Project Deliverable F: Prototype I and Customer Feedback

GNG 1103 – Engineering Design

Faculty of Engineering – University of Ottawa

By: Zaineb Wadood, Rebecca Heller, Matthew Schroeder,

Benjamin Kelly, Cameron Caudle

March 3 2024

Objective: Creating a water tank that is waterproof



Figure 1 Waterproof acrylic tank

Materials Selection: Acrylic

Tank Material reason: Wanted something to see through to observe the sample. For this purpose the acrylic is durable and waterproof.

Sealing Material: methyl chloride as it bonds acrylic

Design:

1. Internal dimensions: 340.5x340.5mm
2. Height: 340.5mm
3. Access Points: top of the tank is accessible by 338x338mm opening and drain

Construction Steps:

1. Designed using Onshape
   1. Tank bottom, tank side, top ring, tank lid
2. CNC each part using the Onshape models
3. Assemble tank using clamps
4. Once parts were locked in locations methyl chloride was applied to the seams

**Feedback from clients/users: Entrepreneur, Electrical Engineer, Middle age**

**Positives:**

* Transparency:
* The use of acrylic sheets allows for clear visibility inside the tank.
* This transparency is beneficial for observing erosion patterns and sediment movements during tests.
* Ease of Inspection:
* Acrylic's smooth surface makes it easy to visually inspect for any sediment buildup or irregularities.
* This can aid in maintaining the tank and ensuring accurate test results.
* Lightweight:
* Acrylic is generally lightweight compared to other materials like metal or concrete.
* This makes the tank easier to handle, transport, and potentially modify if needed.
* Quick Assembly:
* Acrylic sheets can often be easily cut and bonded together, allowing for relatively quick assembly of the tank.

**Areas for Improvement:**

* Durability:
* While acrylic is sturdy, it might not be as resilient to impacts or rough handling as other materials.
* Reinforcing vulnerable areas or adding protective measures could enhance its durability.
* Consider the potential for scratches or abrasions over time and how this might affect visibility.
* Stability:
* Depending on the size and shape of the tank, consider adding support structures or bases to enhance stability.
* This is particularly important during tests to prevent accidental tipping or shifting of the tank.
* Cleaning and Maintenance:
* Acrylic can be sensitive to certain cleaning agents, so ensure compatibility with the materials used.
* Develop a cleaning and maintenance schedule to prevent algae growth or sediment buildup that could affect test results.

**Prototyping Test Plan:**

| Test ID | Test Objective  (Why) | Description of  Prototype used and of  Basic Test Method  (What) | Description of  Results to be  Recorded and  how these results  will be used  (How) | Estimated Test  duration and  planned start  date  (When) |
| --- | --- | --- | --- | --- |
| 1.0  Test the water tightness of the acrylic tank system | Make sure tank is waterproof | Fill tank with water, and let it for an hour. | Qualitative | 1hour  24/02/24 |
| 2.0  Arduino control | PWM motor control functions | Test to insure that arduino is producing correct PWM signals for motor drive circuitry | Qualitative | 30min  29/02/24 |
| 2.1  Arduino control | Emergency stop | Test to make sure emergency stop functions, by cutting the power. | Qualitative | 10min  29/02/24 |
| 3.0  Motor lid assembly | Looking for excessive current draw and vibration | Initial operation of motor and stub shaft a low rpm (100rpm) | Qualitative | 15-20min  1/03/24 |
| 3.1  Motor lid assembly | Looking for excessive current draw and vibration | Operation of motor and stub shaft max rpm | Qualitative | 15-20min  1/03/24 |
| 3.2  Motor with sample shaft | Looking for excessive current draw and vibration | Operation of motor and shaft at low rpm (100rpm) without sample | Qualitative | 15-20min  1/03/24 |
| 3.3  Morot with sample shaft | Looking for excessive current draw and vibration | Operation of motor and shaft at max rpm without sample | Qualitative | 15-20min  1/03/24 |
| 3.4  Morot with sample shaft and sample | Looking for excessive current draw and vibration | Operation of motor, shaft, and sample at nominal rpm with sample | Qualitative | 15-20min  1/03/24 |
| 4.0  Erosion acceleration test | Looking for excessive current draw and vibration | Operation of motor and shaft at max rpm without sample | Qualitative | 1 week  10/03/24 |
| 5.0 |  |  |  |  |

The red highlighted part of the project is already completed and was our prototype 1. The green highlighted part is our next week’s prototype

**Prototyping Test Plan:**

* Objective: Verification of Motor Control Functionality
* To ensure the motor can be turned on and off on command.
* To verify the ability to control the motor's RPM as per requirements.
* **Test 1**: Motor On/Off Command
* Setup:
* Connect the motor to the control system.
* Establish communication between the control system and the motor.
* Procedure:
* Send a command to turn the motor on.
* Observe and record the motor's response time.
* Send a command to turn the motor off.
* Confirm that the motor stops as expected.
* Repeat the process multiple times to ensure consistency.
* Expected Results:
* The motor should start promptly upon receiving the "on" command.
* The motor should stop immediately upon receiving the "off" command.
* Consistency in the motor's response to commands.
* Criteria for Success:
* Motor reliably turns on and off in response to commands.
* Minimal delay between command and motor action.
* **Test 2:** RPM Control: Verify the ability to control the motor's RPM and ensure accuracy.
* Setup:
* Establish a baseline RPM value for the motor.
* Implement code to adjust and control the RPM.
* Procedure:
* Set the motor to a specific RPM value (e.g., 1000 RPM).
* Measure the actual RPM using a tachometer or sensor.
* Adjust the RPM command and repeat the process for various RPM values.
* Note any discrepancies between commanded and actual RPM.
* Expected Results:
* The motor should reach the commanded RPM within an acceptable margin of error.
* RPM adjustments should be smooth and without sudden jumps or drops.
* Criteria for Success:
* Ability to set and maintain specific RPM values.
* Consistency in RPM control across different settings.
* **Test 3:** Integration with User Interface (UI):Verify the integration of motor control with the user interface.
* Setup:
* Implement a basic user interface to send motor control commands.
* Ensure the UI displays current motor status (on/off) and RPM.
* Procedure:
* Use the UI to send commands to turn the motor on and off.
* Adjust RPM values using the UI sliders or input fields.
* Verify the UI accurately reflects the motor's status and RPM.
* Expected Results:
* User interface elements should provide intuitive control over motor functions.
* Real-time updates on motor status and RPM displayed on the UI.
* Criteria for Success:
* Smooth interaction between the UI and motor control.
* Accurate representation of motor status and RPM on the UI.
* **Test 4:** Performance and Load Testing: Verify motor performance under different load conditions.
* Setup:
* Attach the motor to a load simulator or mechanical system.
* Vary the load on the motor to simulate different operating conditions.
* Procedure:
* Run the motor at various RPM settings with different loads applied.
* Measure motor performance metrics such as torque, power consumption, and temperature.
* Observe motor behavior under changing load conditions.
* Expected Results:
* Motor should maintain stable RPM and performance within specified load ranges.
* Monitor for any signs of overheating or excessive strain on the motor.
* Criteria for Success:
* Consistent motor performance across different load scenarios.
* Motor operates within safe temperature and power consumption limits.

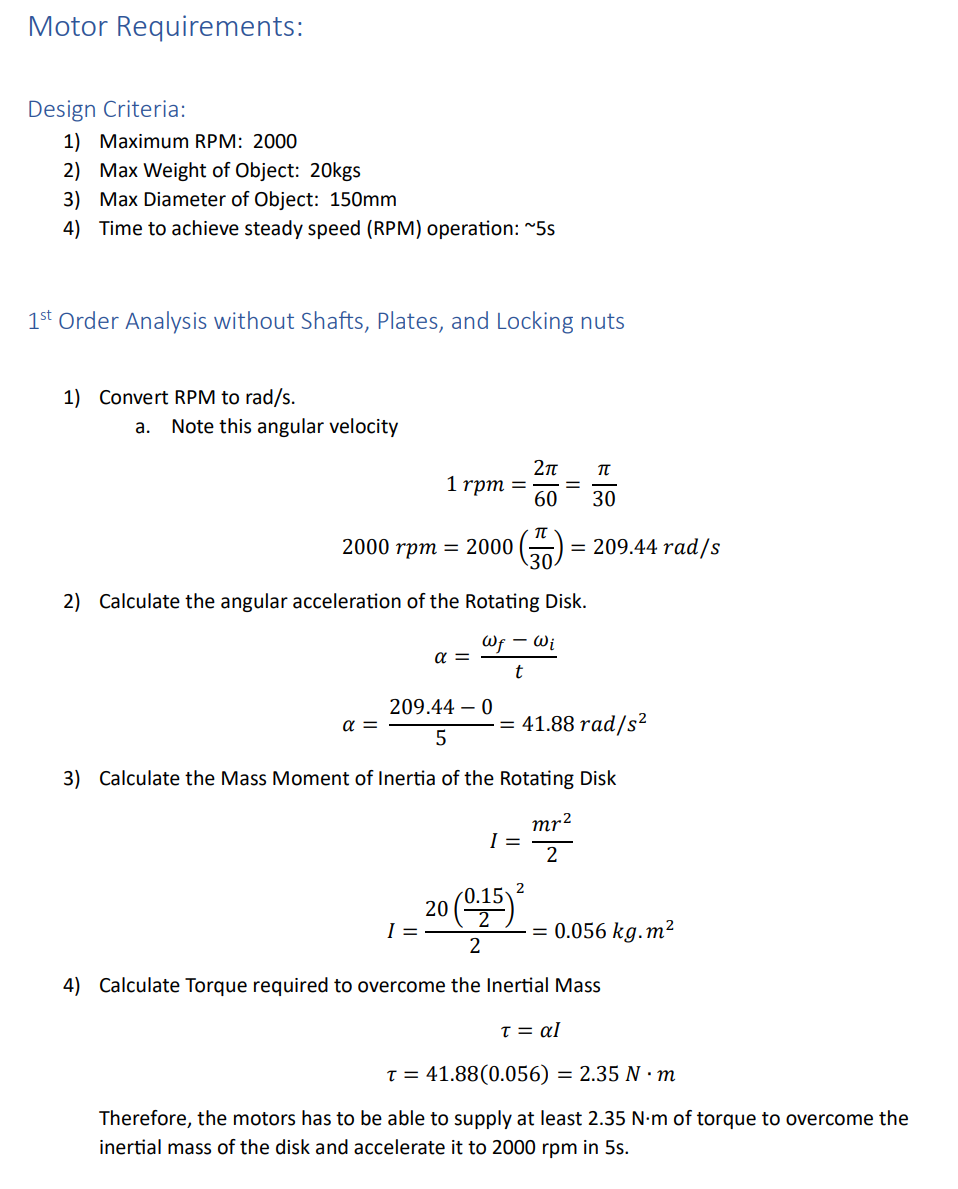
**Summary of Findings:**

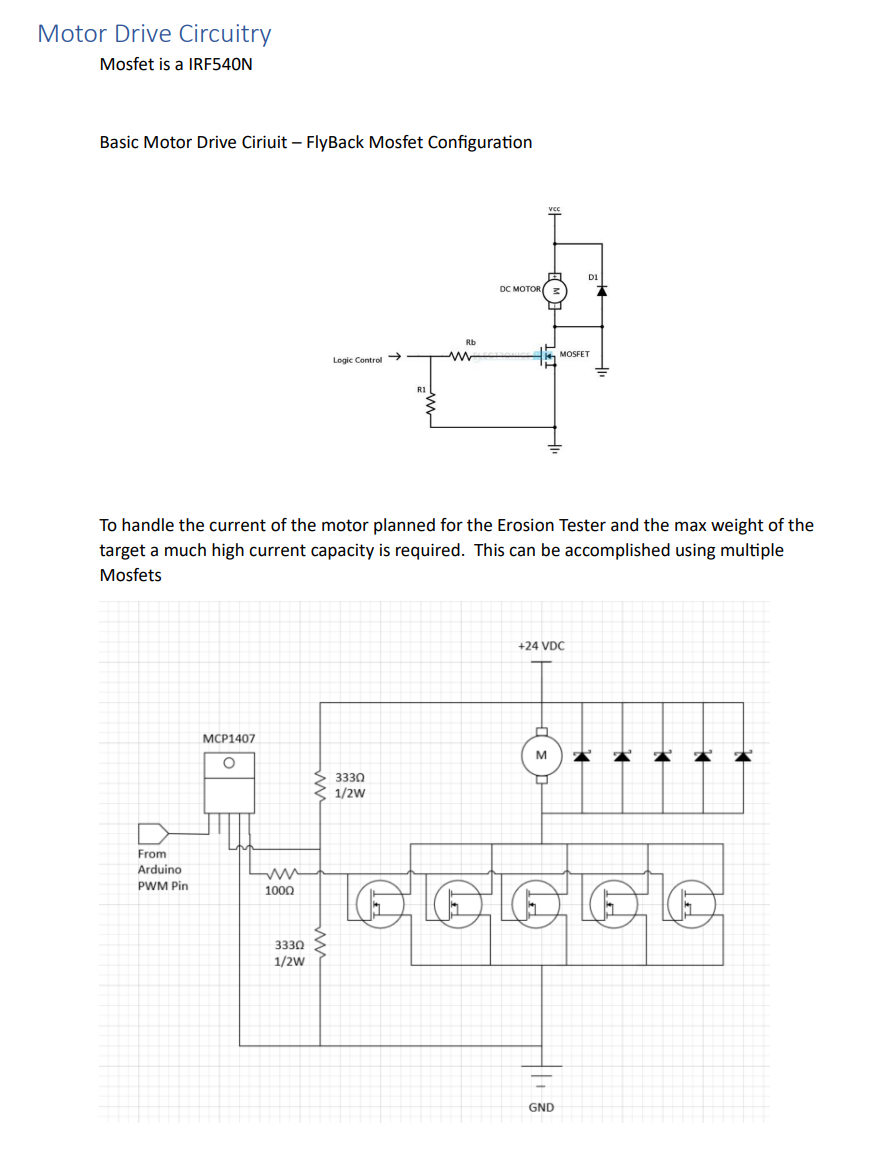
* Document any issues encountered, observations, and improvements needed.
* Provide feedback for refining the motor control system for the next prototype iteration.

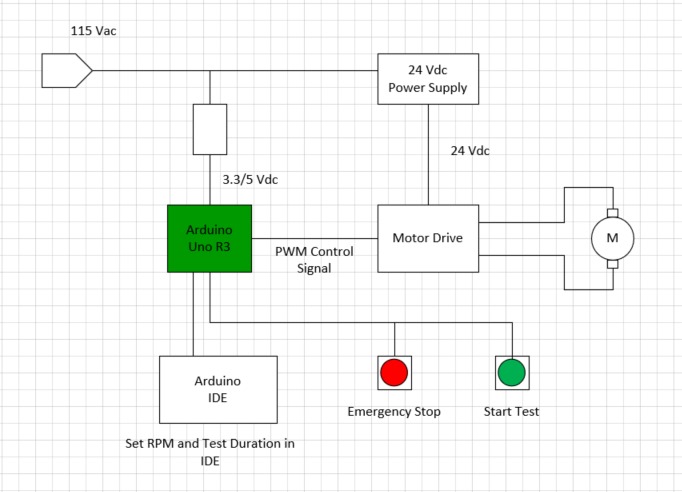
**Stopping Criteria**

* We need a set of criteria to know when each test is complete.
* This will be determined by:
  + Will the motor start and stop on command?
  + Does the arduino successfully control the motor?
  + Is the motor able to spin the weight of the sample at a high speed?

**Analytics of Critical Components**



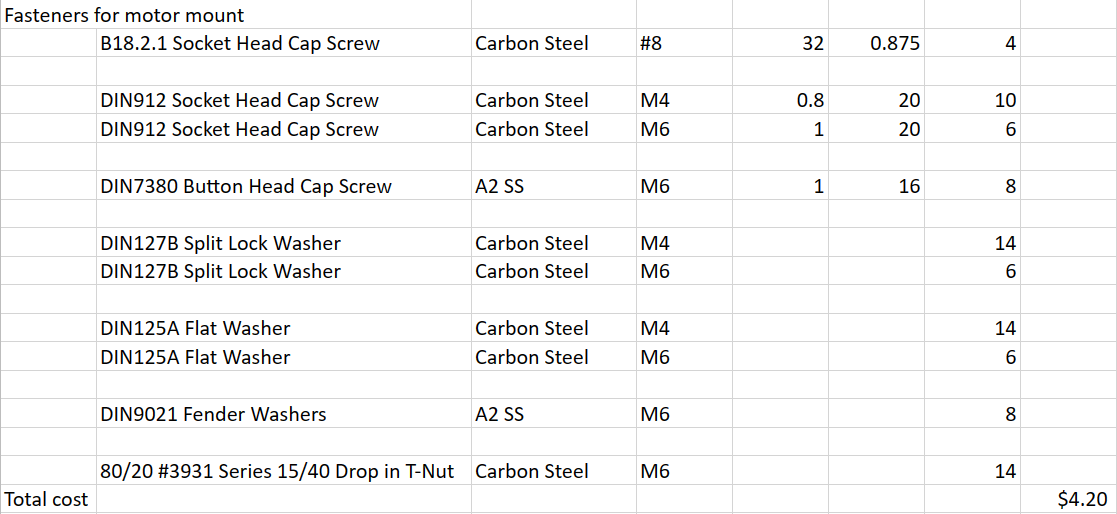




**Functional Block Diagram of the Erosion Tester Electrons**

**Cost Spreadsheet:**

| Item# | Material | Element | Quantity | Dimensions | Unit Cost | Total Cost | Getting from |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | Sand | Abrasive | 1 cup | None | $0.00 | $0 |  |
| 2 | Acrylic | Tank | 1 | 350x350mm | $8 | $8 | Boreal Power System |
| 4 | Motor | Rotates Shaft | 1 | 78x100mm  RPM at Nominal Voltage: 5600  Stall Torque:5Nm | $50.00 | $50.00 | Boreal Power System |
| 5 | Stainless steel rod | Shaft | 1 | 12.5mmx115mm | $8 | $8 | Boreal Power System |
| 6 | aluminum/rubber | Coupler | 1 | 40x30mm | $3 | $3 | Boreal Power System |
| 7 | Washers | Fasteners | 36 | M6 | $.02 | $0.7 | Boreal Power System |
| 8 | Screws | Fasteners | 36 | M6x16 | $0.10 | $3.50 | Boreal Power System |
| 9 | Water (in Liters) | Liquid | 5 | N/A | $0.00 | $0.00 |  |
| 10 |  | Power Supply | 1 | 24v DC  42A | $15 | $15 | Boreal Power System |
| 11 | Arduino Board | Controls | 1 | ‎8x5.51x2.49 cm | $0.00 | $0.00 | Boreal Power System |
| 12 | Aluminum plate | motor support | 3 | 95x125mm | $1.00 | $3.00 | Boreal Power System |

****

From Boreal Power System

Note: Boreal Power system has all the materials needed in surplus/scrap, will get an invoice from them for the prices listed above.

Total: 95$