Peace of mind

Richard Pratt of Emerson Process Management explains how feedback based on new monitoring and analysis technologies from remote pumps can mean the difference between excellent performance and costly stoppages by providing actionable information

THE increased use of automation and advanced controls in mining is providing great benefits to operations, but often leaves large information gaps for the operators, as well as for others in maintenance and planning services.

Since operators no longer touch or hear much of the equipment they are operating these days, they often have no way of knowing when a loss of performance has occurred. Even periodic visual inspections may provide only a limited view of what is happening on the inside.

Yet, capturing information on degraded performance is of utmost importance because minor functional problems can lead to major asset issues like bearing failures, shaft seizures, motor failure and, ultimately, unit downtime. Now, technology enables operations and maintenance personnel alike to get feedback from smart field instrumentation to close those information gaps.

According to Ron Moore in his book *Making Common Sense Common Practice – Models for Manufacturing Excellence* (Third Edition, 2004), almost half of all equipment breakdowns are related to poor operating practices allowing unsatisfactory performance to escalate into a much larger issue. In many cases, mine personnel just don't know what's happening until it's too late because most operators lack the feedback and trending data that could enable them to prevent problems rather than contribute to them.

Periodic vibration data collection and analysis are helpful, but that provides only a snapshot of an asset's condition when the data was retrieved. Traditionally, information from a vibration analysis program is used by maintenance personnel. Integration into process control is limited to vibration amplitudes, which mean little to most operators.

The Emerson Machinery Health Transmitter continually measures the operating parameters of key motor-pump assemblies in the field

A field-mounted machinery health monitor receives inputs from six vibration sensors on a motor-pump assembly

They just don't see the cyclic occurrences that can dramatically affect pump health. Today, most operators only know whether a pump is running or not. That information can be comforting, but is only useful when it is necessary to call the repair crew in the middle of the night.

Operations personnel normally get involved in machinery health only after the root cause failure analysis team starts trying to reconstruct an asset failure. This is a beneficial practice, but it is still reactive; ie, done after something breaks. Identifying mechanical failures, like a failing pump bearing, are important but primarily a maintenance function. Often missed are functional failures, such as the early detection of a pump cavitating because it is operating off the pump curve. These functional failures can be corrected by the operators before they lead to mechanical problems if they have the right and timely information. To truly manage asset health proactively, operations personnel who have the most influence on the conditions affecting a machine's health need access to actionable information. That is the real key to managing the health of assets.

While every mineral producer knows the high cost of breakdowns and strives to prevent problems, they might not be familiar with the role of advanced technology in achieving such goals as operations stability, minimum stoppages, increased safety and reduced operating costs.

THE SMART MINE

The smart approach is to apply technology where it fits economically to protect the most critical equipment against a failure that would lead to a shutdown, or a severe financial impact or safety implication in the mine or processing plant. More and more often, this involves the use of continuous vibration monitoring integrated within the process control system.

Emerson's Smart Mine technologies are capable of delivering field-generated, actionable information to the control centre, so operators can maximise the performance of remote machinery, prevent unexpected failures and reduce any safety hazards caused by unplanned stoppages.

For example, a recently introduced Machinery Health Transmitter continually measures the operating parameters of key motor-pump assemblies in the field and reports a consolidated analysis, based on current operating conditions. This technology is capable of making in-the-field assessments and automatically notifying the appropriate plant personnel whenever the possibility of a failure exists. This involves monitoring critical assets and identifying conditions that degrade the equipment. ➔

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By identifying functional failures, operations personnel can address the factors leading to the most serious problems – and downtime.

Smart instrumentation allows the sharing of critical machinery-health information between operations and maintenance automatically, informing operators of any functional failures they can correct in time for them to make adjustments to the process. When combined with information from other sources, such as lubricant analysis and infrared imaging, maintenance personnel can get a true picture of the operating condition of these assets and their potential for failure.

In one case, information obtained automatically from unmanned water-pumping stations and transmitted to the central host resulted in early identification of such problems as imbalance, misalignment, looseness, cavitation, and gear and bearing faults. When this information was used as the basis for maintenance, unexpected mechanical failures were minimised and emergency costs were reduced by 20%. As one maintenance supervisor said: "It is just too costly to let those big pumps run until something breaks; not when continuous, online condition monitoring is available to trigger predictive maintenance."

AUTOMATING MACHINERY HEALTH

We are now moving beyond predictive maintenance to optimise pump performance by utilising the capabilities of smart, microprocessor-based instrumentation. One field-mounted machinery-health monitor receives input from six different vibration sensors on a motor-pump assembly, along with a tachometer reading for shaft speed, motor flux input from a flux coil, and temperatures at four different locations. Every 25 seconds, these parameters are scanned for evidence of common malfunctions, such as bearing or cavitation problems.

Since motor-pump assemblies tend to have similar failure patterns, this approach lends itself well to embedded analysis software, capable of recognising common motor-pump defects. Frequent examination of vibration data against known patterns provides current verification, versus data obtained periodically, where a rapidly evolving problem might be missed.

An overall machinery-health value, based on the measured characteristics, is calculated and assigned a numerical rank from 1 to 100, with the top number indicating perfect health. By periodically checking on machinery-health values, operators get a quick fix on the condition of any monitored motor-pump system.

By comparing a unit's machinery-health value with such process values as pressure, temperature, and flow rate, operators and supervisory personnel begin to see how changing process conditions affect pump longevity. If certain process conditions emerge that degrade pump health, a determination can be made regarding operational changes that may be implemented to protect the machine.

Beyond that, if the automatic analysis determines that something occurring internally justifies a warning, an appropriate alert is communicated to the facility's control system and maintenance station. In this way, operators and maintenance personnel are immediately informed of a changing level of vibration on an essential pumping system. The new concept of machinery health gives plant personnel greater power in optimising critical, rotating equipment.

Spalling on pump bearing

WIRED OR WIRELESS

Combining smart instrumentation with standard industry communication protocols, including HART and FOUNDATION fieldbus, allows operators to use the richness of field data and access to field-generated recommendations directly from their operating screens. Such online communication from machinery-health transmitters is generally done via higher bandwidth wire connections (ethernet, fieldbus, etc).

However, new methods are emerging to apply a low-bandwidth, wireless transmission standard to remote-monitoring instruments, often making it easier and less expensive to implement. Wireless transmissions are now possible from the machinery-health transmitters permanently connected to critical motor-pump assemblies.

> "We are moving beyond predictive maintenance to optimise pump performance by utilising the capabilities of smart, microprocessor-based instrumentation"

EXAMPLES

In one case in South America, a CSI 9210 Machinery Health Transmitter was monitoring a critical 2,800gal/min pump, driven by a 700HP motor, when machinery health index (MHI) values on the pump began to drop due to increasing vibration. When this vibration reached a certain level, the MHI decreased to the point where an alert was automatically generated and a work order created. In this case, a back-up pump was brought online and the process was not interrupted.

When the bearing was removed and examined, spalling was evident on both the races and rollers. Had the pump been allowed to run unattended for much longer, the bearing would have failed and could have caused a seizure, possibly damaging an expensive motor and shutting down that part of the operation unexpectedly.

Sometimes, an inexperienced operator trying to make up lost production time will start a third pump in a system that can support only two running pumps, creating a functional failure and causing all three pumps to begin cavitating because of low suction pressure. A monitoring system will identify the problem and trigger a local alarm, along with an alert message to the operator. Realising the mistake, the operator quickly shuts down one of the pumps. In this case, no damage was done in the short time that all three pumps were cavitating.

In both cases, actionable information was sent to the right people without any unnecessary alarms to unrelated operations or maintenance personnel.

SUMMARY

Integrating continuous vibration monitoring with analysis-in-the-field and delivery of results to the process-control system transforms the practice of condition monitoring into smart machinery-health management, which:

- Integrates real-time diagnostics into process automation systems
- Converts complex, rotating equipment data into actionable information
- Empowers operators to improve plant performance and availability
- Co-ordinates activities between operations and maintenance personnel
- Enables managers and planners to make better analysis for timely decision making.

Access to reliable, field-based information enables operators to enhance the performance of essential motor-pump systems, while early warnings help maintenance personnel take action as necessary to avert process upsets and unplanned downtime.

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