Leading edge erosion simulation

A simple decision tool for anyone and any turbine

Challenge:

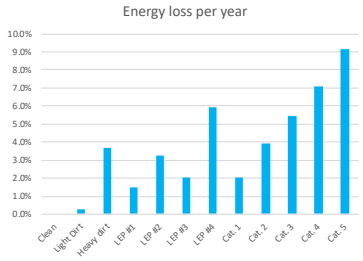
- When should the leading edge be repaired?
- What is the impact of leading-edge protection on energy production?
- Getting accurate numbers to compare sites and solutions

Solution:

- Spreadsheet-based simulation tool
- No aerodynamic training needed
- Requires no proprietary information from turbine OEM or other vendors

Leading edge erosion

Energy loss from leading edge erosion (LEE) has become increasingly important as wind turbines operate at higher and higher tip speeds. Initial damage can initiate within a few years and grow as fast as one damage category per year and cost tens of thousands of dollars in lost production per year.



New and improved leading edge protection (LEP) products are on the market, but it is difficult to understand and evaluate these without being at the mercy of OEMs and vendors because the data needed for the evaluation is often proprietary. Also, evaluations are not tailored to a specific turbine, and the specifics of the damage. Generic vendor information tends to exaggerate the value, because changes over time are not taken into consideration.

Evaluating field tests and SCADA data are tedious, time consuming and often ambiguous because finding a few percent change over several years is close to impossible.

A new model-based approach

While it is easy to see severe cases of degradation in power curves, it is difficult to evaluate smaller losses and gains. To address this, we have developed a method to compute the capacity factor of any given wind turbine based on only a few key non-proprietary inputs and a simple method to access the conditions of the leading edge based on standard industry damage categorization, which can be obtained from visual inspections or from estimating the rain intensity on the specific site.

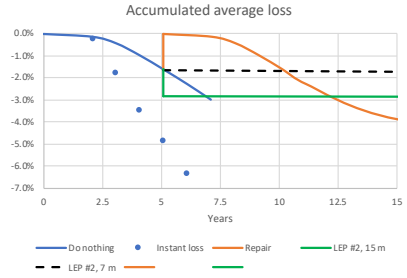
The physics-based method is built in an Excel sheet, allowing a timeline of events to be established and compute the accumulated effects of degradation and planned repairs.

The model includes a simple approach to estimate site and turbine specific incubation time for the initial erosion to begin based on vendor rain erosion test (ASTM G73-10).

Example:

LEE has progressed to a category 3 damage on the outer 15 meters of a 77-meter rotor in 5 years. Shown in the graph below, the snapshot loss value is 4.9% represented by the dots. However, the accumulate average loss over the first 5 years is “only” 2% because of the erosion incubation time and growth rates (solid blue line).

Comparing a LE repair (orange) to a LEP system on the entire 15 meters of damage (green), the accumulated effect of the repair is actually better for the next 7 years. A better repair strategy would have been to restore the inner part, and only protect the outer 7 meters of the blade (black dash line).



Specifications LEE simulator

- Microsoft Excel sheet, and does not contain macros

- Input:
  - Rotor diameter, rating, RPM
  - Average wind speed (Rayleigh distribution), air density, rain rate
  - Dates of repair and other actions
  - Leading edge condition by category and effective length:
    - Clean, light, med dirt & heavy dirt
    - Damage Category 1 to 5
    - LEP, four different (generic) types
- Output:
  - Instant energy loss as function of time and leading-edge condition
  - Accumulated energy loss as function of time and leading-edge condition
  - Initial damage incubation time and damage rate estimates
  - Compare turbines, sites, conditions and technologies
  - Your own graphs, custom data, financials etc.

Other products and services

- Excel based power curve simulator: Simulate any turbine, requires no information from turbine OEM
- Training on rotor performance, rotor design and maintenance for owner & operators and service providers
- Consulting aerodynamics and wind load
- Test and experimentation
- General consulting and inspections

Stop guessing, compute the impact

Contact us For a free trial

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