

Deliverable B: Need Identification and Problem Statement

GNG 1103

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1. Introduction

Canadian Nuclear Laboratories explores various aspects of nuclear science and technology in Canada. They study a variety of materials to help improve design features, however using new material comes with uncertainty and potential challenges. The goal of this project is to help alleviate some of this uncertainty in materials testing by creating a device that can be used to test the degree to which erosion parameters affect a given material/part. This device will be used by Canadian Nuclear Laboratory scientists to determine whether and how long a given material will be suitable for a predetermined application.

2. Determination of Client Needs

2.1. User Perceptions of Similar Products

Canadian Nuclear Laboratories already has an erosion testing device that functions by rotating samples at high rpm in hot water. Nevertheless, the client has expressed concerns about the time it takes to generate results (over one year) and the accuracy of those results in reflecting real-world erosion rates (the actual product erodes at a faster rate than the test suggested prior). They expressed that they are already working at a very high speed and high pressure so they would like to pursue other efficient avenues for accelerated erosion.

2.2. Client Needs

After the first meeting with the client, we converted the intended uses, positives and negatives of current device, and suggested improvements into prioritized needs statements:

| # | Need Statement | Importance |
|---|---|------------|
| 1 | The device is low risk to its users. | 1 |
| 2 | The device is able to accelerate the erosion of a variety of materials. | 1 |
| 3 | The device is able to produce results after a short run-time. | 1 |
| 4 | The device is able to simulate at least one isolated factor causing erosion without increasing the speed of material. | 1 |
| 5 | Within the parameters that are being tested, the device is able to be adjusted to test with the different measurable intensities of these parameters. | 2 |
| 6 | The material used for the device is durable enough to withstand the erosion testing from its internal processes. | 2 |
| 7 | The material used for the device is accessible and inexpensive. | 2 |

| | | |
|---|---------------------------------------|---|
| 8 | The device is portable. | 4 |
| 9 | The device is aesthetically pleasing. | 5 |

Note: This table describes the client's needs and prioritizes them. The importance is measured on a scale of 1 to 5 where 1 is critical and 5 is not important.

3. Problem Statement

Canadian Nuclear Laboratories needs a safe and cost-effective accelerated erosion testing device that produces measurable results after a short runtime to test different parameters causing erosion on various materials.

4. Benchmarking

Information about similar methods (rotating samples in liquid) erosion testing devices is scarce; however, there are various commercial erosion testing devices that utilize alternative methods, one of which is Ducom's Water Droplet Erosion Tester. This particular device employs a technique of subjecting sample components to repetitive water droplet impacts, which simulates the liquid-solid erosion and failure mechanisms of materials [1]. While this method promises faster results, further research is required to determine its accuracy.

5. Conclusion

Canadian Nuclear Laboratories are constantly exploring ways to push the boundaries of different products and materials. To aid this exploration, they need to understand the extent to which various erosion causes erode a given material. The device that we design will produce replicable scientific data on a given erosion parameter in a short time. This device must be safe and versatile.

6. References

- [1] M. G. Gee and I. M. Hutchings, General Approach and Procedures for Erosive Wear Testing, <https://eprintspublications.npl.co.uk/2544/1/mgpg56.pdf> (accessed Jan. 28, 2024).