printed circuit board	https://makerstore.ca/shop/ols/products/smt-breakout-pcb-for-soic-28-or-tssop-28-3-pack	2.33	3	7.99
20cm male to male wires	https://makerstore.ca/shop/ols/products/jump	0.10	10	1.00

	er-cables-pack-of-10/v/C004-20-MM			
N-channel power MOSFET	https://makerstore.ca/shop/ols/products/n-channel-power-mosfet-30v-60a	1.95	1	1.95
USB A to USB B Cable for Arduino Uno	https://makerstore.ca/shop/ols/products/usb-type-a-b-cables	0.20	1	0.20
AAA Battery	https://makerstore.ca/shop/ols/products/aaa-battery-single	1.00	3	3.00
220 ohm resistor	https://www.pishop.ca/product/resistor-220-ohm-14w-5-axial-pack-of-10/	0.95	1	0.95
Battery pack	https://makerstore.ca/shop/ols/products/3-x-aaa-battery-holder-with-on-off-switch-and-2-pin-jst	2.50	1	2.50
Plastic rod		0.00	2	0.00
Propellor		0.00	1	0.00

6.1.2 Equipment list

- Onshape
- AutoCAD
- 3D printer with PETG or PLA filament
- Soldering iron, solder, and wires
- Electrical tape
- Hot glue

6.1.3 Instructions

Connect the circuitry as instructed by the “Wiring of Motor” section. The propellor and rod must be printed from the CAD files. They should be connected securely and glued if necessary, but the design lends itself to fitting snugly without glue. The rod at the other end will have to be inserted through the hole in the lid, then glued to the motor. Finally, the motor itself should be glued to the lid so it can spin the water without being displaced.

6.2 Cooling

Item	Link	Cost per Unit (\$)	Quantity	Subtotal (\$)
Solderless Breadboard	https://makerstore.ca/shop/ols/products/breadboard/v/C005-HLF	5.00	1	5.00
AAA Battery	https://makerstore.ca/shop/ols/products/aaa-battery-single	1.00	2	2.00
Peltier plates	https://www.amazon.ca/Lexiesxue-TEC1-12706-Heatsink-Thermoelectric-Cooling/dp/B0761S8WMD	4.00	3	12.00
Heat sinks	https://www.amazon.ca/Awxlumv-40x40x20mm-Transistor-Amplifier-40mmx40mmx20mm/dp/B07SMX1DB7	4.00	3	12.00
Battery pack	https://makerstore.ca/shop/ols/products/3-x-aaa-battery-holder-with-on-off-switch-and-2-pin-jst	2.50	1	2.50

Aluminum foil roll	https://www.walmart.com/en/ip/great-value-aluminum-foil/10270023	1.97	1	1.97
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6.2.2. Equipment list

No additional equipment was used to assemble this subsystem.

6.2.3. Instructions

Connect all the electric devices (the Arduino, circuit board, temperature sensor, cooling system, and DC motor) as outlined in the section “Wiring of Peltier Plates”, then confirm each component is running. Control the Peltier plates by switching the battery pack on and off. Varying the temperature will affect the level of erosion and can be implemented to accelerate the testing or determine the performance in different conditions.

6.3 Filtration

6.3.1. BOM (Bill of Materials)

Item	Link	Cost per Unit (\$)	Quantity	Subtotal (\$)
Coffee filter	https://www.walmart.com/en/ip/melitta-basket-coffee-filters-10-12-cups-white/6000188868142	0.02	200	3.98
Scale	https://www.amazon.com/NEXT-SHINE-Weighing-Function-	13.99	1	13.99

	Stainless-Platform/dp/B017LUWCAW/			
Sample containment unit		0.00	1	0.00
Compartment separator (bowl)	https://www.dollarama.com/en-ca/p-plastic-salad-bowl-assorted-colours/1000958	4.00	1	4.00
Filter		0.00	1	0.00

6.3.2. Equipment list

- Onshape
- AutoCAD
- 3D Printer with PLA filament
- Hot glue

6.3.3. Instructions

Once the hole is cut in the bowl (see section 6.3.4.), the filter will be glued to the bottom of the bowl and the glue will dry. Insert a metal mesh to stop the larger particles of the material and the fibrous filter, which sits underneath the mesh, will collect the remainder. When the time for the test has elapsed, the chain will be pulled, removing the plug, and all the water will drain through along with the particles. The water will be stored in a separate compartment, but the particles will be caught in the filter. The filter will then be weighed, and the initial mass of the filter components subtracted.

6.4 Containment

6.4.1. BOM (Bill of Materials)

Item	Link	Cost per Unit (\$)	Quantity	Subtotal (\$)
Lid		0.00	1	0.00
Compartment separator (bowl)	https://www.dollarama.com/en-ca/p-plastic-salad-bowl-assorted-colours/1000958	4.00	1	4.00
Water bucket	https://www.dollarama.com/en-ca/p-plastic-bucket/3029893	4.00	1	4.00
Drain	https://www.essentracomponents.com/en-ca/p/threaded-sealing-plugs-metric/462837a?indexed=true	5.75	1	5.75

6.4.2. Equipment list

- Drill press
- Angle grinder
- 3D printer

6.4.3. Instructions

Cut a 57 mm hole in the centre of the bowl using the drill press. Use a grinder to achieve the correct diameter of the bowl to fit about 2/5 of the way down the container. Cut a 57 mm hole in the centre of the bottom of the container using the drill press. Fit the drain into the hole in the bottom of the container. Apply sealant as needed on both sides of the drain and let dry for 2 hours. Apply sealant

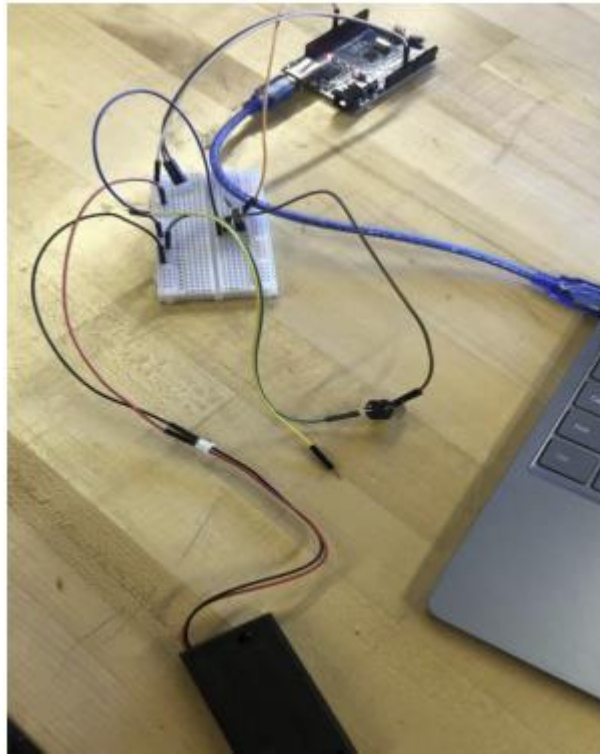
on the edges of the bowl where it meets the container and let dry for 2 hours (at the same time as the sealant around the drain).

6.5 Testing & Validation

Explain the tests that were done on the prototype for validation of the final design. Present all the applicable results that you obtained (i.e. data collected, performance graphs, etc.). List any issues or special requirements for sustained usage. Add pictures to help your explanation.

6.5.1. Water Propulsion Testing

- The objective of our first test was to evaluate the Arduino code. The testing was done by constructing the circuit and running the code in the Arduino IDE. The testing was evaluated by the motor successfully rotating for 5 minutes. The results of the testing were that the motor can rotate for 5 minutes.
- For the second test, we tested how it moves with the code. The testing was done by 3D printing the full-size propellor & connecting a rod, and then attaching those to the motor. The testing was evaluated by whether the propellor rotated for 5 minutes without any issues. The results of the testing were that the motor that is currently in use is too weak. We then had to research different motors and select one with more power and less torque.
- The objective of our last test was to change the value of the rotation of the propellor while the code was running. The testing was done by constructing the circuit with the propellor connected. The testing was evaluated by observing if the rotation of the blade changes as expected when the speed is varied on a 0-255 scale. The results of the testing were the propellor successfully spins faster or slower based on the inputted value.



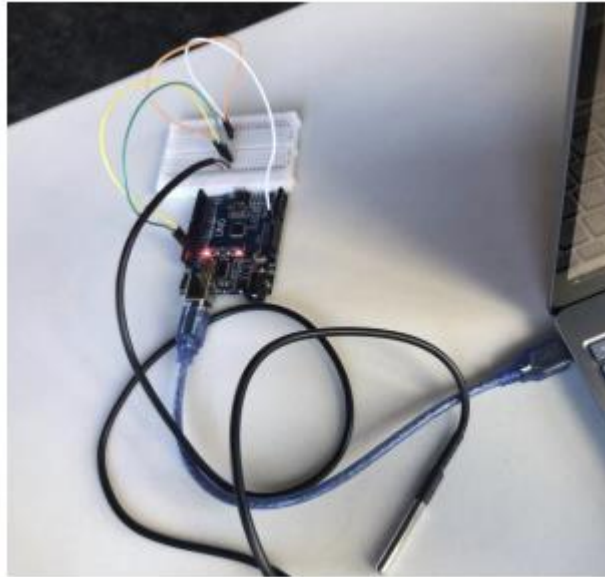
Wiring of small hobby DC motor



Two views of the motor circuitry

6.5.2. Cooling System Testing

- The objective of our next test was to measure the temperature of the testing environment using a waterproof temperature sensor connected to an Arduino Uno. The testing was done by using the code written in the Arduino IDE and building the temperature sensor circuitry using an Arduino and breadboard. The testing was evaluated by testing if the Serial monitor outputs the correct temperature results. The results of the testing were successful as the serial monitor would register the temperature of the sensor every other second.



Circuitry to test temperature sensor

The first test's objective was to measure the testing environment's temperature using a waterproof temperature sensor connected to an Arduino Uno. The testing was done by using the code written in the Arduino IDE and building the temperature sensor circuitry using an Arduino and breadboard. The testing was evaluated by testing if the Serial monitor outputs the correct

temperature results. The results of the testing were successful as the serial monitor would register the temperature of the sensor every other second.

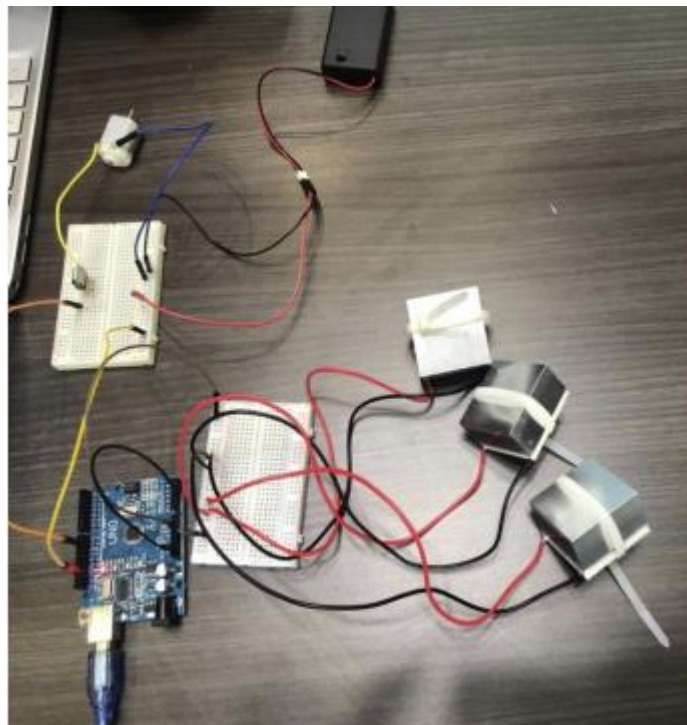
The second test's objective was to assess the physical components of the thermoelectric cooling system, the Peltier plates with heat sinks. The testing was done by connecting components to an Arduino and setting up the components as per the circuit diagram, in a somewhat insulated environment. Measurements were recorded when one Peltier plate was engaged. The testing was evaluated by data gathered over 20 minutes, during which time the temperature will be measured and recorded every 5 minutes (5 measurements in total per sub-test). Recorded temperature values will be analyzed. Based on the power of one Peltier plate, it can be calculated how much power is needed for the Peltier plates to cool the water during the test. The results of the testing with one Peltier plate is summarized in the table below.

Change in Temperature with One Peltier Plate

Time (minutes)	Temperature (degrees Celsius)
0	22.6
5	22.3
10	22.1
15	22.1
20	22.0



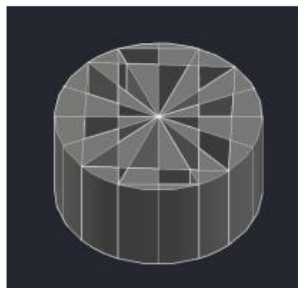
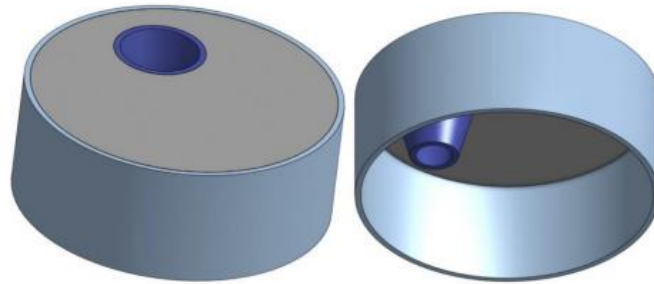
Testing setup of Peltier plate between two wooden rods with tinfoil insulation



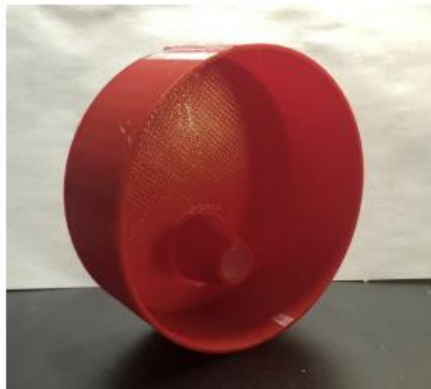
Testing setup with three Peltier plates and other components

6.5.3. Drainage System Testing

The objective of the first test was to analyze the overall containment and drainage. The testing was done by setting up the containment system with the fluid and the drainage system in a small-scale model. The testing was evaluated by visually observing whether all the fluid drains out without any remaining inside the container. There was also a 3D-printed filter at the bottom to catch the material while letting the liquid go through. There will also be a plug at the bottom so once the filtering is complete, all the liquid can be drained through the bottom. The results of the testing were that not all the water drained out. The solution was to modify the bottom part of the plastic insert, so the water drains into the funnel.



Iterations of drainage systems, filters, and plugs.

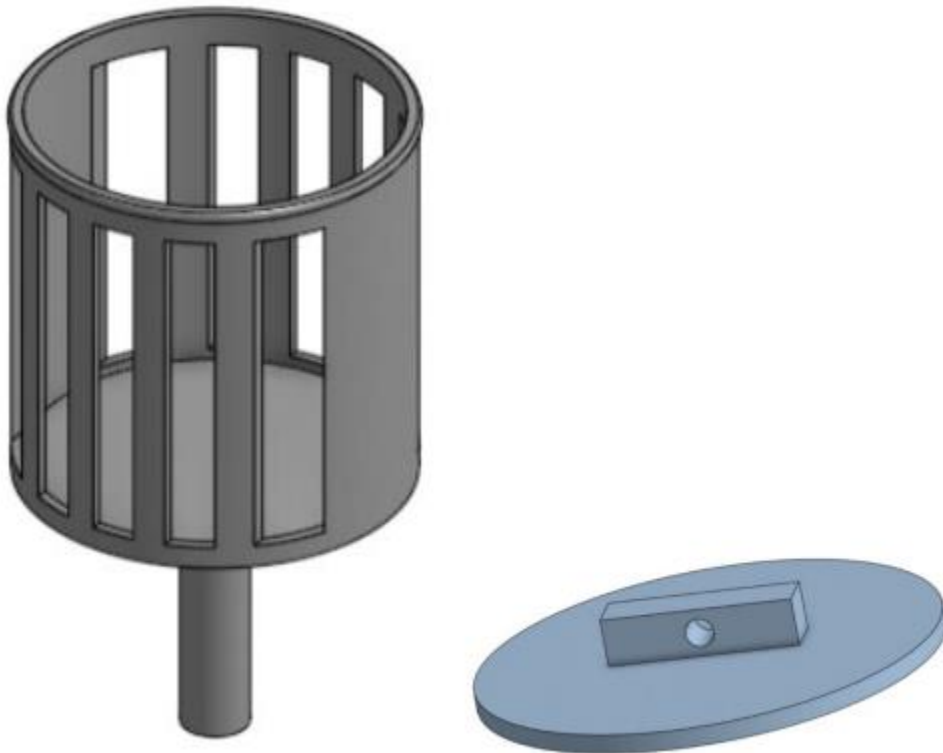


Fi

Printed drainage systems, filters, and plugs

The objective of the next test was to analyze and test how long it takes and how easy it is to install the sample. The testing was done by using CAD to design the sample containment unit top and bottom, then 3D printing it and testing the physical model. The testing was evaluated by the sizing of the sample container top and bottom. Then the CAD model will be modified. As well, the time

required for sample installation is a factor in determining the feasibility. The CAD model will be simplified. The results of the testing were that the container did not yet fit together properly, but the time taken to snap the lid on the container would be about 10 seconds at maximum.



CAD model of sample containment unit

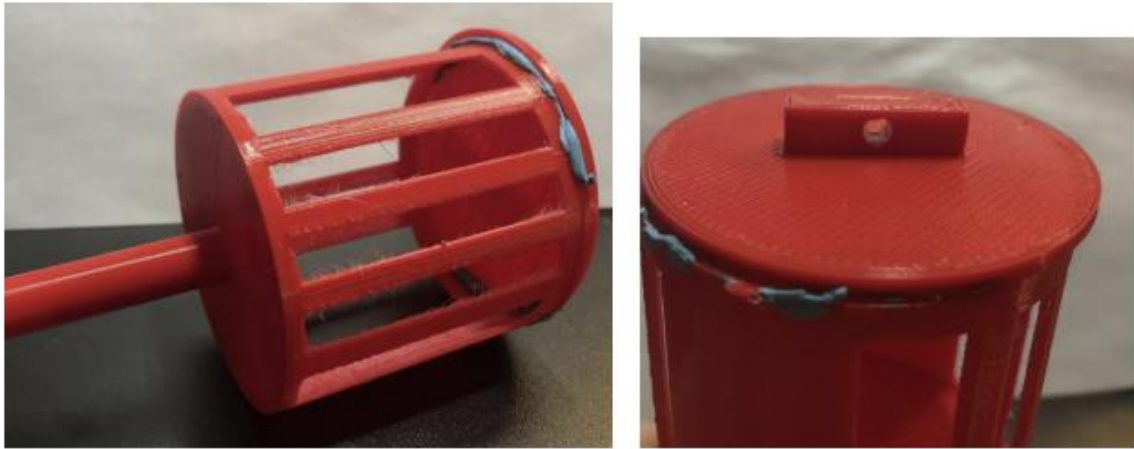


Figure 10a and 10b: 3D printed sample containment unit with lid, held together by blue tack.

The objective of the third test was to analyze and test how long it takes and how easy it is to install the sample using a revised design. The testing was done by generating a sample containment unit lid on an appropriate scale and fitting it onto the existing sample containment unit bottom. The testing was evaluated by timing how long it takes to take out a sample, then placing another in over multiple trials, and calculating the average expected time. The results of the testing were that it takes an average of five seconds to remove the lid, remove the sample, insert a new sample, and close the lid.



Sample containment unit with fitted lid.

The objective of the next test was to analyze how easy it is to install and remove the plug. The testing was done by using the test draining system and timing how long it took to install and take out the plug over multiple trials. The testing was evaluated by the time it took to place the plug inside, securely, then take it fully out. This will be done five times. The results of the testing were an average of 10 seconds between 5 trials to successfully insert and secure the plug as well as removing the plug.

6.5.4. Filtration System Testing

Assuming a linear relation of time to eroded material...

Test 1:

At time = 0, erosion = 0 grams.

Conditions: tap water, room temperature water 20 °C.

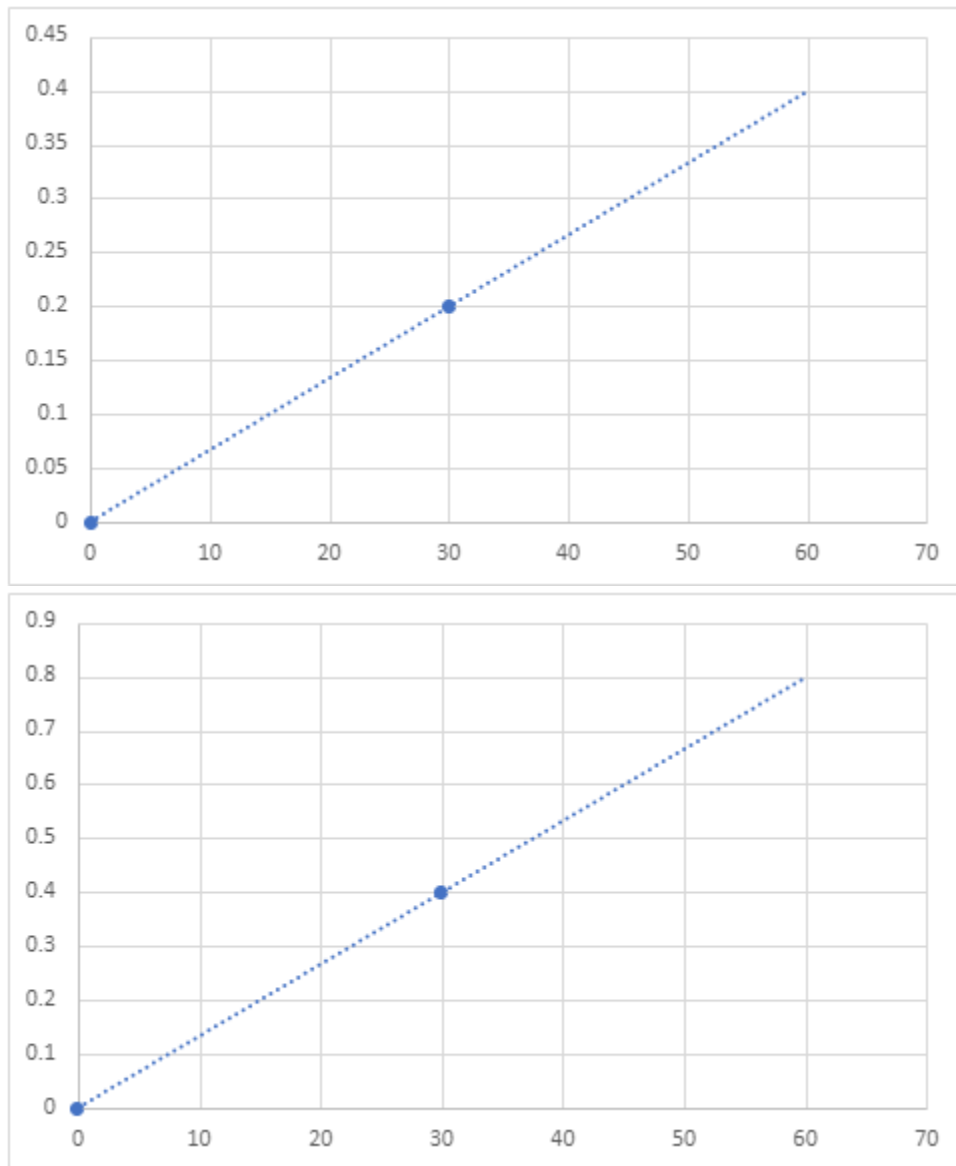
At time = 30 minutes, erosion = 0.2 grams.

Test 2:

At time = 0, erosion = 0 grams.

Conditions: tap water, cold water 5 °C - 8 °C.

At time = 30 minutes, erosion = 0.4 grams.



The objective of our test was to confirm no leakage from the top half into the bottom half of the container. The testing was done by installing the system without applying sealant. The testing was evaluated by the amount of water in the bottom half of the container. The results of the testing were that there is currently leakage and the sealant that will be implemented is hot glue.



The objective of our next test was to test the fit of the drainage system. The testing was done by assembling the drainage system with a sloped divider, filter, and plug to stop water leakage. The testing was evaluated by whether water leaks unintentionally, and how long it takes for the water to drain from the container when the plug is removed. The results were that the water takes 15 seconds from top to bottom and 20 seconds from bottom half into a sink.



7 Conclusions and Recommendations for Future Work

Through the stages of the design process, especially the prototyping stage during which the construction of prototypes took place, there were numerous revisions and continuous research was done. A motor with high torque is key to ensuring the water rotates to erode the sample. The propellor must be able to move a large volume of water at reasonable speeds while avoiding the creation of a vortex: another critical consideration. The cooling system should provide cooling power that is sufficient to lower the temperature quickly and proper insulation should be

implemented to prevent heat transfer. The drainage system must collect all the debris and the filtration system must separate it into large and small chunks to permit further analysis.

One item that was not accomplished due to complications with the Arduino was automating the cooling system to actively cool the water when the temperature was above 5 degrees Celsius and turn off otherwise: a relatively simple task given that the temperature sensor has already been implemented. If more budget was allotted to this project, the team would consider adding a light and a sensor to determine the amount of particulate in the water over time. Finally, insulation quality could be improved as well as the neatness of the wiring setup.

8 Bibliography

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APPENDICES

9 APPENDIX I: Design Files

Table 3. Referenced Documents

Document Name	Document Location and/or URL	Issuance Date
Team Overview	https://makerepo.com/YusraTH/2038.gng-1103-group-3-designott-engineers-inc	April 10, 2024
CAD Files	https://makerepo.com/rails/active_storage/blobs/redirect/eyJfc mFpbHMiO nsibWVzc2FnZSI6I kJBaHBBb0ZkLiwiZXhwIjpudWxsLCJwdXIiOiJibG9iX2lkIn19--f15345121309297bebd9b814fc5820eab3094692/Final%20Designs.zip	April 10, 2024
Arduino Code	https://makerepo.com/rails/active_storage/blobs/redirect/eyJfc mFpbHMiO nsibWVzc2FnZSI6I kJBaHBBb0pkLiwiZXhwIjpudWxsLCJwdXIiOiJibG9iX2lkIn19--965a06a3fd0803e7e1338638d89b07687e605d52/Lauren_updated.zip	April 10, 2024