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Continuous Monitoring Enhances Bottom Line at Great River Energy

Great Savings for Great River

Continuous Monitoring Lowers Costs, Boosts Performance

by Robert Skeirik and Craig Truempi

The ability of continuous vibration monitoring to provide early detection of potential bearing problems in rotating equipment allows users to plan maintenance work in advance. This maximizes uptime by minimizing the impact of costly machine break downs. For example, Great River Energy, a wholesale electric power cooperative headquartered in Maple Grove, Minnesota, has saved tens of thousands of dollars after initiating continuous vibration monitoring as a means of solving maintenance issues at its Elk River Station power plant. In less than two weeks after installing monitors on the high-speed AVP Anhydro rotary atomizers in the exhaust gas scrubbers, two faulty bearings were identified.

Almost immediately after the first vibration monitor was commissioned, a motor bearing fault was detected in time to prevent an unexpected breakdown, saving the plant at least $40,000 in motor repair costs, not including the value of the unplanned downtime. If an atomizer were to stop operating due to a bearing fault, or any other reason, the plant might have to de-rate to 50 percent production while making repairs.

Within a week, a second transmitter detected an atomizer bearing problem at "maintenance level", which meant the atomizer could safely be kept in service while operators monitored its condition. With the information that the first atomizer had a severe bearing fault, it was decided to delay the planned maintenance and keep the backup atomizer available. This proved to be a wise decision as the bearing failed several days later. Without the backup atomizer, it could have taken as long as 12 hours to repair the failed bearing, costing approximately $15,000 in lost production. Predictive vibration monitoring prevented any such loss by showing that the second atomizer could continue to operate for some time.

Great River Energy is a not-for-profit cooperative owned by 28 member cooperatives throughout Minnesota. Collectively, these organizations serve about 1.7 million people. As the second largest electric power supplier in the state, Great River Energy owns and operates nine power plants capable of generating more than 2,500 megawatts of electricity.

The Elk River Station, which is located about 25 miles northwest of Minneapolis, converts nearly two million pounds of refuse derived fuel (RDF) every day into enough electricity to power about 30,000 homes. The waste is collected from five surrounding counties, and those materials that can be recycled as well as items that cannot be burned are removed, leaving 1000 tons of RDF to be consumed daily, producing high-pressure steam to turn the station's three power generators.

Energy is conserved, and the amount of waste entering area landfills is reduced by more than 250,000 tons per year. Emissions of methane, a highly active greenhouse gas, are also greatly reduced. An efficient combustion process is designed to prevent the formation of dioxins as the RDF is burned. Special environmental equipment also treats the smoke and gases formed in the process of incinerating this fuel. Still, despite all these efforts, some undesirable materials must be removed from the burner exhaust gases.

The AVP Anhydro atomizers are commonly used in power plant scrubbers to reduce airborne pollutants before they reach the bag-house. Spinning at 12,000 rpm, they spew a fine lime/slurry mist throughout the scrubber chambers. The spray reacts chemically with the acid gases, forming a fine particulate (dust) that is

Figure 1 - The Elk River Station is a Waste-to-Energy facility, which creates enough electricity to power about 30,000 homes.

Figure 2 - Keeping tabs on the equipment's condition from the control room at Elk River Station.

collected in a hopper below or trapped in the downstream fabric-filter bag-house. This is necessary for the plant to remain in compliance with EPA air quality regulations. Failure to comply can result in fines, but emissions from the station are normally very low.

However, the atomizers require a high degree of maintenance. In the past, they were allowed to remain in service only two weeks at a time before being replaced for inspection and repair. The Elk River Station has three atomizer units available for its two scrubbers. Typically, two atomizers were in service while the third received maintenance, and was then held in reserve on a test stand until time to replace one of the other two, after just two weeks in the scrubber. Even then, the expensive precision bearings for these units were replaced quarterly as a matter of preventive maintenance. At $10,000 per atomizer bearing set, this amounted to an operating cost of $120,000 per year plus the skilled labor involved.

Great River Energy management was looking for state-of-the-art predictive monitoring for these atomizers in this critical application. In response, Emerson proposed a vibration transmitter, which has enough channels to monitor the drive motor as well as the atomizer bearings. By monitoring vibration, including peak values, with the new transmitters, company officials expected to be able to more accurately predict failures well ahead of time, and make repairs during regular hours when full maintenance support is available.

Almost immediately after the first monitor was installed at the Elk River Station, a warning of excess high-pass vibration in a drive motor was received in the control room (see Figure 2). The information was forwarded to Emerson's Asset Optimization facility in Knoxville, Tennessee, where expert analysts made an initial diagnosis that a bearing was dry and needed lubrication. The operators continued to maintain a close watch on the vibration readings after the bearing was lubricated. Within only a few days, high-pass vibration in that motor suddenly jumped to 30 times the normal level, and the peak waveform topped out at 117 Gs, more than six times the fault alarm level of 18 Gs. The operators on duty immediately shut the motor down, preventing damage to either the motor or atomizer. See Figure 3.

Later investigation showed that no lubricant was reaching the bearing, but piling up inside the motor housing. This dry bearing might have seized up at any time causing severe motor damage. However, by quickly shutting down the unit based on the continuous high-pass vibration readings, the operators saved their company at least $40,000 in motor repairs.

When the second continuous vibration monitor was installed just days later, a high waveform value of 36 Gs was identified in the spindle bearing of the atomizer. Because the backup atomizer had to be kept in a "ready" mode, plans were made to delay replacement of the second atomizer for two weeks, depending on the vibration levels.

Fortunately, the spectrum and waveform readings on this bearing did not change appreciably during the following two weeks, so when it was time to rotate that atomizer out of service, a decision was made not to replace the high precision bearings at a cost of $10,000 per atomizer. Instead, plant personnel continued to watch the data with full knowledge of the current condition of the bearings.

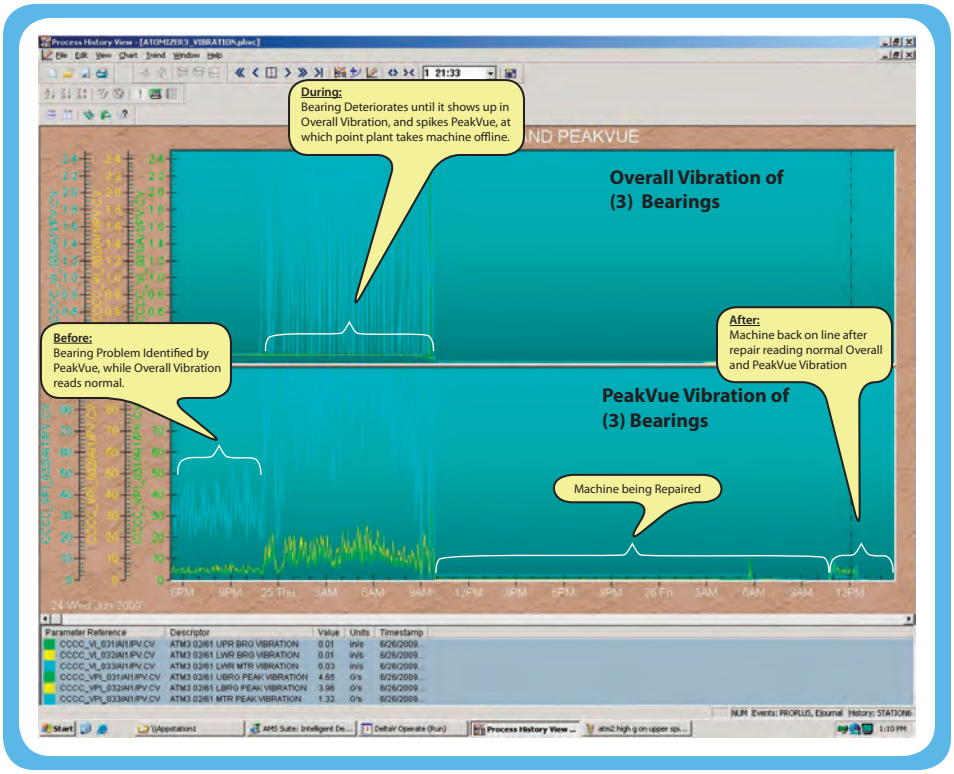

Figure 3 -- Trend Window of Vibration Data on Atomizer #3

Figure 4 - Checking Vibration Readings at Atomizer 2.

Continuous monitoring

Continuous monitoring of both overall and high-pass vibration provides assurance that essential equipment is always available. Smart transmitters acquire vibration, temperature, and machine speed data on driving and driven rotary equipment and calculate user-defined parameters.

The instruments mounted on the atomizers at Elk River Station can moitor multiplr parameters. Outputs include:

- overall vibration velocity ranging from 2 to 2000 Hz on two atomizer bearings and one motor bearing
- maximum waveform energy from 2000 Hz to 20,000 Hz for early fault detection on all three bearings
- two bearing temperatures
- speed (tachometer also used as a belt-break detector)
- one motor surface temperature.

When necessary, alerts are issued and corrective action is recommended and communicated to any host.

The data is passed to the control room, where it is trended and alarmed on the plant's digital automation system. Each atomizer is now allowed to remain in service until the readings indicate it is time for replacement. Since bearing run-time per atomizer has been more than tripled from three to six months and counting, this has extended bearing life and deferred maintenance costs. So far, the plant has saved $90,000 in parts costs over the nine-month period the vibration monitors have been in service.

Since each continuous vibration monitor transmitter utilizes FOUNDATION™ fieldbus communications, it was mounted directly on an atomizer, eliminating a local junction box, field control panel, and associated cabling, so installation and engineering costs were reduced by about $35,000.

Results of Predictive Maintenance

Never-before-available baseline data generated by continuous monitoring of the atomizer bearings is now used to determine how long they should be able run before bearing replacement is necessary. According to Glenn Hauck of Great River Energy, "Early bearing fault detection allows us to predict bearing failures so we can plan ahead for work on the atomizers and avoid lost production."

The goal at Elk River Station is to extend run-times so atomizer bearings are replaced only when necessary – a direct benefit of predictive maintenance. The vibration data are also helpful in predicting when motor bearings will need replacement to maximize their utility without risking unplanned downtime.

Needless to say, continuous vibration monitoring has already reaped enormous benefits for Elk River Station power plant, and will continue to do so into the future.

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