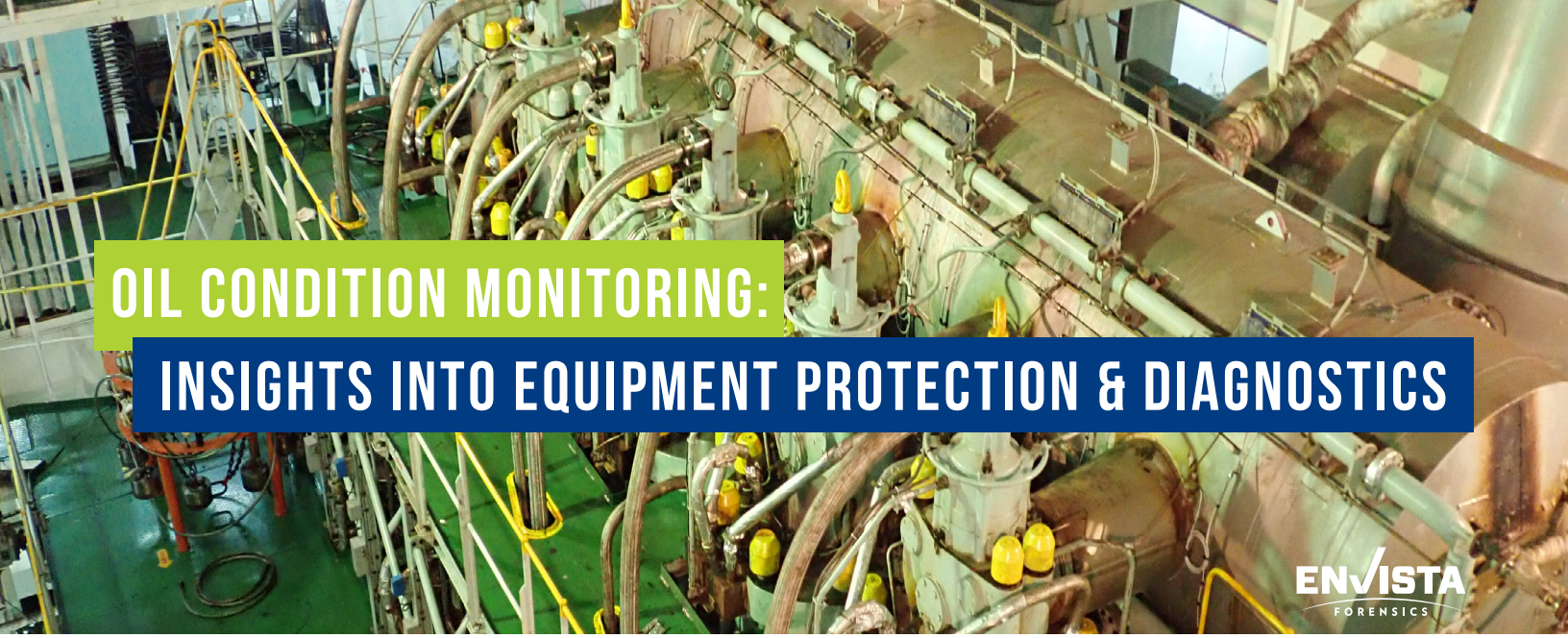

OIL CONDITION MONITORING:
INSIGHTS INTO EQUIPMENT PROTECTION & DIAGNOSTICS

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All industries including mining, shipping, manufacturing, earthmoving and construction rely on critical plant and equipment uptime to achieve business objectives. Any amount of plant or equipment downtime can result in devastating loss of production and costly business interruption. For these reasons, implementation of effective oil condition monitoring (OCM) and maintenance programs in critical plant and machinery should not be viewed as an optional requirement. Indeed, due to ever increasing demand for return-on-assets, it would be unusual to find critical equipment in any industry now without one.

Highlights

- The Function of Oil
- Field Collection and Testing
- Interpretation and Diagnosis
- Proactive Actions Upon Results

The cost for such a program is very small compared to the capital costs to replace the asset or deal with the business interruption associated with loss of use of the equipment due to a breakdown event or otherwise reduced operational life. In this paper, we outline the common uses of oil in business critical equipment, collection and testing scenarios, how to identify contamination and the steps to take to protect assets from future damage and deterioration.

INTENDED FUNCTION:

Oil is a chemical compound existing as a viscous liquid at ambient temperatures and used in machinery for multiple purposes such as lubrication, cooling and power transfer (e.g. a hydraulic cylinder) across all industries.

Primary function ✓ Secondary function ✓✓	Oil Function				
Application	**Lubricate**	**Cool**	**Transfer Power**	**Insulate (electrical)**	**Signal**
Diesel and petrol engines	✓	✓✓			
Compressors	✓	✓✓			
Gear trains / Axles	✓	✓✓			
Wind turbines	✓	✓✓			
Gas turbines	✓	✓✓			
Generator sets	✓	✓✓			
Hydraulic systems	✓✓	✓✓	✓		✓✓
Automatic Transmissions	✓✓	✓✓	✓		✓✓
Transformers		✓✓		✓	

Although typically and primarily used for the purpose of lubrication to reduce wear rates, equipment such as electrical transformers use oil for the purpose of electrical insulation and arc prevention. In most applications however, if not all, the secondary purpose of oil is to provide an important cooling function. Friction is inevitable between sliding surfaces, which produces heat and is transferred away from the heat source by the oil.

OCM provides the "why" something must be done (driving proactive preventative to actions avoid costly damage), not just the "when" (to replace the oil).

TESTING:

OCM can take several forms to aid detection of problems and contamination before excessive equipment wear or catastrophic failure occur. This may include a combination of field testing, laboratory testing and real-time monitoring. The various oil companies, some equipment manufacturers and various other stand-alone vendors, can provide extensive OCM laboratory services. Services usually extend to include all industries and customers requiring specialized analysis of oil, coolant, grease, fuel or other fluids. Sample collection requires a trained technician to attend the machine with appropriate collection equipment. Cleanliness is of utmost importance to ensure contamination is not introduced in the collection process.

Field Testing: Marine Engines

Large ocean-going vessels are away at sea for weeks at a time and are required to monitor systems more frequently to ensure optimal feed rate settings of cylinder lubrication oil. “Scrape down oil” analysis (SDA of cylinder lubrication oil) can be tested on the spot for ferrous iron (abrasive wear), corrosive iron (detects iron salts due to acid attack on cylinder liners) and residual Base Number (BN, a measure of a cylinder oil’s reserve alkalinity).

Laboratory Testing: All Industries

Laboratory testing provides a full insight into oil condition and analysis of wear metal particles. A wide range of tests are utilized, depending on the lubricated compartment or fluid being analyzed. Tests can include:

- Particle count
- Viscosity
- FTIR spectroscopy (element identification and quantification)
- Acidity
- Alkalinity
- Soot content
- Fuel dilution

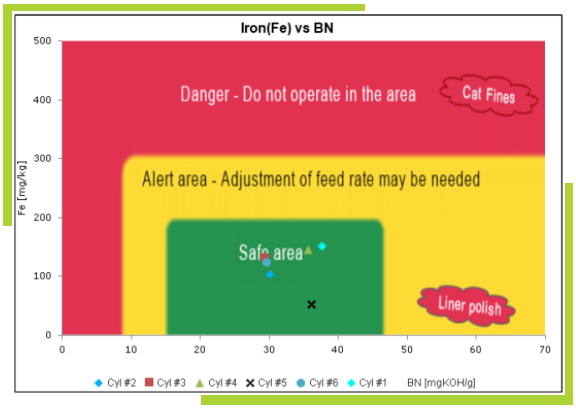
Real-Time Monitoring

Oil quality sensors are available to alert equipment operators of potential problems. These sensors are akin to a fuel level gauge, which provide instantaneous data of the system’s status. Oil changes may be made based on oil condition rather than a schedule, thereby reducing both risk and cost. However, note these sensors are limited to providing only an indication of increased contaminants. The sensor will not detect the source or identify the contamination, just that the concentration has changed. The Internet of Things (IoT) will advance the usefulness of real-time knowledge since the sensed data can be monitored from any location with rapid response.

INTERPRETATION & DIAGNOSIS:

Oil contamination can exist as metallic (wear or foreign) particles, combustion soot (engines), water, elemental products of oxidation (corrosion) and glycol coolant. These may be introduced following oil degradation, poor fuel/oil quality, internal hardware wear and compartment leak sources.

Objective data provided by OCM brings the benefit of analysis through trending of results from both prior tests and anticipated results based on the compartment tested.



OCM can provide the following strategic insights:

- Data collected over time will enable parameter trend analysis, i.e. increasing, steady or decreasing
- Differences between similar machines operated by the owner
- Differences between compartments, e.g. engine SDA results across each cylinder
- Potential sources of contamination, e.g. fuel source, oil source, internal
- Parameter identification and quantity, e.g. bearing wear (Pb/Sn), cylinder liner wear (Fe), soot %

ACTIONS:

Analyzed data will quickly create pro-active work priorities, especially where a sudden increase (or decrease) in certain monitored parameters indicate internal distress. The following examples display how astute operators will optimize machine operation by taking notice of OCM results and prevent catastrophic failure:

- Example 1: A sudden increase in the level of sodium (Na), potassium (K) or boron (B) could indicate a coolant leak into the engine via a worn head gasket or a cracked block.

- Example 2: For large marine engines burning high % sulfur (S) fuel oil, active monitoring of the base number is necessary to optimize appropriate cylinder liner wall lubrication conditions. This is to avoid heavy cylinder liner wear, often referred to as “cold corrosion”, which can reduce engine life by 50%.

SUMMARY:

An equipment maintenance program is not complete without a tailored OCM program, based on the type of machine and the function it performs. Equipment life and reliability is enhanced, reducing maintenance costs and unexpected downtime.

Contact Envista Forensics if you are seeking expert support in interpreting oil analysis results or dealing with an unexplained failure mode in your equipment. OCM often forms the basis of a detailed forensic analysis conducted by Envista’s engineers seeking certainty in an uncertain world.