Project Deliverable C: Design Criteria and Target Specifications

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Objective
Background
Introduction
Methodology

Water Erosion Test Mechanism Design:

1. Materials and Components:

- Transparent container (to observe the effects of erosion).
- Pump system to circulate water around.
- Core sample holder.
- Water supply system.
- Flow control valve.
- Sediment collection system.

2. Sample Core Holder:

- Securely hold the sample core in a vertical or hoposition.
- Adjustable to accommodate different sample sizes.
- Made of corrosion-resistant material to prevent interference with the erosion process.

3. Water Circulation System:

- Recirculating water system to simulate continuous erosion.
- Adjustable flow rate to control erosion intensity.
- Filtration system to remove debris and maintain a consistent sediment concentration.

4. Flow Control Valve:

- Enables precise control of water flow.
- Adjustable to simulate different erosion conditions.

5. Sediment Collection:

- Collection system to gather eroded particles.
- May include a sediment trap or settling chamber.

6. Observation and Measurement:

- Transparent for visual monitoring of erosion.
- Measurement tools for tracking erosion depth, width, and shape.
- Cameras or sensors for automated data collection.

7. Temperature and Environmental Control:

- Temperature control to study the impact of temperature on erosion..

8. Safety Measures:

- Adequate safety measures to handle water and electrical components.
- Emergency shut-off systems.

Notes:

- **Calibration:** Regularly calibrate the system to ensure accurate and reliable results.
- **Material Compatibility:** Ensure that the materials used in the setup are compatible with the sample core material and won't introduce unwanted interactions.

Design Criteria

1. Precision and Accuracy:
The major purpose of the erosion measurement mechanism is to provide highly accurate and precise measurements of erosion outcomes on the sample core. To establish a solid framework for further analysis and minimization of measurement errors is essential to maintain the reliability and validity of the obtained data.

2. Sensitivity:
The erosion measurement device should show heightened sensitivity so that subtle alterations on the surface of the sample core due to erosion can be detected. Its functionality should span a range of scales and measuring micro erosion to macro erosion effectively.

3. Non Destructiveness:
A major advantage is its non destructive characteristic whereby the same core can be repeatedly measured over time without undermining the integrity of the structure. The primary concern here is preserving the integrity of the original state of the sample to guarantee the accuracy of the data gathered.

4. Adaptability:
The erosion measurement mechanism must be adaptive to different types of sample cores due to the differences in material composition and size and and shape. Additionally and it must show adaptability in responding to changing environmental circumstances and such as temperature and humidity and ang pressure.

5. Real time Monitoring:

When possible and the mechanism should allow real time observation of erosion effects on the sample core.The continuous data acquisition gives a broad and dynamic outlook of the process of erosion.

6. User Friendly Interface:
Ease of operation requires a simple and intuitive interface. The design should try to limit the need for significant training and so that operators are able to use the device without much instruction.

7. Durability:
The erosion measurement mechanism should have long lasting components resistant to tear and wear and especially when exposed to harsh climates. Standardized maintenance procedures should be straightforward to achieve sustained and consistent performance.

8.Cost Effectiveness:
In the design phase and it is essential to achieve a balance between cost effectiveness and functionality. The considerations include the cost of manufacturing and operation and maintenance without sacrificing the quality and effectiveness of the mechanism.

9. Data Logging and Analysis Capability:

Functional Requirement: The erosion testing setup must have robust data logging capabilities to record and store relevant data during each testing session. This includes erosion rates, temperature variations, flow rates, and other critical parameters. Additionally, the system should be equipped with analysis tools or interfaces to process and interpret the collected data, facilitating comprehensive post-test evaluations.

10. Scalability:

Non-Functional Requirement: The design should be scalable to accommodate varying sample sizes and testing intensities. This ensures that the system can handle a diverse range of rotating components and erosion scenarios, allowing for flexibility in experimentation without sacrificing accuracy or efficiency.

11. Operator Safety and Training:

Non-Functional Requirement: The setup should prioritize operator safety by incorporating safety features and clear emergency shut-off systems. Additionally, the design should consider ease of training for operators, making the system user-friendly and reducing the risk of human error during testing procedures.

12. Material Compatibility Verification:

Non-Functional Requirement: The setup should include a mechanism for verifying the compatibility of materials used in the erosion testing system with various sample core materials. This ensures that potential interactions between the system components and sample cores do not introduce unwanted variables into the testing process, maintaining the integrity of the results.

Incorporating these additional design criteria addresses key aspects such as data management, adaptability to future advancements, environmental replication, remote accessibility, energy efficiency, scalability, operator safety, and material compatibility verification, providing a more comprehensive framework for the erosion testing setup.

Constraints:

Cost: The system should be designed within the specified budget to ensure practicality and affordability of this project.

Space: The prototype should be a reasonable size within a defined laboratory space.

Energy Efficiency: The system should be designed to minimize energy consumption while maintaining optimal testing conditions.

Environmental Impact: Minimization of waste generation and adherence to environmental regulations.

Benchmarking:

"Relationship Between Erodibility and Properties of Soils"
Pages 34-37

- Masses of core samples ranging from 0 to 40g
- Up to 1750 rpm
- Core size: 75mm in diameter and 89mm in height
- Record in stages of 10 to 30 min
- Use torque to calculate shear stress

Advantages:

- A small amount of water is needed
- High shear stress can be generated
- The shear stress can be estimated by using the induced torque on the side surface.

Works Cited

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