Value from Vibration

***Jonas Berge* discusses how developments in wireless instruments and device management software are helping to deliver a more cost-effective solution for vibration monitoring of machinery health.**

Loss of a process pump or other essential plant assets can be very disruptive. It can force other processing equipment to stop, leading to a production slowdown or even grinding the process to a halt. Furthermore, what could have been a simple bearing replacement on a pump can turn into catastrophic machinery failure, leading to extended unscheduled downtime and increased repair costs. To remain competitive, the maintenance department must be equipped to detect potential failures and prevent them from happening.

And as plants are pushed for increased capacity, many times the "A" and "B" standby service pumps are instead both used simultaneously for increased throughput. Loss of either one would mean reduced capacity. Without redundant standby equipment, plants are finding new ways to achieve greater availability, and one of these is through improving the "health" of mechanical production equipment, which can have a major impact on a plant's availability, throughput, and product quality. How the equipment is maintained also impacts the cost of operation.

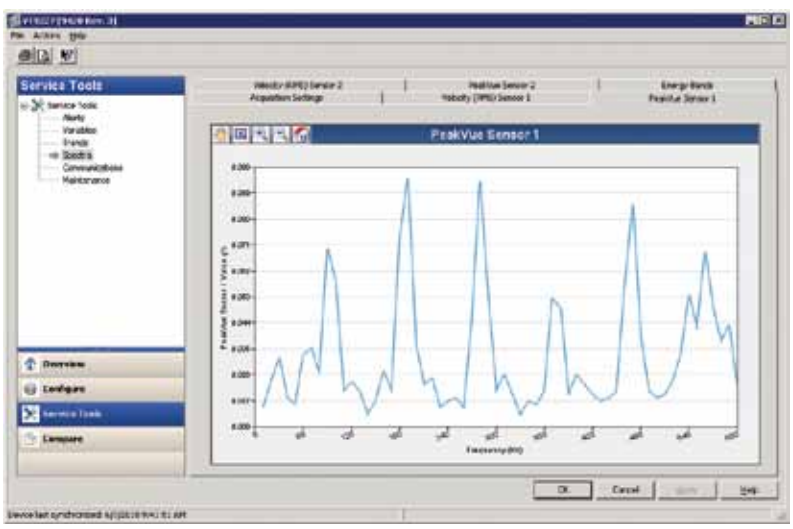
Most plants have already added machinery health management technology to large capital equipment like compressors and turbines. But condition-based maintenance can also be applied to other essential production assets such as:

- Motors
- Fans/blowers
- Rollers
- Conveyors
- Rotating drums
- Pumps
- Agitators/mixers
- Gearboxes
- Crushers
- Rotating kilns

The machinery health monitoring and protection systems used for large compressors and turbines are typically not cost-effective for these types of machines. In addition, traditional vibration transmitters do not provide sufficient information – typically only providing an overall vibration level while the real diagnostic information in the vibration spectrum remains unavailable.

A portable vibration data collector that a plant might use for monthly or quarterly equipment inspection captures a snapshot of the condition at that point in time. Problems thereafter will go undetected until the next measurement several weeks later. If the equipment is not running at the time of check, no data can be collected for that round, and it has to wait until the next opportunity. Moreover, a vibration problem may only be noticeable at a particular speed and go undetected if the machine happens to be running at a different speed at the time of checking.

An online machinery health management system is another solution. However, such systems of modular hardware and software are traditionally very large and expensive. Their use has mostly been limited to major capital equipment like compressors and turbines, not for other essential equipment like pumps.



Compact & wireless

New developments in wireless communications and electronic device description language (EDDL) can now provide an easier and more cost-effective solution for essential equipment monitoring. And health monitoring of small assets can be automated using vibration transmitters.

Compact vibration transmitters allow pumps and other essential machinery to be managed from the same device management software as a plant's intelligent devices. Online health monitoring from a central location is made possible using wireless communication, reducing inspection in the field.

Mechanical faults generate a unique vibration signature depending on the turning speed and number of bearing elements, etc. The new class

of field-mounted and self-contained online machinery health transmitters monitors essential machinery to detect fault conditions like imbalance, misalignment, looseness, and bearing problems. A full-featured vibration transmitter also includes PeakVue technology for advanced bearing diagnostics.

PeakVue is a technique that is extremely useful for isolating high-frequency "impacting" faults, where metal is contacting metal within gears and rolling-element bearings. Impacting faults are readily visible in the PeakVue spectrum long before there is any significant increase in overall vibration, making PeakVue highly beneficial for early warning. It can also be used to detect cavitation on pumps as well as improper lubrication on any type of rotating equipment.

These intelligent vibration transmitters overcome the limitations of hardwiring and communicate using the international standard IEC 62591 (WirelessHart) protocol. Thanks to standard communication, these transmitters digitally integrate with the DCS and intelligent device management software making use of its visualization, alarm & event logging, historian, etc. No separate system is required. When a vibration alarm is triggered, detailed analysis to determine the root cause can be performed from device management software without going to the field.

It is low-power-consuming accelerometer sensors that enable the use of batteries and hence wireless vibration transmitters. A single transmitter can support up to two accelerometers, which can be mounted at two different locations (e.g. one on the motor and one on the pump). Alternatively, you can connect one accelerometer with an embedded temperature probe to measure both vibration and temperature at a single location.

Wireless vibration transmitters make it possible to closely monitor vibration as often as once every minute as opposed to manual readings that might only occur via a portable data collection system once every month or even once per quarter. This provides prompt notification when a problem begins to develop, as well as an indication of how quickly the problem is progressing toward failure.

Most notably, wireless vibration transmitters are simple and easy to commission as there is no need to run wires back to the system. Using WirelessHart and EDDL, the pertinent information is automatically transmitted back to intelligent device management software, where it is displayed using intuitive graphics. In many cases, the transmitters will be permanently installed, but in other cases, they are mounted temporarily to monitor "bad actors" until the developing fault has been addressed.

A wireless vibration transmitter shares the same network infrastructure as other wireless transmitters (e.g. pressure, temperature, pH, conductivity, level, valve position feedback, etc.), and all of the information is transmitted via the same gateway. Once a gateway is in place, plant personnel can easily expand the monitoring network at will by adding new transmitters.

Wireless vibration transmitters make it possible to closely monitor vibration as often as once every minute.

Aside from compressors and turbines, condition-based maintenance technology can also be applied to other essential production assets such motors, fans and pumps.

For example, if a pump – or the piping system attached to the pump – experiences intermittent problems, adding a wireless vibration transmitter to the network can provide a simple but effective means to correlate vibration with other process conditions. This can enable rapid identification of the root cause of the problem.

Visualizing values

Maintenance technicians face the challenging task of managing devices from different manufacturers. In the past, machinery health management required specialized software. A better solution is for operators and technicians to work with vibration transmitters using the same universal device management software used for the other devices in the plant.

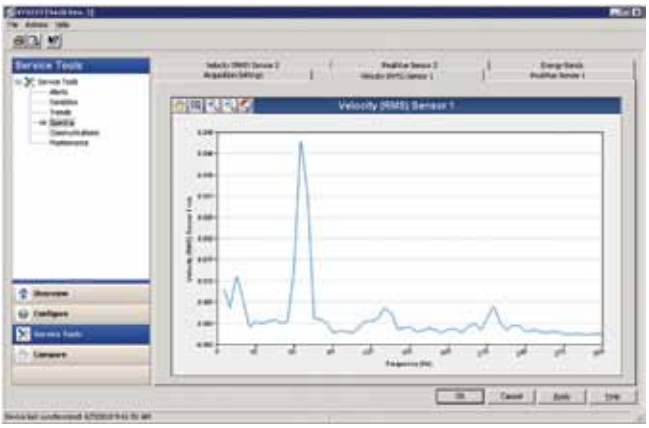
Thank to EDDL (www.eddl.org), the information from vibration transmitters can be displayed side-by-side with information from

Accelerating Technology

The sensor for a vibration monitoring solution is the accelerometer, which measures acceleration in g's (the acceleration due to the Earth's gravity). It contains a reference mass in the form of a cantilever beam, and deflection pick-up in the form of a piezoelectric crystal. As the sensor vibrates, it generates a voltage signal proportional to the acceleration. Typically, the sensor sensitivity is either 100 mV per g for regular sensors or 25 mV/g for low power sensors.

The vibration transmitter powers the accelerometer and conditions the output signal. Primary measurements include the Overall Vibration (velocity within the band of 2 Hz to 1 kHz according to ISO 10816) and PeakVue Vibration (acceleration in the band 1 kHz to 20 kHz). Fast Fourier Transform (FFT) is used to analyze the spectrum (signature).

EDDL graphics provide user-friendly display of complex vibration diagnostics.



Overall velocity spectrum showing machinery imbalance.

transmitters for pressure, temperature, and other process parameters. This enables technicians to apply what they have already learned from working with other devices to the vibration transmitters – thus reducing the requirement for additional training, and eliminating errors induced from using multiple software systems.

When a vibration transmitter is developed around the IEC 61804-3 (EDDL) standard, the user interface is intuitive, providing full support for the functionality. For instance, in addition to the overall vibration level, it also provides an indication of the PeakVue vibration, calculated energy within a frequency band, and even the vibration spectrum. Know-how in the form of text and illustrations is brought into the system through the EDDL file to guide less experienced technicians in interpretation of diagnostics for faster problem identification and resolution.

The primary vibration values (i.e. Velocity and PeakVue) are displayed as dynamic needle gauges with color bands on the scale to distinguish normal from abnormal operation. This makes it easy to visualize the current status, the direction of change, and the proximity to the next alert level.

Both operations and maintenance personnel are concerned with machinery health. If a piece of equipment is not running, operators must take alternate steps to maintain production, while maintenance technicians must act quickly to get the equipment back online.

Unlike other device integration technologies, EDDL does not conflict with system software, so it can be integrated in the DCS's operator console. Device diagnostics are accessible in two clicks, so an operator can, for instance, acknowledge a high vibration alarm, and then distinguish whether it is caused by pump cavitation or a bad bearing without switching to a separate workstation.

In the case of cavitation, the operator can adjust the process to eliminate the root cause of the problem. For a bearing problem, however, the alert would be routed to the maintenance group to take appropriate action.

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Intelligent action

Online vibration monitoring enables corrective action such as balancing, alignment, or part replacement to keep the machine in service longer or put it back in service faster. Costly shutdowns can be avoided. Additionally, it is less labor intensive and is safer for the workforce.

Thanks to EDDL, condition-based diagnostics can be directly integrated into the operator's console for fast and easy access. At the same time, the device management software maintains a single audit trail for changes to all devices including vibration transmitters as well as a single alarm log for all device events.

This makes them easy to correlate while providing a complete picture of plant operation. Full integration into existing systems enables it to become a natural part of daily maintenance practices.

Plants that already have a reliability program using portable vibration data collectors will likely also have vibration analysis software that is used by the vibration specialist. Thanks to WirelessHart, it is now possible to receive the vibration data in this software too, enabling the vibration specialist to make well-targeted maintenance recommendations. Data can be retrieved on-demand or on a scheduled basis.

Once the wireless infrastructure is established, it can be used for many functions. Other wireless transmitters can be added at will to achieve on-going process improvement. These incremental steps, like "mini projects", can be quickly and easily implemented where it would have been impractical with hardwired monitoring technology.

Since WirelessHart is an international standard, devices from different manufactures can function across the same network. In the case of existing Hart devices that are not digitally integrated with the system, there are new wireless adapters that can be used to "upgrade" them to wireless devices. This opens up cost effective new possibilities to transmit stranded diagnostics back to the control room. This applies to devices such as valve positioners, Coriolis and magnetic flowmeters, and radar level transmitters.

A digital plant architecture that uses the power of field intelligence to improve plant performance utilizes an unbroken chain of vibration transmitters and other devices, digital networking, and universal device management software to deliver accurate, actionable information to the right person in time to make a difference. **CEA**

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