Predictive Maintenance
Superior Sensor Technology as the Basis for Success

The market offers a wide range of promising solutions for predictive maintenance. In all systems, machine data are collected and analyzed, and their evaluation serves as the basis for decisions on target-oriented maintenance.
The quality of the measured values depends to a large extent on the measurement technology used for the sensor system. Detecting the change at the time of occurrence, long before an effect will occur, can be considered a superior approach. How this can be implemented for tribologically affected machine components is explained by using the example of rolling bearings and mechanical seals in pumps.

Tribological processes in machines take place in components that perform a movement relative to each other. A lubricant present in the contact area influences the tribological process between the components to a great extent and thus reduces friction and wear. Changes in the lubricant film have an immediate effect on the quality of the lubrication, and under unfavorable conditions there is increased solid friction and consequent wear. This process can occur in any constellation during the operating period. Damage that has occurred cannot be seen without opening the machine. It will remain and extend until failure of the machine component occurs.

Rolling bearings generally operate well on starting conditions. Oils or greases provide sufficient lubrication, and appropriate seals protect the bearing from environmental influences. Under unfavorable conditions, lubrication deteriorates over time, which usually happens unnoticed.

In comparison, a mechanical seal must seal the medium that is in the machine room and minimize leakage to the atmosphere. Unfortunately, many media are not well suitable as lubricants and thus lead to unfavorable lubrication conditions between sliding surfaces of the mechanical seal. Due to the operating principle, good lubrication conditions develop only at a certain pressure of the medium and with a sufficient sliding speed caused by the rotary motion of the shaft. For example, every starting or stopping process leads to insufficient lubrication between the sliding surfaces. Table 1 shows the effect clearly. Particular attention

Why do operating conditions of rolling bearings deteriorate?

- The quality of the lubricant changes over time (substances evaporate, mixed components change their structure due to the application)
- Foreign substances mix with the lubricant (environmental influences, leakage from adjacent seals)
- The lubricant is not optimally designed for the application (unclear requirement, use of standard grades, wrong lubricant)

should be paid to the cumulative time of dry running shown on the right, where the large differences in the application can be seen clearly.

Operating mode	Operating times for one cycle		Number of starts/stops	Time built up lubricating film	Cumulated time critical lubrication
	Rotation	Standstill	per year		
Year-round operation	8.760 h	0 h	1	5 sec	10 sec
One week on – on week off	168 h	168 h	26	5 sec	4,3 min
Interrupted on the weekend	120 h	48 h	52	5 sec	8,7 min
Interrupted daily	23 h	1 h	365	5 sec	1 h
Interrupted every 2h	2 h	0 h	4.380	5 sec	12,2 h
Frequent interrupted	4 min	4 min	131.400	5 sec	365 h
Very frequent interrupted	15 sec	30 sec	700.800	5 sec	1947 h

Table 1- Cumulated time of critical lubrication depending on mode of operation

In real applications, the complexity of the influencing factors becomes apparent (see box below). There are mathematical approaches for calculating the service life of a mechanical seal in the application, but only a rough estimation is possible here. A correct assessment is therefore only possible if the influence on the lubrication quality is differentiated and continuously recorded and documented.

Which technology is suitable for continuous lubricant film monitoring?

This question has led to a development with an outstanding result:
Now we have a clear image of the processes in the lubrication gap.

The targeted generation of high frequency ultrasonic pulses in the range of micro-seconds, independent of machine influences, which move on the surface of bodies and are detected again by a receiver at a short distance, capture any change in the lubrication gap. Individual disturbances caused by abrasion particles, damage to the surface and, as the most important point, the quality of the lubrication, which is indicated by more or less strong contact of the surfaces, are reliably detected by the signal processing and the observation of the signal change. This technology provides the data needed for continuous monitoring of these critical machine components.

Once the data is available, mathematical algorithms can be used to process the measured values and make them available to the monitoring system. Many years of development supported by extensive laboratory and field tests provide the basis for the successful implementation of the

What influences the lubrication conditions at a mechanical seal?

- Lubrication properties of the medium to be sealed (viscosity, temperature, chemical composition, boiling point)
- Operating conditions (pressure of the medium, speed of the shaft, number of starts/stops, influences by the machine (e.g. vibrations), measures for cooling)
- Design parameters (materials of the sliding surface pairing, spring preload, width of the sealing surface, heat transfer)

evaluation technology. Combined with modern transmission and visualization technology, user requirements regarding data storage, availability and ease of operation can be easily met.

Predictive maintenance aims to maintaining machines and systems proactively as needed. Unplanned downtimes or quality losses in production are to be avoided and ultimately the aim is to enable production economically with low costs.

How can predictive maintenance be successfully implemented?

- Measurement of data with relevant significance
- Development of mathematical algorithms that derive a significant score from the data
- Use of statistical evaluations that provide reliable evaluation criteria with the comparison of empirical values

The technology presented here is only one of the building blocks for complex systems, which is supplemented by traditional sensor technology. However, it provides data of a quality that other measurement systems cannot deliver. The user will be enabled to make a more accurate assessment of the machine's condition and the influences due to specific process conditions. The term predictive maintenance often brings to the fore the notion of timely, rather than adaptive, action. Operators save costs if they can postpone regular maintenance to a later date. They can safeguard the extended maintenance intervals via the real measured values.

Which our technology the user can reach the next level of predictive maintenance and turn it into **Adaptive Predictive Maintenance**.

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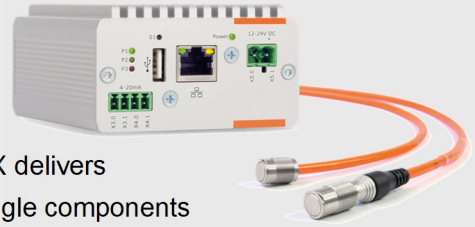
Harald Tobies
Head of product development

Controller and sensors



METAX delivers

- Single components
- Complete customized set-ups

The sensors will be integrated into the mechanical seal and can be connected easily with an electrical plug on the seal housing.

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