Continuous Monitoring Improves Petrochemical Operations

Implementing predictive maintenance measures puts operations and maintenance back in control.

By Jacob Swafford

Recent expansion and innovation in the oil and gas industry have meant greater access to less expensive feedstock for downstream petrochemical and refining operations. For these organizations, taking advantage of low prices on oil needed for production means maximizing throughput to turn out as much product as possible while profits are high.

Unfortunately, maximized throughput often means extra stress on process and production equipment. In addition, maximizing throughput can require adding more equipment to the process, resulting in more opportunities for equipment failure plant-wide. Pumps and compressors in petrochemical plants are designed to last a long time, but with increased wear and tear on these devices, it is essential to maintain organizational awareness of the functionality of these important pieces of equipment.

Critical petrochemical machines have numerous possible points of failure. All of the devices contain many consumable parts such as seals and bearings. With increased use, the parts are subject to more wear and tear and tend to break down faster than they did in the past. Additionally, many petrochemical organizations need to make adjustments to deal with new types of oil, sourced from hydraulic fracking or tar sands, adding forms of stress to processing equipment.

All organizations put resources toward maintenance of critical equipment; however, in many companies, equipment maintenance only takes place after losses in efficiency, safety and production quality have already begun. While some organizations perform no predictive maintenance at all, most are relying on the same periodic monitoring systems that they have used for years. The core problem with this kind of approach to essential process equipment is that in many cases, by the time a problem has been detected through periodic monitoring, developing equipment problems have already caused issues in

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production. Moreover, running with periodic, or worse, no monitoring can mean running to failure on equipment that is critical to the process, resulting in profit loss due to downtime, fines from missed deadlines or environmental impact and safety concerns in the plant.

The key to absolute maximization of production throughput is continuous equipment monitoring that connects the maintenance and operations groups at a production facility. By continuously monitoring the proper variables on essential equipment, which fall under the purview of both the operations and maintenance departments, organizations can develop a plant-wide predictive maintenance routine that allows teams to be proactive rather than reactive.

Monitoring key petrochemical equipment

While there are countless machines and equipment in a petrochemical plant that can be monitored continuously, pumps and compressors are generally some of the most critical and the most common devices to monitor. With producers trying to achieve the highest level of throughput, modern plants are pushing as much raw oil as possible into their processes. This means running pumps fuller and longer than ever before, putting more stress on seals, bearings and valves than in the past. In addition, the location and function of pumps and compressors can often make them difficult to monitor.

Yet, while plants regularly recognize the importance of monitoring pumps and compressors, and often make periodic monitoring of the machines part of regular rounds, they are often overlooked as key candidates for continuous monitoring. When an organization relies on manual collection of vibration data on pumps and compressors, it means only recording intermittent vibration values. As a result, it is very difficult to see true trending conditions. In addition, such monitoring requires the use of a lot of man-hours, and even so, plant staff cannot monitor the pumps all of the time. In the case of an intermittent impact or similar event, it is possible for operators to miss important data. Collecting data manually means limiting the plant's predictive capabilities to a series of snapshots over time.

The key complication of performing predictive maintenance using a small number of snapshots over a long period of time is that engineers end up with little data telling them what exactly is going on. The data blind spot results in more engineer hours used to evaluate detected problems and determine a solution.

In contrast, when an organization monitors pumps continually, maintenance can feel confident that it will be made immediately aware of any change in function, and operators will know that a bearing is headed for failure long before the problem means imminent process upset.

The benefit of this confidence delivers more than just peace of mind. In many cases, unexpected service of a pump can require finding replacement parts that are not always readily available. When these parts are back-ordered or require special orders, the result can be significant downtime. In the most serious cases, equipment failure can mean taking the device offline for a period of months in order to have it repaired. For organizations that cannot afford any downtime, having access to predictive data means that maintenance teams can arrange service on their schedule, rather than out of desperation.

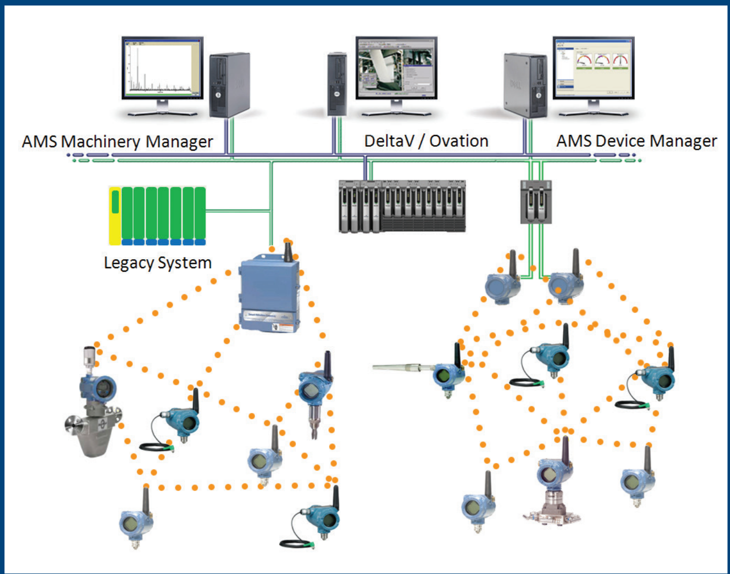
Continuous maintenance in action

For a large petrochemical company in the U.S. needing a solution to avoid equipment failure, and, in worst case scenarios, fires and explosion, using continuous monitoring devices and software from Emerson was the perfect answer. The organization's No. 1 priority for leveraging continuous monitoring technology was personnel and process safety. The primary goal was to lower the risk of explosion caused by failure of pumps at the plant.

Because safety and reliability are very much intertwined, the maintenance team knew that by implementing the right solution to meet safety goals, it could gain reliability benefits as well. It anticipated that early detection would lower the damage to pumps, yielding lower overall repair costs.

Before implementing a continuous monitoring solution, maintenance crews were evaluating the pumps every

30 days to comply with internal regulations. However, the time between detection and failure on the pumps could be much shorter than 30 days, meaning that the periodic data collection simply was not enough.



Self-organizing wireless networks feature tight security, infinite configurability and data reliability that rivals wired systems. *Graphics courtesy of Emerson Process Management*

Adding more maintenance routes was not an option; the law of diminishing returns would have made this pointless at best. Maintenance determined that the optimal solution involved installing wireless transmitters, allowing for data collection every 30 minutes. By implementing an automated solution, the plant gained the benefit of advance warning and time to react without the expense of frequent maintenance routes.

Because of the extreme safety risk associated with the processes in a petrochemical plant, the organization needed to ensure the reliability of data collection over a wireless network. After all, continuous monitoring is of no value if data is not being delivered to the proper alarm system. Fortunately, the organization was able to achieve reliability by putting in a redundant system. In the facility, pumps are grouped in A-B sets. For each set, two transmitters are installed, each with two accelerometer sensors, one on each pump. The transmitters are installed in an opposite fashion. Each transmitter communicates through a separate gateway, so the system is completely redundant.

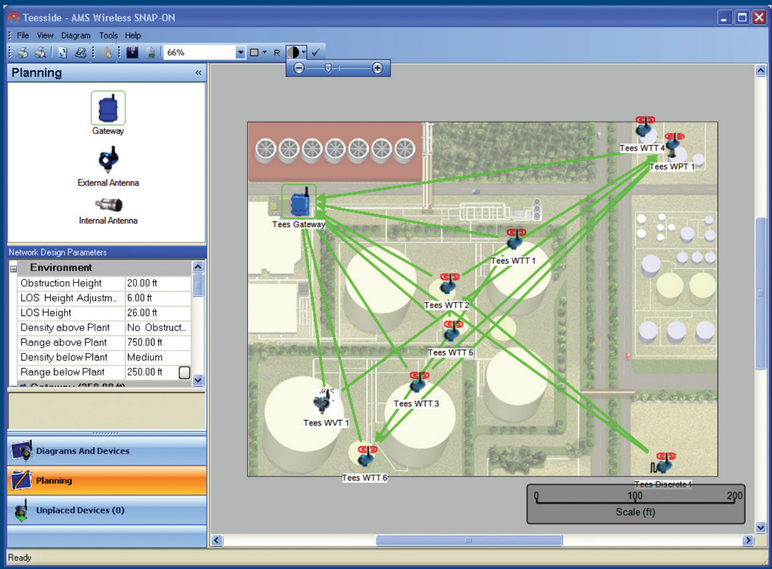
The sensors deliver data into the PI Historian every 30 minutes. The historian selects the highest value of the two sensors and triggers alarms. When a serious alarm is triggered, operators will switch to the spare pump. When this occurs, an email is automatically sent to vibration technicians to check equipment with an Emerson portable vibration analyzer for further evaluation. The handheld devices allow technicians to complete more localized troubleshooting of the pumps, but only after safety precautions have been put in place.

In addition, maintenance has the option of requesting full spectral and waveform data from the wireless transmitters from their desktops, allowing teams to collect the same data they would get from a portable analyzer without ever having to go into the plant. Using all of these options, the plant staff can use wireless vibration monitoring in realtime, shutting down equipment based on results. There is also an additional safety benefit gained from a decrease in need for sending someone to collect the data on the equipment itself. All of this remote capability increases safety and saves time by enabling faster decision-making.

Continuous monitoring even yielded information in unexpected ways. When maintenance installed one set of transmitters, it received an alarm on a pump that was not running. The pump reported vibration levels two times higher when the pump was not running than when it was operating. After examining work order notes, maintenance discovered a history of false brinelling on the pump, a discovery that would not have emerged had maintenance continued to rely on portable measurement. After tracking the source of the vibration to piping resonance, the organization was able to develop a long-term solution to improve reliability and stop premature failure of the bearings.

The operations/maintenance connection

A reliable, redundant continuous monitoring solution plays a pivotal role in keeping petrochemical companies operating at full potential. However, it is important to recognize that, often, a good continuous monitoring solution goes beyond recording data that are considered simply "maintenance related." While vibration is the most common measurement discussed when considering a continuous condition monitoring solution, there are other variables such as temperature, pressure and flow that can be equally important to monitor.



Emerson's AMS Wireless SNAP-ON application graphically displays a plant's wireless network.

Often, organizations do not consider monitoring of temperature, pressure and flow in their continuous condition monitoring solutions, as these values can often be thought of as operations related rather than maintenance related. However, a good monitoring plan will blur the line between value types, always ensuring that the right information gets to the right people.

When maintenance and operations do not communicate effectively, the result can be an impact on plant functionality. Including monitoring values that are typically operations-related into a plant's maintenance plan can improve the time line built around equipment events. When tracked vibration data are coupled with temperature, flow, pressure and even tank level data, maintenance and operations can begin to see how changes in process can act as catalysts for hardware failure.

Using continuous vibration monitoring systems to link all of these data types means that when operations increase flow or pressure in a process they can be alerted to the impact of the changes by unique impacting data that indicate an unsafe change in the process. Linking maintenance and operations functions offer more visibility to operators, letting them know if what they are doing is having a negative impact on the actual machinery in the plant. Since condition monitoring software can detail exactly when a problem arose, maintenance can compare data with logs to see if a change in process occurred at the same time. This gives the whole organization peace of mind that any deployed process changes, no matter how seemingly insignificant, will always be low risk to operations.

Results

On the most basic level, continuous monitoring saves money by avoiding downtime. Critical pieces of machinery are often running fast and can fail quickly in between periodic readings. Not having insight into machine health until the next data collection cycle means not being able to plan and shut equipment down the right way. An asset that has not failed simply costs less to fix. Not allowing equipment to run to failure means less internal destruction of the machinery, resulting in fewer components to replace and less material to order.

The faster critical equipment runs, the faster small problems can become serious issues. When such issues result in fines due to failed delivery or loss of valuable batches, the economic impact can be astounding. Moreover, even if the equipment does not fail, issues requiring maintenance leave machines (and as a result, the plant) operating at less than full efficiency.

Collecting data continually means having the ability to plan. When maintenance is confident that unexpected shutdowns are not looming, it can take down equipment when it is convenient: during an off-season or when backup equipment is available. Proper predictive maintenance can also mean proper management of spare parts storage. Maintenance will only need to order and store the components for scheduled maintenance activities.

Having access to the right machinery health data at all times puts an organization back in control of its own equipment. Providing operators, maintenance and engineers with valuable data on the health of their equipment allows them to perform their jobs much more efficiently and added efficiency translates into much-needed reliability organization-wide. ■

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