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Today's most successful lubrication programs—*those that boast high percentages of equipment availability and enviable machine longevity* —depend heavily on identifying contaminants in lube oils and other factors that can cause mechanical damage. Identification of the root causes of internal damage is definitely part of effective lubrication management. Information on the type and extent of contamination then can be utilized for predictive maintenance to avert breakdowns and extend equipment life.

Too often, however, a "lubrication program" is limited to selecting the correct lubricant for each type of machine and following recommended oil change schedules.

The most effective lubrication programs seek to identify the presence of contaminants and apply that information as a guide to future maintenance. Such programs seem to reflect the following commonalities:

- A motivated manager who is passionate about protecting plant assets and takes the initiative in establishing contamination controls;
- Periodic on-site analysis of oil samples taken from operating machinery; and
- Corrective maintenance based on predicting trouble ahead.

Periodic monitoring for metal fragments, dirt and debris, water and other contamination in a lubricant leads to the early recognition that internal damage may be occurring. Maintenance or repairs in response to such knowledge make it possible for these machines to run longer than ever imagined—*which can lead to substantial economic benefits for a facility*.

An effective program

An effective lubrication and oil analysis program at the General Motors Truck and Bus Assembly Plant in New Jersey recorded an ROI of 738% on the expenditure of $100,810, after a critical gearbox failure caused a very costly 27-hour shutdown. On-site oil analysis yielded reliable information regarding the condition of lubricating oils, and timely oil replacement plus some necessary repairs allowed Maintenance personnel to quickly bring the problems under control. Simply eliminating damage to machinery resulted in documented savings of $1.6 million over the next 28 months, not including the savings achieved in avoiding unexpected downtime.

Predictive maintenance

Predictive maintenance (PdM) has been shown to be less costly than either reactive maintenance (i.e. fixing something after it breaks) or preventive maintenance, which requires significant staffing to perform the numerous tasks recommended by machine manufacturers. PdM programs are built on field-generated information that is evaluated by managers and supervisors in determining just when to perform maintenance in order to maximize productivity without endangering a machine or chancing downtime. Information on the condition of each machine is matched against its importance in the overall production process. Machines that are critical to maintaining production—*key turbines, compressors, pumps, etc.*—are watched carefully so as to predict future performance. When lubricant samples reveal signs of degradation in such a machine, managers have to quickly determine whether immediate repairs are necessary to prevent a catastrophic failure or whether they can wait for a regularly scheduled shutdown to make repairs.

Oil analysis enabled a large pulp and paper mill in the southeastern U.S. to avert the failure of a wood chipper that could have cost the company as much as $100,000 in repairs and lost production time. Fragile babbitt bearings guiding the chipper shaft were fragmenting, possibly due to a slight misalignment or imbalance, and the wood yard supervisor was not aware of the condition. Fortunately, the source of the fragments was identified through analysis of oil samples from the chipper and repairs were performed in time to prevent an unplanned shutdown.

The chipper had been receiving what was considered adequate lubrication—*a quarterly oil change along with filtration*

. However, calendar-based lubrication often is not satisfactory, especially in dirty, dusty areas where oil quickly can become contaminated.

In less critical cases, predicting the runtime of a machine based on its lubricant may result in slating that machine for repair during the next scheduled maintenance period. If the oil is in good condition when tested, it even may be possible to extend the time before an oil change. Lubrication is always most effective and cost-efficient when oil changes are based on the condition of the lubricant, not a predetermined schedule.

The analytical program

The condition of operating machinery may be determined best through a well-structured program of lubricant sampling and oil analysis—but not all oil analysis programs are equal. Just because your plant engages in some form of oil analysis, you can't assume that your machinery is well protected.

The purpose of oil analysis is to identify lubricant components that indicate wear caused by abrasion, adhesion and corrosion. Careful sampling, reliable testing and knowledgeable analysis of the test results are the basic elements of a solid program to determine whether lube oils are contaminated or changed in character. This information can be crucial in predicting when maintenance should be performed.

Sampling…

Samples should be collected and tested often enough to detect contamination and chemistry problems and to establish trends. It's important to be sure sampling is frequent enough to give maintenance personnel time to respond. For example, if contamination due to a bad seal could lead to damage within three months, samples should be taken from that machine at least monthly to identify a problem early enough to replace any faulty seals. In other cases, experience may show that periodic sampling can be extended.

How many samples should be collected? Every plant is different, but most can realize excellent cost savings based on knowledge gained by collecting, testing and analyzing about 100 lube oil samples each month. Some intensive programs actually test more than 1000 samples per month.

Rule of Thumb: If there are 3000 vibration points in the oil lubricated pumps, motors, compressors, turbines, gearboxes, air handlers and other rotating machinery in your plant, at least 100 oil samples should be tested monthly to complement vibration monitoring.

Testing…

Quality and reliability are the most important objectives of sample testing that can be performed offsite by a lube oil supplier or an independent laboratory. A well equipped in-house lab also is capable of doing all the essential tests, including quantitative and qualitative particle counting, particle size distribution and wear debris analysis.

Lubricant suppliers should remain just that—*suppliers*— and should not be involved in testing for a variety of reasons. Since they have a vested interest in retaining your business, suppliers may tend to overstate the condition of tested samples, which can result in unnecessary and costly oil replacement. Beware the supplier who offers free oil analysis as a value-added service. Such programs are generally worth about what you pay for them.

Many independent testing laboratories produce excellent results, but the going price for oil analysis by an independent lab today is about $35 per sample, or $3,500 per month for a 100-sample program. Well-equipped on-site labs operated by trained analysts can be equally effective at a lower per-sample cost.

On-site labs make good sense for plants with more than 100 oil systems in that the site can maintain better control over the samples, and testing can be done as often as necessary. Since results are available immediately, if any of them are questionable, retesting can be done very quickly.

The key to success with an on-site program is having a well-trained, in-house champion with a vision for improvement. Such was the case at the previously-referenced Southeastern paper mill, where testing equipment, similar to that shown in the accompanying photo, was installed for oil analysis. Enthusiasm for the mill's program grew as it received credit for more and more savings.

One individual should be responsible for taking the lead in oil sampling and on-site testing. That

person should be trained in testing and analysis—and should be excited about the possibility of saving money for his or her company. Formal training is essential. The Society for Tribologists and Lubrication Engineers (STLE) provides training and certifies individuals as Lubrication Specialists and Oil Monitoring Analysts. The standards for these courses are high and the exams are not easy. Training and certification also is available from many equipment vendors.

Savings

This is the real measure of effectiveness. A successful PdM program prevents costly problems and has documentation to prove it. A saving of $250,000 in the first year of an inhouse analytical program is not an unreasonable expectation in a large plant. Dedicated oil analysis will identify potentially costly problems that can be averted and oil consumption *will be reduced*.

Savings often are achieved by adopting a plan of "as needed" replacement rather than changing oil periodically. If analysis shows a lubricant to be free of contamination, there's no need to replace it based on the OEM-recommended schedule. Therefore, lubricants frequently last longer than expected, especially in clean environments. Mike Lawson at the Bowater Paper Mill in Calhoun, TN, says he can do a lot of testing at $15 per sample rather than replace the 35 gallons in a gearbox at a total cost of about $480. That includes $140 for the oil, $240 for two mechanics working six hours, $50 to dispose of the used oil and another $50 to restock. As Lawson noted in another article published in this magazine, "When test results show that there is nothing wrong with the oil in a gearbox or other machinery, we don't change it. Most times it is not degraded and is actually quite clean." [Ref. 1]

Other elements

Remember: Oil analysis is just one part of a comprehensive PdM program that also includes vibration monitoring and analysis, ultrasonics and thermography. Oil analysis supplements vibration monitoring and analysis by revealing two key root causes of machinery failure—changes in oil chemistry and oil contamination.

Predict, then act

Any good sized plant that is collecting and testing fewer than 50 lube oil samples per month is probably missing problems that are costing far more in labor (and other expenses) than the price of a more expansive program. It takes a person familiar with the layout about one week a month to collect and test 100 samples from critically important equipment. The payoff in both labor and cost savings is far greater than the time spent doing this work. As a certified technician at the first mill mentioned in this article said, "Our new on-site oil analysis system definitely paid for itself very quickly. We now do condition-based monitoring, oil analysis and predictive maintenance, and we're light years ahead of where we used to be."

References

1. Garvey, Ray, and Martin, Ray, "The Bill Is Coming Due" (Lubrication & Fluid Power, November-December 2005)

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