Machinery Health and Predictive Diagnostics

Advanced automation systems help water and wastewater utilities avoid unplanned equipment downtime

Advanced automation solutions are enabling forward-thinking water and wastewater authorities to improve their operations significantly by addressing some of the greatest challenges facing the industry. The challenge we're talking about today is avoiding the time and expense associated with equipment downtime.

Water and wastewater utilities operate large and expensive machinery including pumps, centrifuges, mechanical separation and filtration equipment, and a host of other assets. With advanced, predictive machinery health solutions, it's possible to better monitor the health of large rotating assets and predict problems before they occur. This simple shift from emergency, reactive repairs to preventative diagnostics and maintenance can save money, reduce unplanned service outages, protect critical assets and improve the safety of both workers and the public.

Vibration analysis is an important tool to ensure that rotating assets are performing as specified. Based on US Bureau of Labor Statistics, approximately 32% of treatment facility employees will be eligible to retire in less than 10 years. Among the retiring will be those with advanced knowledge of vibration analysis. These people may or may not be replaced. If they are, it's likely that they won't possess the same level of experience and knowledge as those who are walking out the door. To fill this gap, the case for automation couldn't be stronger.

As many know, the primary causes of machine vibration are:

- Repeating forces caused by imbalanced, misaligned, worn or improperly driven machine components
- Looseness due to excessive bearing clearances, loose bolts, corrosion or cracked cases
- Resonance which occurs when equipment rotates at the natural frequency of one of its components or one of the pieces of equipment attached to or near it.

To monitor and diagnose problems caused by excessive vibration, some municipalities take a manual, route-based approach in which a vibration analyst moves from machine to machine taking vibration samples at periodic intervals. The asset manager uses this sample data to trend the health of equipment over time. Although this approach requires little capital investment, it isn't without risk. The issue with this approach is that equipment failure caused by excess vibration can often be sudden – with symptoms and failures occurring between sampling intervals. For example, if a sample is taken on a machine for 30 seconds every 30 days, then over 99.99% of the time, the equipment's health is not actually being monitored.

For large rotating assets, some water and wastewater authorities choose protection-only systems that automatically shut down the equipment in the event of severe vibration, thereby preventing further damage or injury to personnel. The problem with these vibration protection systems is that by the time the equipment shuts down, the damage has already been done and repairs are required before the equipment can be returned to service. Depending on the nature of the failure, repairs can be quite costly. And reactive maintenance is always

more expensive and less safe than planned maintenance. In fact, reactive repairs can cost 50% more than planned repairs due to expedited parts and overtime for unscheduled work orders.

Another issue with protection-only systems is that they don't track equipment health over time. Consequently, equipment is often over- or under-maintained. In addition to spending money unnecessarily, over-maintenance can inadvertently induce equipment failure. For example, if bearing replacements are installed improperly, they can introduce additional faults. It's obvious to everyone that under-maintenance can result in significant equipment problems. What may be worth thinking about though, is that those problems may present themselves at the most inconvenient times — during high-demand periods such as weekday mornings or weather events, for example — exacerbating an already difficult situation.

Today, the science of vibration monitoring has matured. Online monitoring systems can now provide both protection and prediction of critical rotating assets. They study characteristics in the vibration waveform to not only help identify what is causing the increased vibration, but also provide an early warning of potential machinery health issues.

Unlike protection-only systems which typically look only at the overall vibration value over time, continuous online vibration monitoring systems dig deeper. They look at waveform patterns to identify specific mechanical issues such as imbalances, misalignments or bent shafts, well before the overall vibration value even changes. Armed with this information, reliability and maintenance personnel can respond accordingly to prevent equipment damage.

Some forward-thinking automation suppliers have taken this a step further by integrating online protection and prediction into their control system platform, eliminating the need for a separate system altogether. With this, operators will now receive actionable alerts about developing equipment issues while they are monitoring plant operations. They'll receive specific direction on actions that need to be taken or maintenance that should be planned to avoid equipment damage or failure.

This one-platform approach offers numerous benefits over an isolated system that sits outside the realm of plant control. The use of a single platform for control and online monitoring means that equipment is no longer over or under-maintained; training on multiple systems is no longer required, parts inventory is reduced, and even cybersecurity is enhanced.

A properly functioning predictive maintenance program can provide a savings of 8-12% over a program utilizing preventative maintenance alone[1]. Aging equipment … increasing regulatory requirements … budget reductions …the pressure to do more with fewer and less experienced personnel … the challenges facing the water and wastewater industries are formidable. Fortunately, unplanned equipment downtime *can* be avoided. With advanced online predictive monitoring technology, there's no longer a need to leave machinery health to chance.

[1]*US Department of Energy's O&M Best Practice Guide, 2010*

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