Getting Started with In-house Oil Condition Monitoring:

An Easy Way to Avoid Equipment Failure

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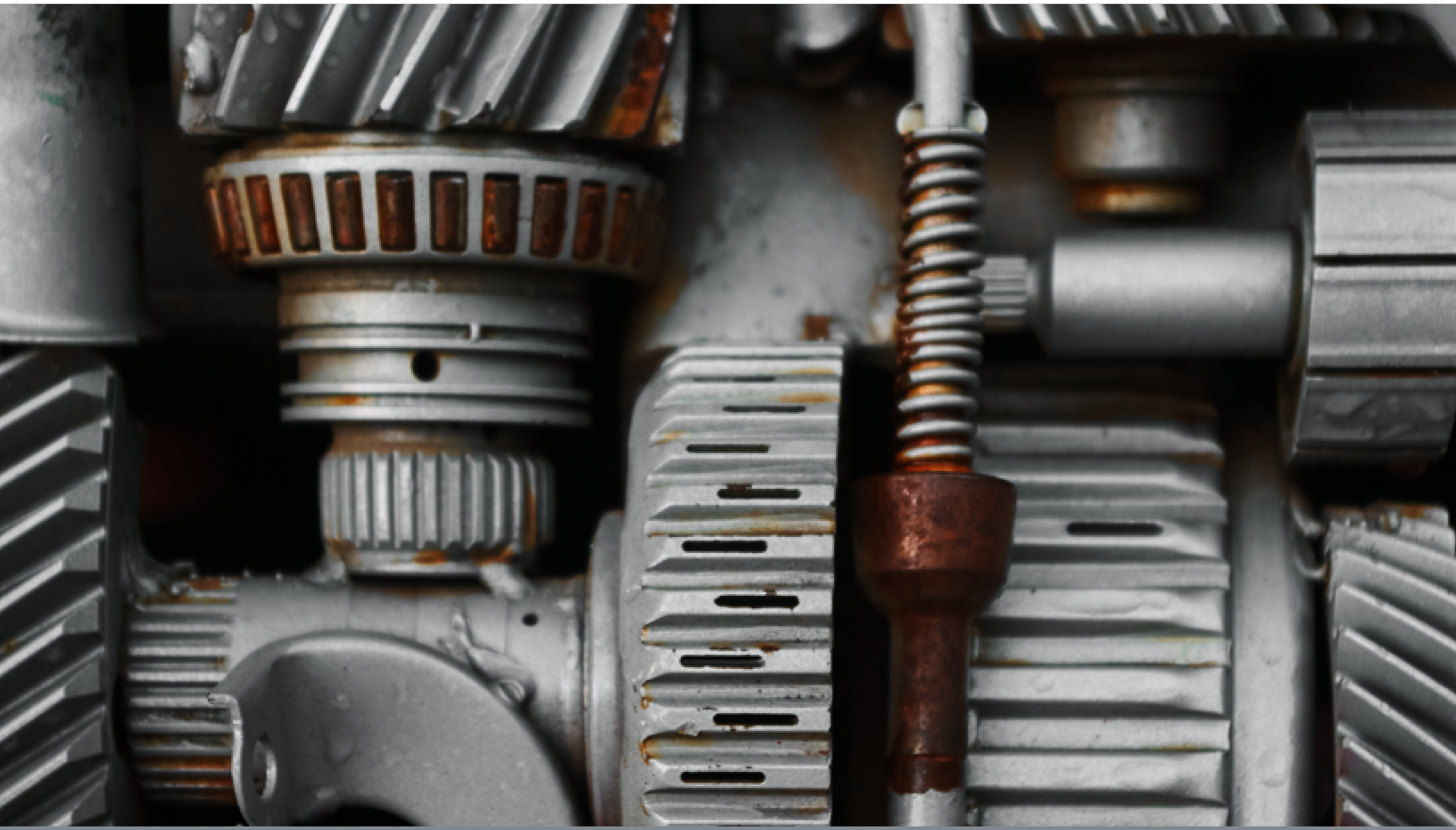


Oil condition monitoring plays a crucial role in predictive and proactive maintenance strategies by providing valuable insights into equipment health and lubricant condition. By analyzing various oil properties, maintenance professionals can detect early signs of equipment and lubricant degradation, identify potential issues before they escalate into costly failures, and optimize maintenance schedules/strategies to prevent unplanned downtime.

Established Oil Condition Monitoring Processes

Over time, the practice of oil condition monitoring has evolved to encompass various techniques and methodologies. These processes typically involve sampling oil from a machine, analyzing its properties, and interpreting the results to make informed maintenance decisions. While some organizations opt for in-house oil condition monitoring capabilities, others rely on third-party service providers for specialized expertise and equipment.

Third-party vs. In-house Solutions

When considering oil condition monitoring, organizations must weigh the pros and cons of using third-party services versus in-house solutions. Third-party providers are known to offer specialized expertise, state-of-the-art equipment, and streamlined processes, but depending on the number of samples can come with high costs and delayed reports. In-house solutions provide significantly faster results and therefore greater control and flexibility but require investment in equipment, training, and ongoing maintenance.

With that said, innovations in condition monitoring technology have enabled in-house oil condition monitoring capabilities to stand out as the superior choice for organizations seeking control, precision, and integration within their maintenance operations.

By bringing oil condition monitoring processes under their own roof, companies gain immediate access to results, eliminating the delays associated with third-party service providers and ensuring swift action in response to emerging maintenance issues, safeguarding against costly downtime and disruptions.

Another benefit of performing oil condition monitoring in-house is it fosters a culture of skill development and knowledge retention among maintenance teams. By training staff to perform oil condition monitoring, organizations cultivate a deeper understanding of equipment health indicators and promote proactive maintenance practices from within. This approach not only enhances confidentiality and data security but also ensures a sustainable, self-reliant maintenance strategy that adapts and evolves alongside the organization's needs.

Overview of Key Metrics in Oil Condition Monitoring Reports

Oil condition monitoring reports typically include a range of key metrics that provide insights into equipment health and lubricant condition. These metrics may include parameters such as chemical condition (TAN and TBN), kinematic viscosity, additives analysis, contaminant and particle analysis, and ferrous debris content.

	New / In-Service	**In-Service**			**After Failure**
	Root Cause Detection	Incipient (Early) Fault Detection	Problem Diagnosis	Failure Prognosis	Post Mortem
What oil condition monitoring is telling you	When something is occurring that can lead to failure (root cause conditions)	When an early-stage fault exists that is otherwise going unnoticed – for example: abnormal wear	What is the nature of observed problem? Where is it coming from? What is the failure mode? Root cause?	How severe or threatening is the condition? How much time is left? Are corrective actions needed?	What caused the machine to fail? Could the failure have been avoided?
What you monitor	Particles, moisture viscosity, additives, oxidation, TAN/TBN, soot, glycol, FTIR	Wear debris density, particle count, moisture, elemental analysis, viscosity, analytical ferrography	Wear debris, elemental analysis, moisture, particle count, viscosity, analytical ferrography	Elemental analysis, analytical ferrography	Analytical ferrography, ferrous density, elemental analysis
Maintenance mode	Proactive	Predictive	Predictive	Predictive	Autopsy - learn from failure
Relative savings (10 = High, 1 = Low)	10	6	3	2	1

Kinematic Viscosity

Viscosity is the most common test run on lubricants because it is considered a lubricant's most important physical property. This test measures a lubricant's resistance to flow at a specific temperature. If the viscosity is not correct, the oil film will not be sufficient for the load. Heat and contamination are also not carried away at the appropriate rates, and the oil cannot adequately protect the components. A lubricant with improper viscosity can lead to overheating, accelerated wear and ultimately the early failure of equipment.

Industrial oils are identified by their ISO viscosity grade (VG). The ISO VG refers to the oil's kinematic viscosity at 40°C. To be categorized at a certain ISO grade, the oil's viscosity must fall within plus or minus 10 percent of a certain grade.

For an oil to be classified as ISO 100, the viscosity must fall within 90 to 110 centistokes (cSt). If the oil's viscosity is within plus or minus 10 percent of its ISO grade, it is considered normal. If an oil's viscosity is greater than plus or minus 10 percent and less than plus or minus 20 percent, it is considered marginal. Viscosity greater than plus or minus 20 percent from grade is critical.

ISO VG Viscosity Grade	Midpoint Viscosity cSt @ 40°C	Kinematic Viscosity limits cSt @ 40°C (+/- 10% from midpoint)	
10	10	9	11
15	15	13.5	16.5
22	22	19.8	24.2
32	32	28.8	35.2
46	46	41.4	50.6
68	68	61.2	74.8
100	100	90	110
150	150	135	165
220	220	198	242

ISO VG Viscosity Grade	Midpoint Viscosity cSt @ 40°C	Kinematic Viscosity limits cSt @ 40°C (+/- 10% from midpoint)	
320	320	288	352
460	460	414	506
680	680	612	748
1000	1000	900	1100
1500	1500	1350	1650
2200	2200	1980	2420
3200	3200	2880	3520
4600	4600	4140	5060
6800	6800	6120	7480

Several factors can influence the kinematic viscosity of oil, including temperature, shear rate, contamination, and degradation.

Contaminants such as water, dirt, and wear particles can alter viscosity by changing the oil's molecular structure or inhibiting its flow characteristics. Additionally, oil degradation due to oxidation, thermal stress, or additive depletion can lead to viscosity changes over time, necessitating regular monitoring and analysis to detect and address potential issues promptly.

For many industrial applications, the degree of change in viscosity as a function of temperature is of great importance. This relationship is determined by the so-called viscosity index (VI). The VI is calculated from the kinematic viscosities at 40°C and 100°C and typical values are often in the range of 70 to 150. The higher the value, the less the viscosity changes with temperature. In addition to the composition of the base oils used, viscosity index improvers (VII) which are typically polymers are also added as additives to enhance the viscosity-temperature relationship.

However, over time, viscosity index improvers can degrade or shear under the influence of temperature, shear forces, and chemical reactions. As a result, the viscosity-enhancing properties of the oil may diminish, leading to a reduction in viscosity index. Monitoring the viscosity index is crucial for assessing the health and performance of the lubricant and determining the need for maintenance interventions.

Additives Analysis

Additives analysis is a crucial component of oil condition monitoring that focuses on assessing the concentration and effectiveness of various chemical additives blended into lubricating oils. These additives play a pivotal role in enhancing lubricant performance, protecting equipment components, and extending oil service life under demanding operating conditions.

Analyzing these additives involves quantifying the concentration of specific additives present in the oil and assessing their effectiveness in providing the desired performance benefits. Techniques such as infrared spectroscopy and emission chromatography are used to identify and measure additive content accurately. Infrared spectroscopy is used to quantify additives such as antioxidants based on their chemical structure. Emission spectroscopy, on the other hand, is used to determine the element content, which provides important information about the presence and content of the additives.

By comparing measured additive concentrations with manufacturer specifications, maintenance staff can evaluate the adequacy of additive levels and assess the oil's ability to meet performance requirements.

Interpreting data involves evaluating additive concentrations, trends, and interactions to assess lubricant health and performance. Deviations from expected additive levels may indicate additive depletion due to prolonged use, contamination, or operational stress, potentially compromising lubricant effectiveness and equipment protection. Trend analysis of additives content over time can prompt proactive maintenance actions such as replenishing additives, adjusting lubrication practices, or replacing the oil.

Aging and Chemical Condition (Including TAN and TBN)

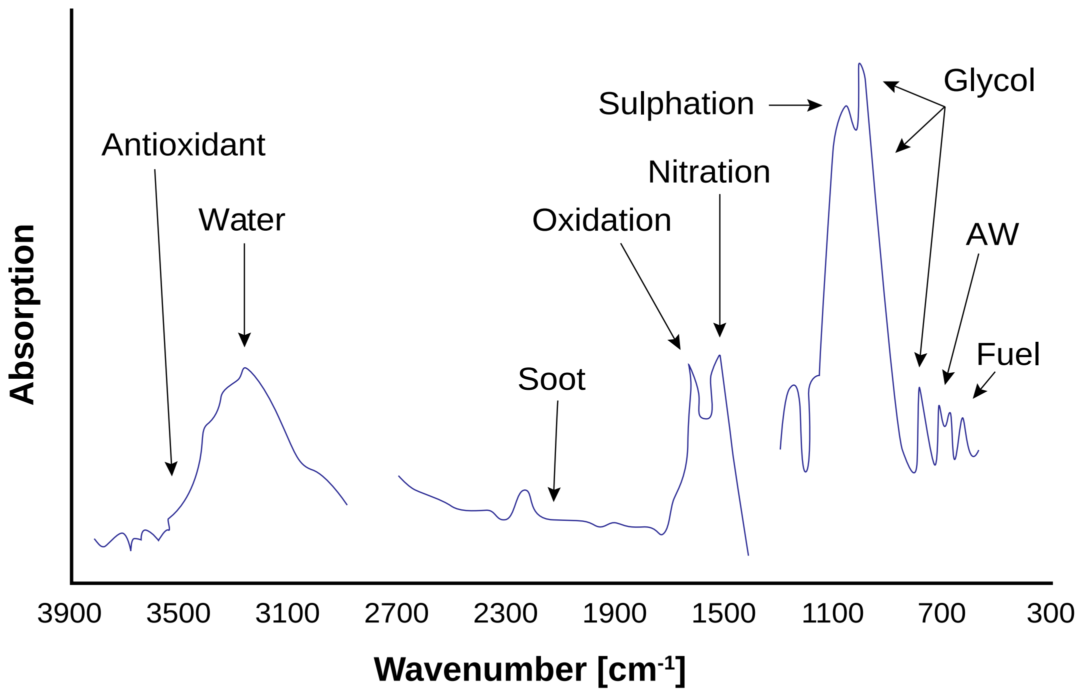
The aging and chemical condition of oil, as indicated by parameters like Oxidation, Nitration and Sulfation but also Total Acid Number (TAN) and Total Base Number (TBN), are critical indicators of lubricant degradation and potential equipment issues. Oxidation, Nitration and Sulfation are typically measured with infrared spectroscopy. The chemical changes caused by the unwanted entry of oxygen, nitrogen and sulfur are made visible. The basic presence of the individual compounds and the resulting risk naturally depends heavily on the type and use of the equipment.

TAN measures the acidity level of oil resulting from the oxidation process. As oil ages and undergoes thermal stress, its molecular structure begins to break down, leading to the formation of acidic byproducts. These acids can accelerate corrosion, degrade lubricant performance, and compromise equipment integrity. Consequently, monitoring TAN levels provides valuable insights into the extent of oil degradation, enabling proactive measures to mitigate potential damage and prevent costly equipment failures.

By establishing baseline TAN values and conducting trend analysis over time, maintenance professionals can identify abnormal deviations, anticipate lubricant degradation, and schedule timely oil replacements or rejuvenation treatments to extend equipment life and optimize performance.

In contrast, Total Base Number (TBN) measures the alkalinity and reserve of a lubricant to neutralize acids and maintain chemical stability. As oil ages and reacts with contaminants and combustion byproducts, its alkalinity gradually diminishes, reducing its ability to counteract acidic compounds. Monitoring TBN levels allows maintenance professionals to assess the remaining alkaline reserve of the oil and predict its remaining useful life. Declining TBN values signal the depletion of additives and the onset of lubricant degradation, highlighting the need for proactive maintenance interventions, such as replenishing additives or replacing the oil, to prevent accelerated wear, corrosion, and equipment damage.

TAN and TBN are both measured classically by titration. However, Fourier Transform Infrared Spectroscopy (FTIR)–a powerful analytical technique used to assess the chemical composition and condition of lubricating oils - offers a very interesting alternative. FTIR works by measuring the absorption of infrared light by molecules in the oil sample, providing valuable insights into the presence and concentration of various chemical compounds, functional groups, and contaminants present in the oil. Chemometric analysis with FTIR involves statistical methods for analyzing spectra and predicting parameters such as the concentration or composition of substances. By correlating spectral patterns with known data, chemometric models can accurately predict various properties. This technique can be easily and quickly applied to estimate TAN and TBN and can be determined simultaneously with the additives and the chemical condition.



Identifying chemical makeup and presence of contaminants in oil with FTIR

Contaminant and Particle Analysis

Contaminant and particle analysis focuses on identifying and quantifying foreign substances present in lubricants. These contaminants and particles can originate from various sources, including environmental ingress, wear debris from equipment components, and degradation products from the lubricant itself.

Thorough contaminant and particle analysis in oil includes assessing solid contaminants and wear particles along with other key parameters such as water content, fuel dilution, and glycol dilution. These parameters provide critical insights into lubricant condition, equipment health, and potential sources of contamination.

Solid Particles Interpreting solid particle analysis data involves evaluating the type, size, concentration, and distribution of contaminants and particles present in the oil sample. Deviations from expected levels or trends may indicate abnormal wear patterns, lubricant degradation, or contamination ingress. Trend analysis of contaminant and particle data over time can reveal patterns indicative of equipment wear rates, lubricant aging processes, or changes in operating conditions, guiding maintenance professionals in implementing proactive measures to mitigate potential risks.

Water Content or Relative Humidity Water contamination in lubricating oils can occur through various means, including environmental ingress, equipment leaks, or condensation within the lubrication system. Excessive water content can lead to lubricant degradation, corrosion of metal surfaces, and reduced lubricating effectiveness. Monitoring changes in water content over time enables early detection of leaks, sealing failures, or other sources of water ingress, facilitating timely corrective actions to prevent equipment damage or failure.

Fuel Dilution Fuel dilution occurs when unburned fuel enters the lubricating oil due to incomplete combustion, fuel leaks, or fuel system malfunctions. Fuel dilution can reduce lubricant viscosity, impair lubricating properties, and accelerate oil degradation, leading to increased wear and potential equipment damage. Even a slight fuel dilution is accompanied by a drop in the flash point, which can be easily detected.

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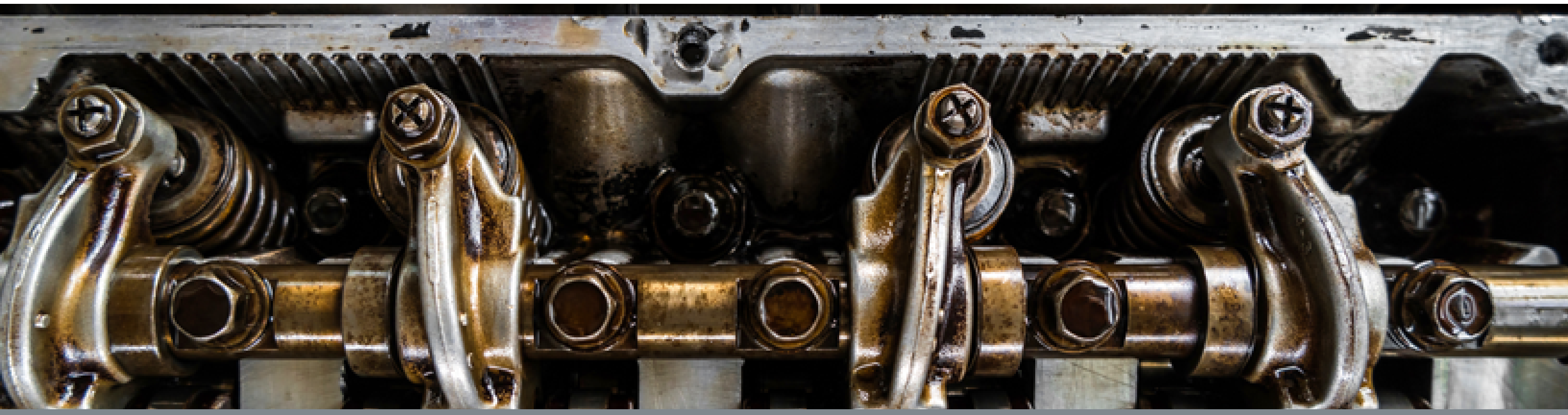
Glycol Dilution Glycol dilution occurs when antifreeze or coolant leaks into the lubricating oil due to coolant system leaks, gasket failures, or overheating. Glycol dilution can degrade lubricant properties, increase viscosity, and promote corrosion of metal surfaces, compromising equipment performance and longevity.



Wear Metals and Ferrous Debris

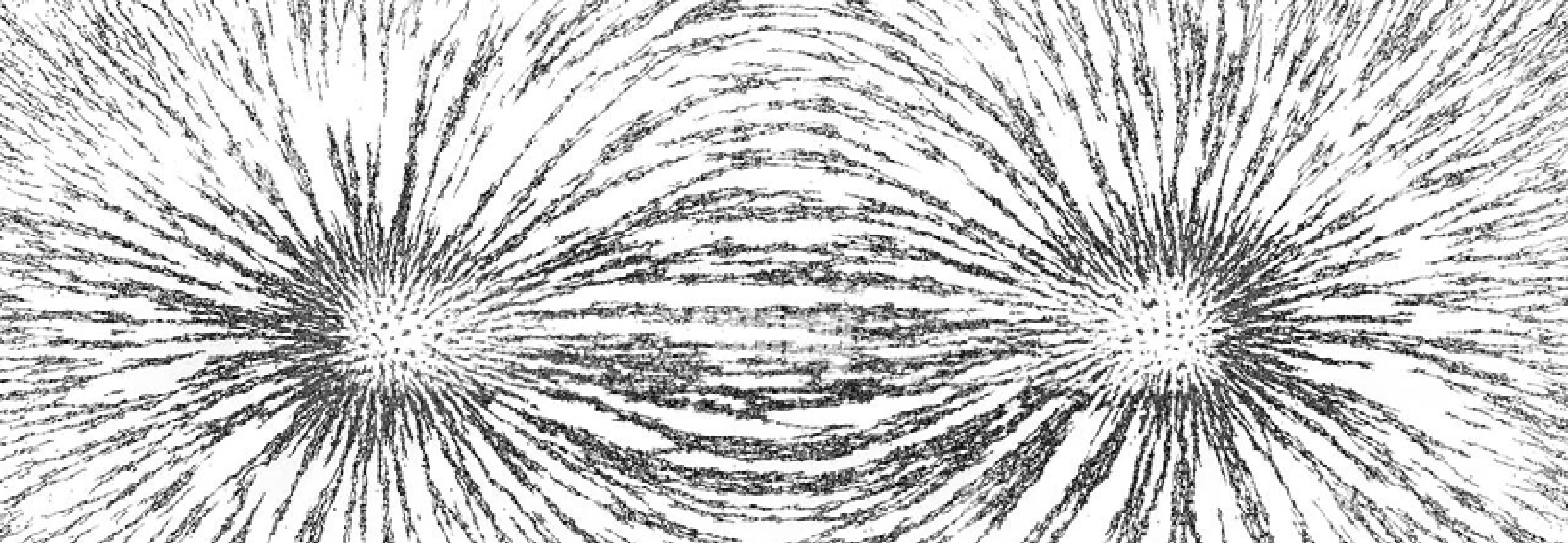
As equipment components wear down during operation, metallic particles are generated and circulated throughout the lubrication system, leading to increased friction, heat generation, and accelerated wear rates. Analyzing wear metals allows maintenance professionals to identify the type, size, concentration, and distribution of wear particles present in the oil, enabling targeted interventions to mitigate their impact, prevent potential damage, and extend equipment service life.

Sample Number	Sample Date	Silicon	Sodium	Potassium	Iron	Chromium	Lead	Copper	Tin	Aluminum	Nickel	Boron	Phosphorus	Zinc	Calcium	Barium	Magnesium	Molybdenum
New Oil		7	1	2	1	1	0	0	2	2	1	2	1071	1343	1496	2	449	1
11/04-1001	10/10/31	5	12	2	6	1	0	4	2	2	1	5	1096	1371	1467	1	427	2
09/29-1001	10/09/25	3	0	1	13	1	0	2	0	2	1	2	986	1276	1237	1	0	1
08/25-1000	10/08/16	3	0	1	13	1	1	3	1	2	1	1	801	1173	1109	0	0	1
06/12-1031	10/05/01	3	0	1	8	0	0	1	0	2	1	1	853	1258	1565	2	0	1
05/06-1001	10/05/01	3	0	2	8	1	0	3	1	2	0	1	778	1290	1502	2	0	2
04/02-1001	10/03/29	2	0	2	5	1	0	2	1	2	1	1	1080	1318	1670	2	0	2

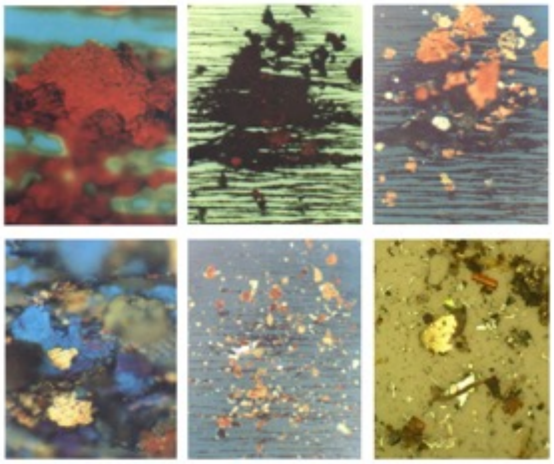
Contaminants | Wear Metals | Additive Elements

Data Trends Upward | Data Trends Downward

Elemental analysis is a key part of oil condition monitoring reports



Ferrography is an advanced oil condition monitoring technique that focuses on the characterization and analysis of wear particles suspended in lubricating oils. It involves the use of a ferrogram, which is a specialized microscope slide designed to attract and capture ferrous wear particles from oil samples. The ferrogram is immersed in the oil sample, and an electrical current is applied to induce a magnetic field, causing ferrous wear particles to adhere to the surface of the slide. The ferrogram is then examined under a microscope to analyze the size, shape, morphology, and composition of the captured wear particles.



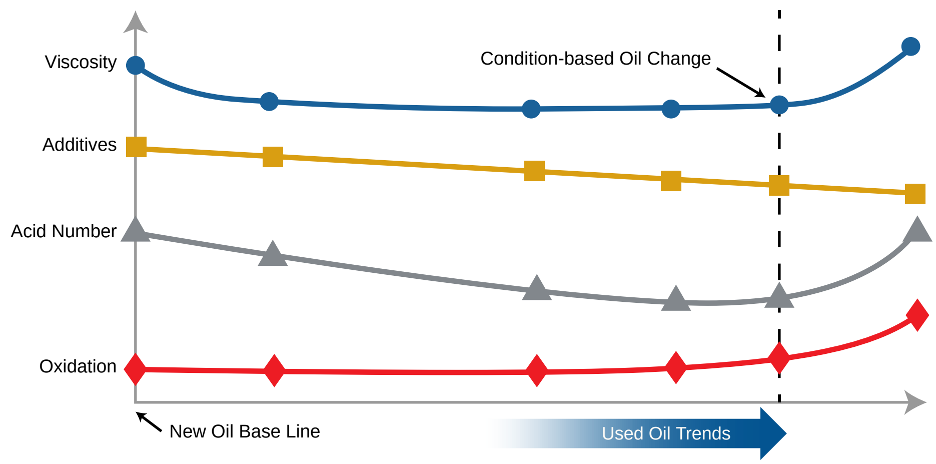
Photomicrograph images of ferrograms

Ferrous Debris Quantification is a more generalized approach to assessing the concentration of ferrous wear particles in lubricating oils. It involves the use of special analytical techniques to measure the magnetization to quantify the amount of ferrous debris present in oil samples. These techniques measure the concentration of ferrous elements, typically iron, in the oil sample, which is indicative of the presence of wear particles.

Establishing Baseline Values and Trend Analysis

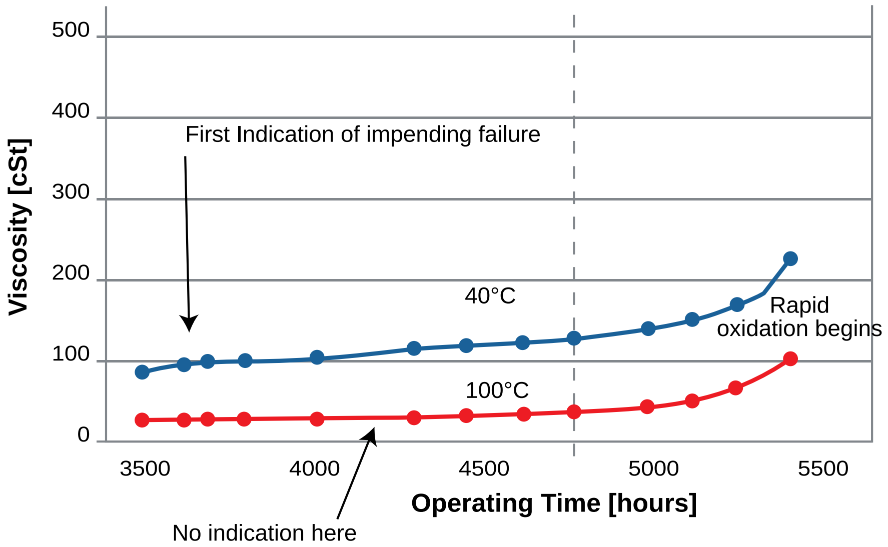
Establishing baseline values and conducting trend analysis are essential components of an effective oil condition monitoring program. These processes provide maintenance professionals with valuable insights into equipment health trends, lubricant condition changes, and potential issues over time.

Establishing baseline values involves determining the typical or expected ranges of key oil condition monitoring parameters for specific equipment and operating conditions. This process typically involves analyzing a series of initial oil samples taken from the equipment when it is in a known good condition or during a scheduled maintenance interval. By analyzing these baseline samples, maintenance professionals can establish reference values for parameters such as viscosity, oxidation, TAN, TBN, contaminants, and additives, which serve as benchmarks for comparison during subsequent oil condition monitoring tests.



Monitoring, controlling, and trending vital physical and chemical properties of a lubricant

Trend analysis involves monitoring and comparing oil condition monitoring data collected over time to identify changes, patterns, or deviations from established baseline values. Trend analysis enables maintenance professionals to anticipate potential issues, predict equipment failure modes, and implement timely maintenance interventions before problems escalate into costly failures or downtime.



Viscosity trends of oil oxidation

Best Practices for Implementing an Oil Condition Monitoring Program

Selection of Sampling Points and Frequency

Identifying appropriate sampling points within the equipment and determining the frequency of oil sampling are key considerations for an effective oil condition monitoring program. Sampling points should target areas prone to wear or contamination, and sampling frequency should balance the need for timely data with practical considerations such as equipment accessibility and operational requirements.

Selecting appropriate sampling points involves identifying strategic locations within the equipment where oil samples can be collected to provide meaningful insights into equipment health and lubricant condition. Sampling points should be placed in areas that give a representative sample of the lubricant in the machine. Common sampling points may include reservoirs, sumps, filters, bearings, gearboxes, and hydraulic systems. Additionally, consideration should be given to the accessibility of sampling points, safety protocols, and operational constraints when selecting sampling locations.

Selection of Sampling Points

Frequency of Oil Sampling

Determining the frequency of oil sampling involves establishing a schedule for regularly collecting oil samples from selected sampling points based on equipment type, operating conditions, lubricant usage, and maintenance requirements. Sampling frequency should balance the need for timely data with practical considerations such as equipment criticality, lubricant degradation rates, and operational demands.

Considerations for Selection and Frequency

Several factors should be considered when determining sampling points and frequency:

Equipment Criticality: Critical or high-value equipment may require more frequent sampling and monitoring to detect potential issues early and minimize the risk of costly failures.

Operating Conditions: Equipment operating under harsh or demanding conditions, such as high temperatures, heavy loads, or corrosive environments, may require more frequent sampling to assess lubricant condition and equipment health accurately.

Lubricant Type and Usage: Different lubricants have varying degradation rates and performance characteristics, influencing the frequency of sampling and analysis required to maintain optimal lubricant condition.

Maintenance History: Equipment with a history of frequent failures, lubricant-related issues, or maintenance problems may warrant increased sampling frequency to monitor performance and identify recurring issues.

As a starting point and general rule, when there are no OEM recommendations for oil sampling frequency, consider sampling it at 2/3 of the oil change frequency. The frequency can be adjusted after enough data has been collected for trending purposes.

Proper Sampling Techniques and Processes

Accurate oil sampling is essential to ensure representative and reliable analysis results. Proper sampling techniques involve following standardized procedures, using clean and appropriate sampling equipment, and minimizing contamination risks during the sampling process.

Sample Collection

Use Clean Sampling Equipment: Use clean, dry sampling equipment to prevent contamination of the oil sample. Ensure that sampling bottles, tubes, and syringes are free from residues, debris, or other contaminants that could compromise sample integrity.

Follow Sampling Procedures: Procedures that outline specific sampling points, sampling techniques, and sample handling instructions should be created based on industry standards.

Sampling Techniques

Use Proper Sampling Tools: Select appropriate sampling tools and equipment based on the application and lubricant type. Common sampling tools include vacuum pumps, sampling valves, thief samplers, and syringes, depending on the sampling point and accessibility.

Collect Representative Samples: Collect samples that are representative of the lubricant in the equipment. Samples should be collected when machines are at normal operating temperatures on a typical day. Temperature fluctuations in the oil sample can cause condensation, evaporation, or phase separation within the oil sample, altering its composition and introducing contaminants, moisture, or debris that may skew the analysis results. Additionally, avoid sampling from stagnant zones, areas with sediment or debris accumulation, or locations prone to localized contamination. Recording the oil temperature at the time of sampling is recommended.

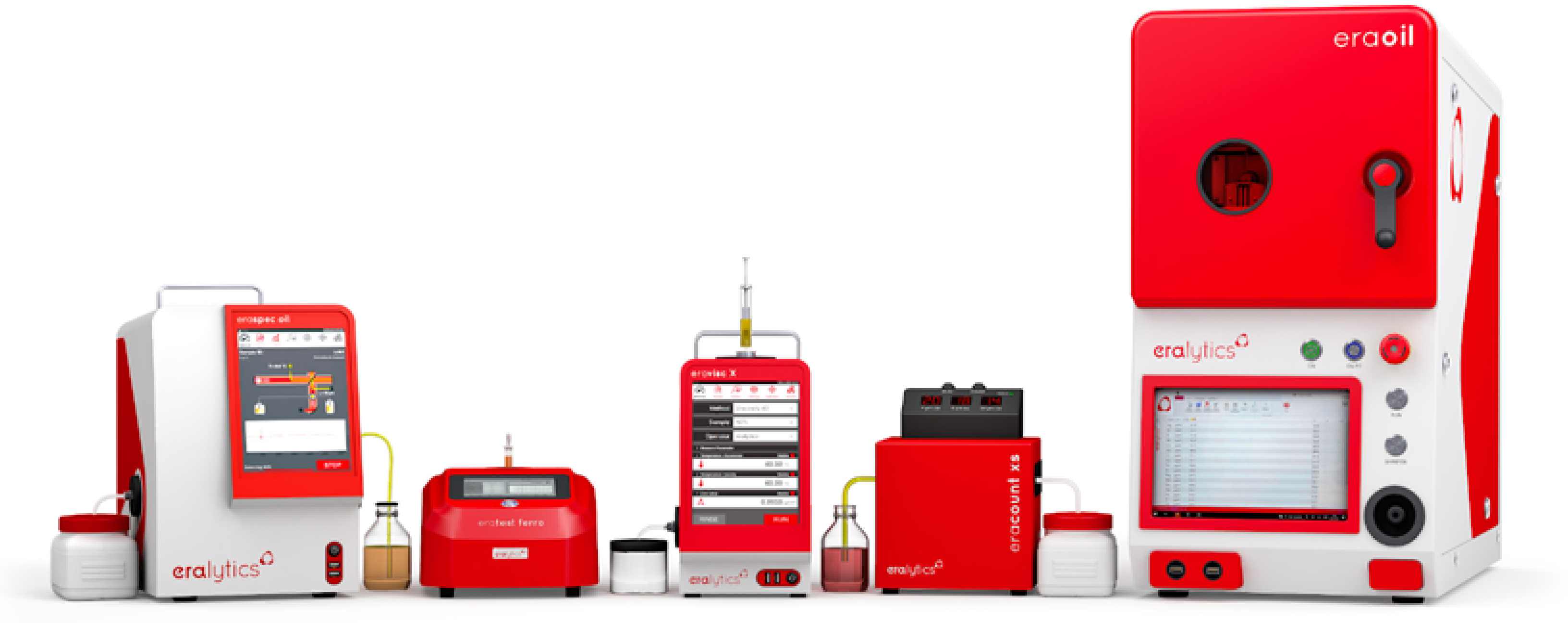
Maintain Sample Integrity: Minimize exposure of the sample to external contaminants or environmental factors during collection. Seal sampling containers tightly to prevent leaks or spills and label them accurately with relevant information, including sampling point, date, and equipment identification. QR or bar codes can be used for automatic sample identification and easy referencing for measurements.

Documentation and Record-Keeping

Maintain Detailed Records: Keep accurate records of sampling activities, including sampling locations, dates, procedures, and personnel involved, preferably with a software as part of an oil condition monitoring system. Using software for keeping accurate records of sampling activities is essential for effective oil analysis management. Furthermore, the software can streamline communication among team members, enabling collaboration, accountability, and adherence to standardized sampling protocols.

Track Sample Chain of Custody: Implement a chain of custody system to track sample handling, transport, and analysis from collection to reporting. Document sample receipt, analysis, and reporting to maintain traceability and accountability throughout the process.

By following proper sampling techniques and processes, maintenance professionals can ensure the integrity and reliability of oil samples, enabling accurate analysis and informed decision-making regarding equipment health, lubricant condition, and maintenance practices.



ERALAB OCM is a range of easy, rugged and accurate oil analyzers which, in combination with a software solution, enable the development of a successful in-house oil condition monitoring program

Using Oil In-House Condition Monitoring Solutions

Investing in Oil Condition Monitoring (OCM) tools with integrated software, such as from eralytics, empowers organizations to proactively manage the health of their lubricating oils and equipment. By leveraging dedicated software, maintenance professionals can efficiently collect, analyze, and interpret oil analysis data in real-time, enabling timely decision-making and proactive maintenance interventions.

In-house OCM tools use specialized instruments to monitor oil condition, similar to the cutting-edge technology found in off-site laboratories. For example, the ERALAB OCM uses a FTIR spectrometer to determine Oxidation, Additives and TAN/TBN in lubricants in just one minute. eralytics also offers a kinematic viscometer for high-precision kinematic viscosity testing at any temperature between 15°C and 100°C and produces results within 60 seconds. It also allows to measure the viscosity index in less than 10 minutes with only one measuring cell. Particle content can be precisely measured according to established ISO standards and there are easy solutions to measure the content for up to 32 elements and the content of ferrous contaminations. With consistent use of these instruments, you can identify trends, patterns, and anomalies in the data, highlighting areas of concern or potential maintenance requirements.

OCM tools offer customization and flexibility to adapt to specific equipment types, operating conditions, and maintenance requirements. Maintenance professionals can customize alarm thresholds, analysis parameters, and reporting formats to suit their unique needs and preferences, ensuring that OCM tools provide actionable insights tailored to their specific equipment and operational environment.

Conclusion

Oil condition monitoring is a valuable predictive maintenance tool for monitoring equipment health and lubricant condition, reducing unplanned downtime, and optimizing maintenance practices. Key metrics such as aging and chemical condition, viscosity, additives, contaminants, and ferrous debris provide insights into potential issues and guide proactive maintenance actions.

The implementation of an in-house oil condition monitoring program offers numerous benefits for organizations seeking to optimize equipment reliability and performance through proactive maintenance practices. Easy-to-use, rugged, and accurate measurement solutions like ERALAB OCM play a pivotal role in enabling the installation of such in-house solutions for oil condition monitoring. These advanced measurement technologies, coupled with integrated software, give maintenance teams the ability to accurately track equipment and lubricant health and stop machine failure in its tracks.

About eralytics

The Austrian company eralytics was founded 2007. For more than a decade, eralytics has been developing and manufacturing liquid quality control analyzers for many industries, including petroleum, oil condition monitoring, beverage, flavor & fragrance, wastewater and many more. “We re-imagine trusted technologies to create innovative solutions. In everything we do we reduce complexity to create easy and intuitive user experience. Basically: trusted solutions, re-imagined.”

eralytics’ fully automated, portable, and easy to operate analyzers are mainly used for high-performance quality control of fuels and lubricating oils. eralytics’ instruments provide fast results with the highest precision and maximum reliability in the laboratory and on-site with mobile laboratories.

With the ERALAB OCM, eralytics offers a comprehensive hardware and software solution for easy and accurate oil condition monitoring, that can be used both in the laboratory as well as directly on site. The focus is on covering the entire oil monitoring process and achieving the fastest results.

Learn more at www.eralytics.com

