Ultrasonics Inspections Avert Motor Failure; Ohio Food Processor Saves $250,000 Over a Decade

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Cargill Foods has been in operation since 1978. The company started out as a soybean-crushing facility extracting oil from soybeans and selling the meal as a protein supplement for animal feed. In l99O, the company expanded, opening a new plant refining its own crude oil. A year later it added a hardening plant which makes different hardnesses of oil for cooking and cooking processes, used in such foods as margarine and the centers of Oreo cookies. Then in 1995, Cargill Foods built a packaging plant where they produce oils for companies like McDonalds and Burger King. Just last year it opened a salad dressing and mayonnaise manufacturing plant. Today Cargill Foods has 350 people at these various business units in the facility.

"We first used ultrasonics technology to inspect bearings 20 years ago, and we have been delighted with the results," says Terry Harris, Facility Maintenance Manager, with Cargill Foods in Sidney, Ohio. "From 1984 to 1991, for example, we operated

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without losing a single motor because of either motor-bearing or pump-bearing failure, and we did not have any unscheduled emergency downtime. It has been an enormous boon for the plant and has contributed significantly to the company's profitability and growth"

Although the company uses ultrasound techniques for other maintenance inspections such as on steam traps and electrical fittings, it is as a means to monitor bearings that it has seen the most dramatic results. "Before we started using ultrasound, we were losing five to six motors a year. Assuming that and hour's downtime in peak season would cost us approximately a thousand dollars per hour, and since it usually takes three to four hours to change a motor," Harris estimates that "ultrasonics inspections saved the company close to a quarter of a million dollars in less than ten years."

"Our maintenance philosophy has always been to do frequent equipment checks and inspections to help determine when equipment might fail," Harris explains. "Then we can schedule repairs. All failures are critiqued, for example, changes in design, improved components, better maintenance procedures.

"Mechanical inspections are a plant-wide effort. Operators and supervisors make daily, weekly and monthly rounds and report defects. The idea is to be proactive and detect problems before they result in failures and/or unscheduled downtime. Ultrasonics is one of the tools we use in this effort," says Harris.

The "Magic" of Ultrasonics

Operating mechanical equipment produces a normal sound signature when operating effectively. As components begin to fail a change in the original sonic signature occurs. This change can be noted on an ultrasonic instrument's meter, or on a recording device such as a portable PC or portable vibration analyzer. The sound quality may also be heard through headphones.

The high-frequency, short wave characteristic of ultrasound allows the signal to be isolated so that a user can hear and determine if a bearing is malfunctioning. Sometimes motors can generate false signals because of a particular bearing. By adjusting the sensitivity and the frequency and listening carefully to the sound, an inspector can determine whether it is the bearing, the rotor or something else that is at the root of the problem. This ability to hear what is going on inside a machine can prove to be of vital importance.

This is accomplished in most ultrasonic translators by an electronic process called "heterodyning" that accurately converts the ultrasounds sensed by the instrument into the audible range where users can hear and recognize them. This high frequency, short wave characteristic of ultrasound enables users to accurately pinpoint the location of a leak or of a particular sound in a machine.

Most sounds sensed by humans range between 20 Hertz and 20 kHz (20 cycles per second to 20,000 cycles per second). The average human threshold is actually 16.5 kHz. These frequencies tend to be relatively gross when compared with the sound waves sensed by ultrasonic translators. Low frequency sounds in the audible range are approximately 3/40 up to 569 in length, whereas ultrasounds sensed by ultrasonic translators are only 1/80 up to 5/80 long. Since ultrasound wavelengths are magnitudes smaller, the ultrasonic instrument is much more conducive to locating and isolating the source of problems in loud plant environments—a major contributing factor to its popularity.

Ultrasound inspection provides bearing information through headphones, as intensity readings on a meter/display panel or on a recording device such as a portable PC or portable vibration analyzer.

Ultrasound detectors work especially well on slow-speed bearings. In some extreme cases, just being able to hear some movement of a bearing through a casing can provide information about potential failure. Even if the sound does not have enough energy to stimulate classic vibration accelerometers, it will be heard via ultrasonic translators, especially those with frequency tuning.

How Cargill Sidney Conducts Ultrasonic Inspections

"In the beginning, when we were just a crushing plant with 1,000 motors, inspectors used our ultrasonic instrument to check all motors on a monthly basis," Harris says. The plant inspected using a fixed setting on the instrument. If a reading was high, the motor was scheduled for a replacement or a rebuild.

"Today, we have 3,000 motors and a team of eight maintenance people. Each month they check all motors in the plant with the ultrasonic instrument," Harris continues. "Inspectors can download information from the instrument directly into our computer system. They check the bearings on both ends of every motor. If it's hooked to a pump they also check the two bearings on the pump and the bearings on the fan if the machine is hooked up to one."

The key to mechanical inspection is consistency; variables should always be kept to a minimum. To accomplish this, whether troubleshooting or trending equipment, a test point should be established. This point can then be used for comparison with other test points on similar equipment or compared with itself over time. For example, for bearing inspection, to determine whether a bearing is in a good or in failed mode, inspectors touch the bearing housing using the ultrasonic instrument's contact probe at one point and get a specific meter reading. They then compare this reading to a similar reference point on a bearing operating under the same conditions. The meter reading and the sound quality should be similar. This same reading can then be used to trend each bearing over time to determine failure mode.

Harris finds that when bearings are worn badly and are left unattended, the stator and the rotor rub against each other because the air gap between these two components is only a few thousands of an inch. Changing the bearings in time avoids costly motor rewinds and rebuilds. Using an ultrasonic instrument equipped with a stethoscope probe accessory, inspectors can detect this situation and deal with it before it escalates.

Ultrasonics also reveals if a bearing is dry or under lubricated. "Usually we do not lubricate motors because on most of them the bearing are sealed so lubricating would simply mean putting grease on the outside of the seal which would not be very effective. Grease on a motor that is failing is just a short term fix," Harris explains. "We do it only until we get around to changing the motor. Lately, however, we have started to lubricate the larger, new motors to extend their lives and also have rebuilt motors coming back in with new bearings and seals. True, motor bearings are sealed, but these seals do have a gap that allows grease to flow in and out of the bearing."

"Inspectors record the readings en route and then bring them back to the office," Harris explains. "We use these readings to determine which motors need to be changed, then we have another inspector return to the machines and to verify that the motor continues to malfunction. If a problem is confirmed, we schedule a suitable time to replace bearings so as not to disrupt manufacturing operations. This ability to schedule downtime is what prevents losses and saves us money."

An Ounce of Prevention

According to NASA research, ultrasonic monitoring of bearings provides the earliest warning of bearing failure. An increase in amplitude of a monitored ultrasonic frequency of 12-50 times over baseline will indicate the initial stages of bearing failure. This change can be detected long before it is indicated by a change in vibration or temperature.

"With ultrasonic inspection techniques, we can determine problems such as cavitation in pumps, compressor-valve leakage, faulty gears, excessive rubbing, and poor electrical connections in their early stages before break down," Harris concludes. "Should a vibration inspection program already exist for bearing analysis, ultrasonics technology is extremely compatible and will greatly enhance the work of any maintenance department."

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Ultrasound inspection of bearings provides early warning of potential failure and helps determine if a bearing needs lubrication.