PdM

Establishing and maintaining levels of cleanliness

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A proactive approach to maintenance

While Szycranczr's maintenance department deals with a wide variety of maintenance issues, any of which can result in downtime, loss of production and costly repairs, it is very common to associate the nature of these maintenance issues with a machine's internal condition.

Process plants and manufacturing companies like Szycranczr have machinery lubricated by mineral-based or synthetic fluids and other machinery powered by lower viscosity hydraulic fluids. We define equipment of this type as fluid-dependent systems. Examples of this include gear boxes, process pumps, gas compressors, speed reducers, blowers, hydraulic metal working machines and machine tools.

When machines have wear, corrosion and associated problems that eventually lead to corrective action, we categorize these problems as internal state failures. Often, equipment operates infrequently, under very low loads, and away from the main production processes. In such cases, it may be perfectly acceptable to operate this equipment with scheduled maintenance activities or simply on a breakdown basis. On the other hand, Szycranczr owns many critical systems directly in the process line or associated with high-productivity manufacturing equipment where breakdown maintenance or scheduled maintenance could prove costly.

In these instances, the maintenance organization should seek out technological solutions that look for conditions such as failure symptoms and root cause conditions. This area of maintenance activity, commonly known as condition-based maintenance, directs maintenance activities in response to changing machine conditions.

Condition based monitoring

Predictive maintenance is a subset of condition-based maintenance. Predictive maintenance focuses on active failure processes, avoiding sudden catastrophic failure, and the occurrence of chain reaction failures. This group includes such technologies as vibration monitoring, thermography, motor current analysis and wear debris analysis.

The second subset of condition-based maintenance is proactive maintenance. This activity is aimed at the detection and elimination of failure root causes. Like predictive maintenance, it is a solution involving a combination of instrumentation, software and inspection activities. Proactive maintenance approaches, such as machine alignment, balance, and fluid contaminant monitoring, generally prove effective. Also included is the monitoring of many other crucial properties of a lubricant to achieve proper protection against a host of wear and corrosive processes.

Proactive maintenance

Central to the theme of proactive maintenance stands the extension of a machine's life, not simply the early detection of failure. In human health, we categorize cholesterol monitoring, for instance, as proactive maintenance and monitoring heart disease using an electrocardiogram as predictive maintenance.

The fluid-dependent systems used by Szycranczr require continuous monitoring for some critical properties and conditions. An installed turnkey maintenance program can help Szycranczr in developing and implementing every aspect of an oil analysis program.

A good oil analysis program involves critical steps that if not performed properly, can completely undermine the effectiveness of a program. The first step involves a comparison of used oil properties with that of new oils. Viscosity, additive depletion, base-stock oxidation, and lubricity fall into this area.

The second area of analysis involves assessing the contaminant suspended

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in a timely manner (1-2 days). Detailed recommendations are based upon the results and equipment being sampled. Reports provide both primary and secondary recommendations, considering the plant operations.

Options available to the customer include:

- immediate personal contact in the event of a *critical call* or advanced wear mode;
- electronic downloading of reports for paper reduction and history retrieval by plant personnel; and
- periodic review of the sampling locations, frequency, and operation of equipment.

Action and follow-up. It is the responsibility of the plant maintenance personnel *to act* on the recommendations. The service organization follows-up on *critical calls* to help the plant in documenting savings for measurement purposes and to gather additional application information.

Without action, the predictive maintenance benefits of the trending and analysis cannot be realized. In the Szycranczr implementation, management will be notified of the progress of the program. The service organization has the responsibility to find out what the results of *critical calls* and to tune the trending limits and optimize the predictive results.

Summary

The Szycranczr plant has many areas to address, and predictive maintenance implementation will be a challenge because of the cultural and motivational shifts required by the organization.

Buy-in from upper management, along with any possible support for Megacorp, will help keep the program on-line. It is essential that the service organization is prepared to support, Sybil Fronge, maintenance superintendent, Frank Geeze, production manager, and the rest of the plant personnel with training, support services, follow-up and the tools to realize the huge benefits of wear particle analysis.

In addition, other predictive technologies can provide benefit opportunities. The service organization is able to help the customer in coordinating these activities as part of a total predictive maintenance program.

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the fluid which, if carried to machine surfaces, can result in corrosion and wear. The most important and potentially damaging contaminants to monitor and control are moisture and solid particles.

The third area of analysis involves assessing the condition of the machine more than the condition of the oil by monitoring wear particles in a fluid in terms of size, shape, type, and origin.

Sampling fluids

After implementing a plan that evaluates these critical areas, maintenance personnel must modify machinery to obtain oil samples correctly and establish schedules for sampling from the equipment.

Installing proper oil sampling taps means getting the samples from the correct location on the machine in a manner that also minimizes the potential for error or accidental contamination of the sample.

Once the taps are properly installed, samples can be obtained for routine analysis.

Today it is common for companies such as Szycranczr to use in-house oil analysis tools to simplify obtaining reliable information quickly about a fluid's condition and the generation of active wear debris. Economic instruments available to maintenance professionals include particle counters, viscometers, and wear debris instruments.

Many companies rely solely on particle counting as their first line of defense in monitoring a fluid's condition. This is due to its recognition as the most common root cause of wear in mechanical systems. This is highly important as a proactive maintenance objective. Additionally, many failure processes, including corrosion and wear, create particles—therefore, changing particle levels can be an early predictive maintenance indicator.

Information is available for companies like Szycranczr that includes the technology and knowledge necessary to build a quality framework for an oil analysis and proactive maintenance program that would let them understand the condition of their fluid-related machinery. Szycranczr also needs assistance with the development of processes and procedures for monitoring and feedback to reduce the mean time between failures of their machines. This reduction in the mean-time-between-failures would translate into a cost savings in downtime, parts, and labor.

Contamination levels

When monitoring and controlling particle contamination levels, Szycranczr's maintenance personnel must observe three steps.

The first step is simply setting a high cleanliness limit beyond which particle counts must not exceed. Machines can achieve exceedingly long lives with maintenance of these limits, generally known as targets. Many companies report life extensions in excess of 10 times.

The second step involves adjusting filtration and controlling the entry of contamination as required to achieve targets. Any target achievable without these types of adjustments will not result in life extension. Simple low-cost techniques are available that improve fluid cleanliness without increasing filtration costs.

The third step is the critical monitoring step. It involves performing frequent tests on the oil to confirm that the cleanliness levels stay within the target range. If there are numerous sources for increasing contaminant levels, high monitoring frequency is essential.

Certain machines require daily monitoring, but some only require monthly or bimonthly monitoring. For instance, high pressure hydraulic machines involving critical production process need monitoring at a 2 to 3 week interval while other low-load, low-speed gear boxes, sealed from contamination ingestion, need monitoring frequencies of only 2 to 3 months. This requirement for frequent particle level analysis can only be effectively performed using in-house particle counters.

Proactive maintenance applied

A large, progressive process manufacturing plant installed a turnkey conditioned—based maintenance program plant-wide to combat high maintenance costs and the occurrence of catastrophic failures in their fluid-related systems. This company understood that by monitoring and controlling the contamination in their fluid-dependent systems, they could extend the mean time between equipment failures, effectively decreasing maintenance costs and unplanned downtime.

The first step in the installation of this program involved an extensive engineering study. Engineers gathered fluid samples, reported filtration information, and assimilated cost information from fluid-related failures. Especially of interest was the cost associated with parts usage, downtime, production loss, repair labor, and fluid usage. Their program included a survey in this first stage for the involved employees.

This survey uncovered the employees' feelings about their current maintenance program and their comfort level with new technology, which provided good information for the project engineers as they developed and installed the second phase of the program.

Armed with complete current cost and fluid cleanliness information, engineers performed a cost benefit analysis, comparing the downtime costs and current cleanliness levels with the potential cost savings and extended mean time between failures that would result with improved system cleanliness.

A favorable internal rate of return spurred company management to move ahead with the second phase of the project—the actual installation of an oil analysis and proactive maintenance program at this facility.

Installation followed three important steps:

- establishing a target fluid cleanliness level on each participating machine,
- improving filtration and controlling the entry of contamination into each system to clean the systems well enough to meet the target cleanliness levels, and
- monitoring cleanliness levels and trending this information to maintain healthy fluid systems and extend machine life.

Throughout this process, system fluids were cleaned to a target ISO Code 17/14/11.

Filtration carts, on-line monitoring equipment for particle counting and ferrous (wear debris) particle counting, and software trending programs were introduced. The company developed processes, procedures, and routes for monitoring and feedback. Using the survey information in the first phase, a technology transfer and training program was structured that allowed for the unique concerns and goals of this particular company.

Personnel received extensive training in equipment, software usage, and system troubleshooting information. The equipment and knowledge was turned over to the company. The complete installed program for fluid system monitoring has already saved the company many thousands of dollars through avoiding downtime equipment and labor costs, and more in reduced parts and fluid usage costs. This savings represents a high rate of return on the cost of the program, and continues to provide a means for extending the mean time between failures in the equipment in this facility.

Benefits for Szycranczr

By stabilizing a fluid's cleanliness level, Szycranczr could not only achieve long machine and fluid life, but effectively detect early stage machine failure. In addition to in-house particle counting, the company should assess other fluid properties on a routine basis.

The framework of the installed program allows for future growth into these other areas of monitoring. For instance, machines that operate where there is a potential for moisture in the fluids and high heat may experience additive depletion and base-stock oxidation failure.

Viscosity analysis can be a very effective tool to identify these types of failures as, in most instances, viscosity rises in response to both additive depletion and oxidation. In-house wear particle analysis could also help identify the source of unacceptable high particle counts.

These instruments evaluate changing ferromagnetic particle concentrations. This information is valuable because 80 to 90% of wear debris in typical industrial machinery is ferromagnetic.

Data management

If left without data management, an oil analysis program would not reach its full potential. Part of an installed program is the software necessary to compile and trend on-line monitoring data.

Software for trending oil analysis data should also look at other machine condition parameters for a condition-based maintenance management capability.

Implementing an oil analysis program, similar to other maintenance technologies, requires an attitude change among maintenance operators; one toward repairing machine conditions and away from repairing the machines themselves.

Part of the implementation process for an installed program would include surveys of all involved employees. The surveys question maintenance philosophies, feelings about the current maintenance program, and employee attitudes to new technology. This would assist in developing the right combination of information and product training for Szycranczr.

Training

Successful programs usually come from a single champion who took on the challenge, sold the benefits to management and maintenance personnel, and developed the implementation plan. As a first step in this installed program, it is recommended that maintenance employees undergo a thorough education program on oil analysis and proactive maintenance to combat some of the confusion that exists at Szycranczr.

Once they understand the basic elements of oil analysis, the development and implementation process of an installed program can be customized to incorporate each of the critical success elements that distinguish high benefit programs. Such subjects as locating and installing sampling ports, setting limits and standards for the various oil properties, selecting instruments and commercial labs, interpretation of data and integrating with companion maintenance technologies must be included in this education.

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