The variety of uses for these two dynamic technologies and the tools that facilitate them is astonishing. Using them in tandem is a great way to increase the success of a PdM program.

These days more and more companies are outsourcing their predictive maintenance (PdM) programs. Perhaps they don't have the manpower and time to devote to a comprehensive PdM program. Or, as the pace of change in available technologies rapicly increases, just keeping abreast of the latest developments could be a full-time job all by itself.

PdM programs reduce repair costs and downtime, while optimizing safety and reliability. Two predictive maintenance tools essential to such programs are the airborne ultrasound probe and the infrared thermal imager. Used individually, either of these tools can provide good results. Based on my own experience, using them in combination is better.

The tools of our trade

My job is to locate problems and provide qualitative data so that a company can make data-driven decisions regarding maintenance timing. Working at a taconite mine, we would use airborne ultrasound probes and thermal imagers for anything from motor and conveyor bearings, to air leaks, to all components of our electrical power systems. These instruments also can be used with steam traps, roof leaks, moisture problems and energy audits.

How much does an unplanned shutdown cost? At the taconite mine, lost production costs ranged from $1000 to $5000 per hour.

What does it cost if a motor bearing fails and not only shuts down production, but damages the windings and/or the shaft of the motor as well? Using airborne ultrasound and/or thermography to locate anomalies and impending failures before they occur allows a company to schedule maintenance efficiently. This helps maximize production, lengthen equipment life, and improve safety.

Airborne ultrasound. These instruments generally sense sounds in the frequency range of 20 kHz to 100 kHz, which is beyond the human hearing range. The high frequencies generated by a variety of air and gas leaks, worn bearings, and faulty electrical equipment are electronically translated down to human hearing range by a process called heterodyning. At this point, they can be heard through headphones and viewed as intensity levels on display panels or meters. Wearing headphones and either touching the instrument to a test spot or pointing it at a target, technicians can hear ultrasonic sounds and determine their sources. The shortwave characteristic of ultrasound provides three major advantages.

- The source of the ultrasonic sound can be identified with little interference from competing sounds.
- The applications for ultrasound are numerous; they cover most potential mechanical, electrical and leak problems.
- Potential failure conditions can be detected, trended and analyzed earlier than is possible with traditional PdM technologies.

Infrared thermography.

Infrared thermal imaging measures infrared radiation that all objects warmer than absolute zero give off in proportion to their temperatures. This type of radiation is invisible to the human eye. Thermography provides images depicting the relative temperature differences of the objects under scrutiny. One can view these ÒpicturesÓ for anomalies, either hot or cold, to locate problems and to determine appropriate corrective actions.

To prevent costly mistakes, it is important to be trained in the safe and proper operation of these instruments. For proper inspection, both technologies normally require the equipment under inspection to be running and under load. The advantage to this is that there is no need to shut down operations or disrupt valuable production schedules to use either type of instrument.

When frequently and properly used, airborne ultrasound and infrared individually offer a quick return on investment (ROI). Combined use accelerates the ROI. The following examples illustrate the benefits of using these technologies in tandem.

Electrical disturbances

Electrical utilities cannot afford power outages. Yet, one such utility in Minnesota had not conducted an infrared inspection in nearly seven years and had never performed an airborne ultrasound inspection.

While conducting an infrared survey for this utility, I noticed a hotspot on an overhead disconnect, indicating a failing connection. Using airborne ultrasound on the same connection, there did not appear to be a problem. When the utility checked the disconnect, everything appeared to be normal until a lineman re-energized it. At that point, the connection began arcing. Locating this problem allowed the utility to repair it promptly, thereby preventing a future unscheduled power outage. In this case, the outage would have affected customers in three towns, over several miles of power lines.

In another situation with this utility, on an extremely humid day, I discovered arcing on an insulator between a power line and a power pole. The ultrasonic emissions from this insulator indicated a crack. Infrared, however, did not detect the problem. Without intervention, the cracked insulator would have eventually caused a power outage.

Although many electrical problems will be revealed by both technologies used individually, there are applications where one will detect a problem and the other will not. Use of both instruments optimizes detection of problems.

Electrical problems usually show up as either temperature changes, which infrared detects, or as electrical emissions, producing ultrasonic frequencies, which ultrasound instruments can detect. Using the two technologies together provides a more complete electrical survey than either can provide by itself. Each technology has its own advantages. Ultrasound, for instance, can detect corona (while infrared cannot) because corona does not generate heat. Ultrasound detects arcing and tracking at earlier stages than infrared, which detects the build-up of heat resulting from arcing and tracking. On the other hand, since infrared detects heat, it will identify problems that do not generate sound, such as those caused by high resistance. An example of this would be a corroded or improperly crimped splice in a power cable.

Playing it safe

Safety while performing infrared inspections on loaded electrical equipment, including switchgear and bus ways, can be increased greatly with the use of airborne ultrasound, prior to performance of the infrared inspection.

Such an inspection cannot be performed through closed panels or covers. But, by scanning around panel covers, seams, and vent holes of electrical equipment with the airborne ultrasound probe, it is possible to detect arcing, tracking, and corona problems, before opening up live electrical cabinets. This reduces the chances of an arc flash explosion occurring when opening the cabinets. Explosions like this can be deadly, generating metal vapors and temperatures up to 35,000 F. Having advance warning of such problems allows for the equipment to be de-energized. The infrared inspection can be safely performed immediately after de-energization and the necessary repairs can be made.

Detecting freon leaks

Ultrasound and infrared technologies work well together to locate underground leaks. One such application where I used them in combination was in the pinpointing of freon leaks at an indoor ice arena. Freon was the refrigerant used in the rink's cooling system.

Rink employees could tell by a drop in pressure on the cooling system's gas gauges that it was losing freon, but they could not find the leak. Freon is not only expensive, it is damaging to the environment when leaked into the atmosphere. If left unrepaired, a freon leak could also destroy the rink floor, causing it to heave. Multiple leaks with severe heaving could require the replacement of the entire floor, at a possible cost of $300,000.

On start-up of the ice plant, I scanned the rink with infrared for abnormally cold areas that might indicate a possible refrigerant leak. (There was only a small window of time for performing this scan, since frost would form on the surface of the rink fairly quickly and mask the cooler areas. This would make the entire surface appear to be the same temperature.)

Normally, in this type of application, there should be a pattern indicating where the refrigerant lines lie. Leaks should appear as large round or oblong spots. During the scan, I marked the abnormally cold areas.

Next, I employed ultrasound, using the ultrasonic instrument with its contact module, and listening for the loudest ultrasonic signal. This pinpointed the source of the leak within inches. Such accuracy was necessary because of the risk of damaging nearby lines during repairs.

While the infrared imager drastically cut down the ultrasound probing time, alone, it would not necessarily have indicated the precise source of the leak, since refrigerant flows away from its source.

Picking out bearing problems
Combining ultrasound and infrared also proved to be an invaluable technique when it came to inspecting bearings at a large distribution warehouse. On this project, I surveyed conveyors incorporating many motors and thousands of roller bearings, most of them in hard-to-reach areas.

An initial infrared scan identified bearings with abnormally high temperatures. Then, utilizing the ultrasonic instrument with its contact module, I listened to determine if the overheated bearings were defective or experiencing a lubrication problem.

If the problem appeared to be under-lubrication, maintenance personnel, aided by the ultrasonic instrument, properly greased the bearing, After a few minutes, I would listen to the same bearing. A recurring signal was an indication that the bearing needed to be replaced.

While ultrasonic signals do appear in bearings before there is a noticeable temperature rise, on this warehouse project, it was not feasible to inspect each bearing using ultrasound. In this case, failure of certain conveyor motors or roller bearings could have shut down the operation at a cost of $2000-$10,000 per hour, for as long as two to three days, while a motor was being rebuilt or while waiting for new components to arrive.

The bottom line
Using a combination of ultrasound and infrared is a way to move PdM to a higher level. In my work, I have found that organizations are more receptive to such activities when they discover the savings that can be achieved.

Whether a company has an overworked maintenance department, limited access to predictive technologies, or time is of the essence, turning to an expert for predictive maintenance needs will help increase equipment reliability and availability, while reducing costs due to unplanned outages. Leveraging ultrasound and infrared technologies together is a value-added technique for ensuring the desired deliverables.

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