Condition monitoring- are we aware of the capabilities and limitations of the methods we use?

Unexpected failures cause unwanted interruptions in the production process and unnecessary costs. The task of CM is to detect an upcoming failure in time and thus prevent unwanted consequences. How successful we will be in using a particular diagnostic method depends on the suitability of the method used and the qualifications of the diagnostician. The selected method must be able to detect an impending failure in a timely and reliable manner. For the selected diagnostic method, its technical feasibility must be verified in the specific operating conditions of the observed machine. It is necessary to take into account the expected amplitudes of the measured quantity, the rate of change of values, the effects of the work process on the change of these values, accessibility, measurement conditions, measurement complexity, safety aspects, costs of measurement equipment, etc. Once the method is selected, it is necessary to define the operating conditions at the time of measurement and select the measurement interval. Recommendations for the implementation process of various technical diagnostic methods are proposed by the ISO 17359 standard.

If the wrong method is used to monitor the condition or the diagnostician is not properly trained, the consequences can be serious. An overlooked damage to a machine part will lead to an unexpected failure, resulting in production downtime and associated costs. Such events can also result in a loss of confidence in diagnostics. That is why it is very important to use the right methods, performed by trained diagnosticians!

The purpose of this paper is to use a few practical examples to point out common mistakes when using various CM methods.

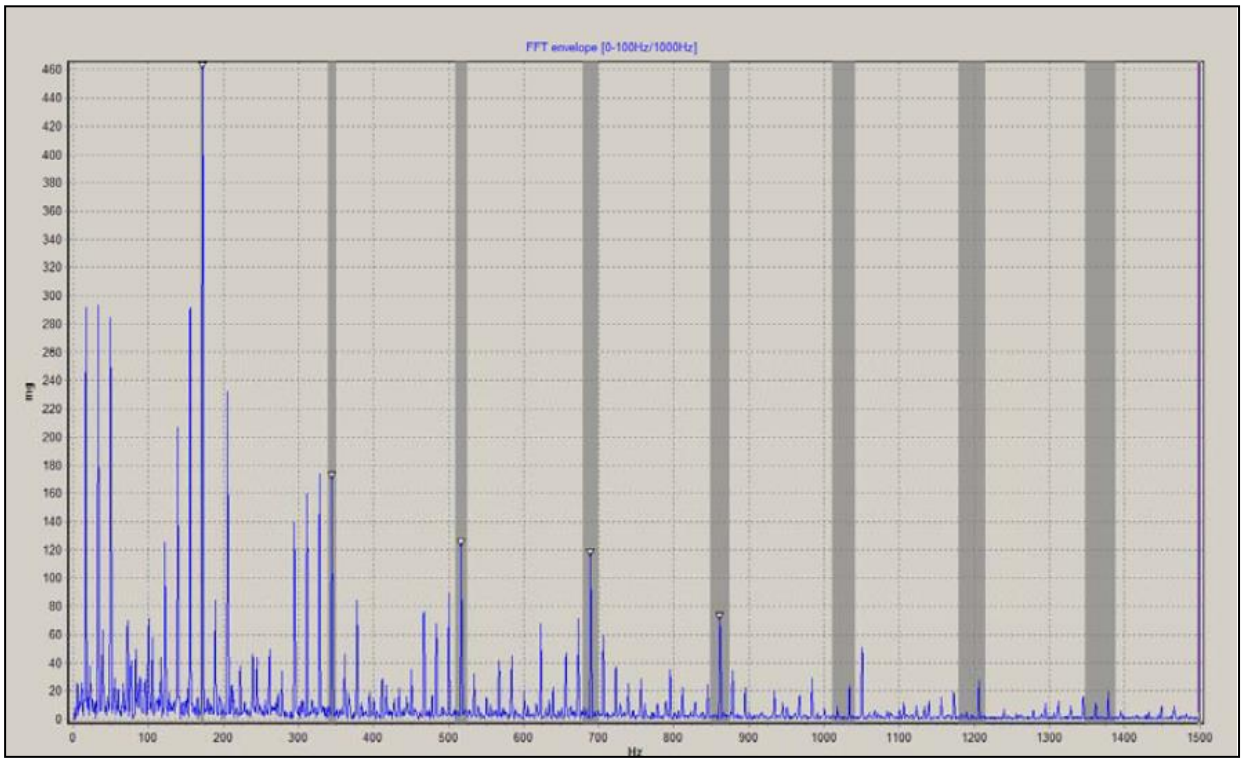
Is temperature measurement an effective method for monitoring the condition of rolling bearings?

Temperature sensors are cheap and easy to use. That is why we often see them installed on bearing housings of various machines. But what can a change in temperature tell us about the actual condition of the observed bearing?

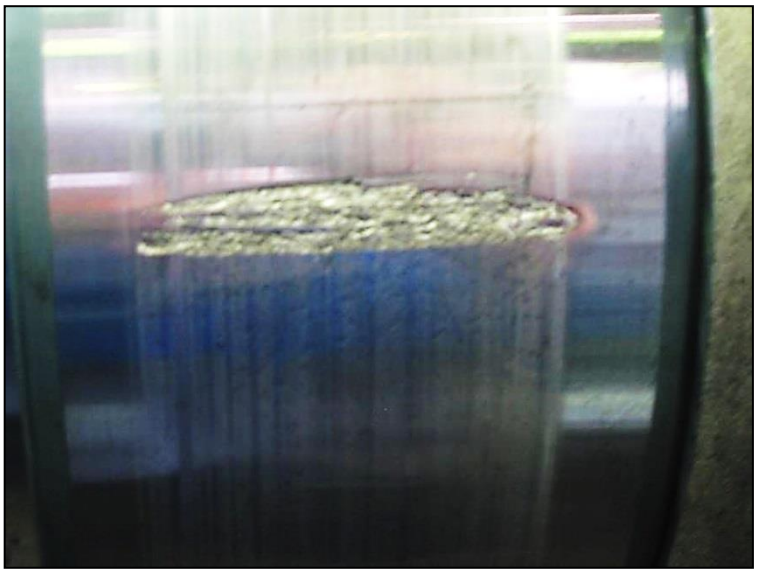
A change in the temperature of a rolling bearing can occur due to a change in the ambient temperature, too much grease in the bearings... In the event of bearing damage, the elements will rub and the resulting temperature rise will only occur at a very late stage, just before the complete failure of the bearing. At that time, it is usually too late and the consequences of the damage are already severe.

Let's show you two practical examples. The first is a mixer drive reducer in the rubber industry. It is a large machine of the 1MW range.

A temperature of 54 °C was measured on the bearing housing, and vibration measurements detected damage to the inner ring of the bearing.



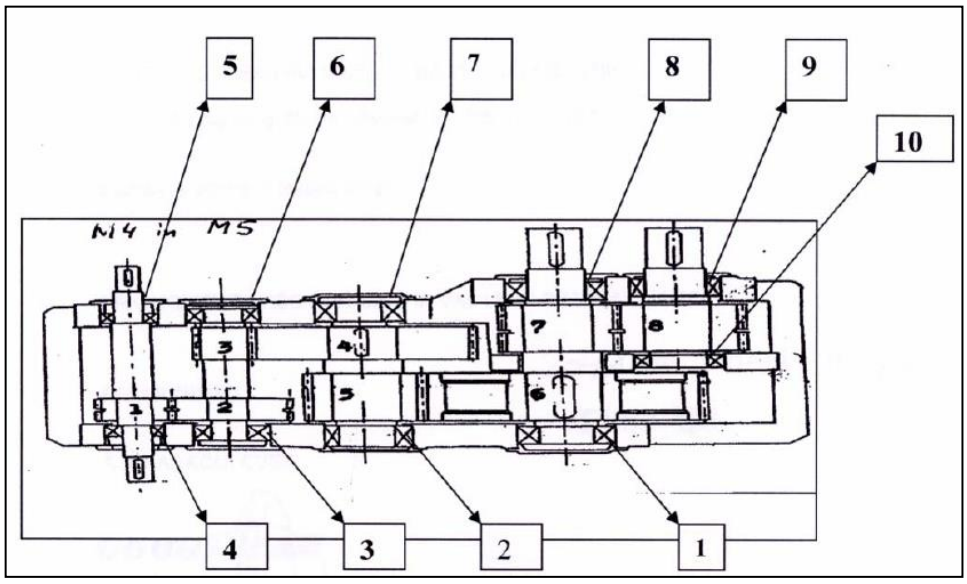
When the measurements were repeated after 1 week, the measured temperature was even 2 degrees lower, and the condition of the bearing is shown in the photo below.



In the second case, we consider a conventional industrial fan. The customer called us because they thought the rotor would need balancing. Accurate vibration measurements showed that there was extensive bearing damage, while the housing temperature was only 36 °C!

What does vibration velocity RMS tell us about the condition of the machine?

Sensors that measure the average vibration velocity (typically 10Hz - 1kHz) are often used as a means of monitoring the general vibration condition of a machine. They are very effective in detecting imbalance of rotating parts (due to wear, damage...), but they tell us little about the condition of the bearings being monitored. A bearing failure will only be detected when the condition is so bad that there is a greatly increased looseness in the bearing, which is usually just before complete failure. As an example, let's use the damaged bearing of the gearbox above.

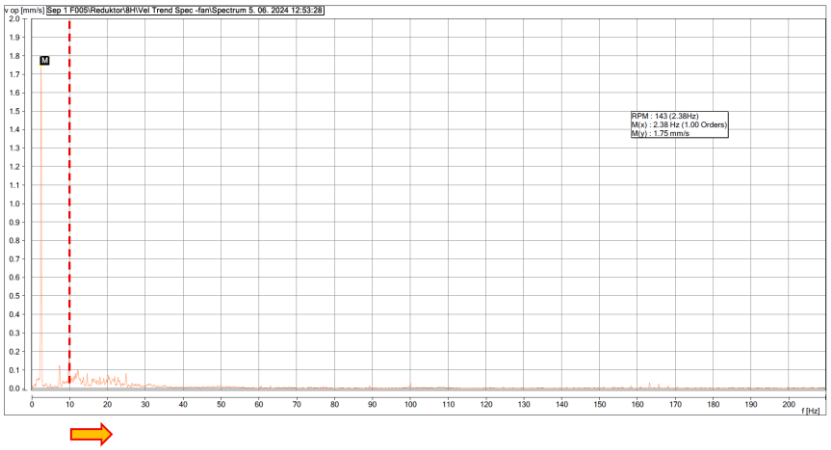


Despite extensive damage to the bearing on the input shaft (1000 RPM), the measured values were below 1mm/s.

The importance of proper sensor selection and measurement setup

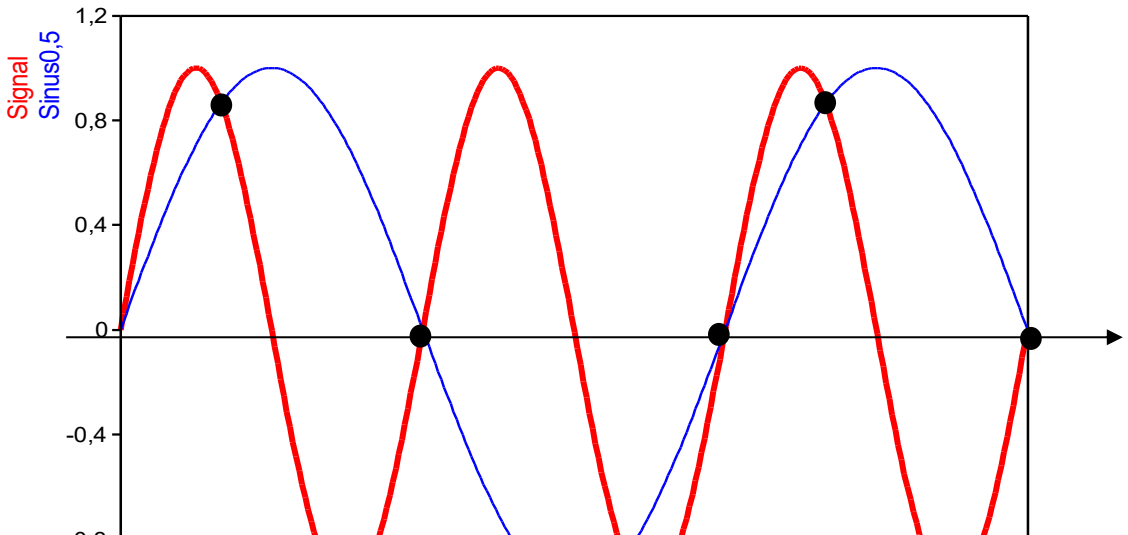
It is not enough to simply decide to measure the appropriate physical quantity (velocity, acceleration, temperature, pressure, etc.). It is equally important to consider the dynamics of the phenomenon and set up the measurement system accordingly!

Let's illustrate with two simple examples. Let's say we plan to use an RMS sensor, which has a measuring range of 10Hz - 1kHz, to monitor a separator in a cement plant. The rotor rotates at approximately 150 RPM (2.5 Hz). The aforementioned sensor would "overlook" the rotor imbalance.



Frequency range

Modern measuring equipment converts analog signals into digital data. This simply means that the continuous change in the measured quantity is recorded in the form of individual values, which are captured at regular time intervals. How often this happens is very important, as the quality and size of the measurement record depend on it! If the acquisition frequency is too low, this leads to signal distortion and significant information loss!



The image above shows two different sine signals that could have the same digital representation (due to the low sampling frequency). A general recommendation is that the acquisition frequency should be at least 2.56 times higher than the highest expected frequency of the observed phenomenon.

We have briefly tried to show with a few examples how important it is to know how various machine part failures manifest themselves and to understand which CM methods can be used to detect them in a timely and accurate manner.