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Plant Reliability Through Essential Asset Monitoring

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With 25% of unplanned outages in refinery operations related to equipment failures, monitoring essential assets is critical for reliable operations. However, the complexity of wired monitoring systems makes many planners hesitate at the cost of such an investment. Vibration monitoring via real-time wired monitoring systems may not be deemed critical enough from a cost-benefit perspective. Fortunately, wireless technology makes it feasible to automatically monitor the myriad of pumps, exchangers, fired heaters, compressors and other assets that could lead to a process disturbance or shutdown.

Table 1. What Data Can Be Collected Wirelessly?

Pumps	Blowers/Fans
Motor Vibration	Motor Vibration
Pump Vibration	Fan Vibration
Bearing Temperatures	Bearing Temperatures
Flow	Flow
Motor Speed	Motor Speed
Discharge Pressure	Suction Filter ΔP
Pump Head	Suction Pressure/Temperature
Seal Fluid Level	Discharge Pressure/Temperature
Seal Reservoir Pressure	Louver Position
Suction Strainer ΔP	

Reactive versus Planned Maintenance

To mitigate monitoring costs, simplified practices, such as visual inspection, have been the norm. These so-called "clipboard rounds" are performed periodically (e.g., one per day/shift) and supplemented by handheld vibration measurements (e.g., monthly) or performance audits (e.g., annual). Facilities accustomed to these marginal reliability practices may lack the instrumentation necessary to consider real- time monitoring solutions that could help avoid run-to-failure (RTF) incidents. The "run to failure" practice at these facilities makes it necessary to maintain a higher inventory of spare parts. This practice provides limited reactive capability to failure incidents.

Considering that reactive maintenance costs are about 50% higher than planned maintenance costs, a more cost-effective strategy for reducing unplanned outages is necessary. Increased unit availability can be achieved with wireless automated monitoring of essential assets including fired equipment, exchangers, compressors, pumps, valves and field instruments. Because there are no wires to run, wireless configuration permits accurate measurements in difficult to reach and cost prohibitive locations. Low installation cost and easy expansion mean that the wireless infrastructure can start "small" and expand as needed. This ensures that the wireless monitoring infrastructure evolves with future unit expansions and remains a reliable means of data acquisition (**Table 1**) .

With wireless implementation, the essential asset monitoring solution cost effectively collects the type of data shown in Table 1 to report overall asset "health." This data acquisition system provides an intelligent, multi-parametric solution, capable of simultaneously analyzing multiple data points (e.g., pump cavitation detected with vibration and discharge pressure) to determine fault conditions. Early warning of an impending fault allows the operator to take appropriate preemptive action.

Peak Impact Detection

With the essential asset monitoring approach, current vibration is measured and transmitted by CSI 9420 vibration transmitters (**Figure 1**) to the plant control network (plant historian + DCS/OPC Server). Statistical process control (SPC) based analysis provides detection of increasing vibration. Two options are available for the CSI 9420 wireless vibration transmitters:[1]

1. Two vibration sensors (accelerometers), each providing both overall vibration (inches/sec) and Emerson's unique peak impact value (PeakVue) (acceleration, G's). This methodology is designed especially for detecting the onset of rolling element bearing wear.[2]
2. One vibration sensor (accelerometer) that provides overall vibration, PeakVue value and temperature measurement (e.g. bearing or case temperature).

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With this peak impact detection capability (**Figure 2**), rapid analysis of impact-like events proves to be an effective tool for early and accurate warning of key mechanical faults, including pump cavitation, lubrication problems and bearing defects. In this figure, it is clear that the PeakVue value is much more sensitive than traditional Overall Vibration measurements to detect certain types of pump failures. Moreover, this tool provides operators in the control room with an assessment of the faults' severity.

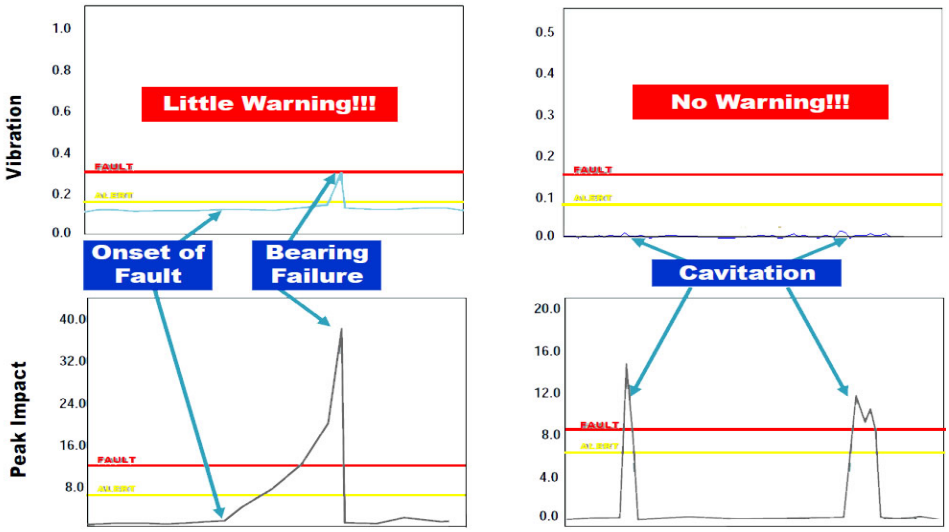

Figure 2. *What is Peak Impact Detection? Both Overall Vibration and PeakVue are shown. The peak value is extracted from very fast sampling at 50,000 times per second. The PeakVue measurement detects the micro-burst that occur when metal impacts metal inside the machine. PeakVue represents the peak value of these impacts.*

Refinery Application: Pump Health Monitoring

A refinery in the mid-continental U.S. recently installed Emerson's Pump Health Monitoring solution (www.emersonprocess.com/pumphealth) on the facility's crude distillation unit (CDU) flashed crude pumps. Tracking the operation of these pumps was important in order to balance flow through the units and increase the mean time between failures (MTBF). The vibration sensors were installed on the pump's bearing housing. Wireless transmitters and a gateway were installed to begin tracking of the pump's operation in real-time.

The three flashed crude pumps in this particular CDU had a history of high vibration due to parallel operation, varying process/crude flow and composition and asymmetric setup. In this three-pump system, operators would run two out of three pumps. Two of these pumps were steam driven (speed adjusted in the field) and the third pump was fixed speed motor driven.

Some of the key issues noted by Emerson Process Management and the operator included:

- Little visibility to these flashed crude pumps (i.e., no instrumentation was available to provide continuous monitoring) so balancing the flow through each pump was done with a manual block valve
- Operations department reported "issues" to the plant's reliability group throughout the day
- The vibration analyst and machinery engineering group reviewed process data and vibration to provide feedback to the operations department
- There were frequent calls for vibration verification during process variations, further straining staff work duties
- There was no continuous data collection. Instead monthly data collection was used for trouble-shooting the system during any upset conditions.

Having noted these issues, the refinery's goals were clearly stated:

- Install an early warning continuous monitoring system to avoid major failures
- Use the continuous supply of data to:
  - Better understand the systems
  - Analyze data
  - Set alarm levels for operations
  - Address and understand unknown problems
- Reduce the time of manual inspection and vibration readings
- Improve confidence in operation
- Bring "pump health" into the control room, thus relieving strain on staff

Figure 1. *An Emerson CSI 9420 Wireless Vibration Transmitter sends equipment data to an integrated plant control network via a wireless gateway. According to one refiner, these field devices can typically be installed in a couple of hours compared with a couple of days for a wired device.*

With the asset monitoring system implemented, the refinery's reliability group has new visibility to the pump operating characteristics, making it easier to see how unit operations impact these pumps. For example, the PeakVue methodology highlighted cavitation-like/recirculation activity on the pumps that appears to be operations driven. The Pump Health Monitor system allows refinery operations personnel to take action and/or inform maintenance of a

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developing problem such that appropriate and timely action can occur.

Operators can now see alerts on these pumps. These alerts have been set for PeakVue and overall vibration measurements, and procedures have been developed for responses to these alerts. In addition, application of Emerson's AMS Suite: Machinery Health Manager provides a predictive, diagnostic foundation for the facility's machinery management programs by combining software, online technology, portable technology and operating training.

Improved Performance

The refiner plans to expand on the benefits provided by AMS Machinery Manager. Spectrums and waveforms are currently being collected with plans to use details to confirm suspected pump cavitation or excessive deviation from best efficiency point (BEP). While data is still being collected, future plans are to build on the analysis tools and usage in AMS Machinery Manager. This includes improving physical access to the data and working more closely with operations on procedures to avoid suspected cavitation. Use of this diagnostic foundation to catch an essential equipment issue, such as pump vibration and cavitation, before it leads to the asset's failure, can be many times more valuable (avoided incident cost) than the cost of the monitoring system. Benefits include improved reliability, less process downtime, and reduced safety and environmental incidents. ■

Editor's Note: This article is based on a more detailed presentation by Nikki Bishop, PE, Senior Applications Consultant, Emerson Process Management, Atlanta, Georgia USA at the October 2011 NPRA Q&A and Technology Forum, Plant Automation & Decision Support Session in San Antonio, Texas, USA (nikki.bishop@emerson.com).[3]

Literature Cited

1. CSI is a registered trademark of CSI Technologies, a legal entity of Emerson Process Management.
2. Emerson Process Management White Paper, "PeakVue Analysis for Antifriction Bearing Fault Detection." August 2011, www.assetweb.com.
3. Bishop, Nikki, "Improve Plant Reliability through Essential Asset Monitoring," NPRA Paper # PD-11-16, Q&A and Technology Forum, Plant Automation & Decision Support Session, October 9-12, 2011, San Antonio, Texas, USA.