

HUMAN HEALTH

ENVIRONMENTAL HEALTH



LUBRICANTS  
ANALYSIS.  
COMPLETE SOLUTIONS  
FOR YOUR LAB.



Lubricants Analysis



**PerkinElmer**  
*For the Better*



# PERKINELMER

## CAPABILITIES FOR LUBRICANTS ANALYSIS.

The analysis of lubricants for conformity and process control has always been important to manufacturers and users in providing a high-quality lubricant. Once the lubricant is in the equipment, degradation and contamination become critical measurements. The ability to measure a wide range of analytes cost-effectively can mean the avoidance of damaged equipment or changing the lubricant more frequently than necessary. The level of machine repair and proper lubricant renewal intervals can be precisely evaluated with measurements of additives and wear metals, contaminants and other oil components over the course of use. Machine life can be extended and lubricant costs reduced by proper testing.

PerkinElmer offers complete analytical solutions compliant with Caterpillar® S•O•S<sup>SM</sup>, military JOAP and ASTM methods to facilitate measurements in new and used lubricants. Highly automated, these solutions provide cost-effective analyses with rapid turnaround time to maximize the impact of monitoring trends for any selected machine.

### Metals in oil

The PerkinElmer® Optima™ Series of ICP-OES coupled with two popular offline automated oil dilutors (Figure 1) is the gold standard for the measurement of additives and wear metals in oil. Typical analytes measured using the routine oil method are shown in Table 1 and reflect the different diagnostic capabilities of the various elements for additive depletion, wear indication and contamination.



Figure 1. The Optima™ 8300DV, with the Janus Oil Workstation (l.) and the CETAC APS 1650 (r.), offers the performance required to maximize productivity.

Table 1. Routine Oil Analysis Metals.		
Element	Lubricant Role	Typical Concentration Ranges* (ppm)
Ba	additive	1 to 5000
Ca	additive	1 to 10,000
Mg	additive	1 to 2000
P	additive	1 to 2000
S	additive	1 to 5000
Zn	additive	1 to 2000
B	contaminant	1 to 100
K	contaminant	1 to 500
Na	contaminant	1 to 500
Si	contaminant	1 to 500
Ag	wear metal	1 to 500

Table 1. Routine Oil Analysis Metals, continued.		
Element	Lubricant Role	Typical Concentration Ranges* (ppm)
Al	wear metal	1 to 500
Cr	wear metal	1 to 500
Cu	wear metal	1 to 500
Fe	wear metal	1 to 2000
Mn	wear metal	1 to 1000
Mo	wear metal	1 to 500
Ni	wear metal	1 to 500
Pb	wear metal	1 to 500
Sn	wear metal	1 to 500
Ti	wear metal	1 to 500
V	wear metal	1 to 500

\* Higher and lower concentration ranges can be analyzed with appropriate wavelength and standard selection.

Both the PerkinElmer Janus Oil Workstation and the CETAC APS 1650 are proven systems for oil dilution in a wide range of oil products. The Janus system is for high-volume labs that want high throughput with minimal waste. The dilutor uses multiple syringes with disposable tips to dilute up to 300 samples per hour with no solvent rinsing. The CETAC APS 1650 is for small to medium labs using a single syringe with a sample probe. It dilutes a sample about every 40 seconds and uses typically under 10 mL of solvent rinsing between samples. Both systems come with liquid level sensing of the oil in each container and can use a variety of racks for the oil and the autosampler. The same computer used to control the Optima™ ICP-OES system can be used with the oil dilutors. The dilutors

automatically create the WinLab32™ sample information file (SIF) and place it in the proper location for Optima™ access. The Optima™ ICP-OES can measure a sample every 20 to 35 seconds (depending upon accessories), including rinsing and two replicate sample readings.

The ICP stability is critical over the course of an 8-10 hour analysis. This can be monitored in real-time through QC samples, reducing the need for recalibration and keeping productivity high. Figure 2 shows excellent recovery of a wide range of analytes in a QC sample run as part of a batch of used oil samples.

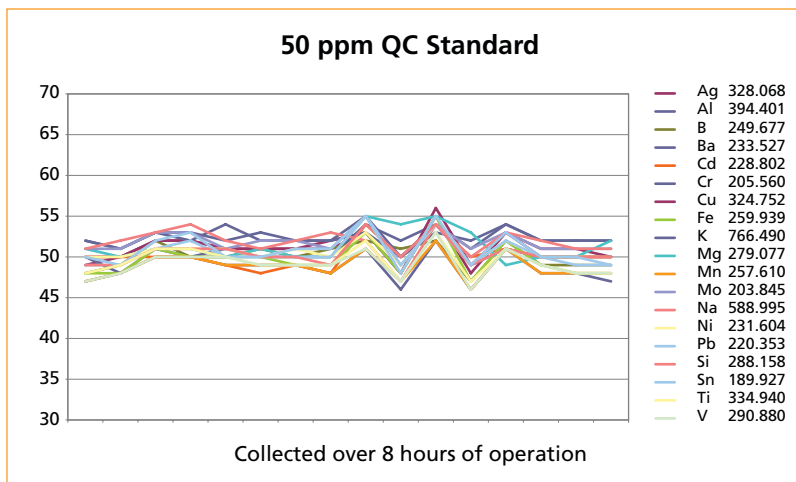


Figure 2. Optima™ 7300 V with the CETAC ASXpress Sampling Valve.



Figure 3. The Frontier OilExpress provides complementary measurement of oil contaminants, oxidation and nitration products.

## Modern analysis of non-metal contaminants and breakdown products

### Classic FT-IR analysis becomes more efficient

FT-IR spectroscopic analysis has been used for many years as a screening test for contaminants and breakdown products in used oils. Advances in technology and software have made the technique highly reproducible, yielding a rapid pass/fail measurement whether in a laboratory or at a remote location. The Frontier OilExpress combines efficient automated liquid handling with FT-IR spectroscopy to provide complementary measurement of oil contaminants, oxidation and nitration products. The Spectrum Two™ Used Oil Analyzer combines small robust size with battery operation to add portability for taking the instrument to remote locations. Yet it will produce identical data with the lab-based OilExpress. Table 2 shows a list of the parameters routinely measured with this technology and the spectral region monitored. Both the OilExpress and Spectrum Two conform to all ASTM FT-IR methodologies for oils such as ASTM E2412, D7418, D7414, D7415, D7412 and D7674.

Table 2. Typical Infrared Measurements.		
Parameter	Spectral Regions (cm <sup>-1</sup> )	Measurement Units
Soot	3800 and 1980	Abs/cm
Hydroxy (water and glycol)	3650-3150	Abs/cm, % water
Glycol (mineral oils)	1140-1000	%
Oxidation (mineral oils)	1720	Abs/cm
NOx/Carboxylate (mineral oils)	1650-1538	Abs/cm
NOx	1630	Abs/cm
Oxidation/Sulfate	1150	Abs/cm
Antiwear Loss (mineral oils)	700-640	Negative Abs/cm
Antiwear Loss (synthetic oils)	1000-930	Negative Abs/cm
Sulfate	640-590	Abs/cm
Fuel Contamination (diesel)	820-800	Abs/cm
Fuel Contamination (gasoline)	780-760	Abs/cm
Ester Breakdown (synthetic oils)	3720-3590	Abs/cm



The Frontier OilExpress takes less than 70 seconds per sample to acquire data and rinse the system, providing twice the throughput of other systems. In addition, less than half the solvent is needed for rinsing when compared to current competitive systems. In spite of the small solvent volume used for rinsing, the carryover is less than 0.1%. Smaller samples are used for measurement, reducing waste and associated disposal costs by half. The system is automated and designed to run samples over a wide range of viscosities (4-700 cSt). The zinc-selenide window transmission cell is not degraded by water, a possible lubricant contaminant, minimizing instrument maintenance costs. Figure 4 shows spectra identifying soot and several oil breakdown products.

Spectrum Two from PerkinElmer offers trouble-free analysis of in-service lubricants with a manually operated instrument. With an intuitive touch screen interface and a dedicated in-service lubricants applications solution, even inexperienced IR-users can generate clear, high quality results. The compact design provides high-quality and reproducible data both in the laboratory and in harsher environments, even when remote from the main analytical lab. Compact, robust and completely transportable, it allows samples to be run in a central laboratory or in remote locations with no compromise in performance.

Results are ready in minutes and meet the same quality standards expected from a full-service laboratory. For areas where a main power supply is not available or is intermittent, the Spectrum Two battery and 12V adaptor supply options ensure that the Spectrum Two will not let you down. Spectrum Two's flow cell can be cleaned using accessible solvents such as kerosene, a practical solution for on-site sampling.

### TBN increases FT-IR use

The total base number (TBN) is a measure of the lubricant base content that can be used to neutralize acids introduced as a result of contamination or component degradation. The base capability is generally provided by a soap additive. Frontier OilExpress coupled with Quant+ software offers an automated and clean alternative as a quick screening tool to ASTM method D2896-01, Titration with Potentiometric Perchloric Acid, to determine the base content. The analysis time is improved by more than three times and the risk of handling and disposal of hazardous components is greatly minimized as you only titrate samples of concern.

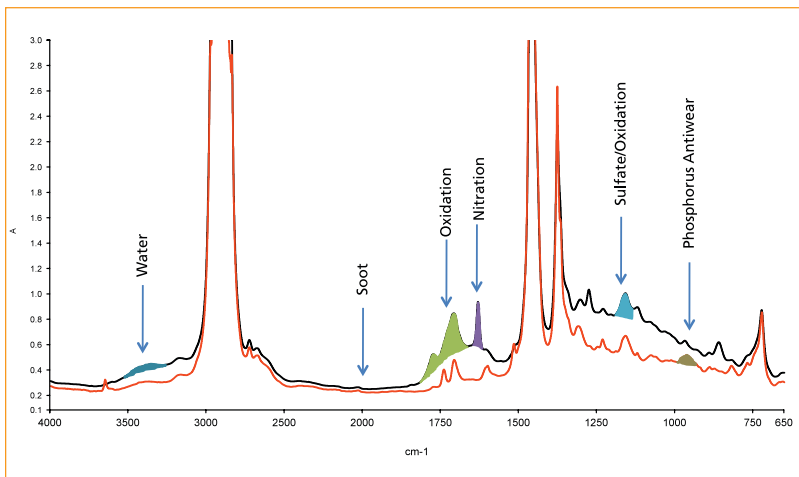


Figure 4. Spectra of oils obtained using the E2412 (JOAP) method.



Figure 5. Clarus GC with liquid and headspace autosamplers for simultaneous determination of fuel dilution and glycol contamination.

### Gas chromatography

Gas chromatography (GC) is a key analytical technique for lubricant analysis. Many analyses, done by simpler techniques in the past, benefit by the added information provided by the more sophisticated GC technique coupled with a variety of detectors. In many cases, the additional information can be generated faster and is more specific. For example, the presence of fuel (whether it is from gasoline, diesel and/or biodiesel) diluent in oil is evidence of mechanical failure. Physical tests, such as specific gravity or viscosity routinely employed in the evaluation of used crankcase oils, might indicate such a condition. However, only gas chromatography can provide a useful quantitative measure of the level of dilution, allowing more precise scheduling of maintenance, thus reducing cost.

PerkinElmer offers a complete family of gas chromatography products that can carry out these determinations and are optimized for performance and reliability. The TurboMatrix™ automated headspace sample handling accessory provides integrated, easy sampling options (Figure 5).

ASTM methods generally used for new and used lubricants are shown in Table 3.

Although well-proven, many of the ASTM methods were originally developed many years ago and, since then, the needs of the industry for throughput and more detailed information have increased. Newer developments allow the combination of methods D3524 and D3525 for the determination of fuels in used engine oil to provide increased sample throughput in a more cost-effective method. Figure 6 shows the chromatogram of an oil standard and sample with fuel diluent with a run time improved by more than 10 times over the original method.

Table 3. ASTM GC Oil Methods.

ASTM Number	Title
D2887	Simulated Distillation for Boiling Point Distribution
D3524	Diesel Fuel Diluent in Used Diesel Engine Oils by GC
D3525	Gasoline Diluent in Used Engine Oils by GC
D4291	Trace Ethylene Glycol in Used Oils by GC

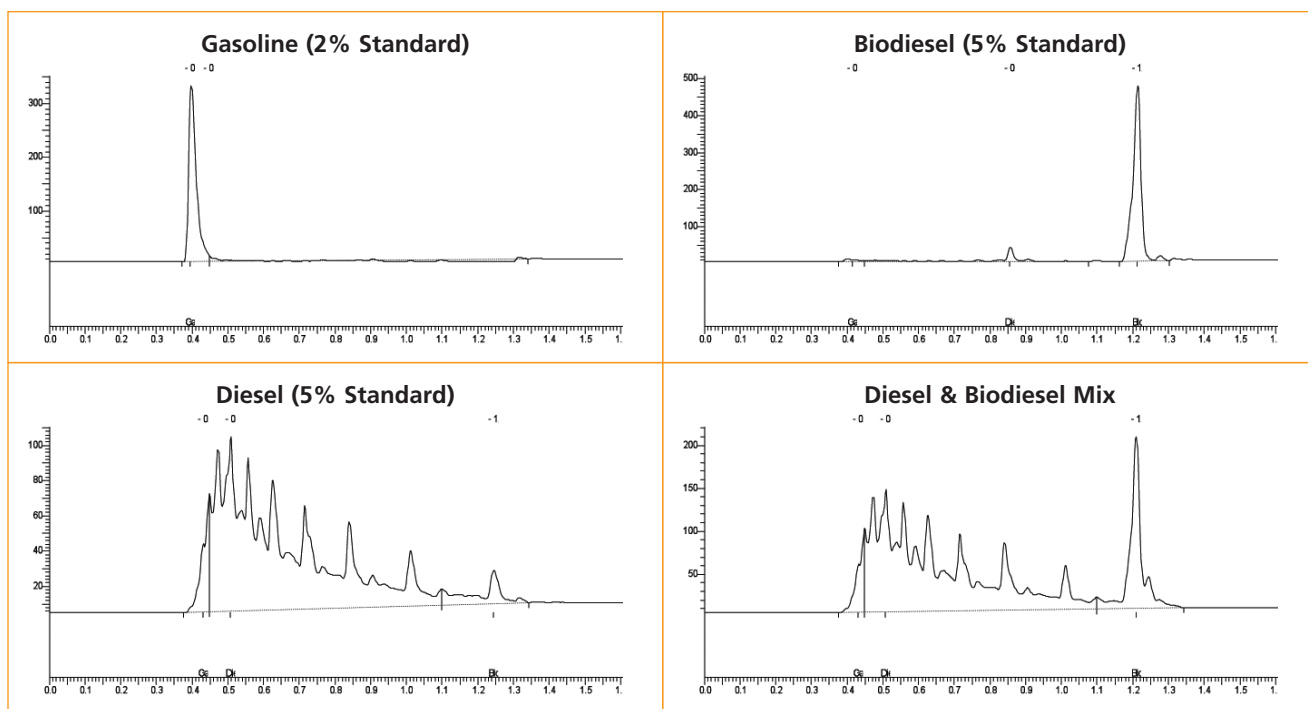


Figure 6: Typical chromatography for different fuels.

Table 4 shows a comparison of fuel diluents from this new version of the method compared with the original version, showing excellent agreement for a single injection. Precision studies show 3% RSD is typical at these concentration levels.

Ethylene glycol analysis in used lubricants is a challenging analysis because of the low molecular weight, low volatility, and high polarity of the analyte combined with the high molecular weights of the oil. In order to overcome this challenge, a simple derivatization will improve the glycol volatility. This derivatization can be performed in a headspace vial and the sample extracted automatically from the vial for GC introduction. Gas chromatography, combined with automated headspace sampling, can help provide a cleaner sample preparation, providing reduced system maintenance.

PerkinElmer will continue to work closely with customers and consensus-standards groups to improve existing methods and offer technology for new methods. Both the fuel and glycol contamination methods are currently being reviewed at ASTM to become standard methods.

### Data handling

Trend analysis requires data to be collected frequently, processed and archived reliably. The individual instrument systems provide flexible data processing and reporting. Figure 7 shows a trend analysis for soot using the Frontier OilExpress native software.

Many labs are moving to laboratory information management systems (LIMS) to manage the data from several techniques. This data moves seamlessly to multiple other business systems for storage or review. Connecting PerkinElmer instruments to an existing or new LIMS system is straightforward and can be easily accomplished. For a full system, PerkinElmer offers the scalable LABWORKS™ LIMS system that can evolve as your needs change. The unique ability to build the database and learn the system in a virtual environment before installation makes the transition seamless.

Sample	Fuel Content (%) This Method	Fuel Content (%) Reference Method
A	1.77	2.41
B	2.33	2.94
C	2.31	2.21
D	4.60	4.45
E	2.96	3.16
F	4.16	5.25
G	2.19	2.49
H	1.37	1.16
I	1.31	1.28

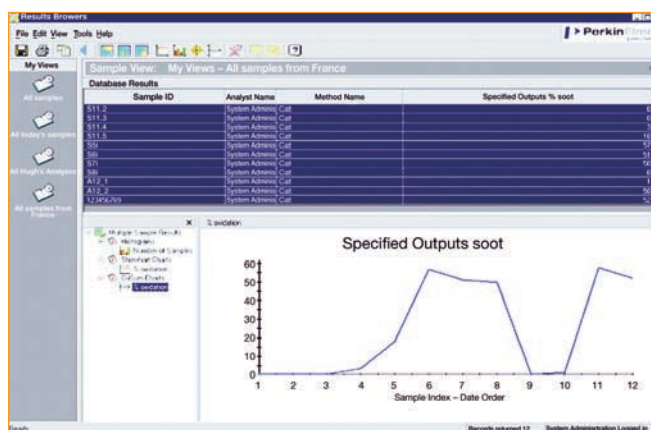


Figure 7. Frontier OilExpress software showing database and trend for soot in oil.

## PerkinElmer, Inc.

### Dependable, worry-free technology

Working with a technology leader brings several benefits. In addition to the existing instruments and applications, you can expect more. Actively pursuing new developments and applications, PerkinElmer is on the forefront of change. For example, some laboratories are now incorporating coolant analysis into their capabilities as a result of new developments.

We have demonstrated compliance of Optima™ ICP-OES technology with ASTM D6130 for the measurement of various elements in new and used coolants. The ability to use the same instrument both for lubricants and coolant analysis minimizes the laboratory's investment and maximizes the laboratory's business flexibility.

We will be there to inform you about new options as they develop. New methods are always being refined and we work with consensus groups, such as ASTM, on ICP-OES, FT-IR, GC, UV/Vis, LIMS and a variety of techniques to ensure that new methods are developed representing all perspectives.

### One Source® provides *one source* to ensure peak performance in your lab

With over 60 years of experience, and as world leader in analytical instrumentation, PerkinElmer is the right partner for the lubricants industry. In concert with global distribution of instruments, turnkey systems and consumables, we provide factory-trained global service and support. Our comprehensive worldwide service capability lets you take care of business and set your sights on what matters most – results. With our multi-vendor services, One Source, our consolidated instrument support, you have a provider to optimize your lab operations. Over 1500 PerkinElmer professionals serve more than 125 countries worldwide. One Source is your source for instrument care and repair, validation services, software and hardware upgrades, relocation, training, education and more.

### Whatever you're looking for, we've got it

PerkinElmer is a leading provider of scientific instruments, consumables and services to the petrochemical, pharmaceutical, biomedical, environmental testing and general industrial markets, delivering integrated solutions, from sample handling and analysis to communication of test results. For lubricants analysis, we have the knowledge, products and comprehensive support you need.

For more information on lubricants analysis, visit [www.perkinelmer.com/lubricants](http://www.perkinelmer.com/lubricants)

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