Making CbM effective

A guide to condition-based monitoring programs, and in particular, ultrasound detection.

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Condition-based monitoring (CbM) is a maintenance process where the condition or health of plant equipment is monitored for the earliest signs of impending failure. Equipment can be monitored using sophisticated instrumentation such as vibration and infrared detection equipment or ultrasound technology using high-frequency sound waves to pick up potential performance malfunctions in mechanical, electrical and fluid systems that are ordinarily indiscernible.

An effective CbM program offers several benefits, ranging from improved asset availability and increased production to the significant reduction of energy consumption.

Instrumentation used as part of the CbM process should provide critical and accurate data needed to optimize the scheduling of downtime, labour and materials, so that productivity is increased while overall costs are reduced.

The health of equipment can mean the difference between meeting production goals and total chaos. For example, if one critical bearing fails during a production run, the consequences can be catastrophic, resulting in potential equipment damage, cancelled production, possible product damage and parts that must be ordered for repair, plus considerable man-hours wasted.

Excessive heat indicates component failure, especially the degradation of electrical contacts that may be hidden behind enclosures.

CbM programs help eliminate these potential disasters through a proactive and disciplined approach to predicting the possibility of failure, while administering consistent maintenance techniques as needed to prolong this inevitability.

An effective CbM program does not have to be extremely complicated, nor does it have to require a large investment of capital in order to effectively analyze, report and trend data logged during the monitoring process for machinery within the plan.

Vibration analysis

The most commonly used technology for CbM, especially for pumps and other rotating machines, is vibration analysis. Measurements are taken of the bearing casings or the rotating shafts. The level of vibration can be compared with established standards to assess severity.

The use of Fourier algorithms, frequency and harmonics help to locate the causes of the vibration and point the way to eliminating it. For example, high vibration that increases with the speed of rotation can be traced to imbalance, which can be rectified by design modifications to the machine.

Thermography

Another CbM technique is thermography or infrared, involving the detection and measurement of infrared emissions related to heat. It is a combination of visual inspection and non-destructive testing (NDT).

Excessive heat is indicative of component failure, especially as in the degradation of electrical contacts and terminations, and in the later stages of bearing failure.

Infrared condition monitoring may be performed by examining samples of debris suspended in lubricating oil under an electron microscope, then using instruments to measure, identify and determine the morphology. This procedure will offer clues as to the defect's cause, location and the time to eventual failure.

Ultrasound

Vibration and infrared analysis are complemented by still another inspection technique — that of airborne/structure-borne ultrasound. Ultrasound is produced by friction, ionization and turbulence, which is why ultrasonic instru-

ments are so effective in testing mechanical, electrical and fluid systems.

These instruments identify early warnings of mechanical failure; locate arcing, tracking and corona in electrical gear; and detect all types of leaks from most applications.

Of note, with increasing energy consumption costing plants hundreds of thousands of dollars annually, ultrasound instruments can also locate faulty steam traps and compressed air leaks. Locating these leaks early and accurately correcting the problem can save plants countless dollars in downtime and energy waste. This procedure involves the diagnosis of high-frequency sound waves.

Most ultrasound instruments are lightweight and portable. They do not require a separate box and cable, which can be cumbersome and potentially unsafe if maintenance personnel are required to carry instrumentation around the plant, in tight areas or on ladders.

Ultrasound instruments translate high-frequency sounds produced by operating equipment down to the audible range where they can be heard through headphones and precisely viewed as intensity levels (decibels) on a display panel. Some ultrasound instruments record test datalog test information only, while others have on-board sound recording along with a data logging capability.

The ability to view sound levels while simultaneously listening to sound quality enhances the monitoring effectiveness, allowing inspectors to quickly identify changes in equipment (e.g., bearings) that occur, simply by hearing the increases in decibel levels or changes in sound quality. Ultrasound also allows inspectors to accurately track subtle changes in vibration or pick up mechanical movements — fault conditions that can't always be detected by vibration or seen by infrared technology (e.g. equipment behind closed doors, enclosed switchgear or transformers).

The sensing of high-frequency sounds through ultrasound also has unique advantages when considering the most effective CbM instrumentation. Sound emissions are localized to the point of origin, making it easy to identify or monitor the location of a problem sound with no cross-talk from other mechanical components. When monitored, subtle changes can be detected and trended before they ever reach the critical failure stage.

Bearing lubrication

Because friction is one of the major contributors to bearing failure, bearing lubrication programs are enhanced with ultrasound technology. As it is related to lubrication issues as well as other applications, it is important that friction is easy to determine, analyze and trend.

Many lubrication programs are based on preventive maintenance, in which equipment is lubricated according to a time-based schedule with pre-determined amounts of lubrication applied. If this approach is followed without any feedback regarding the condition of the application, it may lead to over-lubrication or lubrication starvation, which will eventually lead to equipment failure.

To avoid this, many maintenance departments are using ultrasonic condition-based monitoring programs in combination with predictive maintenance procedures, allowing for pinpoint accuracy with regard to lubrication.

CbM strategies

Aside from the technology used, in order to implement an effective CbM program, it is necessary to create strategies that use available manpower efficiently.

Documentation is all-important. A method of recoding all test data and a method for analyzing that data is critical to the success of any condition-based program. Routes must be planned that are manageable and logical. A route should consider a logical sequence so that an inspector is not wasting time. Scheduling of inspections should depend upon such criteria as criticality, potential for failure and safety.

Regarding safety issues, if the instrument is to be used in potentially explosive or reactive environments, look for an intrinsically safe rating. It is also smart to use accessories such as detachable modules that easily pull away from the front-end of a detection instrument should its sensor (instrument probe) get caught in rotating equipment.

When selecting an ultrasound instrument, you should also consider how it will be used. As an example, if sound analysis is important, the instrument should have sound recording capability and be supported by spectral analysis software. If the instrument is to be used to test both airborne emissions such as gas leaks and structure-borne equipment such as valves, pumps and motors, frequency tuning can help make subtle sounds more apparent.

If data is important for trending and reporting purposes, look for a digital instrument with data logging. Software that accompanies the instrument is an important feature. Be sure to consider whether the software will support your ultrasound CbM program.

Above all, consider the detector manufacturer's reputation. Some suppliers offer inexpensive, simple products but don't realize the limitations of these types of instruments. If you need a simple or sophisticated probe, the supplier should be able to provide you with sound advice to meet your inspection needs.

The benefits of ultrasound condition-based monitoring programs are quite substantial. The initial investment is relatively inexpensive, while the return on investment is potentially immense. To help push your program along, it is also advisable to attend a training course. There are certifiable courses available that cover all the major applications and provide the information necessary to implement a successful program. When choosing technology to monitor equipment, ask the company you choose about customized training opportunities to assure a quality CbM program. **MRO**

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