



**Malvern
Panalytical**
a spectris company

EPSILON 1

Easiest analysis of additives in lubricating oils
for ASTM D6481 compliant performance





2 HOUR FIRE WALL

QUANTIFICATION OF LUBRICATING OIL ADDITIVES

In compliance with ASTM D6481

Easy, economical method

Looking for an easy and economical method for compliant analysis of additives in lubricating oils?

Epsilon 1 is the ideal analytical solution. The system is pre-calibrated in the factory and is an out-of-the-box solution with guaranteed performance in compliance with ASTM D6481. This method describes the testing for phosphorus, sulfur, calcium and zinc in unused lubricating oil by XRF.

Malvern Panalytical has a strong reputation for high-end X-ray instrumentation. Epsilon 1 is built using our market-leading technology with superior quality, worldwide service and application support.

Epsilon 1 produces fast, cost-effective, precise and accurate data with minimal operator dependence and sample preparation. The total running cost is therefore relatively low at only € 1.- per analysis.

This is far less than techniques such as AAS, ICP and wet-chemical methods that are costly and also require a dedicated skilled operator.

THE TOTAL SOLUTION CONSISTS OF

- Epsilon 1 instrument with user software
- Factory pre-calibration for ASTM D6481
- A validation sample
- A starting kit for 100 liquid cups for analysis



15	16	20	30
P	S	Ca	Zn
30.974	32.066	40.08	65.39



Sample preparation foils



Preparation tool



Liquid cups



Validation standard

RESULTS IN JUST 4 STEPS

Easy sample preparation



Use the handy tool for preparing the liquid cup.



Fill the cup two thirds full.

Easy sample analysis



Place your sample for measurement.



Enter sample name and touch the 'measure' icon.

COMPLIANT RESULTS





MEASURE IN YOUR OWN LANGUAGE

Ten most common languages are available for the operator:

測量
Measure
測定
Mesurer
Messung
Mesure
Zmierzyć
Medida
Измерить
Médír

BUILT FOR COMPLIANCE

The Epsilon 1 is a fully integrated energy dispersive XRF analyzer consisting of a spectrometer, built-in computer and analysis software. Powered by the latest advances in excitation and detection technology the Epsilon 1 is a star performer in the low-cost benchtop instrument class. A well-designed optical path, a wide range of excitation capabilities ranging from 7 to 50 kV for light and heavier elements and a highly sensitive SDD detector system contribute to the Epsilon 1's uniqueness.

Self-contained system

Built-in computer running Microsoft Windows 10 with a powerful CPU and 120 GB hard drive ensures flexibility to store and handle thousands of results.

Repeatability for years

A low-drift X-ray tube and a handy drift correction routine give ASTM D6481 compliant results for years without the need for time-consuming re-calibration.

Maximum sensitivity

The thin-window Ag anode X-ray tube, designed and manufactured by Malvern Panalytical, ensures high quality and sensitivity. The selection of Ag anode material is ideal for the accurate quantification of P, S and Cl without interference of possible line overlaps in the XRF spectrum, leading to more reliable results.

The 50 kV X-ray tube and generator are ideal for exciting higher energy elements like zinc, resulting in faster analysis times.

Spillage protection

In order to shield the delicate heart of the system from spillage, a protection foil is in place. In case of spillage, the foil can be replaced easily by the operator.

Economical footprint

Compact design with a built-in computer and touchscreen reduces the requirement of valuable lab space to less than 0.15 m².

Easy operation

High-resolution (1024 x 768), 10.4" LCD touchscreen for easy walk-up and operation.

Easy communication

USB and network connections for use of standard computer peripherals enable extended use, application development and seated operator.

Best accuracy

Highly concentrated samples can cause detector saturation resulting in lower accuracy or longer measuring times. Epsilon 1 uses the latest in silicon drift technology to handle these highly concentrated samples without any loss of accuracy or increased measuring times.

Atmospheric variations

Low-energy X-ray photons, like those of phosphorus and sulfur are sensitive to air-pressure and temperature variations. Built-in temperature and air-pressure sensors compensate for these atmospheric variations, ensuring excellent results whatever the weather.

Sample positioning

Highly repeatable sample positioning reduces sample-to-sample variations.

Safety guaranteed

Epsilon 1 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.

Z		Factory pre-calibrated	
Z		Possible to analyze with Epsilon 1	
Z		Not possible to analyze with Epsilon 1	

1	2											18	19																						
1	H											2	He																						
3	Li	4	Be											10	Ne																				
5	Na	6	Mg											16	Ar																				
11	K	12	Ca	13	Sc	14	Ti	15	V	16	Cr	17	Mn	18	Fe	19	Co	20	Ni	21	Cu	22	Zn	23	Ga	24	Ge	25	As	26	Se	27	Br	28	Kr
37	Rb	38	Sr	39	Y	40	Zr	41	Nb	42	Mo	43	Tc	44	Ru	45	Rh	46	Pd	47	Ag	48	Cd	49	In	50	Sn	51	Sb	52	Te	53	I	54	Xe
55	Cs	56	Ba	57	L	58	Hf	59	Ta	60	W	61	Re	62	Os	63	Ir	64	Pt	65	Au	66	Hg	67	Tl	68	Pb	69	Bi	70	Po	71	At	72	Rn
87	Fr	88	Ra	89	A	104	Rf	105	Db	106	Sg	107	Bh	108	Hs	109	Mt	110	Ds	111	Rg	112	Cn	113	Nh	114	Fl	115	Mc	116	Lv	117	Ts	118	Og
89	L	90	La	91	Ce	92	Pr	93	Nd	94	Pm	95	Sm	96	Eu	97	Gd	98	Tb	99	Dy	100	Ho	101	Er	102	Tm	103	Yb	104	Lu				
91	A	92	Ac	93	Th	94	Pa	95	U	96	Np	97	Pu	98	Am	99	Cm	100	Bk	101	Cf	102	Es	103	Fm	104	Md	105	No	106	Lr				

ADVANTAGES OF XRF FOR LUBE OIL ANALYSIS

- Quick quantification method
- Simple, fast and safe sample preparation
- Non-destructive analysis
- Wide analytical concentration range (ppm - %) reducing the necessity for dilution and associated errors
- Accurate and reproducible data compared to other techniques
- No need for helium





ROBUST AND ACCURATE QUANTIFICATION

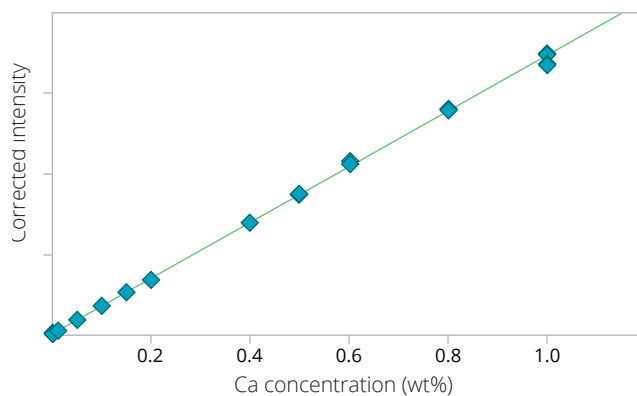
Calibration

Sixteen commercially available oil standards from VHG Labs Inc. (US) were used to pre-calibrate Epsilon 1 for P, S, Ca and Zn according to ASTM D6481. The measurement time was 5 minutes per oil sample.

Element	Concentration range (wt%)	RMS (wt%)	Correlation
P	0 - 0.30	0.005	0.99889
S	0 - 1.75	0.028	0.99864
Ca	0 - 1.00	0.007	0.99982
Zn	0 - 0.30	0.004	0.99936

The RMS value is a measure of the difference between the calculated concentration and the chemical concentration and is therefore a measure of the accuracy of the method (standard deviation).

The calibration root mean square (RMS) values presented in the table and the calibration graph demonstrate a high degree of accuracy for the method.





OF LUBRICATING OIL ADDITIVES

Accuracy

The accuracy of the method is demonstrated by measuring two validation standards as unknown samples and comparing the measured concentrations against the certified concentration. The data in the table demonstrate excellent accuracy.

Element	Standard 7		Standard 10	
	Certified concentration (wt%)	Measured concentration (wt%)	Certified concentration (wt%)	Measured concentration (wt%)
P	0.150	0.147	0.150	0.149
S	1.000	0.948	0.380	0.361
Ca	0.500	0.487	0.100	0.098
Zn	0.150	0.151	0.200	0.199

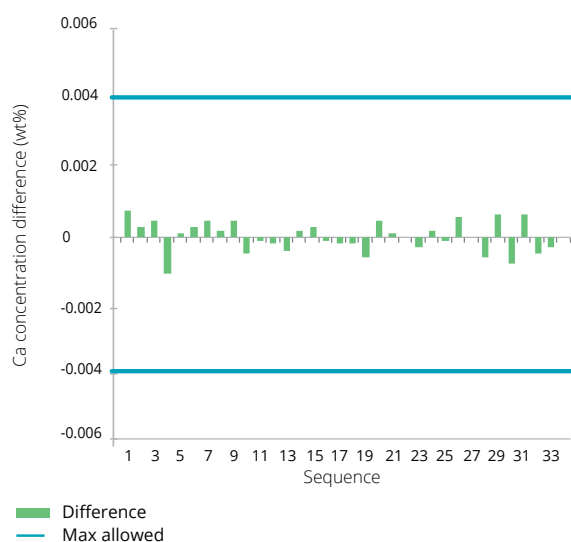


COMPLYING WITH ASTM D6481

Precision

Measurement precision is an important requirement of ASTM D6481. Epsilon 1 easily meets the requirements set in the norm.

To test the precision of the method, 34 freshly prepared samples of a commercially available unused lubricating oil product were measured consecutively. This precision is illustrated graphically for calcium. The blue lines show the maximum difference allowed by ASTM D6481. The average concentration, maximum achieved difference between successive measurements and the difference allowed by ASTM D6481, are presented for phosphorus, sulfur, calcium and zinc in the table.



Element	Average concentration (wt%)	Largest difference (wt%)	Maximum permitted difference by ASTM D6481 (wt%)
P	0.092	0.001	0.006
S	0.477	0.006	0.009
Ca	0.225	0.001	0.004
Zn	0.101	0.001	0.002

Epsilon 1 is a star-performing benchtop XRF instrument and is well suited for the analysis of phosphorus, sulfur, calcium and zinc in unused lubricating oil according to the latest ASTM D6481 test method.



The results of the repeatability test for all four additives are well within the limits set by D6481.

Other additives can also be quantified with Epsilon 1, like chlorine, molybdenum and barium.

Another pre-calibrated petrochemical application option is available:

Sulfur in fuels in compliance with ASTM D4294 and ISO 20847





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 Analytical is part of Spectris, the productivity-enhancing instrumentation and controls company.

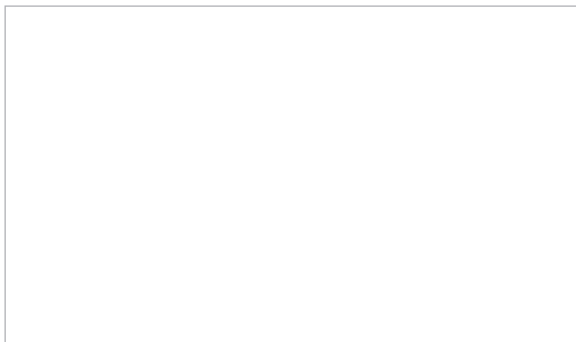
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SERVICE & SUPPORT

Malvern Analytical 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



MALVERN PANALYTICAL

Groewood Road, Malvern,
Worcestershire, WR14 1XZ,
United Kingdom

Tel. +44 1684 892456
Fax. +44 1684 892789

Lelyweg 1,
7602 EA Almelo,
The Netherlands

Tel. +31 546 534 444
Fax. +31 546 534 598

info@malvernpanalytical.com
www.malvernpanalytical.com

www.malvernpanalytical.com/epsilon1oils