Continuous condition monitoring: A way robustly predicting catastrophic failures of your machine

The POM project (Prognostics for Optimal Maintenance, www.pom-sbo.org), aims to define an integrated methodology for implementing predictive maintenance (PdM) on industrial machines. In this project the focus is on the continuous monitoring of the machines conditions. This continuous monitoring has several crucial advantages with respect to periodic condition monitoring since it can detect faults that would otherwise be missed.

With the continuous decline of sensors prices, thanks mainly to the automotive industry, online Condition Monitoring (CM) programs are becoming possible in machine manufacturing industry. These programs consist on monitoring the condition of machines in order to assess their performance and take necessary actions when needed. As a consequence, the way companies manage maintenance has drastically changed thanks to such programs.

Therefore, Condition Based Maintenance (CBM) and Predictive Maintenance (PdM) policies became practically possible once a Condition Monitoring program is adopted.

A typical use case to show these advantages is a catastrophic failure of a steel wire production machine due to bearings failures. The most common bearing rating factors are speed and load. Of the two, load has by far the greater effect on bearing life. For example, speed and life are inversely proportional. Doubling the speed of a ball bearing halves its life, while, reducing speed by one-half doubles its life. However, doubling the load on a ball bearing reduces its life by a factor of 8 to 10. The detrimental effects of load on life are even more dramatic with roller bearings [1].

One of the consequences of excessive speed is broken cages and retainers. High speeds increase inertial forces within the bearing. These forces, combined with inadequate lubrication and sudden stopping or starting, can produce high forces between rolling elements and the retainer. Repeated forces skew and eventually crack the cage or retainer.

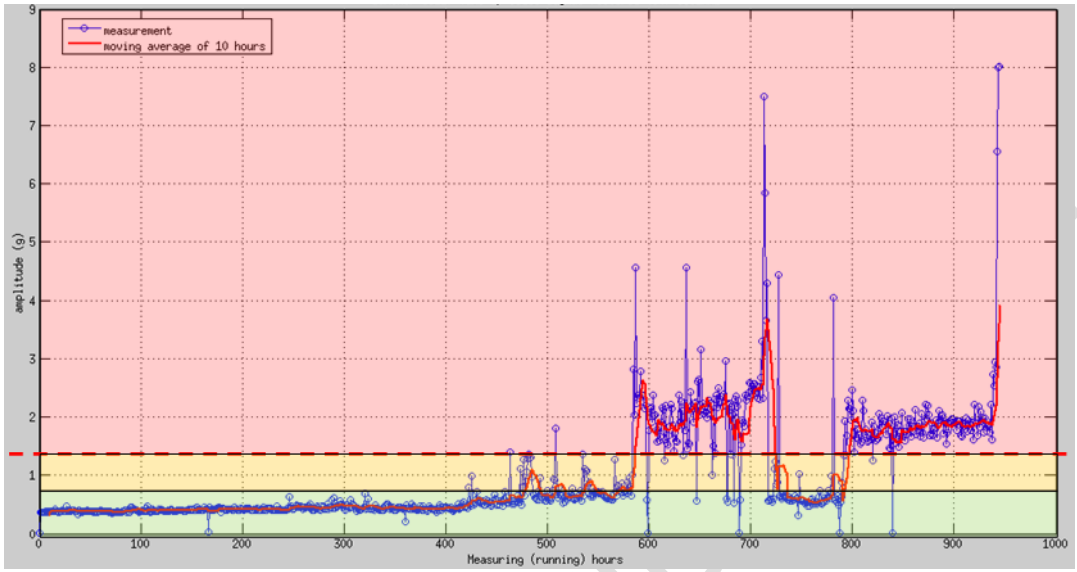
The catastrophic failure can be very sudden and impossible to prediction using an intermittent condition monitoring system. Another problem hampering such a prediction could be due to the stochastic nature of vibration signals in production process, due to other vibration sources, and which make the optimal choice of the time to measure with an intermittent CM system very crucial.

A continuous monitoring system, however, allows a continuous tracking of bearings conditions and is able, with the right features in place, to anticipate such failures in advance allowing thus the service people to take actions in the right time and optimize availability of the machines.

The feature monitoring the condition of the bearing is shown in the graph below using raw data (green line) and smoothed data using a moving average of 10 hours. Initially the vibration level was quite low and considered as a good state of the bearing. Incipient degradation start evolving slowly afterwards till around 600 hours after measurement start, where an abrupt change was recorded. Recording this change with an intermittent CM system would depend on the time you choose for measuring. If unluckily this measurement took place when the raw data amplitude (blue line) is low, this abrupt change will not be recorded.

The continuous monitoring system helps also to observe the behaviour of the machine, allowing thus some insight to understand it. For instance, after this abrupt increase in

vibration, a decrease of amplitude was also recorded right after 700 hours followed by a second increase around 800 hours and then a catastrophic failure around 950 hours. These sequences records are certainly good inputs for machine builders to better understand the behaviour of their machines and use this information to discuss improvement with their suppliers.



[1] Bearing failure analysis, www.applied.com

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