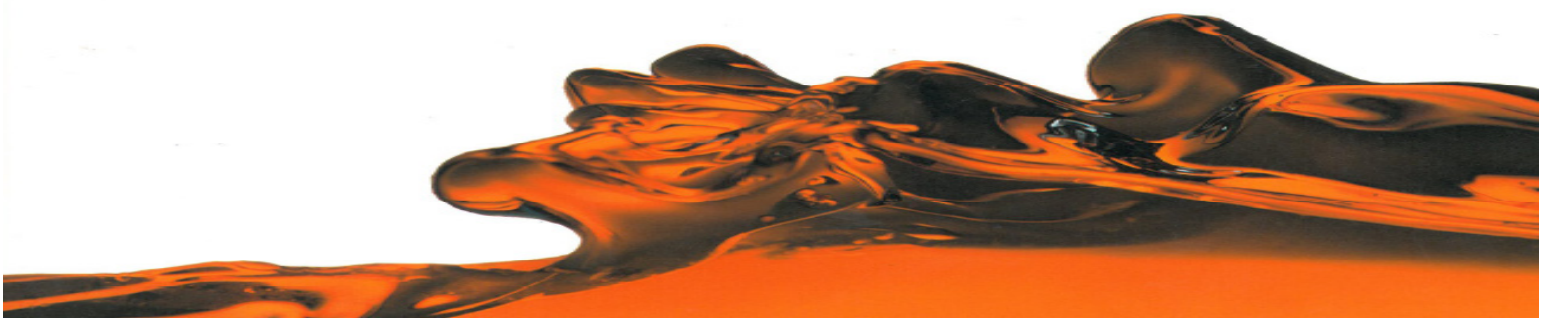
SENGENUITY
sensor engine technology
a division of Vectron International

Fluid Condition Sensing

Laboratory Analysis

Today, lubricant analysis is still conducted primarily by specialized laboratories. These labs provide a wide variety of very precise analytical tests of both the fluid and the particulates, which makes lab-based oil analysis an integral part of any serious preventive maintenance program for high value assets. The downside to lab-based analysis, aside from cost, is the logistics of getting fluid samples taken at regular intervals, then getting those samples sent to the lab, and then waiting to get the results returned to the maintenance team at the asset location. For remote fixed assets such as wind turbines, and for highly mobile assets such as marine engines, these logistical challenges can be daunting.



Advantages of Real-Time Condition Based Monitoring

Thus, there is an ever increasing demand for immediate, real-time lubricant health monitoring, commonly known as Condition Based Monitoring (CBM). This demand is driven by several additional factors aside from lab cost and fluid sampling logistics:

For the asset owner and operator, there is a logical desire to extend oil-drain intervals for both economic and environmental reasons.

- Lubricants are often changed and/or additive-enhanced based primarily on rules of thumb: mileage, hours of usage, etc. These rules are designed to minimize any potential damage to the equipment that might occur as a result of degraded fluid based on certain average operating conditions. As a result of not taking the true condition of the lubricant into consideration, these rules are typically quite conservative, which results in the fluid being replaced prematurely. Premature fluid replacement has a number of non-trivial costs:
  - The cost of the new fluid, which can be a substantial volume in very large assets.
  - The cost (and environmental cost) of waste fluid disposal.
  - The cost of maintenance labor to service the fluid change.
  - The opportunity cost of idle equipment and idle operators during a change.

- Where oil-drain intervals are simply extended without a careful monitoring system or plan, there are risks to the health of the equipment and potential costs that can offset any savings to the asset owner:
  - If the lubricant chemistry begins to break down, or if there is an excess of gradual contamination (such as soot, silica, wear metals), then the equipment's useful life can be shortened.
  - If the equipment is under warranty or service agreement, then there is the possibility that any resulting damage may not be covered.
  - If the equipment is subject to unusually harsh operating conditions or environment, then even the manufacturer's recommended fluid change intervals may not be frequent enough to prevent premature failure of the lubricant.

The asset owner and operator must also always be attentive to the possibility of catastrophic lubricant failure. This can be caused by any number of factors, such as gasket leaks between fluid types (glycol, fuel, etc) or even simple human error by adding the wrong liquid to the fluid intake. Regardless of the cause, such failure can cause severe damage to high value equipment in a matter of minutes if not caught and acted upon immediately.

The asset owner and operator may also be in a position to implement sophisticated remote monitoring of asset health from an economically central location instead of relying on field maintenance teams or on operator training and attentiveness. Local, regional and global data transfer via cellular networks and even satellites is now a highly viable economic reality.

For the Original Equipment Manufacturer (OEM) there is also interest in providing real-time sensing of the condition of critical fluids in high value assets.

- The OEM may be able to enjoy a reduction of warranty costs where machine operators may inadvertently contribute to mechanical failure in equipment by not knowing the true condition of lubricants. When such failure occurs within the warranty period it is not uncommon for the OEM to bear the cost of repairing or replacing equipment versus engaging their customer in a debate over who is at fault.
- The OEM may also gain a competitive advantage over non-sensorized equipment by promising to help the asset purchaser reduce their total cost of ownership by extending oil-change intervals, minimizing downtime, preventing both gradual and catastrophic damage, and realizing the benefits of continuous remote monitoring.
- The OEM may also offer to provide continuous remote monitoring of assets as a value added service for a monthly subscription fee or as part of a bundled asset purchase price.

Fluid Condition Sensors

Fluid condition sensors have been in various stages of development and field trial for a number of years. Early attempts have led the way to ever more successful versions, while the demand for a robust, reliable and affordable design has been growing rapidly. The key to success in sensing fluid condition is to be able to accurately characterize healthy fluid across a variety of independent parameters, and to then quickly spot aging or contamination trends that are causing the fluid to go out of tolerance. The ideal fluid condition sensor is robust enough for the environment, requires little if any maintenance, is accurate enough to provide useful trending analysis (a yellow "caution" flag), and is quick enough to catch and prevent catastrophic failure damage (a red "stop" flag) within the equipment monitoring system.

The SenGenuity FLUIDTRACKR™ Fluid Condition Sensor series

After years of development work with solid-state acoustic wave based devices, SenGenuity has recently introduced its long awaited entry to the world of fluid condition monitoring. The FLUIDTRACKR™ Fluid Condition Sensor is designed to continuously monitor the overall health of lubricants and other critical fluids. It does so by tracking real-time changes in four important fluid metrics: viscosity, conductivity, dielectric constant and temperature.

- Gradual deviations in any one of these metrics over an extended time period most likely indicates chemical fluid breakdown or contaminant buildup, in which case a detailed lab analysis may be needed. Depending on the fluid, its useful life may be extended prior to fluid change by the addition of additives or perhaps the simple change of a filter, thus bringing the metrics back into their defined tolerance range.
- Significant and deviations in any one of these metrics within a short time interval most likely indicates the onset of a catastrophic event such as fuel leakage into the lubricant, a situation which may require immediate intervention to prevent equipment damage.

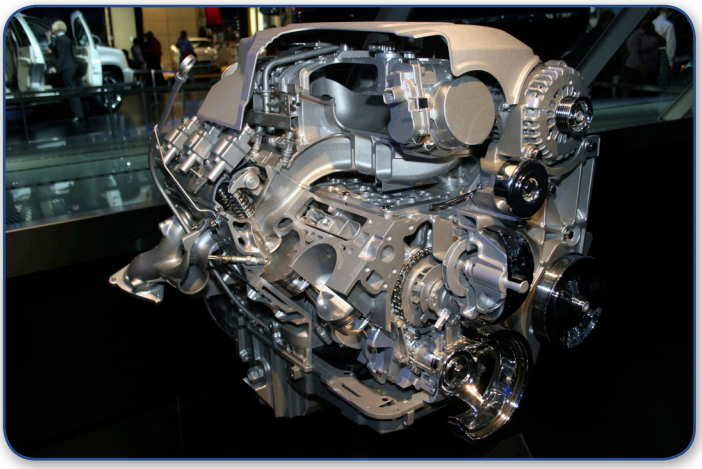
By tracking all four metrics simultaneously in real-time, the FLUIDTRACKR™ Fluid Condition Sensor can be used very effectively in conjunction with periodic lab analysis to provide a comprehensive fluid health regimen for machine operation. All of the economic benefits of Condition Based Monitoring can be enjoyed while also protecting the asset from both gradual and catastrophic lubricant failure damage.

The FLUIDTRACKR™ Fluid Condition Sensor combines solid-state circuitry, state-of-the-art correlation algorithms, world-class manufacturing expertise and advanced packaging techniques together with the latest advances in acoustic wave sensing technology. The result is a ruggedized, industrial strength sensor that is fundamentally self-cleaning when properly positioned in a stream of moving fluid. Owing to its unique design, the sensor is able to take accurate readings even in an environment where equipment vibration defeats other sensors.

Key Applications

Diesel Engines

Operators of large diesel engines don't typically have the tools to optimize drain intervals. Since most operators are cautious, especially when it comes to engine damage, the tendency is to replace oil sooner rather than later - they would rather waste oil than incur the risk of lubricant failure. Lubrication costs are therefore far from optimized. Further, a heavy reliance on lab based analysis does not provide operators with critical real-time data that may provide early indications of catastrophic events. Fluid condition sensors address both these problem areas. They can be used to extend oil drain intervals by providing operators with real-time oil health data, which can be used to derive the right point in time to change the oil. Further, this same data can also be used to flag the onset of a catastrophic event. The SenGenuity FLUIDTRACKR™ Fluid Condition Sensor provides a real-time assessment of oil/lubricant health by continuously monitoring the Viscosity, Conductivity, Dielectric Constant and Temperature of the oil or lubricant.



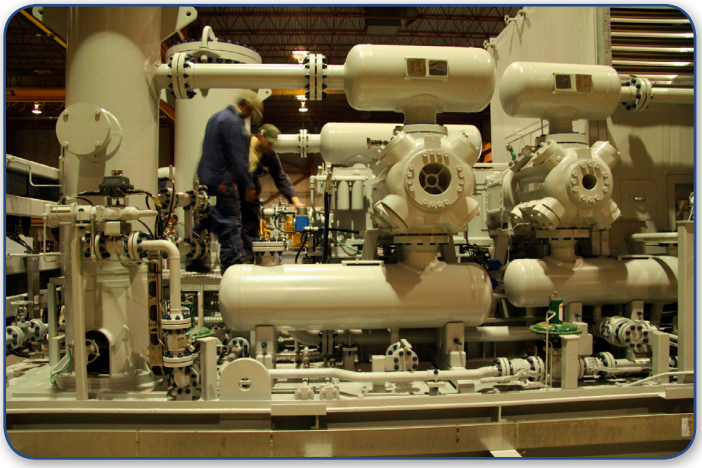
Windmill Gearbox

The oil used in windmill gearboxes needs generally to be checked after 120 days and then after 6 months of installation and commissioning. After this, it is recommended that the oil be sampled at least once a year. While this may not appear to be difficult, the cost of sampling quickly adds up after you take into consideration the effort involved in climbing the windmill tower to obtain a sample and then replicating this effort for all the windmills in a wind farm. The cost and effort of oil sampling are magnified due to the fact that wind farms are typically installed at remote locations. Fluid condition sensors can significantly reduce oil sampling costs for windmill operations by providing real time health assessments of the gearbox oil. With these sensors, the overall health of gearbox oil can be monitored on a 24x7 basis on a laptop or computer in a control room. Maintenance personnel need to be deployed to specific windmill towers only if the data obtained from the sensors installed in the gearbox indicate a need for detailed lab analysis of the oil.

Further, by virtue of monitoring oil health in real-time, fluid condition sensors can quickly detect the onset of a catastrophic event, functionality that traditional lab analysis just cannot provide.

Hydraulic Systems

Hydraulic systems can benefit from continuous fluid condition monitoring by detecting the early onset of fluid degradation and the presence of contaminants like water or cleaning fluids. Similar to operators of large diesel engines, operators of hydraulic systems use rules of thumb when replacing hydraulic fluid and tend to replace the fluid before it needs replacement in order to secure the overall health of the asset. Fluid condition sensors like the FLUIDTRACKR™ can provide system operators with a valuable tool to optimize the life of hydraulic fluids and reduce overall operating costs.



Fluid Condition Sensors Augment Lab Analysis

Fluid condition sensors do not replace lab analysis; rather, they complement and augment lab analysis in a comprehensive fluid health program. Fluid condition sensors provide a means to more judiciously schedule periodic lab analyses while ensuring the general health of asset fluids within certain tolerances. Failure trends can be spotted affordably at an early stage, and owners can thus trigger an in-depth analysis and investigation that leverages the millions of dollars of capital investment in an oil lab's equipment. Fluid condition sensors generally reduce the frequency of need for a full lab analysis, however in some cases it may increase the frequency – but in doing so it may significantly extend the useful life of the equipment asset.

Fluid condition sensors provide real-time information that can be tracked locally or from a central location. The owner of the asset has the assurance that if conditions were to suddenly deteriorate quickly due to catastrophic lubricant failure there is the opportunity to intervene quickly to minimize damage to the equipment. That is a benefit that even the most precise and complete lab analysis cannot offer.

Fluid condition sensors plus lab analysis provide the foundation of a comprehensive and cost-effective fluid management program. The net result is smart asset management with low total cost of ownership.

Contact Information

If you would like to learn more about our sensors and the applications we address please contact us at sensors@sengenuity.com.

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