



Malvern
Panalytical

EPSILON 4 OILS & FUELS



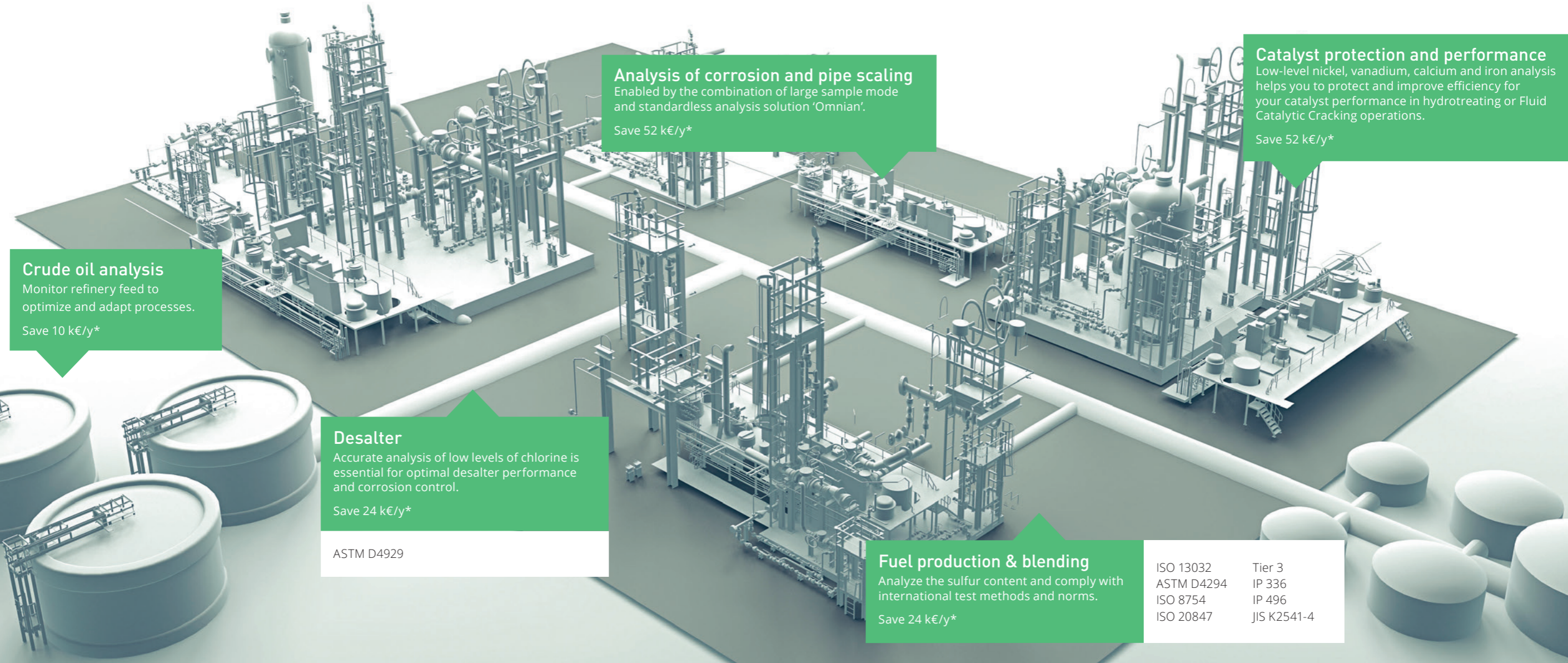
TRUST YOUR ELEMENTAL ANALYSIS

Value beyond compliance

Compliance with international test methods like ISO and ASTM is an essential industry requirement for elemental analysis of oils and fuels. For the Epsilon 4 this mandated compliancy is merely the starting point. Where the instrument really shines is the additional value it brings for many other analytical tasks in the production of oils and fuels. For example, the analysis required for the protection of expensive FCC catalysts and indicators for corrosion, like low-level chlorine. Illustrated below are the significant added values achievable relative by this single modest investment.

Epsilon 4's value for refineries

- Less than 1 € / analysis cost of ownership
- Compliant with relevant test methods and regulations
- Accurate results for crude oils to fuel-biofuel-oxygenates mixtures, with only a few calibrations to maintain using the Oil-Trace solution
- Low-cost calibration maintenance
- Suitable for solids, liquids, powders and large samples like plant pipes
- Elemental screening of unknown samples with Omnian



Crude oil analysis
 Monitor refinery feed to optimize and adapt processes.
 Save 10 k€/y*

Analysis of corrosion and pipe scaling
 Enabled by the combination of large sample mode and standardless analysis solution 'Omnian'.
 Save 52 k€/y*

Catalyst protection and performance
 Low-level nickel, vanadium, calcium and iron analysis helps you to protect and improve efficiency for your catalyst performance in hydrotreating or Fluid Catalytic Cracking operations.
 Save 52 k€/y*

Desalter
 Accurate analysis of low levels of chlorine is essential for optimal desalter performance and corrosion control.
 Save 24 k€/y*
 ASTM D4929

Fuel production & blending
 Analyze the sulfur content and comply with international test methods and norms.
 Save 24 k€/y*

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|------------|-------------|
| ISO 13032 | Tier 3 |
| ASTM D4294 | IP 336 |
| ISO 8754 | IP 496 |
| ISO 20847 | JIS K2541-4 |

* Monetary savings are based on typical refining capacity and operating costs and are additional to the next best alternative option. No warranties of guarantees are given.



ACCURATE AND COMPLIANT SULFUR ANALYSIS

Epsilon 4 is a star-performing benchtop XRF instrument and is well suited for the analysis of sulfur and other trace elements in fuels according to the latest ASTM, ISO, IP and JIS test methods.

The results of the repeatability tests of two of the international sulfur norms are shown below; one for ISO 13032 and one for TIER 3. Repeatability and reproducibility are two important requirements in international test methods. This precision is illustrated graphically in **Figure 1** for ultra-low sulfur in gasoline according to ISO 13032 (twenty repeat measurements) and for TIER 3 in **Figure 2** (twenty-one repeat measurements over twenty-one days).

ISO13032 compliant - sulfur in gasoline

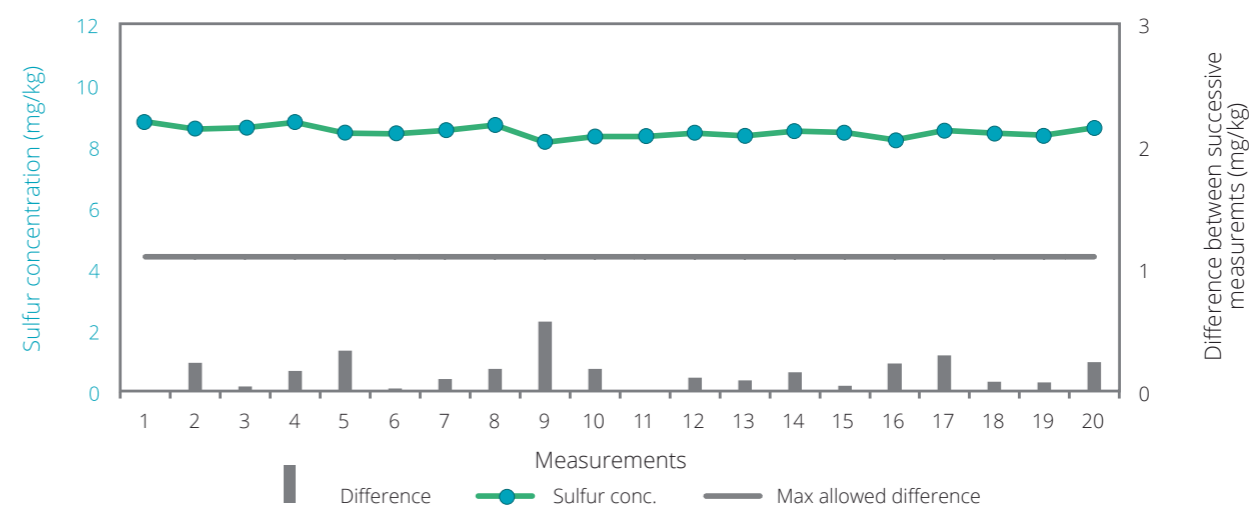


Figure 1. ISO 13032 - Repeatability

EPA TIER 3 compliant - sulfur in gasoline

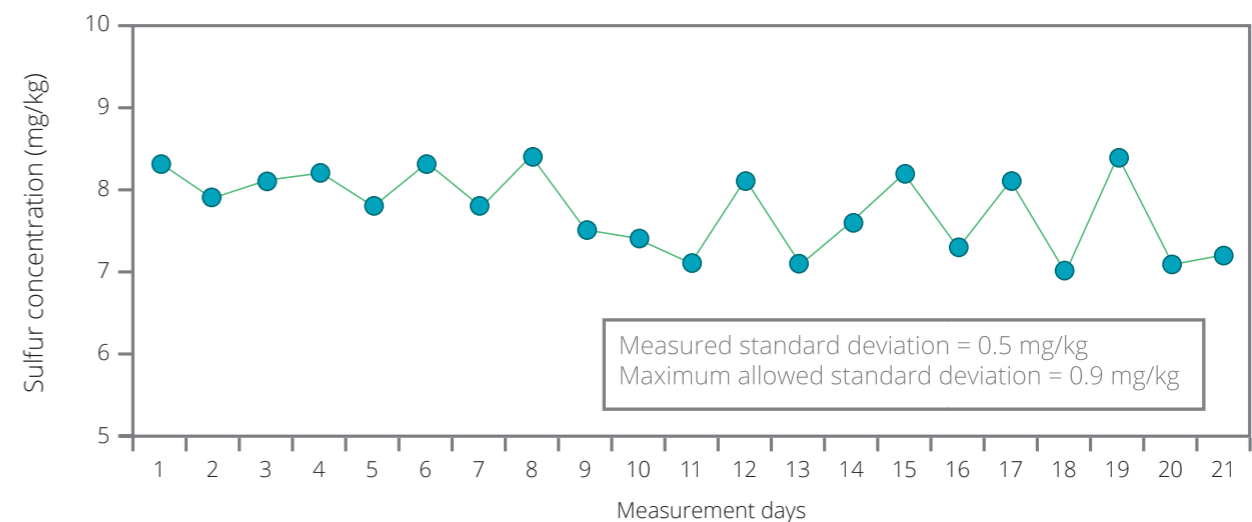


Figure 2. Tier 3 - Repeatability

THE POWER OF BENCHTOP XRF SYSTEMS

Combining the latest excitation and detection technology with smart design, the analytical performance of Epsilon 4 approaches that of more powerful and floor-standing spectrometers. Selective excitation and careful matching of the X-ray tube output to the capabilities of the detection system underlie the system's outstanding performance.



Epsilon 4 - Highly flexible analytical tools suitable for a wide range of applications:

- 10-watt version - used for elemental analysis (F - Am) in areas from R&D through to process control
- 15-watt version - used for higher sample throughput with improved and extended light-element capabilities (C - Am)
- 15-watt version - used for higher sample throughput in challenging environments (F - Am)

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|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|
| | | | | | | | | | | | | | | | | | | Z | Possible to analyze with Epsilon 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | Z | Not possible to analyze with Epsilon 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | Z | Possible with Epsilon 4 and optional detector | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| H | | | | | | | | | | | | | | | | | He | B | C | N | O | F | Ne | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Li | Be | | | | | | | | | | | | | | | Al | Si | P | S | Cl | Ar | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Na | Mg | | | | | | | | | | | | | | | Ga | Ge | As | Se | Br | Kr | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| K | Ca | Sc | Ti | V | Cr | Mn | Fe | Co | Ni | Cu | Zn | Ga | Ge | As | Se | Br | Kr | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Rb | Sr | Y | Zr | Nb | Mo | Tc | Ru | Rh | Pd | Ag | Cd | In | Sn | Sb | Te | I | Xe | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cs | Ba | L | Hf | Ta | W | Re | Os | Ir | Pt | Au | Hg | Tl | Pb | Bi | Po | At | Rn | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Fr | Ra | A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | L | La | Ce | Pr | Nd | Pm | Sm | Eu | Gd | Tb | Dy | Ho | Er | Tm | Yb | Lu | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | A | Ac | Th | Pa | U | Np | Pu | Am | Cm | Bk | Cf | Es | Fm | Md | No | Lr | | | | | | | | | | | | | | | | | | | | | |

Reduce helium consumption

The high performance of Epsilon 4 enables many applications to be operated in air atmosphere, without longer overhead time and costs involved for helium or maintenance of vacuum system. When measuring in air, low-energy X-ray photons characteristic of sodium, magnesium and aluminium, are sensitive to variations in air-pressure and temperature. Built-in temperature and air-pressure sensors compensate for these environmental variations, ensuring excellent results whatever the weather.

Calibrated for years

A low-drift X-ray tube and an automatic drift correction system give compliant results for years without the need for re-calibration. This results in a more efficient use of the system and less cost of calibration maintenance.

Online remote support

In the unlikely event of the Epsilon 4 needing specialist attention, an on-line diagnostic facility is available in the local service centers. Problems can be diagnosed, and in many instances corrected, directly online. This significantly reduces system downtime and cuts maintenance costs to a minimum.

Accurate results

Our unique high-performance, metal-ceramic X-ray tube, specifically designed and manufactured for Epsilon 4, ensures high quality and reliable results. Flexible voltage settings from 4.0 to 50 kV and a maximum current setting up to 3.0 mA can be used to define application-specific excitation conditions that optimize the performance across the periodic table.

Ultimate light-element performance

With the optional SDD^{Ultra} detector, Epsilon 4 enables ultra-light element analysis of even carbon, nitrogen and oxygen.

Quality results through mature software

Accurate and precise results are obtained through advanced spectrum processing and state-of-the-art correction and quantification algorithms.

Safety guaranteed

Epsilon 4 complies with the latest Machinery Directive, CSA, IEC, EMC, Vollschutz norms and standards for protection and radiation safety to guarantee a safe instrument for the operator.

Unattended operation

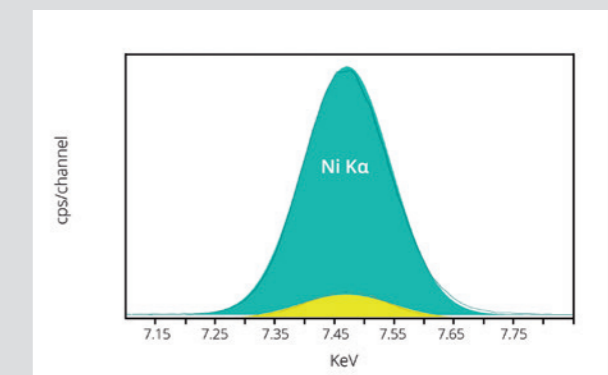
The unique combination of a 10-position removable sample changer with spinner enables the automatic processing of sample batches without the need for operator attention. Continuous rotation of the sample during measurement minimizes any errors caused by non-homogeneity or surface irregularities within individual samples and provides more accurate results. Automatic transfer of data to a central location gives you access to the latest results.

Fast and sensitive

Fast measurements are achieved by using the latest silicon drift detector technology that produces significantly higher intensities.

Unique detector electronics enable a linear count rate capacity to over **1,500,000 cps** (at 50% dead time) and a count rate independent resolution typically better than 135 eV for better separation of analytical lines in the spectrum.

This allows the Epsilon 4 spectrometer to run at full power, realizing a much higher sample throughput compared to traditional EDXRF benchtop instruments.



Eight times higher intensities for nickel obtained with Epsilon 4, in comparison with its predecessor Epsilon 3^{XL}E

FAST, REPRODUCIBLE ANALYTICAL METHOD

Compared to other analytical techniques XRF requires little or no sample preparation

XRF is an ideal means of determining the chemical composition of all kinds of materials. Measurements in Epsilon 4 are carried out directly on the solid material (or liquid) with little to no sample preparation. There is no need for any dilution or digestion and therefore no disposal of chemical waste.

Epsilon 4 spectrometers can handle a large variety of sample types weighing from a few milligrams to larger bulk samples.

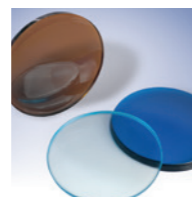
Samples can be measured as:

- Solids
- Pressed powders
- Loose powders
- Liquids
- Fused beads
- Slurries
- Granules
- Filters
- Films and coatings

POWDERS



SOLIDS



LIQUIDS



TAILORED SOLUTIONS THROUGH EXPERTISE

Experienced Malvern Panalytical staff work in close cooperation with you to provide not only training but also tailored analytical programs and procedures, balancing throughput and accuracy while minimizing set up and running costs.



Access to the right calibration samples is the key to accurate XRF analysis. Malvern Panalytical helps in obtaining or creating the standards you need. We provide total solutions including standards for several key applications. We can also generate suites of in-house standards by certifying your materials through our ISO 17025 certified laboratory.

Sample preparation, although typically straightforward for XRF, is an important factor in the overall analytical precision and accuracy. Sample preparation needs to be quick, robust and reproducible, and the choice of sample preparation technique starts with your requirements and materials.

Malvern Panalytical can advise you which approach suits best given your material types and analytical requirements. Tap into our knowledge network through our global Expertise Centers to optimize your complete analytical process, including sample preparation methods and equipment.

Our aim is to make Epsilon 4 an essential part of your oils and fuels operation

The added value for you is what drives us:

- The largest support network in the industry
- Training programs customized to your needs
- Reference materials
 - *Certified reference materials (CRMs)*
 - *Synthetic reference materials tailored to your requirements*
- Analytical services
 - *Certify your samples through our ISO 17025 certified laboratory*
- Consultancy
 - *Norm compliance*
 - *Laboratory information management*
 - *Process automation*
 - *Standard operating procedures*
 - *Interlaboratory standardization*





MEASURE IT IN YOUR OWN LANGUAGE

1. Load your sample
2. Select required method
3. Enter relevant sample information
4. Just click Measure
 測量
 測定
 Mesurer
 Messung
 Mesure
 Zmierzyć
 Medida
 Измерить
 Médir

ENHANCE YOUR ANALYSIS THROUGH SOFTWARE OPTIONS

Five industry software options are available to further enhance the capabilities of Epsilon 4: Omnian, Stratos, Oil-Trace, Enhanced Data Security and FingerPrint. These dedicated options add new functional dimensions to benchtop spectrometry and take the hard work out of regulatory compliance.

One calibration for oils and fuels OIL-TRACE



Oil-Trace is an innovative solution to the challenges often faced in the analysis of oil and petrochemicals with variable light matrix compositions. Oil-Trace offers a universal solution for a range of elements in a wide variety of applications, including fuel-biofuel mixtures and lubricating oils. Analysts benefit from a simplification of application maintenance and analytical procedure, and from cost savings through the use of simple and relatively inexpensive standards.



Standardless package OMNIAN



Our Omnian software is ideal when there is no conventional calibration established for materials that require analysis. When faced with non-routine samples or materials for which there are no certified reference materials, Omnian provides excellent insight into the elemental composition. Designed to provide fast and reliable quantification, Omnian's advanced fundamental parameters (FP) algorithm automatically deals with the analytical challenges posed by samples of widely differing types.

Instant material identification FINGERPRINT



FingerPrint is a material type confirmation routine that uses a rapid statistical analysis of the spectrum for a simple Yes/No answer. It is ideal for material testing when identification or speed is important, but the actual composition is not of interest. Spectra used for the FingerPrint routine can also be used for conventional compositional determination and for a more complete diagnostic analysis.



WHY CHOOSE MALVERN PANALYTICAL?

We are global leaders in materials characterization, creating superior, customer-focused solutions and services which supply tangible economic impact through chemical, physical and structural analysis.

Our aim is to help you develop better quality products and get them to market faster. Our solutions support excellence in research, and help maximize productivity and process efficiency.

Malvern Panalytical is part of Spectris, the productivity-enhancing instruments and controls company.

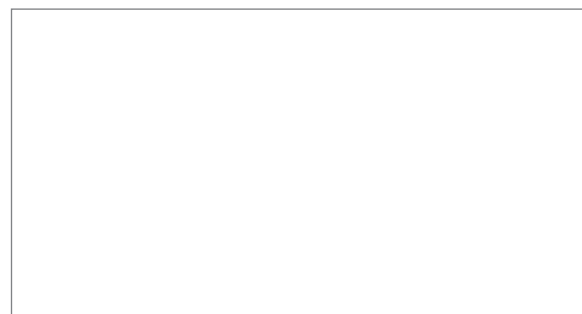
www.spectris.com

SERVICE & SUPPORT

Malvern Panalytical provides the global training, service and support you need to continuously drive your analytical processes at the highest level. We help you increase the return on your investment with us, and ensure that as your laboratory and analytical needs grow, we are there to support you.

Our worldwide team of specialists adds value to your business processes by ensuring applications expertise, rapid response and maximum instrument uptime.

- Local and remote support
- Full and flexible range of support agreements
- Compliance and validation support
- Onsite or classroom-based training courses
- e-Learning training courses and web seminars
- Sample and application consultancy



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