Project Deliverable C: Design Criteria and Target Specifications

GNG 1103 – Engineering Design

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**Description:** This document describes the specific design criteria that are required for each and every aspect of our erosion testing machine. Below we have a table with priority of each need, description and design criteria to understand what is required for our design. This document also includes the functional and non-functional requirements as well as the constraints necessary to build this erosion testing prototype.

| **Priority #** | **Needs** | **Description** | **Design Criteria**  |
| --- | --- | --- | --- |
| 1 | This device is reproducible  | Develop a device that allows for repeatable tests with different materials and conditions | * On/Off button
* Keep the motor at the same speed always
 |
| 2 | The device should be measurable | Provide a clear display of results for each test to showcase erosion effects | * Measure erosion by weighing the material
* Taking before/after pictures
* Measuring weight of sand before and after
 |
| 2 | This device must be cost effective | Utilize easy and accessible materials for construction. Follow the principle “beg, borrow and steal” | * Plastic bucket (to hold liquid and material)
* Styrofoam (material used for erosion testing)
* Sand (free)
* Water
* Motor
* 3D print gears maybe
 |
| 1 | This device must be safe | Operates at atmospheric conditions, no pressurized components. Limit RPM to 2000 or below for safety and to obtain erosion results within a week. Temperature must be below 40 C | * Room temp water
* Safety googles in case things blow out
* Lid to ensure water doesn’t splash around
 |
| 3 | This device must be time efficient | Design a device that simulates erosion within 2 weeks to a month | * Prototype 1: test the device to see if its time efficient
* Put abrasives such as sand to ensure it erodes faster
 |
| 4 | This device must be visually appealing  | Design the system to have a presentable appearance, without requiring exquisite aesthetics. | * Must be quiter then a pressure washer
* Clean
* Cable managment
 |

**Constraints:**

| **Design Sepcification** | **Value** | **Units** | **Verification method** |
| --- | --- | --- | --- |
| Spinning shaft Speed | >= 2000  | rpm | Mesure |
| Erosion testing time | <= 1 week | Days | Keep track |
| Cost  | < 100 | $ | Keep track |
| Operating temperature | < 40 | °C | Use thermometer if necessary or keep it room temperature |
| Operating conditions(sand) | N/A | N/A | Testing |
| Reproducible (On/Off button) | N/A | N/A | Testing |
| Drained and filtered | Must be less then original weight of the eroded material | mg | Measure weight before/after testing |
| Weight | <=10 without water | kg | Measure |

**Functional Requirements:**

* Must simulate erosion/demonstrate how our device would conceptually simulate erosion on a rock core sample.
* Must be safe to use
* Must be cost effective

**Non-Functional Requirements:**

* Looks professional and well constructed
* Minimal environmental impact

**Target Specifications:**

* Shape such that it stirs the water and keeps the sand suspended
* Water volume: Enough to completely submerge the sample
* Frame must fit over a plastic Home Depot bucket and have enough area to support a motor and control systems
	+ We will find dimensions once the bucket is purchased

**Design Specifications:**

1. Target Size:
	1. Max diameter of target: 150mm
	2. Max thickness of target: 50mm
	3. Max weight of target: 20kgs
		1. Max density of target: 22.6g/cm^3 (Note: Iridium is 22.5g/cm^3)
2. Tanks size:
	1. Length and width should be a multiple of target diameter so that fluid flow over target is not affected by reflection of tank wall(i.e 3 or 4 times - 450-600mm
	2. Height should be a multiple of the target height such that the target plus any mounting/clamping devices or shaft bearings are accommodated such that they are not affected by tank bottom or lid (i.e. 4-6 times 200-300mm)
	3. Tank Lid should be selected to
		1. Accommodate the weight of the Motor and all shaft bearing and attachment parts.
		2. The weight of the target
		3. The combined weight of lid, motor, shafts, target will be approximately 30- 40kgs.
		4. Erosion Tester should have a lift system to allow for easy lid removal and support for changing of targets
3. Speed of Rotation: Max 1500rpm
	1. 1500 rpm is selected to reduce 1yr of erosion down to less than a week depending on temp.
	2. Motor selection has to be able to spin 20Kg target plus the weight of any target holding devices at 1500 rpm.
4. Operating Pressure: 100kPa (1 Atmosphere)
	1. Simple design – no requirement for pressure vessel design 5)
5. Liquid:
	1. PH Range should allow for weak acids to weak alkyds.
		1. 4 < PH< 10
			1. Water, Heavy Water in Range of 6.5-7.5
			2. Glycols or heat transfer in the range of 9-10.
	2. Should be able to be easily drained from the tank.
	3. Should be able to head to 40C without affecting the tank material.
6. Operating Voltage:
	1. 120 – 240 Vac 60Hz
	2. System should handle ground fault conditions to prevent electrocution through the liquid.
7. Operation Interface:
	1. Graphical Touch Screen to set the following parameter.
		1. RPM
		2. Temp
		3. Target Weight – for motor acceleration calculations

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**Figure 1.** Prototype drawing of erosion tester

**Technical Benchmarking:**

* Other rotational erosion testers utilize a similar design with variable conditions such as:
	+ Decreased rmp which prolongs the testing time
	+ Various temperatures depending on the target material and the desired duration of the test
	+ Some operate with different fluids to simulate erosion in real like fluid examples
	+ Depending on the material, the max weight limit would be around 20kg in order to test exotic materials due to their increased density (more common in the nuclear industry)

**Conclusion:**

In conclusion, the development of the erosion testing system has been guided by a thorough analysis of both functional and non-functional requirements, aligning with the client's needs and priorities. These requirements outline the specific features and capabilities necessary for the system to perform erosion tests effectively, ensuring reproducibility, measurability, cost-effectiveness, safety, time efficiency, and visual appeal. These requirements provide a roadmap for the technical development of the system, ensuring it meets the core objectives set by the client.