White Paper

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FieldLab 33C

A mobile oil analysis tool to predict lubrication failures and avoid unplanned repairs

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The FieldLab 33C is the latest generation of portable oil analysis tools designed to answer key questions regarding the lubricated machinery. Three test modules measure ferrous wear, lubricant viscosity and fluid chemistry with a tablet interface for ease of use. This enables any machinery maintainer to quickly test 10 ml or less of oil and generate enough high quality data to populate a Trivector™ status report when used with TruVu 360 software. This is an excellent advisory approach that has been used globally for over 20 years to effectively communicate oil analysis data. This whitepaper recaps the challenges the FieldLab 33C solves, giving a review of the core measurement principles and typical examples of failure avoidance when those technologies are employed onsite.

Figure 1: FieldLab 33C Portable Fluid Analysis System

Figure 2: Fluidscan and Minivisc combo kit is widely used for onboard monitoring today

Background

Over a decade ago, ship owners in the government marine space (logistics and Coast Guard) recognized the significant costs involved in changing oil for their fleets on time-based schedules. Traditional onshore oil analysis was suggested as a technique to extend drain intervals. However, the practical difficulties in transporting oil samples from ship to shore, combined with long sample turnaround times, made the effort ineffective and expensive. Onboard chemical test kits were acquired to at least detect fluid contamination and fluid degradation. These kits were very subjective to the operator, involved hazardous chemicals, and required manual recording of data. The introduction of the Spectro Scientific FluidScan/MiniVisc combo kit enabled operators to generate high quality chemistry and fluid condition data (Figure 2). They documented significant cost savings by avoiding mix-ups and wrong oil additions, detecting aged oil and water/fuel contamination events – so much that it has become a standard onboard.

Importance of three facets of oil analysis

Oil analysis does not refer to one or two tests, but rather a suite of tests chosen to ensure three aspects are addressed as shown in Figure 3. The Trivector™ is a very effective radar plot covering all aspects, thus enabling any equipment maintainer to quickly visualize the equipment health and immediately form an action plan to address abnormalities. The TriVector™ is available when FieldLab is used with optional TruVu 360 software.

Figure 3: Trivector™ oil analysis: A powerful way to summarize data from all 3 facets of oil analysis by graphically illustrating direction and severity of faults, enabling quick decision making

Understanding Ferrous wear

The most common wearing components in rotating and reciprocating machinery are manufactured with iron-based alloys. Pumps, motors, compressors, gearboxes, fans, couplings, rolls, screens, and other rotating, reciprocating or articulating machines are prone to experience severe sliding adhesive wear, rolling fatigue wear, and bending fatigue fracture. It is common for defects to progressively transition in stages. Successive stages of severity involve increasing size ranges and increasing quantities of metal wear debris. Severity stages may be described as benign, severe, advanced, and then catastrophic wear debris.

Severe sliding adhesive wear involves abnormal metal-to-metal sliding contact between moving components. Localized adhesive wear often takes place due to extreme loading, slow speed, absence of lubrication, low viscosity oil, or misapplication of lubrication.

Rolling fatigue wear is caused by high cycle rolling compression load such as between roller and raceway or between gear teeth in vicinity of the pitch line. Fatigue fractures are caused by low cycle fatigue crack propagation originating from a defect or stress concentration.

The graph in Figure 4 shows wear particle size range for stages of wear from benign to catastrophic. Abnormal abrasion, adhesion and fatigue wear debris particles are large and contain base metal. Microspall particles range between 10 µm and 50 µm. Laminar particles and chunks range from 50 µm to several hundreds of microns. It is important to collect samples during the prediction interval so repairs can be planned and accomplished before reaching the catastrophic stage when repairs and downtime are unavoidable.

Total Ferrous findings are excellent prediction data and may complement and validate vibration analyses regarding severe sliding and rolling fatigue failures in gears and antifriction bearings. They may also supplement resonant motion amplification regarding bending and torsional fatigue.

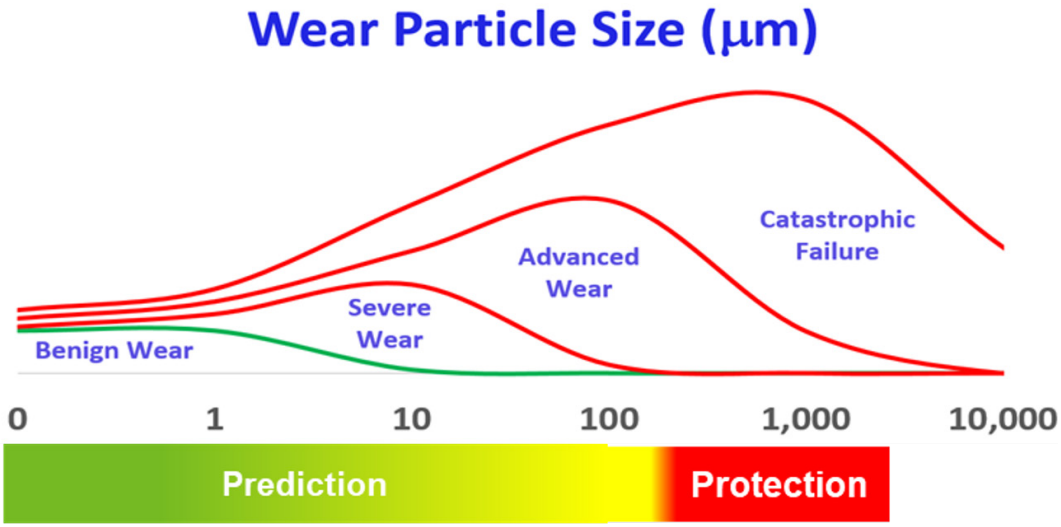

Figure 4: Total ferrous measurement is very useful for looking at ALL particulate, by measuring Fe PPM iron wear debris size range from sub-micron to very large.

Total ferrous measurement for onsite oil analysis

In 2016, Spectro Scientific developed an innovative, patented approach to address the need for a NIST traceable, proper approach to detecting ferrous wear in oils and greases. The methodology was publicized and standardized (ASTM D8120) to report iron for wear debris sizes ranging from nanometers to millimeters with concentrations ranging from a PPM to percent (Figure 5).

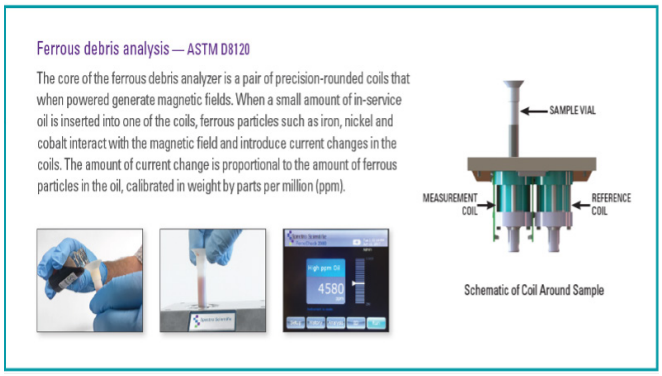

Figure 5: Total Ferrous wear measurement makes use of an innovative magnetometer approach (ASTM D8120)

Figure 6: MiniLab 33 for Industrial workshops. This solution has been in the market for several years and is a popular package for discrete industries new to oil analysis.

Available as a stand-alone device (FerroCheck) for oil and grease, and also built inline to a direct imager particle counter/classifier (LaserNet Fines 230), the test has been widely employed for in service lubricants using total ferrous PPM measurements to improve reliability, planning and scheduling FerroCheck as an active wear measurement, in addition to fluid chemistry and viscosity have been used to reduce unscheduled repairs, and nurse troubled equipment to a point where planned and scheduled repairs may take place - a major cost savings and stress relief to overworked maintenance teams.

FieldLab 33C

The FieldLab 33C is the latest product, combining the modules of the current successful stand-alone devices into one integrated mobile package, with the benefit of each module communicating with a rugged tablet. Mobility is increasingly important to maintenance teams where critical machines are widely dispersed such as wind turbine farms, pipeline compressor stations, or temporary equipment sites (used in mining or construction projects). Collating samples to bring to a centralized location is time consuming, and the opportunity for a qualified mechanic to act on a detailed analysis at the equipment location is squandered. FieldLab 33C is designed to provide comprehensive data for TriVector™ analysis reports. A rugged tablet streamlines workflow, controls all modules, compiles data to analyze in situ, and integrates with the TruVu 360 fluid intelligence system, which manages asset analysis data and alarms. The sample vial shown in Figure 5 is versatile and suitable for testing including oil and grease. The oil, grease or wipe-sample media within the vial is not consumed or otherwise destroyed by the ASTM D8120 test method. When a sample test reports severe, advanced, or catastrophic wear, the specimen may be further inspected using microscopic analysis to view and classify the type of wear debris.

Figure 7: FieldLab 33C series builds on the successful single instruments in use for several years and proven to detect failure and lower costs for maintenance

Detecting difficult ferrous wear problems onsite - where FieldLab 33C makes sense

Onsite analysis with the FieldLab 33C system, when sampled at the appointed time, can detect large ferrous wear particles. Combined with the chemistry and viscosity results, this provides a very detailed picture of the situation. This rich information, with built-in diagnostics providing real actionable findings, empowers onsite personnel to begin planning for repairs or design changes. The FieldLab 33C results are in the predictive range of sensitivity that enables the team to buy time. This provides normal priority task scheduling, and when implemented, avoids high risk and expense.

Severe sliding and fatigue failures	Unplanned repair	Lost production	Total cost	Ferrous debris
Lumpbreaker roll bearing failure	$3,000	$138,000	$141,000	Grease sample
Felt roll bearing failure	$2,000	$97,000	$99,000	Grease sample
Hamilton press rocker arm failures	$100,000	$2,000,000	$2,100,000	Oil sample

Table 1: Examples of failures where early detection could avoid unplanned repair and lost production costs.[3]

On one of the examples shown above (Hamilton Press) is a typical 1000-ton mechanical press common in manufacturing plants such as automotive assembly. The high loading forces connected to rocker arms to transfer the hammer power makes routine online measurement subject to excessive noise and vibrations. In the example cited, large ferrous wear measurements alarmed on two separate occasions, where no other technology alerted. Oil analysis was the only indication for these component failures. In both of these cases, the lead Predictive Maintenance Engineer reported: "Continued operation without immediate maintenance would have been catastrophic. Avoided danger to the press operator. Avoided costly expense to the company. Without oil analysis problems like these are not known until the table drops." At that point, it takes several months to repair." These results allowed both presses to be repaired quickly. Press 16-3 took about three weeks to repair the broken rocker arm. The sheared stud on press 16-4 was repaired within 24 hours. Several months of lost production was avoided by detecting these hidden problems and planning and scheduling the repairs. Savings in each case is estimated at $50,000 in avoided maintenance and $1,000,000 in lost production.

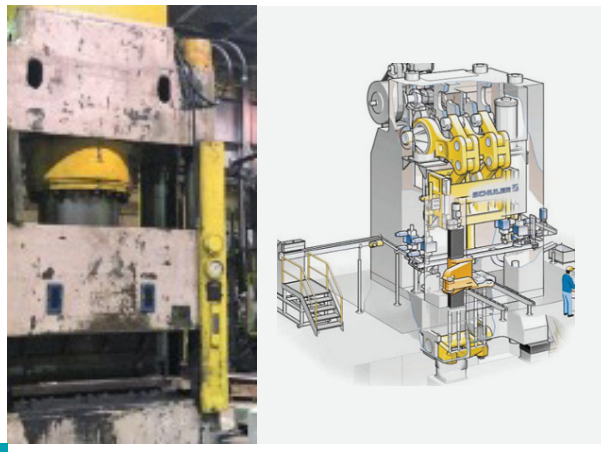

Figure 8: A 1000t press used in automotive assembly. Up to 4 Rocker arms (highlighted in yellow) transmit force, and need to be monitored (Ref : Schuler Presses)

Conclusion

The FieldLab 33C is the newest onsite solution designed to detect abnormalities in ferrous wear, viscosity and fluid chemistry in oil lubricated systems as early as possible. Its portability, combined with solvent free testing, small sample volumes, quick tests, and reports automatically uploaded to the TruVu 360 Fluid Intelligence System, make FieldLab 33C the ideal tool for maintenance personnel looking to enhance their reliability programs.

References: 1) "The bill is coming due" Garvey, R. Lubrication & Fluid Power November 2005 2) http://themilitaryengineer.com/index.php/item/555militarysealiftcommand%E2%80%94savingtimeonoilanalysis?tmpl=component&print=1 3) Garvey, Ray, Consulting Engineering case studies.

For more info visit: **www.spectrosci.com/fieldlab**

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