About Spectro Scientific

Spectro Scientific develops a broad array of fluid analysis instruments for evaluating machine and lubricant condition in the field, in the lab and in highly mobile, handheld applications. The instruments provide critical data about machinery condition and can provide an early warning of incipient failure. Capturing, analyzing and trending this data on Spectro Scientific products enables you to:

- Schedule maintenance before a failure occurs
- Avoid the expense of maintenance you don't need
- Avoid the disruption of taking machinery out of service unnecessarily

The result is higher equipment availability, greater productivity, lower maintenance costs, lower total cost of ownership, fewer outages, optimal equipment performance, and greener operation – all empowered by accurate fluid analysis.

Customer Services

Spectro Scientific's Customer Service Team and its global partners are committed to providing the highest levels of support and customer satisfaction related to applications, basic instrument operation, troubleshooting and parts identification.

Our service offerings include:

On- and Off-site Product Training for instrument operation and routine maintenance

Support Agreements –Extended Warranty, Preventative Maintenance and other additional services

Field Repair – Certified Customer Service Engineers perform Preventative Maintenance and repair work on site.

In-house Instrument Calibration, Maintenance, Repair, and Upgrades – Performed at our facility near Boston, MA

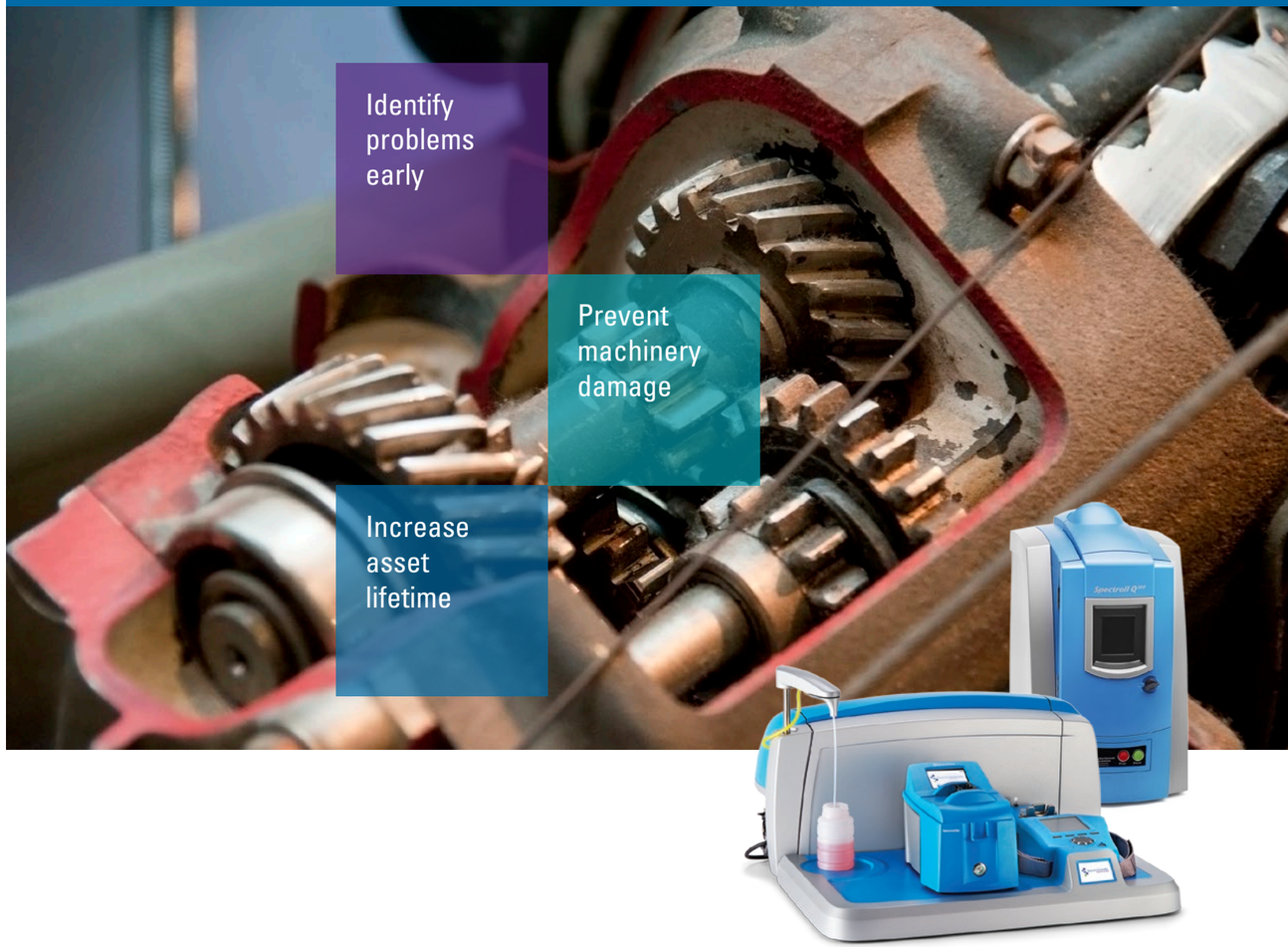
Resource Library – Web-based Resource Library offers instant downloads of application notes, white papers, case studies and product information.

For more information:
support@spectrosci.com
+1 (978) 431-1130

To learn more about Spectro Scientific products please call 978-431-1120 or visit us online at www.spectrosci.com.

Spectro Scientific
Confidence in knowing

Industrial Solutions for On-site Fluid Analysis



Spectro Scientific | One Executive Drive, Suite 101, Chelmsford, MA 01824-2563
978-431-1120 | www.spectrosci.com | sales@spectrosci.com | An ISO 9001:2008 company

Industrial_BRv2_2016-05-12

In-service Oil Analysis for Machine Condition Monitoring

Since the reliable operation of high value, fixed assets is critical to all industrial plants, predictive maintenance programs are implemented to manage machinery uptime.

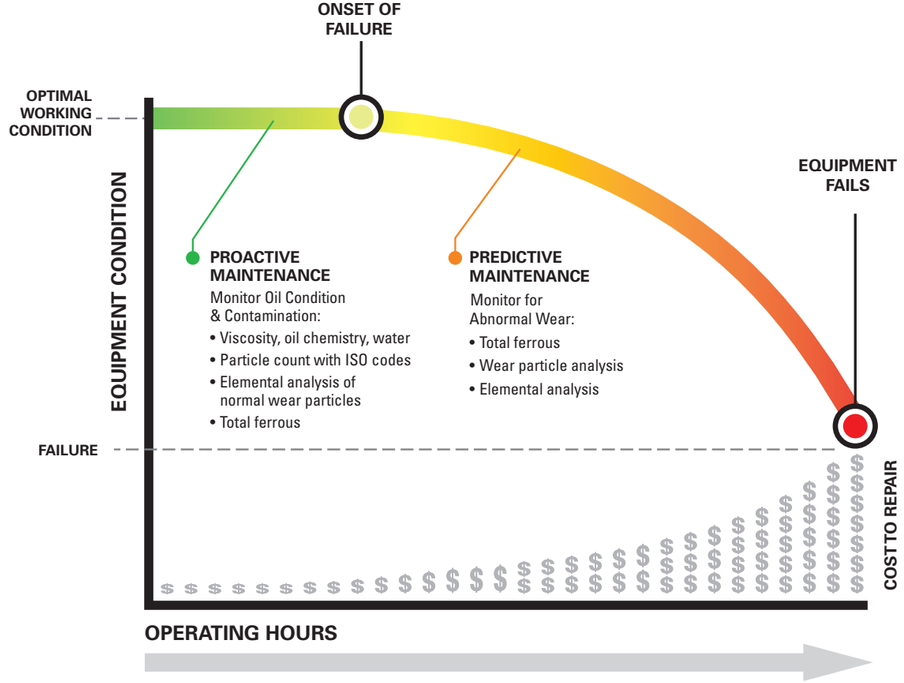
In-service oil analysis is a key machine condition monitoring technique for Condition Based Maintenance (CBM) and Reliability programs. It complements vibration analysis, thermography and other predictive maintenance technologies. In the time it takes external laboratories to return oil sample results, machinery condition can change significantly. On-site oil analysis eliminates this wait and enables immediate decision making.

Corrosion and wear cause surface degradation of the lubricated surfaces in machinery and are the root causes of most mechanically-induced equipment downtime. Corrosion is caused by water or other fluids reacting with metal surfaces, while wear is caused by surface abrasion, adhesion and fatigue.

Oil analysis provides early indications of equipment wear and identifies the root causes of corrosion.

The P-F Curve (Potential-Failure Curve) illustrates how in-service oil analysis provides critical information on machine condition in both Proactive and Predictive Maintenance periods.

In the Proactive period, oil condition and contamination monitoring help prevent the onset of the root causes of machine failure. In the Predictive period, monitoring the increasing severity of wear particles allows maintenance work orders to be executed for component replacement or repair before catastrophic failure.



As part of a proactive maintenance program, on-site oil analysis delivers rapid results with immediate decision making to:

- Lower operating costs
- Reduce unscheduled downtime
- Increase machine availability
- Extend equipment life
- Decrease total lifecycle equipment costs
- Provide immediate retest capability

Trivector™ – oil and machine health simplified

The TriVector™ is a simple representation of the integrity of the lubrication system and the health of the machine itself. The Trivector indicates the degree of health in each vector. Each vector is a representation of Alarm Limits based on underlying parameters, such as viscosity, water contamination, acid number, oxidation, total ferrous, particle count and ISO code, large ferrous particle count, etc. In order to understand the Trivector condition, one must measure the key physical and chemical parameters of the oil.

The following questions can be answered:

- *Is the machine healthy?*
- *Can I predict when the machinery will fail?*
- *Is the oil dry?*
- *Is the oil clean/ free of dirt?*

- *Is it the right oil?*
- *Is the oil fit for use?*

*Trivector is a trademark of Emerson Process Systems

MiniLab Series

4 simple tests and less than 15 minutes to comprehensive oil analysis

Can be operated on-site by plant staff; no chemist required.

1

ELEMENTAL ANALYSIS

The elemental analyzer provides measurement of 23 elements to identify individual contaminants, wear metals and the elemental composition of additives.

2

PARTICLE COUNT AND FERROUS MONITOR

The direct imaging particle counter and ferrous monitor provides particle counts and ISO codes, wear classification, ferrous particle counts & size distribution, and total ferrous measurement.

3

VISCOSITY

The portable viscometer provides high accuracy 40C kinematic viscosity measurements.

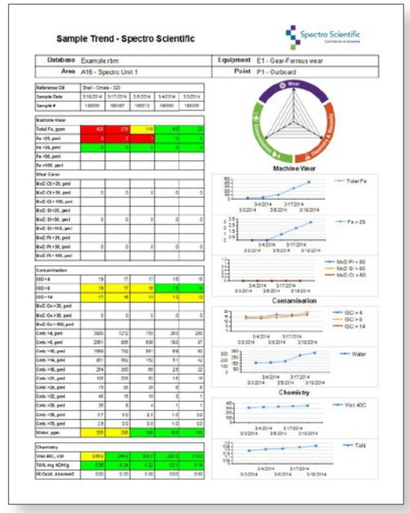
4

CHEMICAL ANALYSIS

The infrared spectrometer measures Total Acid Number (TAN), oxidation and water for machinery oils and hydraulics.

Trivector reports on machinery health

Easy to interpret results with Trivector sample and trend reports.



Three MiniLab Options. Which One is for You?

MiniLab 153 – *4 tests*

MiniLab 53 – *3 tests*

MiniLab 23 – *2 tests*

	PARAMETER	Elemental ASTM METHOD D6595	Particle Count and Ferrous ASTM METHOD D7596	Viscosity ASTM METHOD WK52894	Chemical ASTM METHOD D7889
Contamination	Particle count and ISO codes		✔		
	Non-metallic particle count, distribution and images		✔		
	Boron, Calcium, Sodium, Lithium, and Potassium	✔			
	Water				✔
Chemistry	Viscosity			✔	
	Total Acid Number (TAN)				✔
	Oxidation				✔
	Total Base Number (TBN), Oxidation, Nitration, and Sulfation for engine oils				✔
	Copper, Chromium, Boron, Magnesium, Calcium, Barium, Zinc, Silicon, Sodium, Molybdenum, and Phosphorus	✔			
Wear	Wear particle images, counts and distribution		✔		
	Total Ferrous content, ppm		✔		
	Ferrous particle count and size distribution		✔		
	Copper, Silver, Chromium, Titanium, Aluminum, Silicon, Magnesium, Nickel, Zinc, Iron, Manganese, Lead, Tin, Molybdenum, Cadmium, and Vanadium	✔			

Oil Analysis in Industry

Oil library database

The MiniLab Series includes an extensive industrial oil library database to analyze in-service oils as a variety of lubricants and fluids are used in industrial equipment. The following fluid categories can be tested:

- Mineral oil-based hydraulic fluids and lubricants
- Synthetic hydrocarbon-based hydraulic fluids and lubricants
- Phosphate Esters (Fyrquel/Skydrol)[1]
- Polyalkylene Glycols (PAG)[2]
- Poly Alpha Olefins (PAO)
- Poly Internal Olefins
- Ester-based Lubricant blends
- Oil Soluble Polyglycols (OSP)
- Organic Esters (OE)
- Polyol Esters (POE)

1 = Requires Skydrol configuration. 2 = No water/glycol mixtures.

Typical limits for machinery

The most common oil analysis tests and typical alarm limits for several component types are shown below. Component manufacturers establish alarm limits for their equipment for specified parameters.




MEASUREMENT	TURBINES	GEAR BOXES	HYDRAULICS	ENGINES
Particle Count / ISO Code	< 18/14/12	<19/16/13	< 15/13/11	
Water	< 100 ppm	<1,000 ppm	< 150 ppm	< 2,500 ppm
Glycol				0.1 % max.
Fuel dilution				5% max.
Viscosity	+15%/-10 % of nominal ISO	+15%/-10 % of nominal ISO	+15%/-10 % of nominal ISO	+20 % to -10 % of nominal SAE
TAN	Baseline + 0.1 mg KOH/g max.	Baseline + 1.0 mg KOH/g max.	Baseline + 1.0 mg KOH/g max.	
TBN				20% of Baseline mg KOH/g min.
Sodium				< 40 ppm
Boron				< 20 ppm
Aluminum, Chromium, Tin				< 15 ppm
Iron, Lead				< 100 ppm
Silicon				< 10 ppm
Copper	< 30 ppm			< 40 ppm
Zinc	< 2 ppm			

ALARM
ALERT
WITHIN LIMITS

OilView™ LIMS Asset Management Software

The Minilab Series uses the AMS OilView™ LIMS module to operate the MiniLab. The OilView software includes an Asset Management database and a reference oil database which can be expanded by the end user.

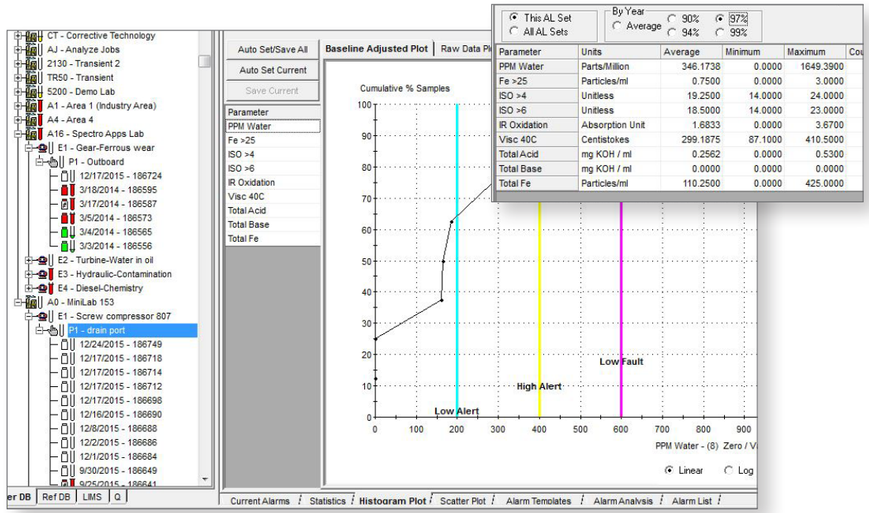
It provides several standard and configurable report formats with automatic email distribution of reports and Alarm Limit templates and analytics.

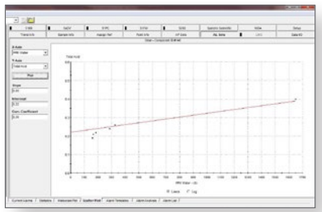
Color-coded Trivector reports provide a clear snapshot of machinery health by identifying parameters that are outside normal limits.

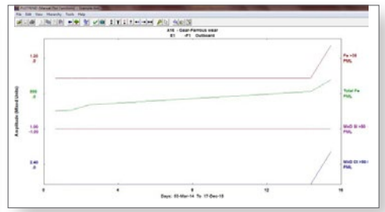
Alarm Limits are initially established for key parameters from the provided templates, supplier specifications from user-defined criteria.

Industry best practice is to refine Alarm Limits based on machine history. Once a series of measurements is made, adjust the initial alarm limits using the OilView cumulative probability distribution analysis function.

This calculates new alarm limits based on desired confidence level for either a specific machine or class of machinery with the same alarm limit set.

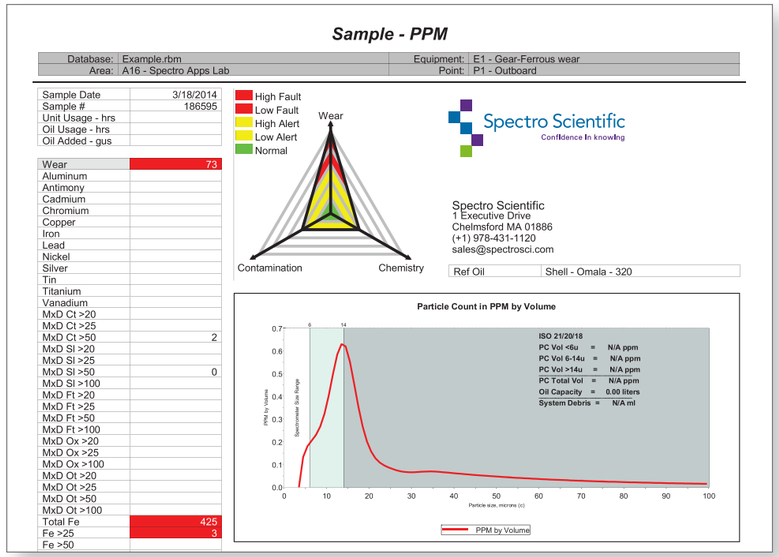




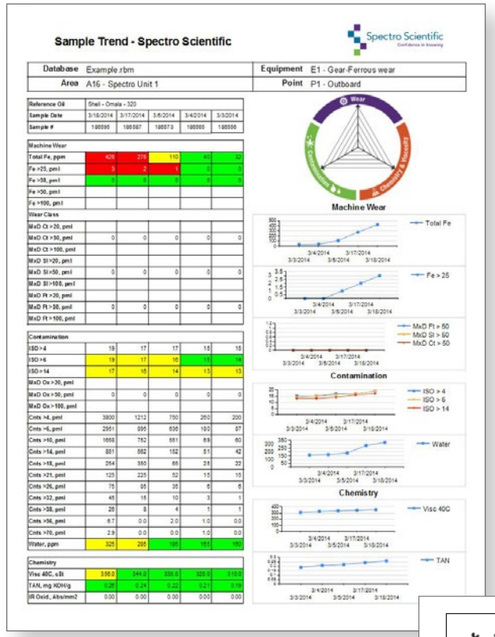


Analyze correlations between different oil parameters for insight into root causes.

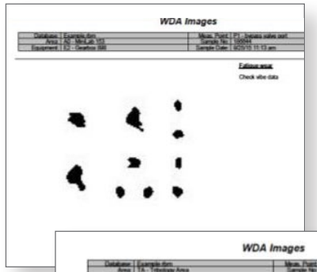
Analyze correlations between oil parameters and other predictive technologies such as vibration and thermography to improve confidence in deciding to pull a machine out of service.

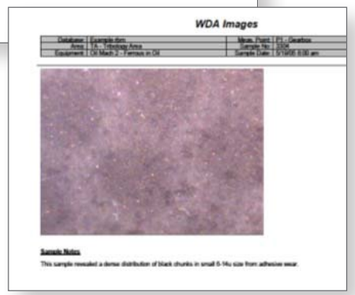


Sample Report – provides measurement results for a single sample and a single parameter plot of ISO codes or system debris by volume.

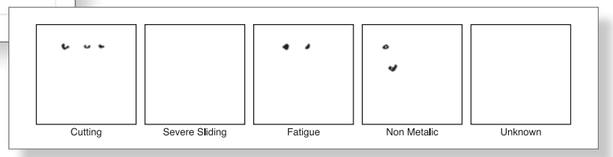


Trend Report – Provides data and multiple parameter plots for a series of samples from the same component. Provides 'thumbnail' images of wear particles from the LNF.





WDA Images – optional Wear Debris Analysis (WDA) module allows import of images from either a file or direct from a camera and can be printed as an OilView WDA Report.

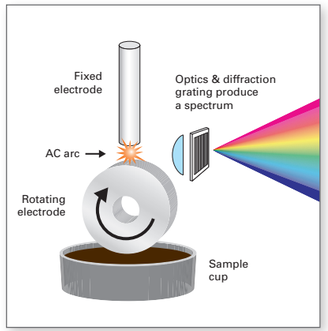


› **Wear particle by metal type**

› **Contamination ID by source**

› **Oil additive levels**

Spectroil Q100 instrument can be purchased separately.



Q100 Rotating Disc Electrode Optical Emission Spectrometer schematic

TEST 1

Elemental Analysis

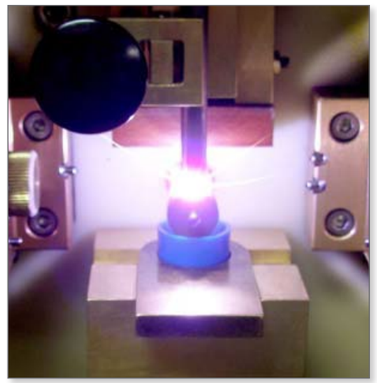
The Spectroil Q100 analyzes small particulate wear, lubricant additives and contaminants for trace quantities of elements dissolved or suspended as fine particles. Using the proven rotating disc electrode (RDE) technique, the Spectroil Q100 is has become the workhorse of industrial, commercial and military oil analysis laboratories requiring rapid analysis of wear metals, contaminants and additives in lubricants.

Coolant, wash-down water and JOAP calibrations are available in addition to in-service lubricating oil and hydraulic fluid analysis..

- Measures ppm levels of up to 32 elements in less than 30 seconds
- Easy to operate – no sample preparation, gases, coolants, or solvents needed
- Compliant with ASTM D6595 for used oil analysis

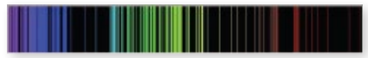
On-site oil analysis provides greater insight into contaminant sources by linking elemental parameters with the probable source:

ELEMENT	Oil Chemistry – metallic additives possible sources
Sodium	Corrosion inhibitor additive, also indicates coolant leak into oil, can also be road salt, sea water, ingested dirt
Boron	Corrosion inhibitor additive, antiwear/antioxidant additive; can indicate coolant leak, grease contamination
Magnesium	Detergent/dispersive additive, can also be alloying element in steels
Calcium	Detergent/dispersant additive, alkaline reserve additive for high sulfur fueled engines, can be grease contamination,
Molybdenum	Solid/liquid antiwear additive, alloy in bearing and piston rings
Barium	Corrosion inhibitors, detergents, rust inhibitors
Zinc	Antiwear, corrosion inhibitors, anti-oxidants, alloying element for bearings, thrust washers, galvanized cases
Phosphorus	Antiwear, corrosion inhibitors, anti-oxidants additives, EP additives



Sample consumed using RDE technology is optically analyzed with AE Spectroscopy to detect elements.

Emission Spectrum of Hydrogen



Emission Spectrum of Iron

TEST 2

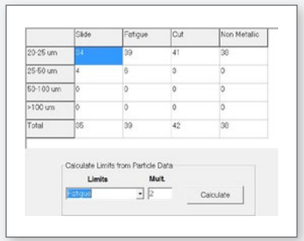
Particle Count and Ferrous Monitor

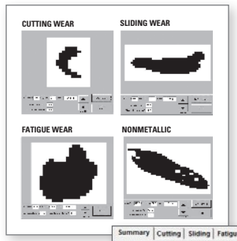
The LNF Q200 Series provides particle counts and codes, large wear particle classification and ferrous wear monitoring.

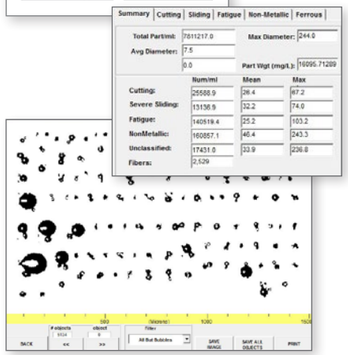
- Particle count, size distribution and codes (ISO 4406, NAS 1638, NAVAIR 01-1A-17, SAE AS 4059, GOST, ASTM D6786, HAL, and user defined bins).
- Differentiates contaminants (silica and fibers from machine wear metal)
- Classifies wear particles, stores images, and reports particle count and size distribution for each wear type of Cutting, Sliding, Fatigue, Fibers and Non-metallics
- Ferrous Monitor measures total ferrous content in the sample and provides Ferrous particle count and size distribution
- Widest range up to 5,000,000 particles/ml
- Test oil viscosity up to ISO320 without dilution
- Images through dark fluids containing up to 2% soot
- Error corrections for water and air bubbles

Options include an autosampler for high throughput sample processing as well as configurations without the ferrous monitor and wear classification.

Establishing alarm limits and condemnation levels for large machinery wear particles is often challenging because unlike parameters such as ISO code, water, elemental concentration and TAN there are no pre-defined limits set by the equipment supplier. In each piece of equipment, machinery wear particles of different sizes reach their own dynamic equilibrium condition. The LaserNet software calculates recommended wear particle limits for categories of cutting wear, severe sliding wear, and fatigue wear by analyzing a series of six or more samples.





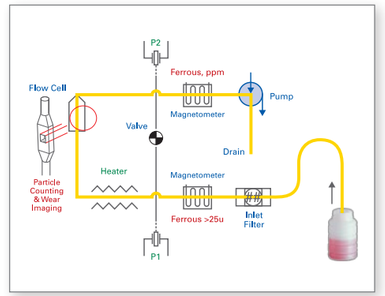


Wear images are stored and analyzed directly on the LaserNet 200 software. They can be sorted by wear class. OilView software also reports on particle count and size distribution by wear category.

› **Ferrous content**
› **Wear particle shape**

› **Particle count and codes**

LNF Q200 instrument can be purchased separately.



LNF Q230 schematic

› Viscosity

SpectroVisc Q3050
portable viscometer can be purchased separately.

TEST 3 Viscosity

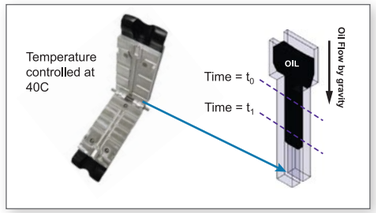
The SpectroVisc Q3050 provides fast, accurate 40C kinematic viscosity measurements for easy detection of viscosity variations caused by contamination, mix-up and oil degradation.

- Solvent free, portable, and easy to use
- Viscosity range 1-700 cSt @40C
- Accuracy +/- 3% to NIST viscosity standards
- Fast results - ISO 15 ~10 seconds, ISO 320 ~ 3 minutes

For machinery oils, the 40C kinematic viscosity is used as the reference value. Engine oils operate at higher temperatures than rotating machinery, so they require V100C kinematic viscosity. The Viscosity Index of an oil is a parameter that relates the V40C measurement value to the V100C value. A reference Viscosity Index value can be entered in the viscometer and both the measured V40C viscosity and the calculated V100 viscosity values are displayed.

Positive displacement pipette

Open the two parallel plates for easy cleaning.



Q3050 Kinematic viscometer schematic

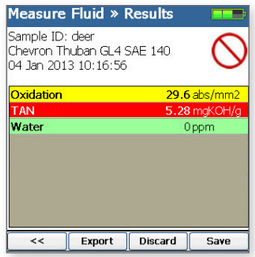
TEST 4 Chemical Analysis

The FluidScan® 1100 determines when in-service oil is no longer fit for use due to oil degradation or the ingress of water or glycol. It is fast and easy to use, with just one drop of oil needed for the sample and less than one minute for test results. The analyzer includes an extensive oil library; additional oils can be added by the user.

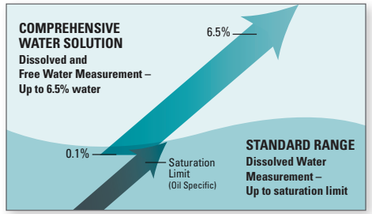
- Compliant to ASTM D7889 "Standard Test Method for Field Determination of In-service Fluid Properties Using IR Spectroscopy"
- High correlation to TAN and TBN laboratory tests conducted with ASTM D664 and D4739
- Comprehensive Water Measurement option extends range to 6.5%. (Included with all Minilab systems.)

The oil library contains various categories of fluids. The industrial library provided with the MiniLab series includes the Comprehensive Water Solution and the Industrial Fluid Oil Library.

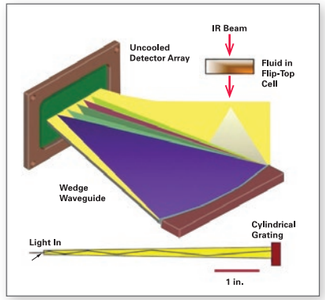
CATEGORY	Industrial Fluid Library
ASTM EP Gear/Hydro	✔
ASTM Petroleum Crankcase	✔
ASTM Polyol Ester	✔
BIODIESEL FEEDSTOCK	
CHILLER	✔
ENGINE	✔
ENGINE-HEAVY DUTY	
ENGINE-HFO	
ENGINE-NAT GAS	
ETHANOL IN GASOLINE	
FAME	
FAME in DIESEL	
GEAR-PRESSURE	✔
GEAR-SPLASH	✔
HEAT TRANSFER	✔
HYDRAULIC	✔
HYDRAULIC-FIRE RESISTANT	✔
SLIDEWAY	✔
TRANSMISSION	
TURBINE-AERO	✔
TURBINE-CCGT	✔
TURBINE-STEAM	✔



Measurement results for industrial oil



Water measurement range



Patented wedged optical design of the FluidScan Infrared Spectrometer

› Water

› TAN
› TBN
› Oxidation
› Nitration
› Sulfation
› Soot
› Additive depletion

FluidScan Q1100 handheld infrared spectrometer can be purchased separately.

Accessories & Consumables

Sample Preparation Equipment

Sample preparation equipment such as the Homogenizer, Ultrasonic Deaerator, Electrode Sharpener and Consumables for 100 samples are included with each MiniLab 153 system.

SAMPLE PREPARATION – 3 SIMPLE STEPS

1. Sharpen electrode
2. Homogenize the sample for better water measurement
3. Ultrasonically degas the sample for particle analysis

Consumables

Spectro Scientific consumables are selected and carefully tested with all Spectro Scientific instruments to ensure consistent, repeatable results. Always use Spectro Scientific supplied consumables for best results.

Validation Standards and ASTM Standards

Validation standards are supplied for all MiniLab Series instrumentation. These NIST traceable standards support internal quality programs and compare current instrument performance against factory calibration.

Each instrument in the MiniLab Series has an associated ASTM Standard Test Method.

Accessories

A variety of accessories to support your oil analysis program are available, from drawing a sample from an oil sump to preparing it for analysis.

Sampling Pump (MHM-92610)

Solvent Filtration and Dispenser (A5051SF)

Wear Debris Analysis Kit (115V) (400-00101)

T2FM Analytical Ferrograph Maker

MiniLab Series Product Information

PART NUMBER	
800-00029	MiniLab 153 with OilView LIMS and PC, 115VAC, 60Hz. Requires 800-00031 Standard Accessories Kit.
800-00027	MiniLab 153, 115VAC, 60Hz. Requires OilView LIMS and 800-00031 Standard Accessories Kit.
800-00030	MiniLab 153 with OilView LIMS and PC, 220VAC, 50Hz. Requires 800-00031 Standard Accessories Kit.
800-00028	MiniLab 153, 220VAC, 50Hz. Requires OilView LIMS and 800-00031 Standard Accessories Kit.
800-00017	MiniLab 53, 115VAC, 60Hz. Requires 800-00019 Standard Accessories Kit and OilView LIMS module.
800-00018	MiniLab 53, 220VAC, 50Hz. Requires 800-00019 Standard Accessories Kit and OilView LIMS module.
800-00025	MiniLab 53, 115VAC, 60Hz with OilView LIMS. Requires 800-00019 Standard Accessories Kit.
800-00026	MiniLab 53, 220VAC, 50Hz with OilView LIMS. Requires 800-00019 Standard Accessories Kit.
800-00037	MiniLab 23, 115VAC, 60Hz. Requires 800-00039 Standard Accessories Kit.
800-00038	MiniLab 23, 220VAC, 50Hz. Requires 800-00039 Standard Accessories Kit.
800-00041	MiniLab 23, 115VAC, 60Hz with Oilview LIMS. Requires 800-00039 Standard Accessories Kit.
800-00042	MiniLab 23, 220VAC, 50Hz with Oilview LIMS. Requires 800-00039 Standard Accessories Kit.
ACCESSORIES AND CONSUMABLES	
800-00031	MiniLab 153 Standard Accessories Kit, includes consumables for 100 samples
800-00032	MiniLab 153 Consumables Kit for 500 samples
800-00019	MiniLab 53 Standard Accessories Kit, includes consumables for 100 samples
400-00088	MiniLab 53 Consumables Kit for 500 samples
SA1022	MiniLab 23 Standard Accessories Kit. Includes consumables for 100 samples
800-00040	MiniLab 23 Consumables Kit for 500 samples
PRODUCT INFORMATION	
Applications	Mineral and synthetic lubricants including gear, engine, hydraulic, turbine and distillate fuels
Output	Particle count, size distribution and ISO codes per ISO 4402/4406 Wear particle counts and size distribution by wear mode-cutting, fatique, sliding, non-metallic, fibers Total Ferrous, ppm Ferrous particle count and size distribution Total Acid Number (TAN), mg KOH/g Total Base Number (TBN), mg KOH/g Oxidation, abs/mm^2 Nitration (abs/cm), Sulfation (abs/mm^2) Water, ppm 40C Kinematic viscosity, cSt Elemental concentration of 23 elements, ppm
Methodology	ASTM D7596, ASTM D7889, ASTM 40831 ASTM D6595
Calibration	Factory calibrated, field calibration not required. Validation standards supplied.

OPERATIONAL SPECIFICATIONS		
Environmental Requirements	5-40C ambient temperature, 10-80% RH non-condensing, 2000 m maximum altitude	
Sample Volume	10-30 ml, varies with viscosity	
Solvents	Lamp oil, odorless kerosene, or Electron 22	
USER INTERFACE SPECIFICATIONS		
Software/Operating System	Personal Computer with Windows 7 Pro, 32 or 64 bit, US English version. Recommended microprocessor speed 2.6 GHz or higher and 8 GB RAM minimum.	
POWER REQUIREMENTS		
Power	MiniLab 153: 1 Phase, 115VAC/60 Hz or 220VAC/50 Hz, 1200W (max) MiniLab 53 or MiniLab 23: 1 Phase, 115VAC/60 Hz or 220VAC/50 Hz, 110 W (max)	
MECHANICAL SPECIFICATIONS		
Dimensions (H x W x D)	MiniLab 153:	71 cm x 214 cm x 66 cm (28" x 84" x 26")
	MiniLab 53:	35 cm x 50 cm x 53 cm (13.8" x 19.7" x 21")
Shipping	MiniLab 153: 2 crates: 122 cm x 64 cm x 109 cm (48" x 25" x 43"), 150 kg (331 lbs.) and 112 cm x 97 cm x 114 cm (44" x 38" x 45"), 159 kg (350 lbs.) MiniLab 53: One crate: 112 cm x 97 cm x 114 cm (44" x 38" x 45"), 159 kg (350 lbs) MiniLab 23: One crate: 112 cm x 97 cm x 114 cm (44" x 38" x 45"), 150 kg (159 lbs)	
Weight	MiniLab 153: 84 kg (185 lbs) MiniLab 53: 14 kg (31 lbs) MiniLab 23: 9 kg (22 lbs)	

COMPLIANCE
CE Mark-EMC directive, RoHS

ANALYTICAL RANGE AND REPEATABILITY		
	Analytical Range	Repeatability
Particle Count	4-100 um	≤ 6% RSD
Total Ferrous	10-2,000 ppm	≤ 5% RSD
Ferrous Particle Count	25-100 um	≤ 5% RSD
Viscosity	1-320 cSt at 40C 320-700 cSt at 40C	≤ 3% RSD ≤ 5% RSD
TAN	0-6 mg KOH/g*	≤ 3% RSD
Oxidation	0-3 abs/mm^2	≤ 3% RSD
Water-dissolved	100 ppm-saturation*	≤ 6% RSD
Water-free	0.1-6.5% (1,000-65,000 ppm)	≤ 25% RSD
Elemental Analysis	Range and repeatability vary with element	

*Oil specific. RSD = Relative Standard Deviation.

SUPPORT CONTRACTS	
SVC016	MiniLab 53 Support Contract with OilView LIMS Support
SVC015	MiniLab 53 Support Contract
SVC057	MiniLab 153 Support Contract with OilView LIMS Support
SVC058	MiniLab 153 Support Contract

See next page for information about service and customer support.