POWER Engineering

Installing Predictive Vibration Monitors

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Officials at Elk River Station, a waste-to-energy power plant operated by Great River Energy in Maple Grove, Minn., decided to install continuous vibration monitoring to solve maintenance issues with rotary atomizers built by Danish company APV Anhydro AS. The decision helped them save money right away.

Immediately after commissioning, a new vibration transmitter detected a motor bearing fault in time to prevent an in-service breakdown, saving the plant at least $40,000 in motor repair costs, not including the cost of unexpected downtime. Within a week, a second transmitter detected an atomizer bearing problem. In this case, the bearing alarm was at "maintenance level" and the atomizer could remain in service while operators monitored its condition. That was a benefit because the backup atomizer was out of service for extended maintenance work and repairing the in-service atomizer could have cost as much as $15,000. Data now being generated may enable the plant to extend the service lives of those bearings in the future, saving still more money.

Atomizer Maintenance

The Elk River Station uses nearly 300,000 tons of refuse derived fuel (RDF) each year, producing 35 to 42 MW. Energy is conserved and the amount of waste entering area landfills is reduced by more than 250,000 tons per year, but a variety of undesirable materials must be removed from the burner exhaust gases. To help meet environmental regulations, Elk River Station uses a combination process designed to prevent the formation of dioxins during combustion. Special environmental equipment also treats the smoke and gases formed in the incineration process. Emissions from the station are normally low.

Atomizers are commonly used in power plant scrubbers to reduce airborne pollutants before they reach the bag house. APV's rotary atomizers spin at 12,000 rpm, spewing a fine lime/slurry mist throughout the scrubber chambers. The spray particles chemically react with the acid gases, forming a fine particulate (dust) that is collected in a hopper below or trapped in the downstream fabric-filter bag house to comply with EPA air quality regulations.

The atomizers are allowed to remain in service two weeks at a time before being removed for inspection and repair. The plant has three atomizer units available for its two scrubbers: two atomizers are in service while the third receives maintenance and is then held in reserve on a test stand until time to replace one of the other two. The precision bearings for these units have been replaced quarterly as a part of preventive maintenance. At $10,000 per atomizer bearing set, this amounts to $120,000 a year not including the cost of skilled labor required to make the changes.

Elk River Station management was looking for state-of-the-art protection for the atomizers. Emerson proposed the CSI 9210 machinery health transmitter, which has enough channels to monitor the drive motor as well as the atomizer bearings, to predict failures ahead of time and make repairs during regular hours when full maintenance support is available.

Continuous Monitoring

New systems such as the CSI 9210 transmitter are evolving for automated data collection and analysis. The new class of smart transmitters acquires vibration, temperature and machine speed data on driving and driven rotary equipment and calculates user-defined parameters, including PeakVue vibration values for early detection of bearing degradation. It issues alerts when necessary and recommends action to be taken through a PlantWeb alert. Results can be communicated via the Foundation fieldbus communications protocol to any host system, which in this case is Emerson's DeltaV plant automation system.

Using a machinery health analyzer to retrieve spectral data files captured by the continuous vibration transmitter at the Elk River Station. Photo, Novaspect Inc.

The transmitters mounted on the three atomizers at Elk River Station each monitor 10 parameters. Outputs include overall vibration velocity ranging from 2 to 2,000 Hz on two atomizer bearings and one motor bearing, maximum PeakVue waveform energy for early fault detection on all three bearings, two bearing temperatures, speed (tachometer also used as a belt-break detector), and one motor surface temperature. Transmitted data passes through quick-disconnect connectors on the Foundation fieldbus segment and then to the control system where operators can view a continually updated display.

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The CSI 9210 package monitors 12 input channels in a compact and field-hardened enclosure with fieldbus communications. Because so much information can be gathered and transferred within this transmitter, installation and engineering costs were reduced by about $35,000 at Elk River Station. Since each transmitter is mounted directly on an atomizer, a local junction box, field control panel and associated cabling could be eliminated. Use of the fieldbus technology reduced costs even further through less wiring, less conduit and fewer terminations. This installation allowed maintenance personnel to "kill two birds with one stone"—monitor the atomizers for excess vibration and eliminate a nagging control wiring problem.

A Bad Motor Bearing

Each of the CSI 9210 transmitters is able to monitor a drive motor as well as the atomizer on which it is mounted. This capability paid off immediately when the start-up crew noticed an abnormal PeakVue reading in the drive end bearing of the motor. The reading occurred during startup of the first monitoring system in June and prompted the plant to order new motor bearings as a precautionary step.

The information was forwarded to analysts at Emerson's machinery health management group in Knoxville, Tenn., where the initial diagnosis was that the bearing needed lubrication, which maintenance personnel did. A CSI 2130 machinery health analyzer validated the initial finding of the newly installed 9210 transmitter and the motor bearing was lubricated one more time. A few days later, operators saw the overall vibration jump to 30 times the normal level and the PeakVue reading topped out at 117 Gs, more than six times the fault alarm level of 18 Gs. The motor was shut down to prevent damage to the motor or atomizer.

Lubricant was not reaching the bearing at all, but piling up in the motor housing. The bearing was dry, confirming the original analysis, and might have seized up at any time, causing severe motor damage. Inspection of the motor showed it was undamaged and only needed the new bearing. By shutting down the unit when they did, the operators saved at least $40,000 in repairs.

An Atomizer Bearing

Within hours of shutting down this motor, a second atomizer equipped with a CSI 9210 transmitter went into service in the other scrubber. Almost immediately the drive end bearing registered a high PeakVue waveform value of 36 Gs above the maintenance alarm level for high-speed machinery. Associated PeakVue spectra for this measurement indicated an outer race problem with the bearing. Operators were alerted to monitor the PeakVue trend on this bearing using DeltaV. An order for atomizer bearings was placed and plans were made to replace the atomizer in two weeks, earlier if the readings continued to trend upward.

Fortunately, the velocity and PeakVue vibration readings did not change appreciably during the following two weeks, so when it was time to rotate that atomizer out of service, the decision was made not to replace the bearings. Instead, plant personnel continue to watch the data. Baseline data has been gathered on the atomizer bearing experiencing high PeakVue values as well as on the other bearings that were producing vibration levels more in line with expectations.

After a week on the test stand during which the atomizer wheel was cleaned and spray nozzles replaced, the same atomizer was returned to service in a scrubber. As long as the readings do not increase significantly, the atomizer will remain in service with extended bearing life and maintenance costs deferred until the predictive vibration monitor tells them it is time for replacement.

Value of Predictive Maintenance

Baseline data gathered during the ongoing operation of all three atomizers will be valuable in determining how long they can actually run before bearing replacement is necessary. If the runtime can be extended one month per atomizer so that only three replacement sets are needed per year, the plant will save $10,000 per atomizer. Longer runtimes mean greater savings and the stated goal is now replacement just two times per year.

The same is essentially true of the motor bearings. Already, the maintenance crew at Elk River Station has learned that the motors run better if the bearings are lubricated more often than called for in the OEM manual, with half as much lubricant used each time. Meanwhile, motor vibration data is being collected to help in predicting when motor bearings will need replacement in time to maximize their utility without risking unexpected downtime. pe