Too Big to Fail: Predictive maintenance protects heavy-duty mobile assets

Contributed by Allan Rienstra and Gus Velasquez

Ultrasound as a predictive maintenance (PdM) tool is used in many applications in industries of all kinds as an inspection tool for detecting positive and negative pressure leaks, such as those found in compressed air systems or vacuum pumps. Some industrial processes use ultrasound to identify failed steam traps, and all facilities derive safety benefits from its ability to find electrical faults. Most recently, PdM professionals have opened their eyes to the benefits it offers as a predictive technology, giving early alert that an impending problem is developing in a bearing or helping to optimize the lubrication of rotating equipment.

All of these valuable applications contribute to billions of dollars saved in downtime, energy efficiency and improved product quality. Perhaps most interesting of all is that most of these inspections are carried out on fixed assets.

However, in many companies, such as mines and quarries, the production cycle depends on heavy vehicles, loaders and off-road vehicles. These have a range of applications, such as moving goods from land points to sea ports and beyond, excavate earth and move thousands of tons of raw materials in quarries and open-pit mines.

Although their size can vary between 30 to more than 350 metric tons, they all have in common an internal combustion engine to provide the power to move the vehicle. Most have a cabin to keep the operator safe, dry, warm or cool while others have storage volumes, which must be weather tight and hermetically tight in the case of chilled-container transports. And in many cases, compressed-air systems are used for breaking and suspension systems.

To protect the investment in these mobile assets, preventative and predictive maintenance is performed on a regular basis. Most fleet managers rely on oil analysis for PdM â€" while other PdM technologies, such as ultrasound, vibration and infrared, are seldom considered. Additional investments in these technologies is not a priority; however, there are several important applications that can be served with ultrasound technology that are not currently understood.

How does it work?

Many people in maintenance departments of factories responsible for fixed assets know that the principle source of ultrasonic waves is turbulent flow, friction and discharge related to electrical problems. They also know ultrasound waves are sound waves vibrating over 20,000 Hz, which is impossible for humans to hear without the help of special instrumentation, such as an SDT170 ultrasonic measurement instrument.

Early stage problems produce ultrasonic signals that are transmitted from the source as ultrasound pressure waves. The instrument detects these waves and translates them into an audible signal that can be heard by the inspector, all the while measuring the ultrasound signal so it can be compared and trended to determine gradual deterioration.

A growing demographic of qualified and skilled ultrasound inspectors is poorly represented in the mobile maintenance shop where the technology is virtually unknown, and sadly, many cost-saving applications have not been revealed. If you are working in the maintenance department responsible for mobile asset maintenance, look for applications in diesel engines, hydraulic cylinders, air-braking systems, air suspension and cabin tightness.

Diesel Engines

Internal combustion engines burn fuel, and regardless of size, they require air. The air we breathe is the same air engines breath. No matter where we are on the planet, air contains particles in suspension. Some of these particles are harmless, but others represent a serious danger. Silica ranks as one of the hardest elements on earth â€" and also the most abundant.

All diesel engines have primary and secondary filters fitted between the air intake vents and the turbocharger. When the engine is operational, a negative pressure is created in the air intake system, and any leaky orifice (loose clamps, cracked hoses, pin holes) downstream of the filters means the engine is breathing without filtration. This means air full of silica can reach the pistons, rings, sleeves and other engine components, causing damage and premature failure.

Oil analysis is used as a predictive tool, comparing the metal content and silica in parts per million (PPM) found in the oil sample against limit values set according to the engine manufacturer. When a sample shows values over the limit, the contamination source needs to be found quickly and the mobile asset must be removed from service to avoid further damage. As a companion to visual inspection, ultrasound testing to find the leak will net quick results.

â€¢ Inspection with the engine running: Start the engine and leave it to idle. With noise attenuating headphones, adjust the sensitivity of the SDT170 according to the ultrasound sources near the engine. Using the flexible sensor for safety (if you have one), inspect the entire intake system starting from the air breather and ending at the turbocharger. Any air ingress will produce an ultrasonic signal that sounds like the hissing, swooshing sound you know from a compressed air leak.

A well-trained ear will pick up this sound quickly despite competing noises. Additional training teaches ultrasound inspectors how to deal with parasite noise and harsh environments and is highly recommended for mobile mechanics

that are adopting ultrasound testing.
â€¢ Inspection with the engine turned off: The air intake system can also be inspected for leaks when the engine is not running. In fact, this may be more desirable if the parasite noise from the engine is too much. In lieu of turbulent flow, we can generate artificial ultrasound signals in the air breather system. This is done by means of an SDT 200mW Bi-Sonic Transmitter, a small accessory that generates a 40-kHz signal powerful enough to fill small volumes. The signal can be heard and measured directly through the various membranes that make up the air breather system.

A large mining company in northern Canada recently shared their experience inspecting the air intake on a LeTourneau production loader. In response to very high levels of silica and iron from oil samples, an attempt was made to determine if there were any leaks in the breather system. A visual inspection failed to produce any definitive results. A second check of the breather system was conducted using airborne ultrasound. Finding the leaks was easy, the mining company reported, and the mechanics reported that the fix was relatively simple once the leaks were discovered. The production loaderâ€™s oil was re-sampled after about 48 hours operating in the field, and all indications of dusting had disappeared. Ultrasound inspection of air intake systems is now standard practice at this site.

n Hydraulic Cylinders: Hydraulic cylinders are widely used in fixed and mobile hydraulic systems. Seals are one of the most important components: they create a barrier between the high-pressure and low-pressure chamber. When the integrity of seals is compromised, the cylinder no longer transmits its full force potential. A sure symptom that the cylinder has problems is a loss of power and/or slow operation. In severe cases, the cylinder can stall even under light loads. An increase in pump noise and temperature is also a sign of leaking cylinders. A leading cause for failures is contaminated fluid.

A conventional method to check for leaks requires an operator to run the piston to one end of its stroke and leave it stalled in this position under pressure. Then they crack the fitting at the same end of the cylinder and check for fluid leaks. This is time consuming and requires the asset to be out of service for a longer time than necessary.

Ultrasound can speed this up, and in many instances, the inspection is performed in the field, avoiding the cost and delay to float the equipment back to the repair bay. The inspector places the contact sensor or magnetic sensor over the barrel near the piston. The system is put under pressure and the sensor scans around the barrel 360 degrees while listening for the characteristic sound produced for a leak when the fluid pass from the high to low-pressure chamber. This sound could be that made by small bubbles of oil bursting on the non-pressure side of the wiper. In the case of larger leaks, the sound is more like a squishing sound as oil is forced across a small orifice in the seal. The point where the signal is most intense indicates the integrity breach of the seal.

Air-Operated Brake Systems
Air-break systems are used in all type of trucks, buses and rail cars. For an efficient operation, the system must be absolutely tight. Brake-systems manufacturers establish pressure guidelines for all circumstances, and this working pressure must be maintained. These systems have several parts, including the compressor, an air dryer, valves, air reservoir tank, pipes, fittings and the system itself â€” all susceptible to leaks.

Finding the leak is easy and fast. In fact, many manufacturers â€” including Volvo Trucks and Mack Trucks â€” already use SDT170 detectors on the assembly line to ensure leak-free brake systems. Start the engine and let the compressor run until the required pressure is reached in the system. Turn off the engine and, using the detector with the flexible sensor, scan from the compressor side to the brakes in the wheels.

The hissing sound of any leak will be easily heard, and because itâ€™s ultrasonic, itâ€™s directional and easy to localize.

Air-Suspension Systems
Air-suspension systems provide a much smoother ride, which can add protection to cargo that is sensitive to transportation shocks. The air spring is basically a bellow filled with compressed air and run off the same compressor that the braking system uses. Leaks in the air suspension system affect the smooth ride, but also can draw on the brake system making it unreliable, and therefore unsafe.

There is, of course, the added risk for a vehicle transporting several tons of cargo; when the air spring loses its pressure, there is the chance of balance loss and tipping. Troubleshooting air suspension systems is essentially the same procedure as that used for braking systems.

Cabin Tightness
A final but important application where ultrasound inspection is usefully employed ensures the tightness of cabins and cockpits. In smaller vehicles, tightness is important to prevent noisy interiors from wind noise and water leaks. On larger mobile assets like loaders and tractors, keeping micron sized dust particles out of the cabin is a comfort and health issue for the operators.

The inspection is simple: place a 200-mW tone generator inside the cabin and close all windows, doors and vents. Using the SDT170 and flexible sensor, scan the outside seals on all windows and doors. The artificial ultrasound source is powerful enough to fill the entire cabin and transmit directly through glass and steel. Follow this procedure to understand the difference between a leak and non-leak.

While great progress has been made applying ultrasound to inspections on fixed assets, there are equal wins to be gained from applications on mobile assets.

As ultrasound technology proliferates around the globe, one canâ€™t help but wonder what other simple applications exist that will help a company save the next million dollars.

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