The Value of Combining Vibration and Oil Analysis

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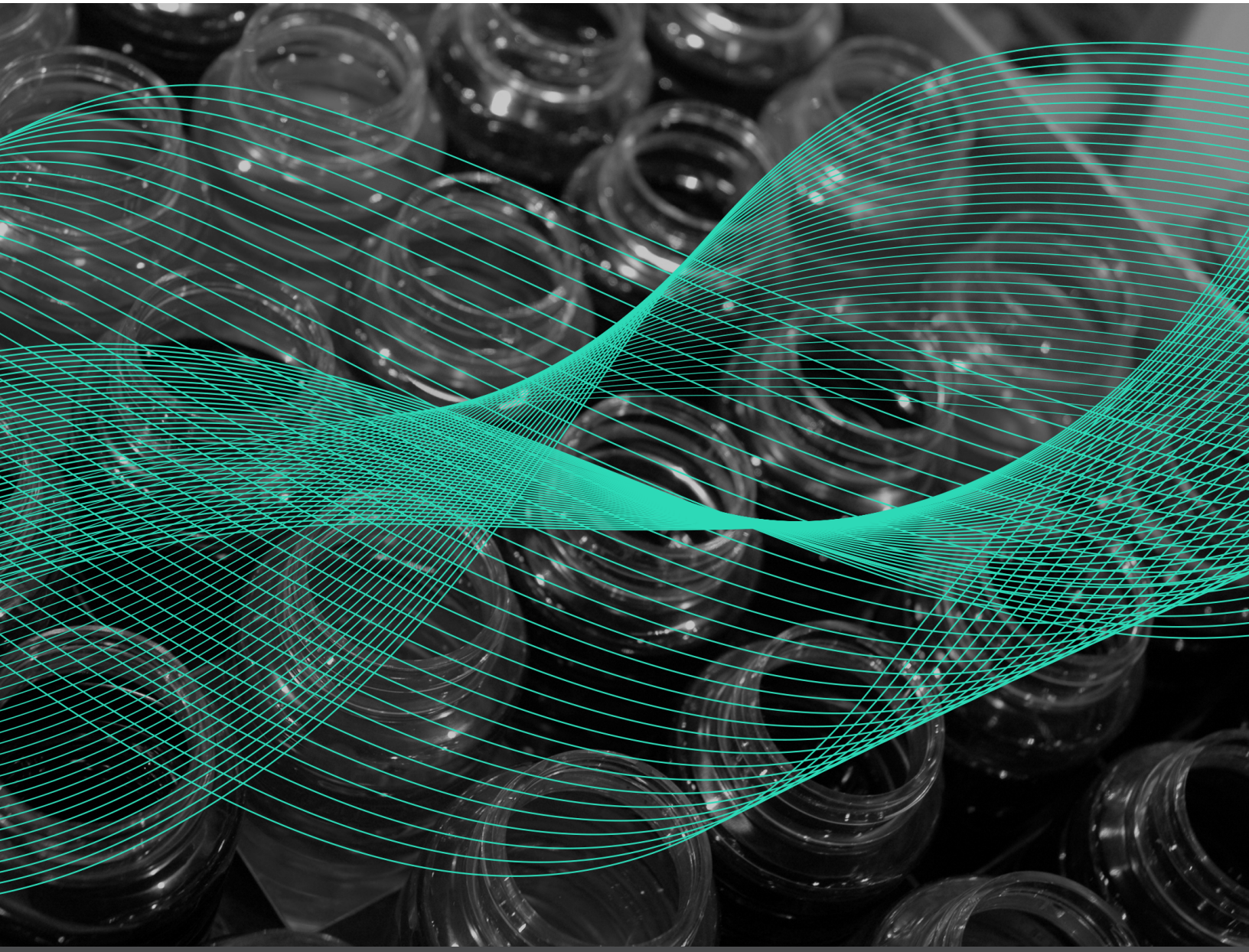


In the early days of the modern condition monitoring era, oil analysis and vibration analysis were often seen as rivals, competing for resources and attention. However, with time and data-driven insights, it has become clear that these two powerful technologies are not adversaries, but rather complementary forces in the realm of machine health management.

When combined, oil and vibration analysis create a comprehensive approach to condition monitoring, allowing organizations to leverage the strengths of each method while compensating for their respective limitations. Nevertheless, to fully benefit from this dynamic combination, it is essential to both integrate the techniques and collect the data correctly. Embracing the integration of oil and vibration analysis in machine condition monitoring can lead to significant improvements in performance, reliability, and overall equipment longevity.

Advantages of Vibration Analysis

Vibration analysis is a powerful predictive maintenance technique used to monitor and diagnose the condition of rotating machinery such as motors, pumps, and gearboxes. By measuring the vibration signals emitted by the equipment, engineers can identify patterns and abnormalities that may indicate potential failures or deteriorating conditions.

Vibration analysis can identify a wide range of issues including misalignments, imbalances, bearing wear, and loose components. By detecting these issues early, organizations can schedule maintenance during planned downtime, thereby ensuring smooth, continued operation, and reducing the financial impact of equipment failure.

Advantages of Oil Analysis

Oil analysis is another critical predictive maintenance solution, as it provides valuable insights into the condition of a machine's lubricant and internal components. By analyzing oil samples, analysts can identify signs of contamination, machine wear, and changes in lubricant properties.

When oil analysis detects early signs of wear debris, this predictive indicator can trigger action before the failure becomes severe. Wear from surface friction can be due to contamination, misalignment, lubricant issues, among other root causes. Corrosion can also lead to wear debris detected by oil analysis.

OIL ANALYSIS CATEGORY	TESTS
Fluid Properties	**Viscosity, Acid/Base Number, FTIR, Elemental Analysis**
Contamination	**Particle Counting, Moisture Analysis, Elemental Analysis**
Wear Debris	**Ferrous Density, FTIR, Elemental Analysis**

Oil analysis tests reveal the state of the lubricant along with information about the condition of your equipment.

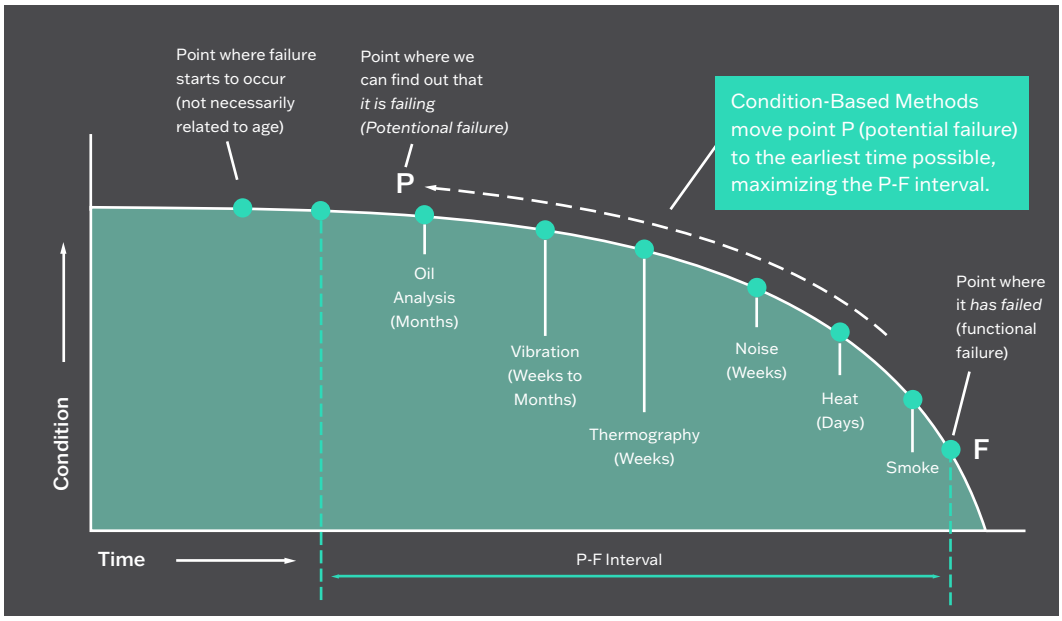
Detection of the root cause, such as an increase in contamination or abnormal changes in fluid properties is a proactive indicator. In other words, acting during the introduction of a root cause can fix a problem before a machine ever experiences failure, thus reducing downtime and extending the equipment life considerably. Alternatively, if no corrective action is taken at this stage, the problem will escalate into machine wear.

Combining Vibration and Oil Analysis

Integrating vibration and oil analysis data offers a more comprehensive view of an asset's health, allowing organizations to optimize their maintenance efforts. While each method is effective on its own, combining the two provides a more precise and complete picture of the equipment's condition, enabling maintenance personnel to identify issues that may not be conclusive when using only one technique.

Which Comes First?

Mechanical issues, such as misalignment, imbalance, or even a loose mounting bolt, are sometimes detected by vibration before wear particles show up in oil analysis. If oil analysis is being used alone in this case, unnecessary wear and damage will have occurred before the issue is identified. Evidence of wear debris can also get tricky if there are other sources of debris present in the sample, making vibration key in early failure detection and resolution.



Oil analysis and vibration provide earliest failure detection among common condition monitoring methods.

On the other hand, oil analysis is well known to detect certain issues before vibration. For example, the most common failure modes in gearboxes are gear tooth wear and gear tooth fracture. Detecting wear-related gear faults with vibration analysis can be challenging because there are so many competing vibration signals – particularly at slow speed where the amplitude of the vibration signal may not be strong enough to overcome the noise factor. However, oil analysis provides excellent resolution in detecting wear debris from contact fatigue, abrasion, and adhesive wear, making it a great choice for the early detection of these failure modes. Even further, if the gear wear is because of contamination or unwanted changes in fluid properties and is detected first, corrections could be made before wear ever occurs.

Who Benefits?

The combined approach not only helps organizations to pinpoint and address issues more effectively, but it also enables them to optimize their maintenance schedules. By using both vibration and oil analysis data, maintenance personnel can prioritize tasks based on the severity of the issues detected, ensuring that the most critical problems are addressed first. For example, if a gear mesh issue is detected by vibration, an oil sample may show low viscosity which is a common cause of gear mesh problems. This is much less time-consuming than a physical inspection and, in most cases, does not require the machine to be shut down. This strategic approach to maintenance reduces downtime and ensures that resources are used efficiently, regardless of industry.

With that said, industries that face higher contamination levels, such as pulp and paper or mining, have a higher benefit of integrating vibration and oil analysis, as oil contamination is the most common cause of equipment failure and machine downtime. Once contaminants meet the lubricant, the resulting abrasive wear can cause a chain reaction in lubricated machinery, and it doesn't take much to cause detrimental damage. Particles smaller than 5 microns are often the most damaging to the lubricant film, impacting delicate components like bearings, so the more comprehensive the data, the better you can prioritize repairs (Simmonds).

The Power of the Oil Sample

The two primary goals in oil sampling are maximizing data density and minimizing data disturbance. Maximizing data density means the sample should be taken in a way that ensures there is as much information per milliliter of oil to accurately represent the frictional zones of the machine. This indicates criteria such as cleanliness and dryness of the oil, depletion of additives, and the presence of wear particles being generated by the machine.

The second goal is to minimize data disturbance. The sample should be extracted so the concentration of information is uniform, consistent, and void of anything that could lead to a false positive. For example, it's important to make sure that the sample does not become contaminated during the sampling process.
If you plan to add, or currently use, oil analysis in your maintenance program, attention to detail is key to getting an accurate sample. A representative sample enables effective monitoring of oil condition, prediction of machine failures, and extension of asset life. Whether using a test kit or your own equipment, attention to detail during oil sampling ensures accurate, consistent, and valuable data.

Successful Oil Sampling

Sampling procedures will vary in form from organization to organization and changes based on the type of equipment. At a minimum, your sampling procedure should include elements like clear objectives, frequency of sampling, proper sample locations and equipment, and a guide to the method for transparency among different assets and locations. A documented plan will ensure that your results are consistent and accurate.

Safety Considerations

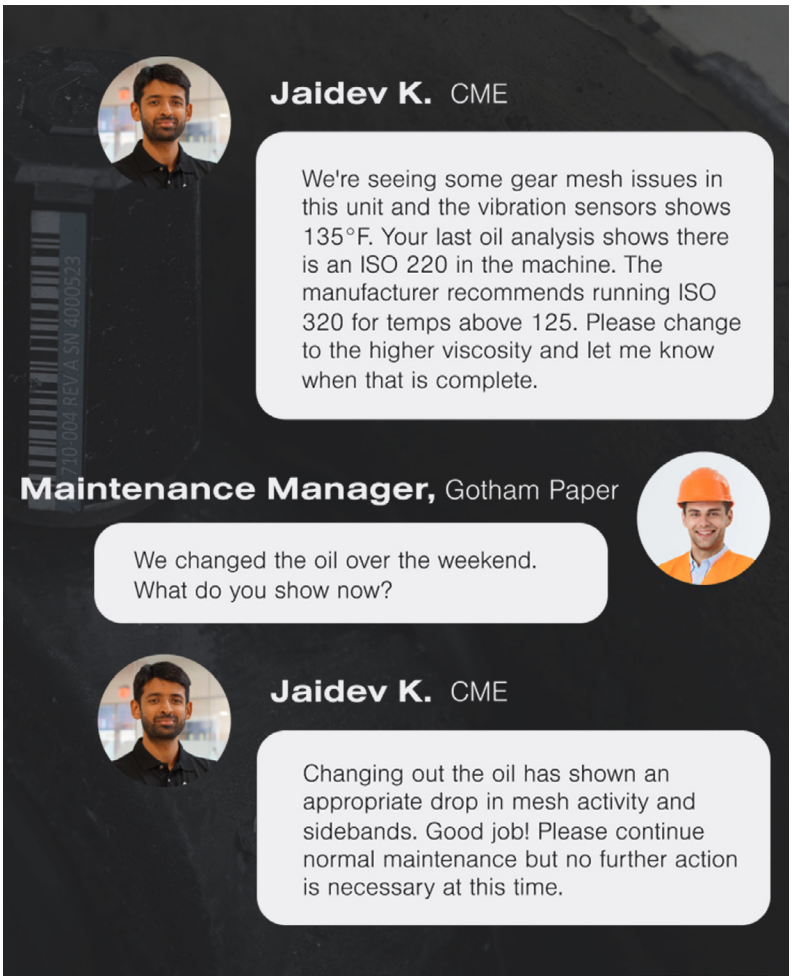
In any activity, priority 1 is technician safety, and oil sampling is no exception. Consider these factors:

- **System pressure** - Fluid under high pressure can be deadly if mismanaged. Take special precautions when sampling from or around high-pressure systems, such as hydraulic systems.
- **Fluid toxicity** - Some lubricants and hydraulic fluids may be toxic (e.g., phosphate ester). When sampling these oils, state clearly the risks associated with exposure and the recommended remedy or treatment in accordance with plant policy or manufacturer's recommendations.
- **Hazardous environment** - Some environments are inherently hazardous due to the presence of chemicals, heat, cold, radiation, open or exposed mechanical equipment, high pressure systems, etc. Proper cautionary measures when working in these areas should be noted in the sampling procedure.

Developing and deploying effective sampling procedures is crucial for oil analysis success. Consistent data and confidence in decision-making depend on these procedures. However, it is only the beginning. Proficiency in report interpretation is necessary to fully benefit from oil analysis.

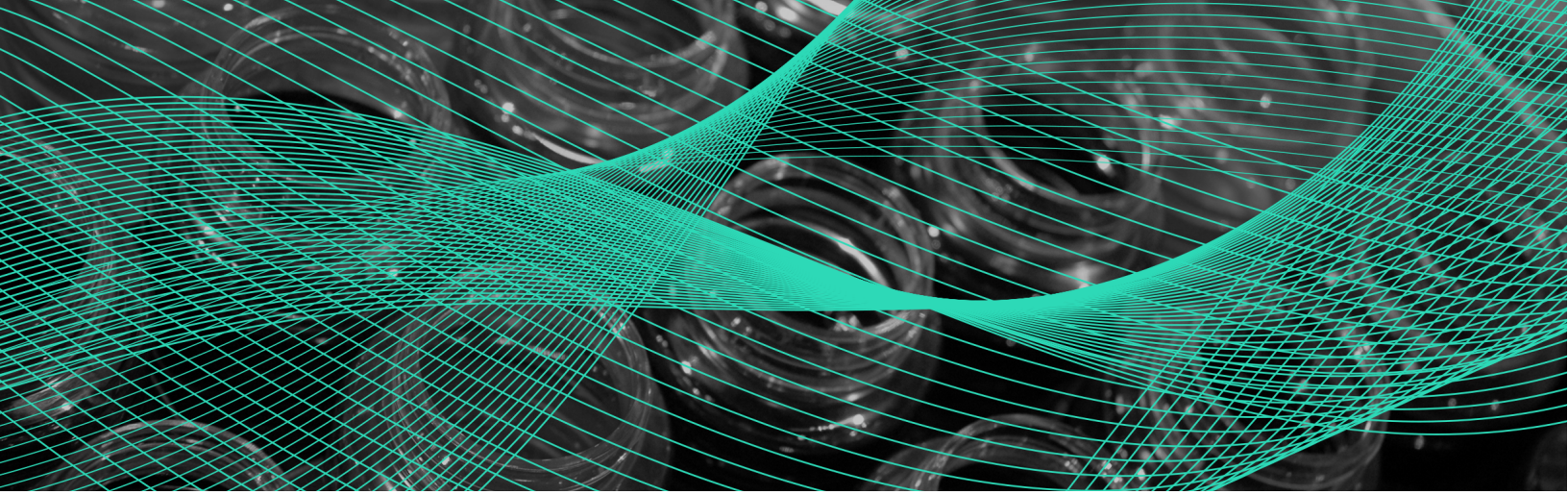
Data Interpretation

Interpreting oil analysis reports requires considering various test results, such as viscosity, free water, acid number, and wear limits. Analyzing trends over time helps gauge lubricant and machine aging, while determining rates of change aids in informed maintenance decisions. Skilled experts are essential for this process.



Data analysis and corrective action plans are crucial. For some plants, employing trained analysts for vibration and oil analysis might strain budgets, especially if there are few assets and infrequent samples. In such cases, **partnering with a third party** offering certified analysts at lower costs can be a more viable choice.

AssetWatch's Condition Monitoring Engineers (CME) are skilled in both oil analysis and vibration and can help your plant achieve a holistic predictive maintenance program. Not only does an asset reliability technician from AssetWatch's team come to your facility to install the sensors, but they will also instruct you on how to take the representative oil samples correctly. Then, your machine health data will be sent to the AssetWatch software where your dedicated CME will help decipher your readings and provide prescriptive insights and maintenance recommendations.



Bottom Line

Incorporating both vibration and oil analysis in a comprehensive maintenance strategy fuses predictive and proactive best practices and revolutionizes equipment management. By combining the strengths of these two techniques, organizations can create a force multiplier effect, enabling them to identify and address potential issues more effectively. As a result, businesses can improve operational efficiency, reduce costs, and maintain a competitive edge in today's fast-paced industrial landscape.

Sources:
Simmonds, Rob. "It's All about Size." Machinery Lubrication, Jan. 2007,
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