Grease Sampling and Analysis for Wind Turbine Bearing Applications

Grease analysis is a reliable, cost-effective way to determine the health of any grease-lubricated equipment. For wind turbines, grease analysis can be particularly effective in preventing costly failures of multiple different components within a wind turbine, with the most commonly sampled being the main shaft bearing, generator bearing, blade bearing, and pitch bearing, among others.

Image 1. Image shows samples being taken from a wind turbine

In this case study, grease samples were collected from wind turbines across multiple different wind farms. To ensure that a representative sample was obtained, grease sampling was performed per ASTM D7718 and analyzed per ASTM D7918. The grease screening test slate, which includes ferrous wear analysis via FerroQ, grease optical transmission via the Grease Thief Colorimeter, and FTIR analysis identifies outlier samples for further analysis at the laboratory. Data from these three tests gives insight into the wear rate, and any contamination of in-service greases. Action levels are determined by trending the results from an asset over time or comparing similar assets in a fleet.

Screening Tests

Ferrous content screening is a non-destructive test that can be performed while the grease is still in the sampling device. Grease differs from oil samples in that it accumulates wear until purged with new grease. Fig. 1 shows 15% of blade bearing samples were flagged as unsatisfactory for high ferrous wear and are candidates for further laboratory testing.

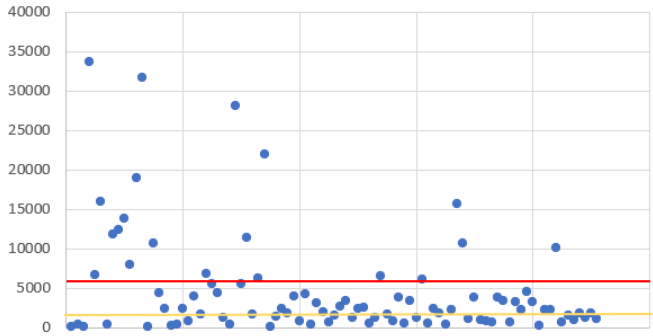

Figure 1. Plot of ferrous content values from blade bearing samples, results are in ppm Fe.

Optical transmission is a second quick and easy screening test that is performed on the in-service grease. Fig. 2 shows most of the blade bearing samples are acceptable; less than 2% of samples were flagged. As grease ages, accumulates wear or becomes contaminated the color changes creating a larger ΔE value compared to the referenced baseline. The screening analysis flagged just under 2% of samples from the tested bearings indicating that few of the in-service greases sampled could have oxidized or have picked up contamination.

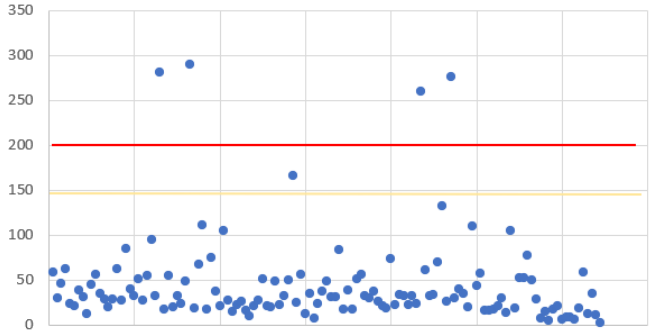

Figure 2. Plot of colorimetry values for a collection of blade bearing samples, results are given in differential spectrum sum (ΔE).

Lastly, FTIR was performed on the in-service greases, and the spectra were compared to the reference baseline to complete the screening testing. The FTIR confirmation can identify samples that have deviated from the expected response and can confirm contamination in a sample. The closer to 1.0 the less has changed compared to the referenced baseline. Fig. 3 shows recent samples

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from blade bearings with most FTIR confirmations being acceptable. About 5% of the samples were flagged as possible mixed greases, highly oxidized, or heavily contaminated grease.

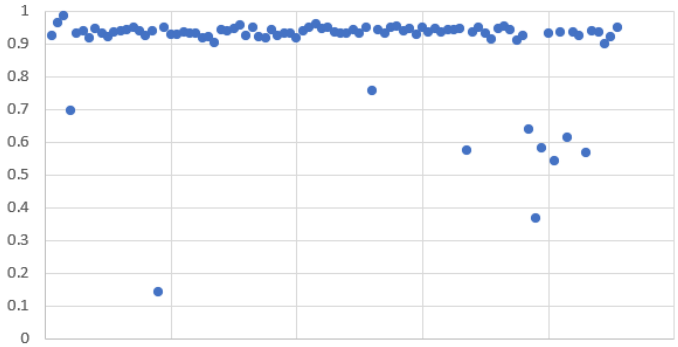

Figure 3. Graph of the FTIR comparisons of a collection of blade bearing samples to their baseline.

Further Testing

In-service greases that have high ferrous wear identified via FerroQ can be candidates for further analysis in the laboratory to understand the wear present better. One valuable advanced test for wind turbine grease is analytical ferrography, which involves looking at wear particles under magnification to determine a root cause for the wear. Determining the root cause or type of wear can help to determine which wind turbines may need maintenance or an adjustment to the lubrication frequency.

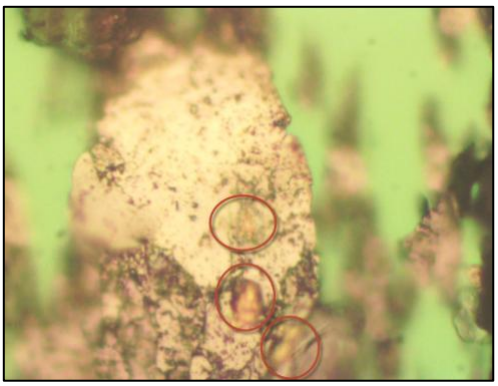

Image 1: A 500x magnification image of a laminar wear particle ~50 microns in size. There are also copper alloy particles embedded on it (circled).

Within the ferrography image, there is evidence of rolling element fatigue which formed the large, flat laminar wear particle. There are also copper wear particles in the image, meaning that a copper component was wearing. With knowledge of the internal components of the wind turbine and their respective metallurgy, it was determined that the copper particles most likely came from cage wear.

Samples flagged for Optical Transmission and FTIR can indicate greases that have accumulated wear, aged, or are contaminated. This can be further analyzed as well to understand the origin of the contamination, or the severity of oxidation. Understanding this can help to adjust regreasing intervals to the optimal level for each wind turbine based on its unique case versus a traditional time-based interval.

In-service grease analysis gives a cheap, easy, and effective way to monitor the health of wind turbines, extend asset life, and prevent costly repairs. Grease screening analysis can test all of the locations on a wind turbine quickly and inexpensively. Periodic scheduled sampling can help to understand how the components are aging over time and develop maintenance best practices. Screening analysis also leads to identification of potential problems, and further lab analysis can be performed on these identified outlier samples in order to recognize and correct issues before they lead to failure, helping to prevent costly maintenance repairs and maximizing availability and production.

Challenges:

- Remote site or location – screening can be done on-site with field testing instruments leased by MRG Laboratories.
- Getting a representable in-service grease sample – ASTM D7718 compliant Grease Thief sampling tools can be purchased. Customized tools can be fabricated for custom sampling challenges.
- Data Management – MRG Laboratories provides data evaluation and management via the web-based **NAVIGATOR** data cloud dashboard with the **machine learning** enabled **Clever AI**

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