WEAR CHECK
Condition Monitoring Specialists

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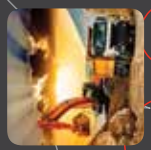
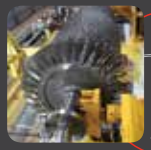





Condition Monitoring Specialists

NAVIGATING THE ONLINE VIBRATION ANALYSIS MINEFIELD

By WearCheck's Reliability Solutions division

INTRODUCTION

There is currently a notable spike in online installations in all industries, driven by Industry 4.0. This trend is also evident in the condition monitoring field. Installing online vibration transducers is a revolutionary step in the monitoring process but can be challenging without knowing what is available in the market and without a comprehensive understanding of the equipment capabilities and the relevant terminology. In this Technical Bulletin, we will guide you through the minefield of available technology, discussing the different measuring capacities, installation levels and how these can be aligned with your requirements.

Image courtesy of Wi-Care

Some of the benefits of online monitoring systems and remote sensors are that they ensure that machinery is monitored without interruption, human error is minimised and far less manpower is required to keep components in tip-top condition.

AN OVERVIEW OF ONLINE VIBRATION ANALYSIS

There are three different levels of online installations:

1. Overall vibration monitoring
2. Discrete frequency monitoring
3. Analytical monitoring

Combined with the three different levels of monitoring, there are also different installation types that one needs to consider:

1. Wireless
2. Wired
3. Less-wires

Each one of these types of installation can deliver various levels of monitoring.

Before making a choice, it is important to understand what you would like to achieve with the monitoring and what level of detail you would like to attain.

Overall vibration monitoring:

This type of monitoring only provides an overall vibration level spanning a certain range of frequencies. It will not be able to tell you what type of defect is causing the increase in vibration, and – depending on the frequencies that are generated by the machine – you may not even notice any change with this type of measurement. Technical specification is important in choosing this type of transducer and it needs to match the application and the main failure modes that you would like to detect.

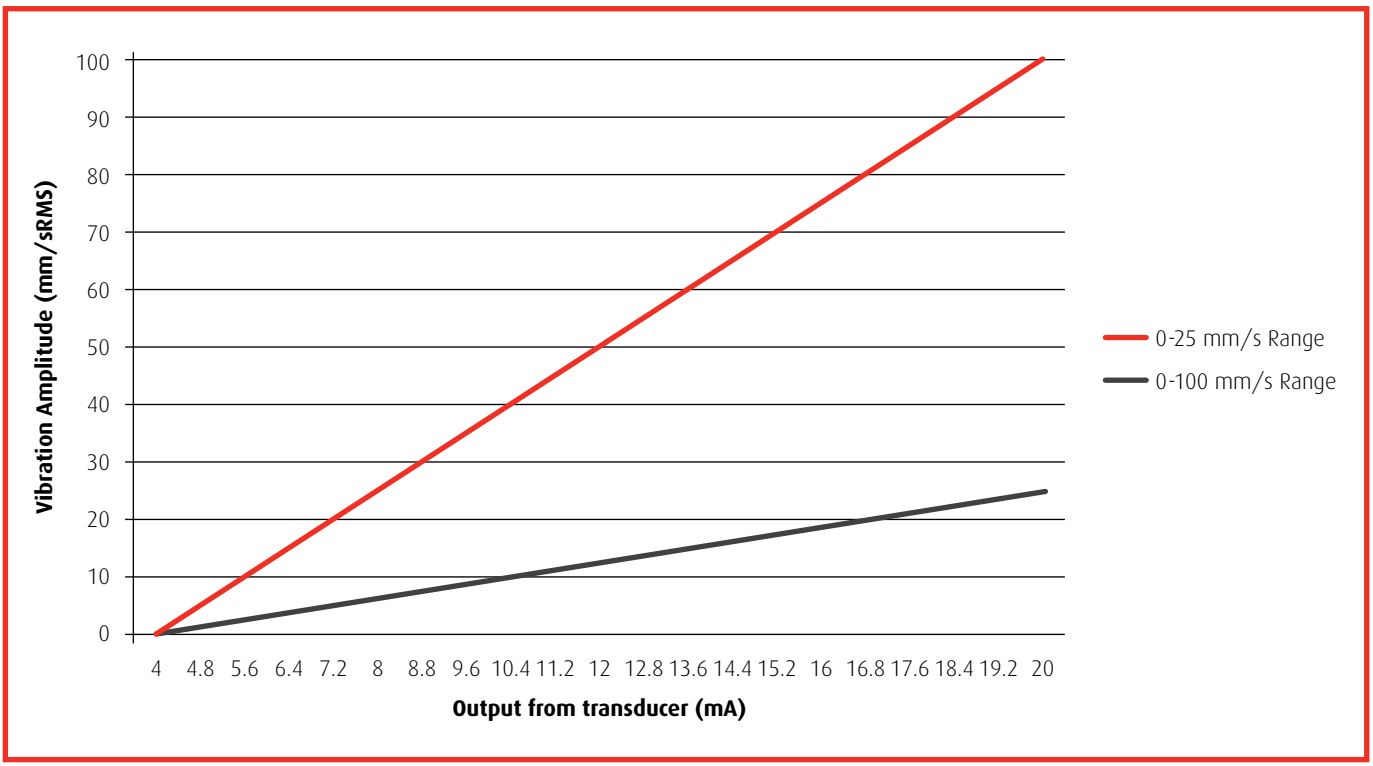
Example:

If you have a 4-20mA transducer mounted on the bearing of a fan, with the following technical specification from which to choose:

Transducer	Frequency Range	Measuring Range	Output signal
Type 1	10-1000Hz	0-25 mm/s RMS	4-20mA ±5%
Type 2	10-1000Hz	0-100 mm/s RMS	4-20mA ±5%

Which transducer would you select?

Considering the frequency range, both these transducers would satisfy the ISO10816 in respect of the frequency range that they cover. Depending



on the application, this frequency range would typically cover unbalance, looseness and possibly misalignment, but it would not be effective in detecting the early stages of bearing failure. Depending on the failure modes that you are interested in detecting, both these transducers could be ineffective.

On variable speed fans where the running speeds are able to decrease below the minimum frequency range – in this case 10Hz(600cpm) – then these transducers would not even be able to detect unbalance of such a fan at the lower speeds.

Considering the measuring range, more is not necessarily better. The amplitude range needs to be carefully selected to match the expected increase in vibration should a failure mode develop and push the ambient/normal vibration experienced on the machine higher.

In the example provided, one can see that if the vibration increases from 5mm/s to 10mm/s it will result in the following output changes for the two transducers:

Transducer	Measuring Range	Δ Output (Amp)	Δ Output %
Type 1	0-25 mm/s RMS	3.2mA	20%
Type 2	0-100 mm/s RMS	4-20mA ±5%	5%

The 5% increase seen in the Type 2 transducer could be seen as noise due to the accuracy of the output being ±5%, thus causing the severe increase in vibration to be totally disregarded.

Discrete frequency monitoring:

Not only does this type of monitoring provide one value for the vibration, but it also returns various vibration levels for discrete frequencies that can be associated with particular forcing frequencies expected in a specific machine.

Image courtesy of Wi-Care

Remote wireless monitoring of the vibration patterns of rotating machinery has revolutionised condition monitoring. The remote sensors (pictured) are 'on duty' 24 hours a day, keeping the machine under constant surveillance while transmitting the data wirelessly, thus reducing the risk of failure.

These values allow certain alarms to be set and subsequently help to identify a probable source for the increased vibration. When these systems are used, there is a degree of first line fault finding possible when alarms are raised. Detailed analysis might still be needed depending on the criticality of the machine being monitored.

Depending on the system used, there are limitations to the amount of parameters that are being monitored, so priority is given to the more common failure modes.

Data is also typically used in machine learning applications, but detailed analysis is still performed on a routine basis.

Example:
In a ventilation fan operating on a mine shaft, the system can be programmed to trend the main forcing frequencies. Each one of these parameters is then linked to an alarm and named according to the most likely corrective action associated with the specific parameter. Then, if an alarm is triggered, the first responders to that alarm already have an indication of where to start their investigation and repairs.

Analytical monitoring:

This is by far the most powerful type of monitoring system in the field. These systems typically capture and store raw waveform data from the machine continuously, scheduled or rule-based. This data is then processed, allowing the user to perform detailed analysis on the following: FFTs (fast Fourier transform), waveforms, parameter-trending and special signal processing techniques. Process data can also be integrated with the data.

Alarms can then be triggered, taking operational conditions into consideration and data can be exported via OPS, Modbus, Rest API, etc. to third-party software and machine learning applications.

In many cases the ability of these systems is limited only by the user's imagination, but depending on the system response time, they are considered protection or monitoring systems.

INSTALLATION LEVELS

The type of installation being considered affects the required level of installation. The three options – wireless, wired and less-wires, offer different

Image courtesy of Arius / SPM

Airius wireless vibration sensors provide advance warning of vibration-related problems as well as gear and bearing faults. They are especially useful for remote or inaccessible machines that operate in hostile or risky environments.

monitoring capabilities. There are important performance criteria that must be considered before deciding on a level of installation.

Wireless:

As the name implies, the system consists only of a battery, transducer, transmitter and receiver. This system needs to connect via any one of a multitude of communication protocols and networks that are used in industry, ranging from dedicated frequency bands to standard Bluetooth and Wi-Fi.

Monitoring capability

- From overall to analytical.
- Wireless systems should definitely not be used for protection - in many cases sampling is only performed once a day to conserve battery life.
- Alarm generation is a possibility, but due to sampling frequency the alarms are not considered a continuous alarming system.

Performance characteristics to consider

- Battery life expectancy.
- If battery replacement is needed, can it be done on site?
- What is the frequency range?
- Measurement techniques that are available on the system. Can multiple techniques be applied on the system under consideration?

Wired:

As the name implies, the system has transducers wired to a controller/processor that is then hardwired into a LAN/Server from which data can be exported to a third-party software or control system.

Monitoring capability

- From overall to analytical.
- These systems can be used as a protection system as the measurement is normally continuous.

Performance characteristics to consider

- Measurement task assignment – does it measure all channels simultaneously or is it multiplexing?
- If communication is lost with the unit, what happens to the data?
- What type of communication does the unit use?
- What are the typical output protocols that are used?

Image courtesy of Wi-Care

Condition monitoring technicians interact with remotely-placed sensors through an online system which enables the data to be transmitted just about anywhere in the world.

Less-wires:

This is a hybrid of the two systems that compromises where needed, either with the communication between the transducer and processor or from the processor to software. The combinations are infinite and are mainly controlled by the application and location.

Internet protocol/firewalls

In most industrial applications there are high levels of privacy considerations regarding data and the availability of the data on cloud. When considering an online system, these protocols must be considered – where and how you would like to access the data and who should have access to the data?

Data size

The streams of data that are processed in these systems can be quite daunting. The saying "be careful what you ask for, because you might just get it" is true for a lot of online vibration analysis systems. Online systems can generate values at a rate of up to 102400 samples per second per channel. If this vast amount of data is not responsibly handled, it can easily cripple a network and flood a database. When setting up data that is used for historic purposes or for machine learning then size limitations need to be considered.

CONCLUSION

Choosing the most effective online vibration analysis system for your organisation is a complicated matter that requires careful consideration and research. However daunting it may seem, it is well worth implementing an online vibration analysis system because this is the most effective monitoring technique available. Furthermore, your return on investment is virtually guaranteed and the system never sleeps or misses a schedule, so you can rest assured that your equipment is constantly being monitored.

Copies of previous Technical Bulletins can be accessed on WearCheck's web site: www.wearcheck.co.za

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Head Office KwaZulu-Natal
No. 4 The Terrace,
Westway Office Park,
Westville, KZN, 3629
PO Box 15108,
Westmead, KZN, 3608
t +27 31 700 5460
e support@wearcheck.co.za
w www.wearcheck.co.za

Gauteng Office
30 Electron Avenue, Isando,
Gauteng, 1600
t +27 11 392 6322
e support@wearcheck.co.za

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