SMART MONITORING OF MAIN BEARINGS

APPLICATION PAPER

EMPOWERING YOUR 4.0 STRATEGY WITH SIMPLE AND SMART SOLUTIONS

Executive Summary

The application paper shows a solution allowing existing WTs to be retrofitted easily and cost effectively. Our non-invasive sensors provide high quality raw data after only 30 minutes of installation. The overall system is self-sufficient and does not need to interface with the turbine controls. Due to our unique sensor fusion solutions, it is possible to significantly enhance the value of each measurement by combining different sources, ensuring the highest quality of information.
Our Smart Main Bearing Monitoring can detect the onsets of defects early on and our continuous monitoring will warn about changes and trends in the data to enable true predictive maintenance.

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Introduction

Shrinking PPA, climate change and missing wind spots are increasing the pressure on the wind production efficiency. Therefore, wind turbines shall be operated always longer.

Critical components such as the main bearings and the tower structure shall be be properly monitored in order to avoid unplanned damages.

Solution

With the wireless system LYRA, developed by GradeSens, clockworkX and GradeSens can offer cost effective monitoring solutions. Not just lowering sensor cost, but also installation effort (typically made in 30 to 60min) and infrastructure cost, this system makes it possible to monitor far more systems than the current industry standard.

System Features

LYRASens - autonomous sensor providing high resolution, raw acceleration signals of up to three axes, as well as temperature data.

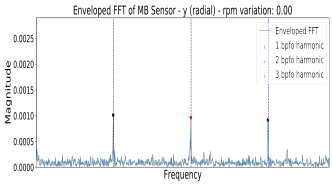
LYRAGate - gateway used to configure all LYRA devices, to trigger the acquisitions and to collect data. One of the key elements of the technology is the multi-sensors raw synchronized data acquisition below 0.1ms.

Measurement Set-Up

Our Smart Main Bearing Monitoring is based on frequency analyses of acceleration data coming from two sensors installed on the static seat of the main bearing (MB). A third sensor is placed on the rotating seat of the bearing and lets us derive the rotor speed of the turbine, which is crucial for a precise interpretation of the results. A fourth sensor placed near the top of the nacelle provides measurements such as the tower side-side and for-aft motion. We use these sensors to "clean" the vibration data from the MB sensors and isolate the parts of the signal relevant to fault detection, increasing precision and signal-to-noise ratio.

Results

At constant rotor speed, the FFT of the envelope signal shows very sharp and distinct peaks. The Ball Pass Frequencies over the Inner (BPFI) as well as the Outer race of the bearing (BPFO), as well as the Ball Spin and Fundamental Train Frequencies (BSF & FTF) can be readily calculated with the bearing dimensions and the rotor speed. The plot below illustrates how clearly the peaks in our example can be attributed to the BPFO.



Signal Evolution

To determine the criticality of the detected issues, the BPFO amplitudes need to be monitored over time. The plot below shows the amplitudes of the first harmonic over four month. The amplitude grows with increasing rotor speed but remains stable along the time axis. We can observe changing amplitudes around rated speed, as rotor speed does not correlate with wind speed and loading from rated speed onwards.