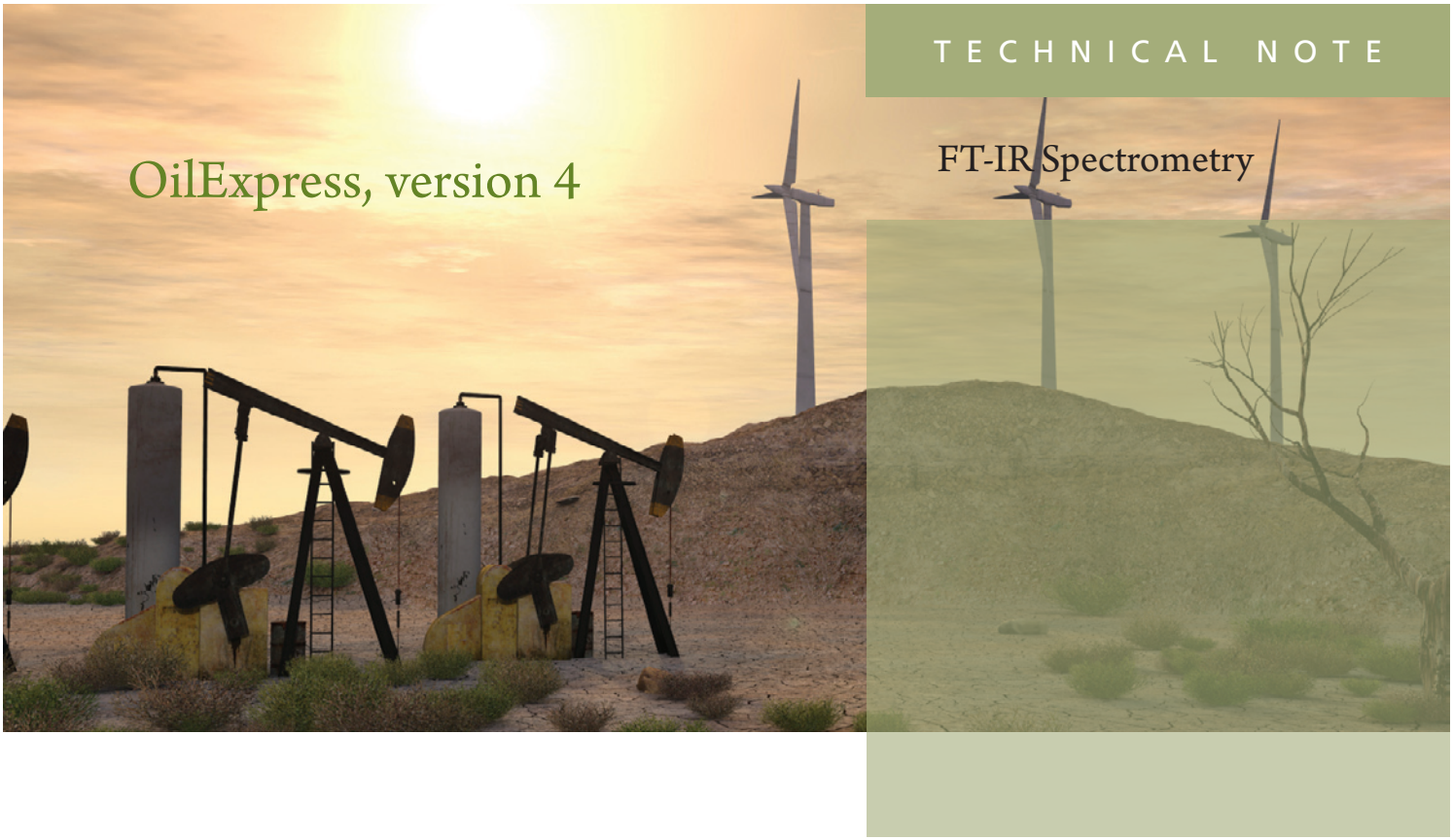
TECHNICAL NOTE

OilExpress, version 4

FT-IR Spectrometry



Introduction

The PerkinElmer® Spectrum™ OilExpress oil condition monitoring system provides a complete solution for laboratories conducting high-throughput used oil analysis. The proven performance and reliability of the syringe-pump-based autosampler and Spectrum 100 FT-IR spectrometer ensure quality spectral data. The dedicated, database-driven OilExpress software validates ongoing system performance through system checks (Figure 1a), ensures optimal coordination of sampling and measurement processes (Figure 1b), calculates numerous oil quality parameters from the spectra using the selected analysis program (Figure 1c), and maintains a full record of all analysis results that are easily accessible via the results browser (Figure 1d). Both the spectra and the calculated results can be exported during the run, for additional processing or archiving, such as by a LIMS.

Oil Express software...

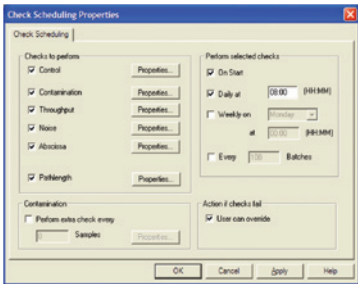


Figure 1a

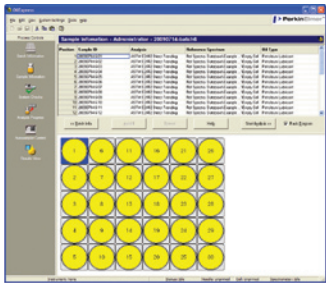


Figure 1b

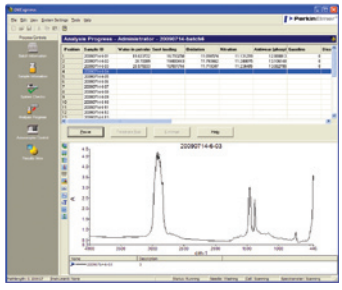


Figure 1c

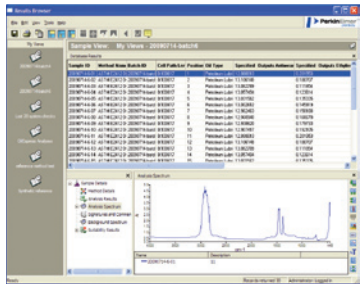


Figure 1d

PerkinElmer®
For the Better

Comprehensive FT-IR oil condition monitoring

OilExpress, version 4 represents a major update to the software for the OilExpress oil condition monitoring system. The update builds upon the flexibility and ease-of-use of the software, and allows for the use of new, standardized analyses as well as user-defined calculations tailored to specific applications.

New oil analysis algorithms

See Table 1 for a full list of the analytes measured by each method provided with OilExpress, version 4.

- ASTM® E2412 direct trending for petroleum lubricants, polyol ester fluids, and petroleum extreme pressure fluids
- ASTM® E2412 spectral subtraction for petroleum lubricants
- New methods for petroleum and synthetic turbine fluids: phenolic and phosphate antioxidants, water, oxidation, unsaturated ester, synthetic lube breakdown
- Plus the tried and tested PerkinElmer mineral and synthetic oil spectral subtraction methods and the JOAP direct trending analyses

Complete flexibility

The ASTM®, JOAP and turbine fluids methods can be customized by tweaking analysis parameters or adding new analytes, with a range of calculation types available: peak heights and areas, calibrated Beer's Law methods, and chemometric PCR and PLS analyses developed in PerkinElmer QUANT+ software. The graphical interface to this functionality (Figure 2) greatly simplifies method implementation. Common examples of where this may be used include replacing the ASTM® soot definition with a Beer's Law calibration to obtain soot as a percentage (Figure 3), or the addition of a chemometric method for determining TBN.[1]

New, user-defined methods – either direct-trending or following subtraction of a reference spectrum specified by the user at run-time – can be developed with the same degree of flexibility and each method can include variations for several oil types.

Enhanced productivity for multiple analyses and method development

OilExpress, version 4 now includes a facility to reprocess previously measured batches of data. For example, this allows spectral subtraction and direct trending methods to be run and compared on the same data. Use of this feature in combination with the method editor allows rapid evaluation of the effects of changes to analysis parameters – for example, to optimize the correlation between the IR results and data from a conventional laboratory analysis.

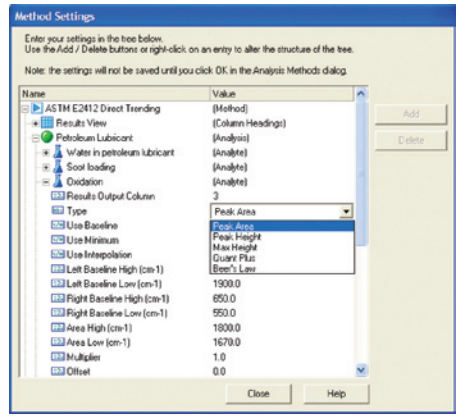


Figure 2. The OilExpress method editor, new in version 4 of the software, allows easy customization of the supplied methods as well as the addition of new analytes or methods.

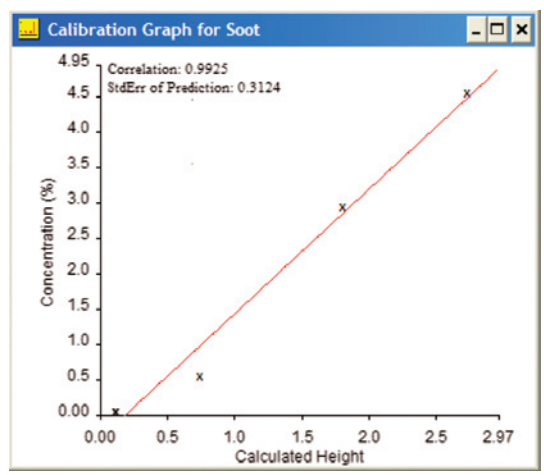


Figure 3. Calibration for soot as a percentage in Spectrum Beer's Law software.

Outstanding reproducibility

For transmission measurements of used oils, zinc selenide (ZnSe) is the best choice of window material due to its long-wavelength cut-off below 550 cm^{-1} and its resistance to water damage. However, ZnSe cells tend to suffer from interference fringing caused by its high refractive index. The OilExpress system uses a unique cell design in which a wedged spacer breaks the parallelism of the windows, and reduces the fringing to negligible levels (below 0.002 A for an empty cell at 2000 cm^{-1}; lower again for a cell filled with oil).

The cell pathlength is automatically determined by the system from measurement of a check fluid (or can be entered manually), and spectra are normalized to a pathlength of 0.1 mm prior to analysis, in accordance with ASTM® D7418.

These two measures ensure very good correspondence between measurements made using different cells. For the best possible reproducibility with direct-trending methods, we describe a procedure for subtraction of a modified empty-cell spectrum that accounts for slight variations in reflection and absorption losses caused by the cell windows.[2]

As an example, Figure 4 shows the spectra of a used oil measured with three different flow cells and following subtraction of the empty cell spectra (as described above) and pathlength normalization. The relative standard deviations for soot and phenolic antiwear are 2.0% and 1.3%, respectively.

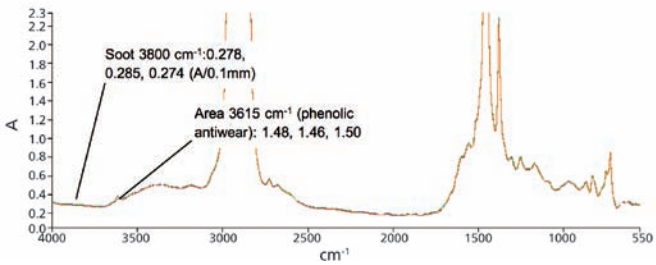


Figure 4. Spectra of a diesel engine oil measured in three flow cells following empty-cell correction and pathlength normalization. Calculated results for soot and phenolic antiwear are shown.

Table 1. **Analysis methods and analytes measured by OilExpress.**

	Synthetic	**Mineral**	**JOAP**	**ASTM® E2412 Direct Trending**	**ASTM® E2412 Differential**	**Petroleum Hydraulic**	**Turbine Oil**
New in v4?	No	No	Updated!	Yes	Yes	Yes	Yes
Oil types	Synthetic	Mineral	Run All, Mil-I-17331, Mil-I-9000, Petroleum ground, Petroleum EP, Synthetic ground, Synthetic hydraulic, Synthetic turbine	Petroleum lubricant, Petroleum EP, Polyol ester		Petroleum Hydraulic	Synthetic turbine, Turbine fluids
Reference spectrum?	Yes	Yes	No	No	Yes	No	No
Soot							
Water							
Nitration							
Oxidation							
Sulfation							
Phosphate antiwear					*Requires user specification*		
Phenolic antiwear							
Glycol							
Gasoline							
Diesel							
Ester breakdown							
Unsaturated ester							
Other synthetic contaminants							

Analytes measured by OilExpress

Analytes not measured by OilExpress

Ordering information

L125000H	Spectrum 100T OilExpress system
LX108859	OilExpress software upgrade kit (with Spectrum 10)
LX108859 LX108928	OilExpress software upgrade kit (with Spectrum 6)

References

1. Dave Wooton, Stuart Barry, Samuel White and Robert Thomas. "Using Infrared Spectroscopy in Used Engine Oils: Estimating Base Number". Practicing Oil Analysis, November-December 2005.

2. "Obtaining Optimum Reproducibility for FT-IR Measurements in ZnSe Liquid Transmission Cells". PerkinElmer technical note 009051_01.

PerkinElmer, Inc.
940 Winter Street
Waltham, MA 02451 USA
P: (800) 762-4000 or
(+1) 203-925-4602
www.perkinelmer.com

For a complete listing of our global offices, visit www.perkinelmer.com/ContactUs

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