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GNG 1103F Deliverable 2

Deliverable B - Needs Identification & Problem Statement

Introduction

What the Client Has Said with Minimal Interpretation

- The length of the experiment must be able to demonstrate up to 2 years of erosion equivalence within 4 months.
- The real erosion test used various polymers as the fan which were damaged over 4 years.
- The erosion occurred after 2 years in the real experiment thus we need to replicate that within our time frame.
- Methods mentioned to accelerate erosion were the following: increase of rpm's of the blade, increase the diameter of blade/component, higher viscosity fluid or water in this case, operating pressures, density, additive of abrasives in the fluid.
- Things to keep in mind throughout the experiment are chemical compatibility, temp resistance, fatigue behavior, and erosion resistance.

Benchmarking

- Efficiency in accelerating the rate of erosion (efficiency and effectiveness)
- Safety standards (Industry standards)
- Cost-effectiveness
- User-friendliness
- Stability (as the system rotates and the speed changes the structure should be able to withstand the conditions.)
- Standard testing for erosion protocols (that it meets and exceeds the industrial standards)
- Reproducibility of the results (consistency included)
    - When comparing to the pre-established benchmarks for reliability within the field of erosion testing
    - Uniform flow (Achieving a uniform flow of the fluid around the sample material to reproduce flow conditions accurately.)
- https://www.cnl.ca/facilities/high-pressure-water-test-loop-facilities/
    - (Similar to the current project, a water erosion system used to test nuclear components by CNL)
- https://www.sciencedirect.com/science/article/pii/S0734743X09000517#:~:text=In%20the%20wet%20steam%20stage%20of%20a%20steam%20turbine%2C%20the,the%20mechanical%20reliability%20of%20turbine
    - (study of water drop erosion on steam wind turbines,study explains how water droplets come in contact at high speeds with turbine blades leads to erosion with time)
- https://www.sciencedirect.com/science/article/pii/S0043164809002075?via%3d Ihub
    - (erosion resistance on engineering materials in various test conditions)

Central message

Needs Identification (Organized Numerically)

1. Safety

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   a. In the case of testing for hazardous materials, chemical exposure, high temperatures, high pressure, and high speed rotating components. We must ensure that our prototype complies with safety regulations.
2. Repeatable results within the system
   a. Ensuring that the data is accurate, there is some kind of validity to the data extracted from the prototype, following the industry practices and/or compliances while being innovative.
3. Carefully controlled parameters (involving precision and accuracy within the setup)
   a. Ensuring there is a feature of control within the acceleration of the erosion.
4. Flexibility of the erosion test setup
   a. Having the ability to test the erosion resistance of a wide range of materials.
   b. Having the ability to operate at standard atmospheric system pressure and temperature under 40 degrees.
   c. Having control over the rotation speed for various testing conditions.
   d. Avoid using materials prone to corrosion in the setup.
5. Various operating conditions for testing
   a. Capability to operate at different rotation speeds (e.g. 10rpm).
   b. Versatility in testing erosion resistance on different components and parts.
   c. Ability to expose materials to harsher conditions to reproduce long-term effects.
6. The versatility of testing erosion resistance
   a. On different components and parts.
   b. Expose to harsher conditions (reproduce long-term effects).

Goals

- To create a prototype design for accelerated erosion to test the resistance of various materials.
- Conduct at least one comprehensive erosion resistance test under controlled conditions.
- Provide data with before/after of the blade's weight to compare the erosion throughout time.
- Operate within the budget given.
- Emphasize the use of a safe and non-corrosive liquid within operational limits.

Conclusion

With the given raw information and our interpretations of the client's needs, we can use the client's suggestions and online benchmarks as a reference to produce our prototype. Given that we are limited with budget, safety standards, and time limit, we have come to the following problem statement.

Problem Statement

The client needs a prototype that operates within safety standards and produces the equivalent of 1-2 years of erosion to study the various reasons why erosion occurs. The challenge is to design an accelerated erosion test system that meets safety regulations, provides repeatable and controlled results, accommodates a variety of materials and operating conditions, and adheres to industry standards. Additionally, the system must address missing details such as temperature limits, safety certifications, and data analysis methods to ensure the overall success of the erosion testing prototype.