

Analysis of Air Filters by EDXRF

ARL QUANT'X High Performance Energy Dispersive X-Ray Fluorescence Spectrometer

Key Words

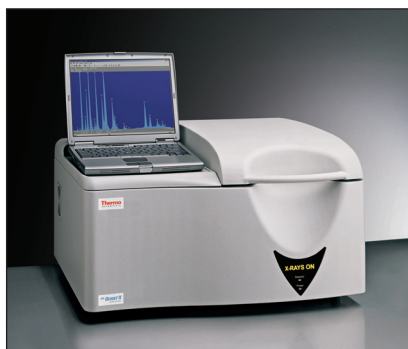
- ARL QUANT'X
- EDXRF
- Air filters
- Environment
- Pollution

Introduction



There is an increasing demand to monitor the air pollution in both residential and industrial areas. Indeed, air, water and soil contamination have become principal subjects of analysis for environmental protection agencies, service laboratories, urban development authorities and health departments.

X-ray fluorescence is one of the best analytical methods to deal with samples related to environmental issues. XRF is a non-destructive technique and is capable of analyzing F to U in solids, liquids, powders and depositions. Some of the high power instruments can measure elements below F but the main interest in this area of environmental concern is to monitor toxic and heavy elements. In particular, Energy Dispersive XRF (EDXRF) is the most suitable technique, for example, to analyze air filters because it needs little or no sample preparation and is truly capable of handling multi-element and multi-matrix analysis. XRF is also well established as a technique to perform precise and reliable analysis on a variety of materials which are sometimes totally unknown.



ARL QUANT'X: Features and benefits for the user

The Thermo Scientific ARL QUANT'X is a high performance bench top Energy Dispersive XRF system.

The key features of ARL QUANT'X are:

- Element coverage: Sodium to Uranium
- Various sample types:
 - Solids or liquids samples
 - Bulk sample or thin films
- Wide dynamic range ppm-%
- Multi-matrix, multi-element
- Eight-position X-ray filter wheel
- 10-position automated sample changer
- Choice of detectors
 - Peltier cooled Si(Li) with < 155 eV resolution
 - LN cooled Si(Li)
 - PIN Diode
- Transportable for field analyses

In addition, it has the performance of a high end EDXRF without the need for complicated instrumentation.

For example, ARL QUANT'X has the following technical features which are very attractive, useful and provide added value to the analyst:

- Digital Pulse Processing for optimal throughput
- Ethernet connectivity
- Flexible sample handling from 1mm diameter onwards
- Mechanically simple: Only 1 moving part
- Installation in less than 30 minutes
- Fully customizable on-site
- Field-portable and rugged for mobile use
- Lowest running and maintenance cost

Sample preparation and handling

Several air filters containing known relative concentrations of various elements were analyzed to determine the feasibility and sensitivity of the technique for such measurements.

No sample preparation was performed. The samples were analyzed in a 10-position sample changer, which features removable sample holders that accommodate samples between 32 and 47 mm in size. The filters provided were 47 mm in diameter and therefore fit perfectly into the sample holder shown at right.

Excitation conditions

The ARL QUANT'X employs filtered radiation to excite a sample and cause its constituent elements to fluoresce. With a set of eight filters specifically designed to optimize the excitation and sensitivity for all elements from Na to U, every ARL QUANT'X is a versatile, high-performance instrument that can be easily configured for any application or combination of elements. Several conditions were used to scan the samples for all potential analytes.

Analysis time

All measurements were performed in 120 seconds livetime or ~4 minutes of real time (accounting for ADC Deadtime).

Quantitative analysis

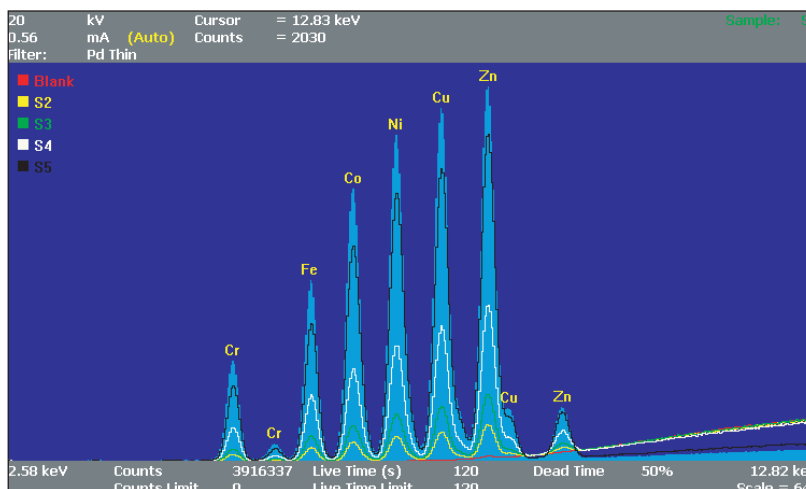
A simple linear calibration was used to relate peak intensities to the relative values given for the standards. The concentration values for each element can be expressed in relative %. The ARL QUANT'X can also be used to determine the absolute, actual amount or mass of material deposited on the filters. Such analysis requires the use of an exclusive analytical algorithm developed specifically to analyze thin deposits or layers. The algorithm is based on the Fundamental Parameters (FP) technique and offers the following features:

- Calibration standards may be very different in structure and composition from the samples being analyzed
- "Standard-less" analysis of elements for which no standards are available
- Correction for matrix effects, which accounts for the absorption effects of all sample components on each other
- Thickness analysis

These capabilities are especially useful when analyzing samples for which type standards may be prohibitively expensive or simply unavailable.

Typical limits of detection for various elements on air filters

As can be seen from the Table 1 below, the typical limits of detection for most of the elements are between 1ng/cm² to about 10ng/cm².



Spectra of all standards and a Blank (in red) collected under conditions optimized for Cr-Zn. The difference in background (on the right side of the spectrum) between the various samples is due to a decrease in X-ray scatter as the density of the samples increases

(ng/cm ²)		(ng/cm ²)		(ng/cm ²)		(ng/cm ²)	
Na	14.14	Mn	0.85	Zr	1.56	Eu	2.83
Mg	4.24	Fe	0.71	Nb	1.70	Tb	2.83
Al	3.68	Co	0.99	Mo	2.83	Hf	4.24
Si	3.54	Ni	0.71	Ag	8.49	Ta	2.83
P	3.39	Cu	0.85	Cd	8.49	W	2.26
S	2.83	Zn	0.85	In	11.31	Ir	1.84
Cl	2.40	Ga	0.85	Sn	14.14	Au	1.70
K	2.26	As	0.85	Sb	15.56	Hg	1.56
Ca	2.26	Se	0.71	Cs	4.24	Pb	1.56
Sc	1.70	Br	0.71	Ba	4.53		
Ti	1.41	Rb	0.85	La	3.54		
V	1.41	Sr	1.13	Ce	2.83		
Cr	0.99	Y	1.41	Sm	2.83		

Table 1: Typical limits of detection

Conclusion

This application note illustrates that various elements deposited on air filters can be conveniently analyzed using the ARL QUANT'X EDXRF spectrometer with speed and precision. The analysis time can typically take about 4 to 10 minutes per filter depending on the number of elements and their concentration level. The ARL QUANT'X is best suited for such direct, non-destructive and reliable analysis of toxic and other elements of environmental concern with typical detection limits in the nanogram/cm² range.

In addition to these offices, Thermo Fisher Scientific maintains a network of representative organizations throughout the world.

Australia
+61 2 8844 9500
Austria
+43 1 333 50340
Belgium
+32 2 482 30 30
Canada
+1 800 532 4752
China
+86 10 5850 3588
Denmark
+45 70 23 62 60
France
+33 1 60 92 48 00
Germany
+49 6103 408 1014
India
+91 22 6742 9434
Italy
+39 02 950 591
Japan
+81 45 453 9100
Latin America
+1 608 276 5659
Netherlands
+31 76 587 98 88
South Africa
+27 11 570 1840
Spain
+34 91 657 4930
Sweden/Norway/Finland
+46 8 556 468 00
Switzerland
+41 21 694 71 11
UK
+44 1442 233555
USA
+1 800 532 4752

www.thermo.com



Thermo Electron SA, Ecublens, Switzerland is ISO certified.

©2007 Thermo Fisher Scientific Inc. All rights reserved. Windows is a registered trademark of Microsoft corp. All other trademarks are the property of Thermo Fisher Scientific Inc. and its subsidiaries.

Specifications, terms and pricing are subject to change. Not all products are available in all countries. Please consult your local sales representative for details.

AN41903_E 06/07C