Brüel & Kjær Vibro

Analyzing Generator Bearings Fault Development Rates Based on Statistics

Kun Marhadi[1], Nikolaos Nezeritis[2], and Alexandros Skrimpas[3]

[1,3]*Brüel & Kjær Vibro, 2850 Nærum, Denmark*
[2]*Technical University of Denmark, 2800 Kgs. Lyngby, Denmark*
[1]*Kun.marhadi@bkvibro.com*
[2]*S152297@student.dtu.dk*
[3]*Alexandros.skrimpas@bkvibro.com*

1. Introduction

Condition monitoring system (CMS) has become an important part of wind turbines operation and maintenance. It helps detect incipient faults early so that maintenance can be well planned in order to minimize downtime. Faults in wind turbine generator bearing are usually well defined, and their detection using CMS is well established. Currently Brüel & Kjær Vibro is monitoring around 8000 turbines all over the world from different wind turbine manufacturers. The data collected in regards to the development or progressions of faults in generator bearings are numerous. Based on these data, the rates or how fast a fault progresses into a danger level, where it may cause secondary damages can be analyzed. The analysis results can then be used to create fault progression models based on statistics for better prognosis of generator bearing faults. The information is also helpful for uncertainty quantification of the prognosis models.

2. Approach

Accelerometers are normally installed at generator bearings (both Drive End and Non Drive End) of wind turbines to monitor their vibrations. Various vibration measurements, such as high frequency band pass harmonics/orders of the running speed of the generator (e.g. 1X, 2X, 3X), and the vibration RMS level (ISO RMS) are trended over time. ISO RMS level is generally used as an indicator of the overall health of a generator bearing. As it increases, the bearing condition normally deteriorates, and it can be used as the basis for doing prognosis. In this work, the increasing rates of ISO RMS are calculated from a number of turbines. The turbines are of the same type, and both ISO RMS data from Generator Drive End and Non Drive End bearings are collected. The data are normally collected over short interval periods (e.g. minutes). In this work the data are averaged over a period of one day and one week. Thus the rates indicate how much ISO RMS increases every day and every week. Figure 1 shows an example how generator bearing ISO RMS increases as the bearing condition deteriorates.

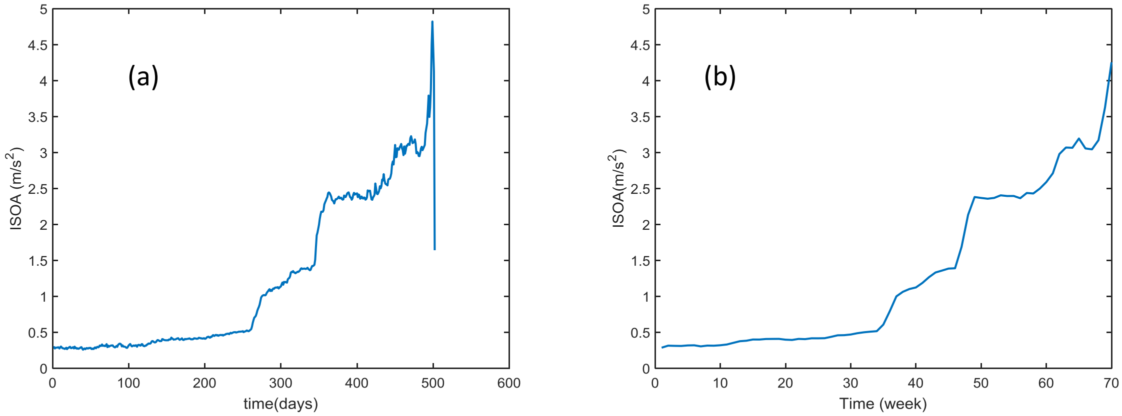

Figure 1. Increasing generator bearing ISO RMS from a turbine averaged: (a) daily and (b) weekly.

3. Main body of abstract

Information regarding how fast ISO RMS increases every day and every week are plotted as statistical distributions. For comparison, data from one turbine and from several turbines are plotted. The results in Figures 2 and 3 show that depending on the number of data available, the resulting distribution could be different. Here exponential distribution is fitted to the data, shown in red. This signifies the importance of having enough data to obtain accurate representation of the distribution. The results also show that the rates are not constant, and they can vary from one turbine to another even though they are of the same type. Other factors can contribute to this variation such as bearing types, stochastic condition of the wind turbine location, etc. Once an accurate representation of the statistical distribution is obtained, it can be used in data-driven prognosis modelling, where the uncertainty can be quantified more accurately.

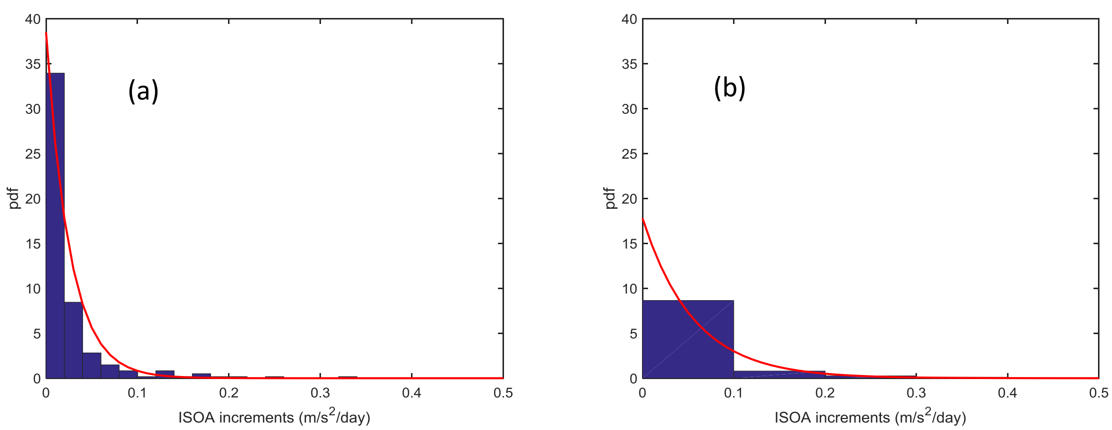

Figure 2. Distribution of generator bearing ISO RMS increasing rates based on daily averages: (a) from one turbine and (b) from multiple turbines.

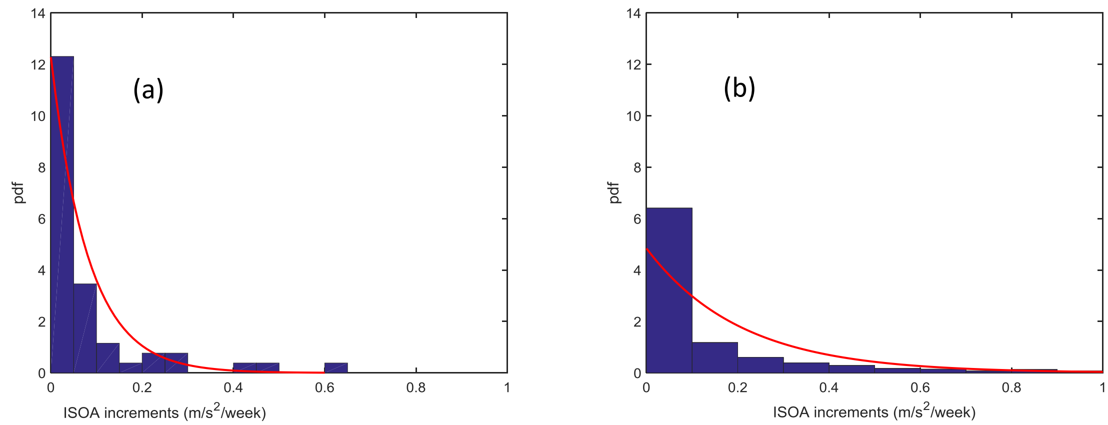

Figure 3. Distribution of generator bearing ISO RMS increasing rates based on weekly averages: (a) from one turbine and (b) from multiple turbines.

4. Conclusion

Every turbine, depending on its components configuration, can have its own fault development rate that can also vary day by day or week by week. In order to have a general model that can predict the fault progression of a turbine, a statistical distribution that can represent variation in fault progression rates is needed. Furthermore, in order to obtain accurate representation of the distribution, large data are normally needed.

5. Learning objectives

This work highlights the fact that fault progression of every turbine is not the same, and it can change from time to time. However, the variation can be captured in statistical distributions, where it can be further used for data-driven modeling and prognosis. In order to achieve that, large amount of data may be needed.