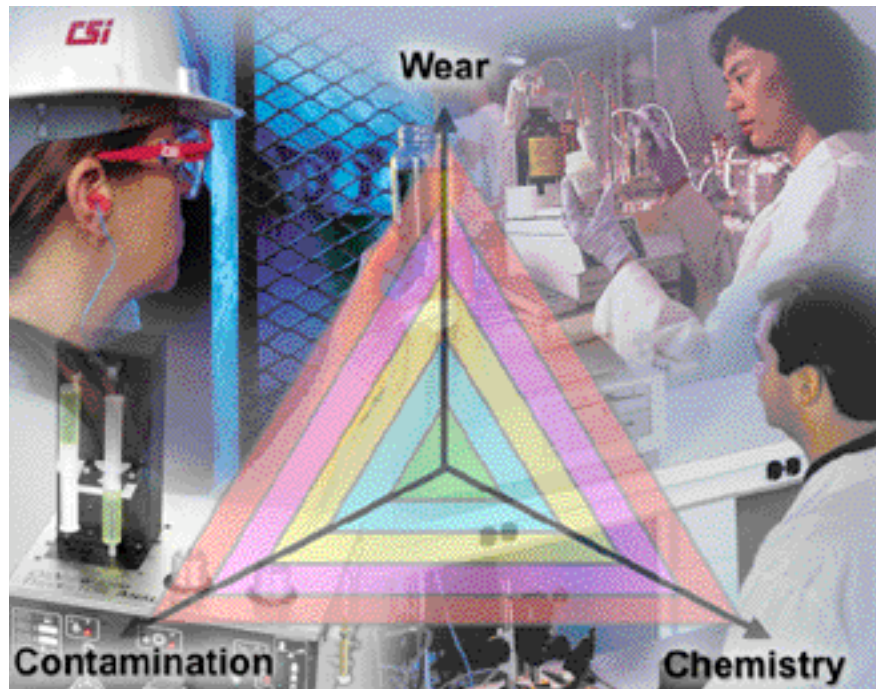


Tribology Story Book



Industrial equipment generally produces large wear particles and therefore it is vital to ensure that the appropriate oil analysis is performed including wear debris analysis, particle counting, and particle size distribution. Do not simply go for the cheapest option.

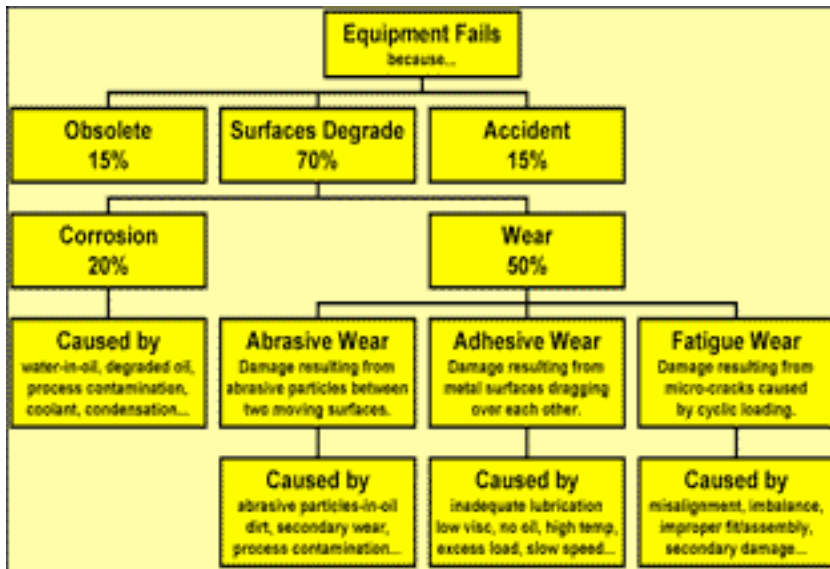
Emerson can offer you both on-site industrial oil analysis using our 5200 Trivector Analyzer and off-site oil analysis using our Industrial Oil Analysis Laboratory.

To ensure that you gain the maximum benefit from your oil

analysis program we recommend the OilView software to manage the data and reporting requirements.

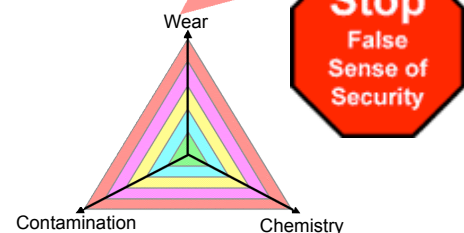
Numerous case studies have shown that if you follow these guidelines you should get a minimum of a 5:1 return-on-investment (ROI), 50% of which comes from keeping your oil clean, dry, and fit for use. A large portion of the ROI also comes from continual monitoring using appropriate industrial oil analysis.





Wear Debris Analysis, Ferrous Index (> 5 microns)
Spectrometric (Fe, Cu, Pb, Sn, Cr, Al, Ni, Ag) (< 5 microns)

Conventional Oil Analysis

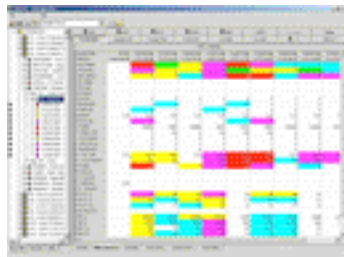


Industrial Oil Analysis

Particle Counting with size Distribution (>5 microns), Contaminant Index
Spectrometric (Si, B, Na) (<5 microns), Water

Viscosity at 40C and 100C, Viscosity Index, Dielectric, Chemical Index, Water, Spectrometric (Zn, Mg, Ca, P, K, Ba, Li, Mn) TAN, TBN, FTIR

OilView® Laboratory Information Management System (LIMS) Software



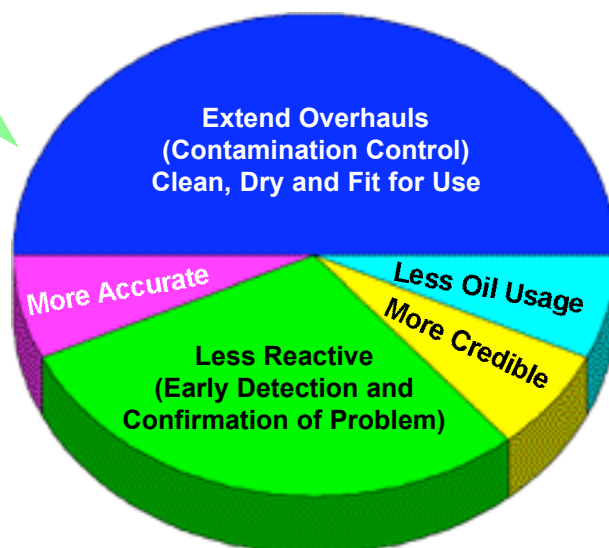
Essential to reap the benefit of your Oil analysis program



5200 Trivector Analyzer Industrial Minilab



CSI Industrial Oil Analysis Laboratory



Abnormal wear in industrial equipment generates large particles (typically > 10 microns). Be sure that the correct oil analysis is being performed to monitor all sizes of wear and contamination. You must not rely on spectrometric analysis alone as it can only see small particles (typically < 5 microns). Particle counting with size distribution and wear debris analysis are essential for industrial oil systems.

The Hidden Cost of Free Oil Analysis



Laser Turntable operating a Robotic Welder

Laser Turntable samples were collected and sent off to two different labs who provide "Free Oil Analysis." The labs reported:-

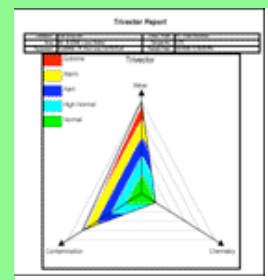


"No corrective action required."

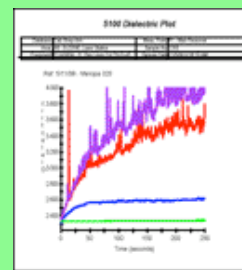


"Analysis indicates component and lubricant conditions are acceptable."

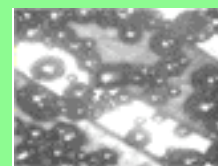
5100 Analyzer Minilab Results on the same sample



Trivector indicates Extreme Wear condition and Alarming Contamination condition!



Spikes on 5100 Analyzer plot indicate numerous Large Ferrous Particles



The Shop Microscope showed Iron Spheres in Laser Turntable Oil Reservoir

Moral of the story

Ensure proper Industrial Oil Analysis by either using the on-site 5100/5200 Industrial Minilab or a lab that performs Industrial Oil Analysis (Particle Counting and Wear Debris Analysis).

Maximizing Bearing Life

A bearing operates for most of its life in a damage free state. Only after some damage occurs can vibration analysis begin detecting bearing fault frequencies. However, during this damage free stage, you can and should perform proactive maintenance using oil analysis to ensure that the lubricant is clean, dry and fit for use. This will prolong the life of the bearing by limiting or preventing the onset of damage. Oil and vibration analysis are complementary and synergistic. Together they provide a more complete and accurate view of equipment health.

“The effective integration of oil analysis with Normal Vibration and PeakVue® for machine health monitoring provides much more than the sum of two parts. For example, PeakVue analysis will detect corrosion after damage is present but oil analysis will detect the presence of contaminants which will lead to corrosion damage if left unchecked. Normal vibration, PeakVue and Oil analysis will be very supportive of each other in severe damage situations allowing confidence in severity assessment and accompanying action items to reduce chances of catastrophic failure.”

Dr. Jim Robinson is a recognized innovator in signal processing technology and has participated in the development of patented techniques such as PeakVue®, SST and others.

NEW


Proactive Stage (Damage Free)

1
2
3

FAILED

Proactive Stage
Initial Damage Stage
Second Stage
Third Stage
Final Stage

Bearing Life TimeLine

Vibration Analysis		Oil Analysis	
<p>Find and Correct Root Causes Before Damage.</p> <p>Check for Misalignment, Imbalance, Structural Resonance, Rub, Looseness and Correct Assembly to keep equipment in good working order.</p>	<p>Find and Correct Root Causes Before Damage.</p> <p>Measure Dust and other hard particles leading to abrasion. Measure Water and other fluids leading to corrosion. Check Viscosity to ensure correct lubrication. Extend Bearing Life by keeping oil Clean, Dry and Fit for use.</p>		
<p>PeakVue® will detect and identify bearing component damage.</p> <p>Demodulation generally will not detect.</p> <p>Normal Vibration generally will not detect.</p>	<p>Initial Onset of Wear.</p> <p>Early detection of small wear debris (<5 micron) at the onset of abrasion, fatigue and adhesion.</p> 		
<p>PeakVue® will detect and identify bearing component damage.</p> <p>Demodulation can detect, but no trending and no indication of severity.</p> <p>Normal Vibration may detect.</p>	<p>Early Detection of Bearing Damage.</p> <p>Particles from rollers, races, and retainers are counted, sized, and examined. Quantity and size of wear debris increasing (>15 micron). Identify root cause using wear debris analysis.</p>		
<p>PeakVue® shows fault frequencies and trending shows severity.</p> <p>Demodulation can detect, but no trending and indication of severity.</p> <p>Normal Vibration shows bearing defect frequencies.</p>	<p>Excellent Detection of Severity.</p> <p>Dramatic increase in wear particle counts and particle sizes as defects grow. More large fatigue chunks and platelets in the oil (>30 microns). Evidence of secondary damage as hard particles promote abrasion.</p>		
<p>PeakVue® shows an increase in harmonic (spectral) activity and a rapid increase in peak values (g's) of impacting events (time waveform).</p> <p>Demodulation can detect, but no trending and indication of severity.</p> <p>Normal Vibration shows increasing amplitude, broad band and looseness.</p>	<p>Severe Damage Indications.</p> <p>Increasing friction from damaged bearing components rapidly generates wear particles. Extreme concentrations of wear debris and secondary contamination found in the oil. Very high concentrations of very large wear particles (>50 microns).</p>		

“Oil Analysis effectively detects certain problems within rotating machines before they are evident with vibration analysis - particularly on multi-stage gearboxes, plain bearings, rotary screw air compressors, roots blowers and certain rolling elements bearings which might be located at a distance from an accelerometer mounting location.”

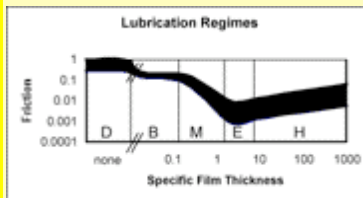
James E. Berry - from the article **“Good Vibes About Oil Analysis”** in **Practicing Oil Analysis** by **James E. Berry** who is a recognized expert in vibration analysis.

Difficulties Monitoring Greased Bearings

- Maintenance professionals often report that the biggest problem with their Tribology program is anti-friction bearing lubrication - specifically grease.
- Greasing problems include when to grease, methods to grease, how much to grease, using the wrong grease, no grease at all.
- Over greasing results in bearing damage and premature grease breakdown as a result of shield and seal damage and increased bearing temperature. Under greasing causes inadequate lube delivery and possible contamination entry resulting in premature bearing failure.
- Improper lubrication generates increased mechanical energy (high frequency stress waves) and thermal energy (increased temperature).

SonicScan 7100 Methodology

- Sensor specifically designed to measure lubrication regime by monitoring stress waves at 30 kHz using tuned resonant wave guide.
- Also detects mechanical faults, using a tuned 4 kHz resonant wave guide, and able to distinguish them from the 30kHz lubrication faults.
- Monitoring performed without intrusion while machine is operating.
- Indicates when to grease and when to stop greasing.
- Condition-based rather than schedule-based greasing.
- Grease sampling not required.

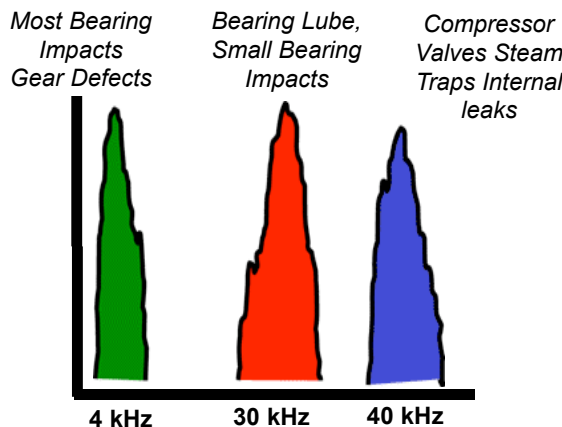


Grease is notoriously difficult to monitor using conventional oil analysis. Not only is it difficult to get a representative sample but there are many difficulties in trying to find a suitable solvent to dissolve the grease.

CSI's SonicScan Model 7100 analyzer is ideally suited to monitor the lubrication regime of greased bearings. It has been specifically designed to detect friction induced stress waves at the frequencies generated by bearing surfaces that have too much or too little lubricant. Rather than finding bearing faults after they have occurred, this proactive practice can prevent defects from developing prematurely due to lubricant issues.

Use SonicScan stress wave analysis to set greasing intervals and determine how much grease is needed to re-lubricate bearings.

Three Distinct Frequencies



Cleaning up your oil storage and using clean and correctly labeled storage containers is the first step in the process of gaining control of your lubrication.

Once this has been achieved it is important to ensure that the system is working by careful and continual monitoring of both the incoming and used oils. These should be checked for contamination and to ensure that the correct oil is being used.

In this case history many problems occurred with wrong oils, mixed oils, and contaminated oils found throughout the plant. Before the reliability team took ownership for the tribology program no one was really paying attention to lubricant storage, handling, and sampling.

Before

Unmarked and poorly marked oil storage containers....



Unmarked and inappropriate oil transfers....



Poor labeling and disorganized storage lead to many problems....



After

Well-organized, well-marked oil



Well labeled containers for new oils



Oil labels on plant equipment



Accurately labeled oil sample bottles



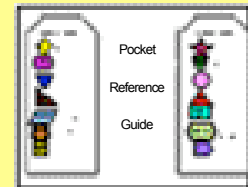
Ensure that good practices are being followed by implementing a sampling and analysis program

Solution



Fingerprint your oils using dielectric and viscosity to ensure correct labeling

Oil Type Labels



Clean up, label containers and equipment, accurately label sample bottles

5200 Trivector Analyzer Industrial Minilab

The 5200 Trivector Analyzer uses a simple, 4-part test procedure to analyze an oil sample in about 7 minutes.

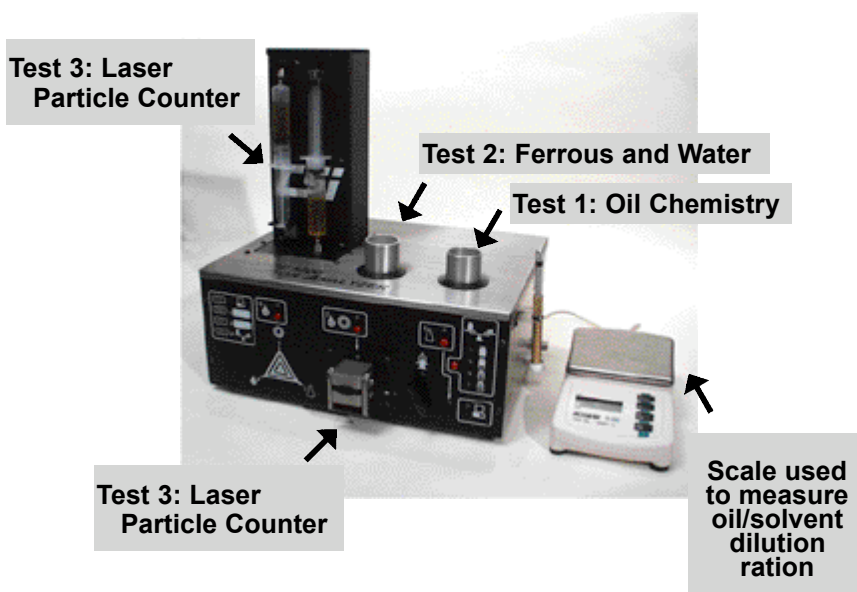
Test 1 measures the dielectric of the oil sample, which gives an indication of the deterioration of the oil and whether it is the correct oil.

Test 2 measures the water and ferrous content.

Test 3 uses a laser particle counter to look for particulate contamination and particle size distribution.

Test 4 is used to create a filter patch to trap particles for detailed wear debris analysis to determine root cause and severity.

The combination of these 4 tests and viscosity using the 52DV digital viscometer gives a comprehensive analysis for industrial oil systems.



The 52DV digital viscometer uses a rotating ball to measure the viscosity of the oil sample.

1 - Oil Chemistry (Dielectric + Viscosity)

Measures the dielectric of the undiluted oil and compares it to the reference oil dielectric to calculate the chemical index.

The Chemical Index gives an indication of the deterioration of the oil due to oxidation, nitration, contamination, etc. It also gives a clear indication of wrong oil.

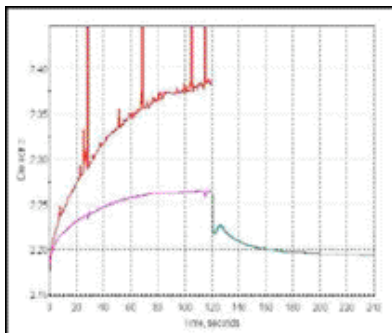
Viscosity is used to find wrong oil, mixed oil, checking incoming oil, oil storage points, used oil.

2 - Ferrous and Water

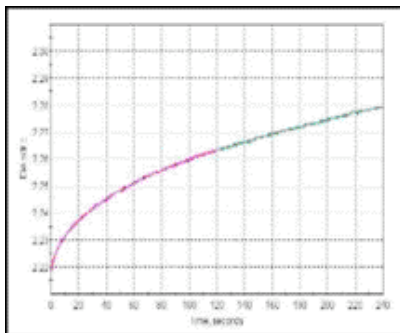
Measures the change in time resolved dielectric. An oscillating magnet is used to detect ferrous material.

The results are reported as contamination and ferrous indices as well as estimated water content.

Ferrous Particles



Water

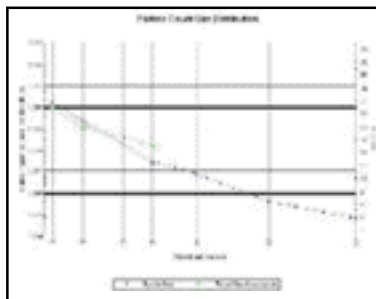


3 - Laser Particle Counter

Measures the number and size distribution of particles in the oil sample.

The results are reported as particle size distribution and ISO codes and are compared to a target cleanliness level assigned to the piece of equipment.

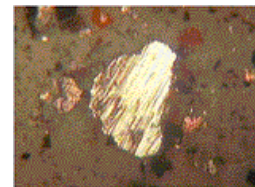
Particle Size Distribution



4 - Wear Debris Analysis

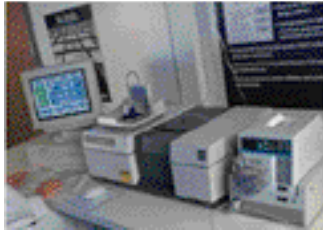
The Patch Maker creates filter patches for viewing under a microscope. The images can be captured using a video camera attached to the microscope.

The type of Wear Debris particle identifies the wear mechanism such as adhesive wear, abrasive wear, fatigue wear, etc.



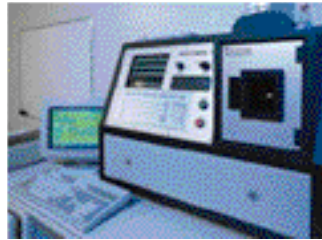
A fatigue wear particle as seen by an optical microscope.

FTIR



Fourier Transform Infrared Absorption spectroscopy is used to measure the extent to which a lubricant has been oxidized, its nitration levels, sulfate levels, water content, soot content and any fuel dilution.

Spectrometric Metals



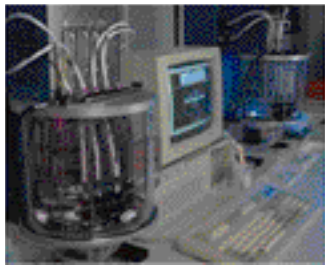
Spectrometric analysis is used to measure wear metals (particle size typically less than 5 microns), contaminants such as silica (dust), and additive levels (adding wrong lubricant, additive depletion).

Water



The presence of water is detected using a simple crackle test. The quantity of water is then measured using the Karl Fisher method.

Viscosity



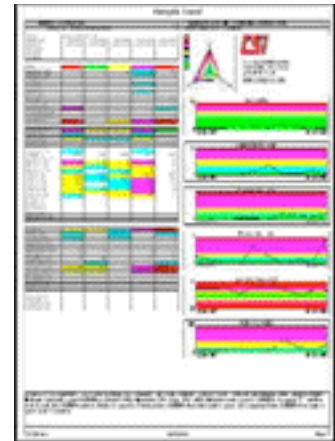
Viscosity is one of the most important properties of an oil. Without the correct viscosity a machine will not have the correct lubrication, resulting in severe damage. Viscosity is measured at 40C and 100C.

Neutralization Numbers



Total Acid Number (TAN) measures the extent to which a lubricant has been oxidized by monitoring the acid content. Total Base Number (TBN) measures the amount of neutralizing agents still available to counteract the acid build-up.

Reporting



Reports and/or data are automatically emailed to customers using the **Oilview LIMS**.

The OilView Laboratory Information Management System (LIMS)

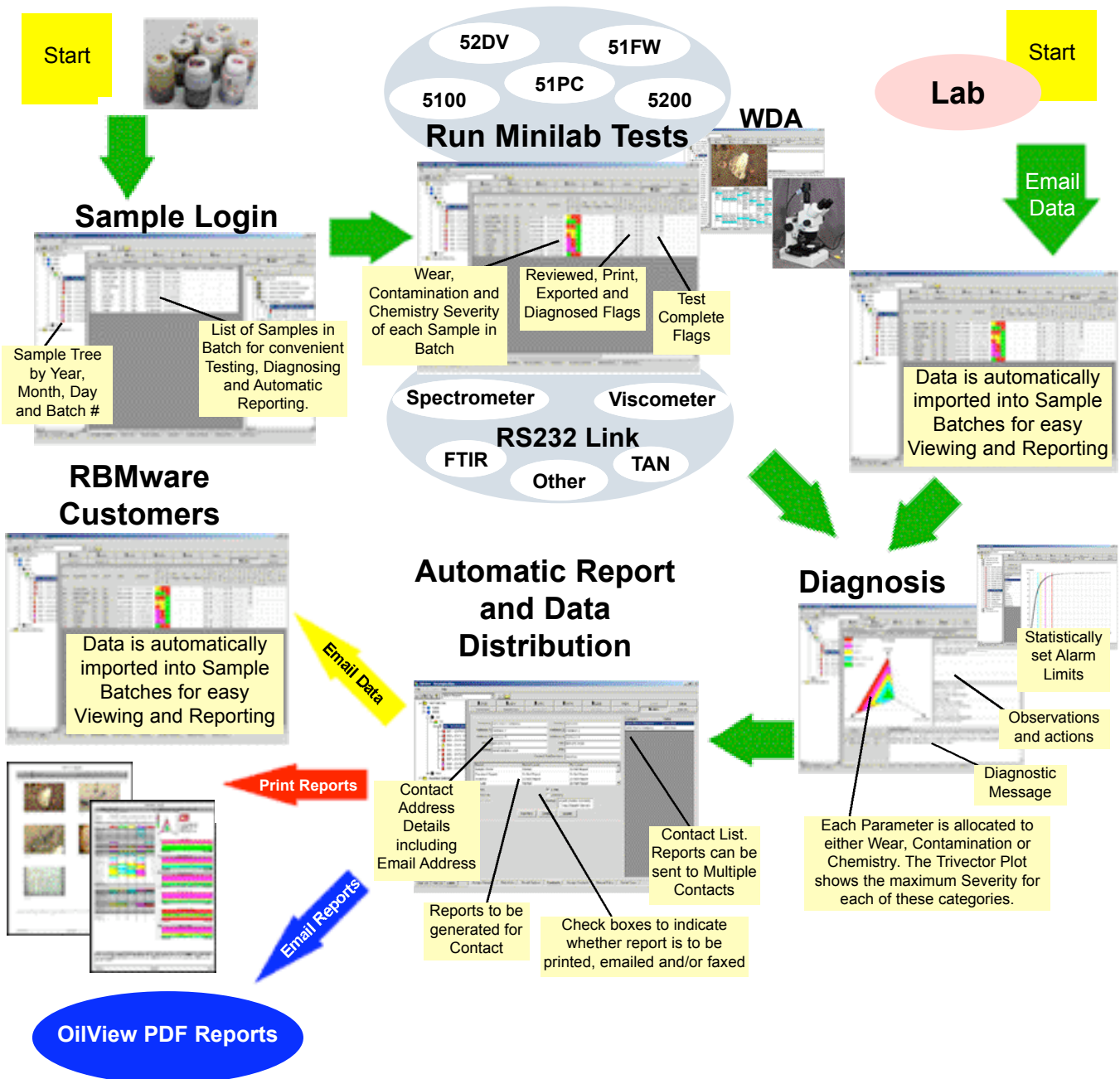
has been specifically designed to support the operation of an oil analysis laboratory. Samples are logged into convenient batches for easy management. All tests can be run

directly from the batches without having to search for individual samples in the database.

The LIMS system can gather data directly from CSI's Minilab oil analysis instruments and links to non-CSI instruments such as spectrometers.

A contact address book is used to automatically distribute reports and data via email.

Data from both the industrial oil analysis laboratory and other commercial laboratories can be imported directly into batches for easy viewing and reporting



OilView Minilab Options

Emerson Financial Services low-interest leasing is available

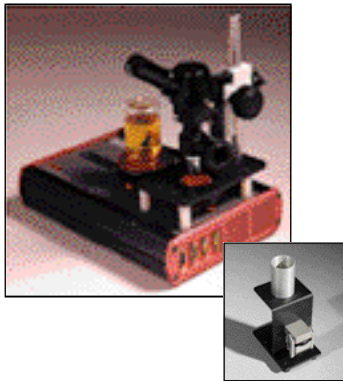


Comprehensive 5200 Minilab

- 5200 Trivector Analyzer
- 52DV Digital Viscometer
- 52ZM Stereoscopic Zoom Microscope
- Wear Debris Image Capture System
- OilView Minilab Module
- OilView WDA Module
- OilView LIMS Module
- 4-Day On-Site Startup Service

Basic 5200 Minilab

- 5200 Trivector Analyzer
- 52DV Digital Viscometer
- OilView Minilab Module
- 3-Day On-Site Startup Service
- Does not include microscope shown above



Basic 5100 Minilab

- Single Channel 5100 OilView Analyzer
- Wear Debris Patch Maker
- Shop Microscope
- OilView Minilab Module
- Training Certificate

SonicScan Fault Isolation System



- SonicScan 7100 Fault Isolation Kit
- SonicRoute Data Collector
- RBMware Sonic View

Industrial Oil Analysis Laboratory

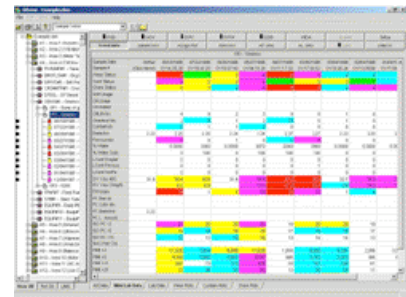
Lab options available as Kits and Single Samples. Customized Sample testing on request.

Clean Industrial Oil Analysis

- 40C and 100C Viscosity
- Emission Spectroscopy
- Particle Counting
- Water Determination (Karl Fisher Water when appropriate)
- FTIR
- TAN or TBN
- Wear Debris Analysis where appropriate

Advanced Industrial Oil Analysis

- **Clean Industrial Oil Analysis**
- Rotrode Filter Spectroscopy (Larger Particles)
- Scanning Electron Microscope when appropriate



OilView Software

OilView Software Modules

- OilView Minilab Module
- OilView WDA Module
- OilView LIMS Module
- Link to non-CSI Instruments

Machinery Health Management

It is a strategy for maintaining and operating mechanical assets for maximum performance and availability. Monitoring, diagnosis, preventive and corrective activities are planned based on operational significance, production requirements, and available resources. Resulting improvements: reliability, product quality, availability, equipment life, maintenance cost, rework/scrap cost, spares inventory, energy consumption and safety.

Emerson Process Management

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