

Analysis of Aluminum and its Alloys by Optical Emission

ARL 3460 Metals Analyzer

Key Words

- ARL 3460
- Aluminum
- Metals Analyzer
- Optical Emission



Introduction

The Thermo Scientific ARL 3460 Metals Analyzer is custom designed to meet your specific requirements whether you are a small foundry or a large aluminum plant. Our long experience in metals analysis comes from an installed base of over 10,000 spectrometers worldwide. The ARL 3460 is the answer to your metallurgical analysis needs, whether they be incoming material control or metal QC and production analysis. Working 24 hours a day and 7 days a week, the ARL 3460 delivers dependable performance year after year.

Aluminum

Aluminum is one of the most versatile, economical and attractive metallic materials for a broad range of uses from soft, highly ductile wrapping foil to the most demanding engineering applications like aircraft construction.

The most useful characteristics are:

- Low density and high specific strength
- High resistance to corrosion
- No toxic reaction with food
- High electrical and thermal conductivity

Today, the principal applications are:

- Container and packaging 35 %
- Transportation 20 %
- Building and construction 17 %
- Electrical 9 %
- Machinery and equipment 7 %
- Miscellaneous 12 %

Packaging remains the primary use of aluminum. The recycling market from scrap cans represents a large volume of global aluminum production.

The transportation sector also holds great potential for future aluminum demand.

The US Aluminum Association system for all identification is used world-wide and employs different nomenclature for wrought and cast alloys:

1000 series	Pure aluminum	Electrical applications
2000 series	Al - Cu	Aircraft
3000 series	Al -Mn	Packaging
4000 series	Al -Si	Pistons
5000 series	Al - Mg	Marine
6000 series	Al -Mg - Si	Extrusion
7000 series	Al - Zn	High strength applications

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The ARL 3460 optical emission spectrometer can determine up to 60 elements. The HiRep source has the flexibility to customize the excitation parameters providing the best analytical conditions for a wide variety of sample types.

The source uses the HEPS (High Energy-Spark) technique to minimize the metallurgical effects and produce consistently accurate results. The printout of average concentration for the required elements from a repeat analysis is obtained in typically one minute.

Sample preparation

A lathe or a milling machine is used to prepare the samples. Grinding is not recommended due to the risk of contamination.

Sample analysis time

The analysis time is taken between the start of the analysis and the display of its result:

ALUMINUM MATERIAL	ANALYSIS TIME
Pure aluminum	30 s
Low alloy aluminum without phosphorus	25 s
Low alloy aluminum with phosphorus	30 s

Factory calibration (CARL)

Thermo Scientific optical emission spectrometers can be factory calibrated for aluminum and its alloys utilizing CARL, a very sophisticated multi-variable regression tool that corrects for matrix effects as well as spectral interferences. CARL provides an immediate “turn-key” system which gives the user the highest accuracy possible.

Our company provides calibrations for several qualities of aluminum and aluminum alloys:

- Pure aluminum
- Low alloy Al
- Al-Si
- Al-Si-Cu
- Al-Cu
- Al-Zn
- Al-Mg
- Global calibration

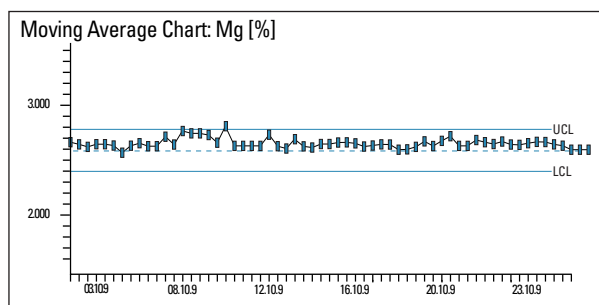
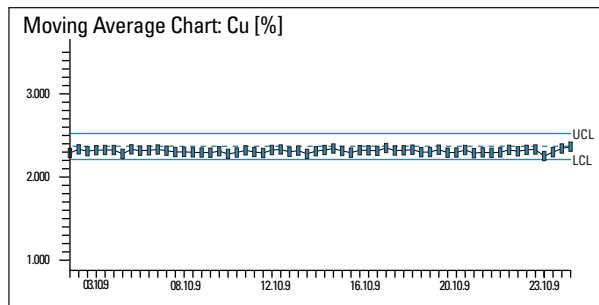
For each quality we use certified reference material as primary calibration samples and setting-up samples are delivered with the instrument to maintain the accuracy of the calibration.

The global calibration offers more than a sorting program in terms of accuracy and number of analyzed elements. It can also be considered as the basic low cost calibration of the instrument, allowing the analysis of unknown samples.

Stability

Stability of the instrument is of the utmost importance when doing routine analysis. Typical mid-term stability measured over 24 hours shows that the standard deviation achieved is below two times the precision value, which is excellent.

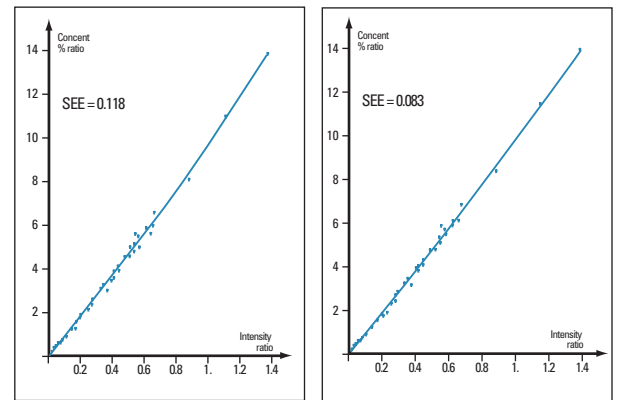
The example below shows the long term stability of two elements recorded over a period of more than 15 days without any intermediate drift correction. The values almost never went outside the control limits.



Accuracy

Precision is only a small part of providing accurate analyses. The most important factor is the accuracy and quality of the calibration standards. Next is the development of the calibration curve relative to a specific analytical task. Matrix matching and high energy pre-burn reduce or eliminate matrix effects, and spectral interferences are significantly reduced by applying appropriate corrections.

The two curves below show the influence of a silicon multiplicative correction on the calibration of copper. With this correction the Standard Error of the non-corrected value is reduced by one third.



Element: Cu9 510.55 x 1
without correction

Element: Cu9 510.55 x 1
with correction

The table below shows some key elements and illustrates the accuracy of the Thermo Scientific global factory calibration:

ELEMENT	CALIBRATION CURVE RANGE [%]	NR. OF STANDARDS USED (SEE)*[%]	STANDARD ERROR OF ESTIMATE
Si	0.001 - 23	60	0.170
Cu	0.0005 - 11.5	61	0.049
Fe	0.0005 - 1.2	61	0.031
Mg	0.0005 - 11	61	0.065
Ni	0.0005 - 2.8	60	0.046
Zn	0.0020 - 8	61	0.030

Table 1: ARL 3460 - Typical detection limits (3 sigma) and precision values (1 sigma) for aluminium base

ELEMENT	Ag	As	B	Be	Bi	Ca	Cd	Co	Cr	Cu	Fe	Ga	Hg	In	Li
TYPICAL DL [ppm]	0.02	2.7	0.1	0.005	0.5	0.05	0.25	0.2	0.2	0.1	0.8	0.2	0.5	0.5	0.01
GUARANTEED DL [ppm]	<0.04	<4.5	<0.25	<0.003	<1.2	<0.1	<0.5	<0.3	<0.3	<0.2	<1.7	<0.25	<0.8	<0.8	<0.02
Level [ppm]	SD	SD	SD	SD	SD	SD	SD	SD	SD	SD	SD	SD	SD	SD	SD
10	0.2	1.5	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	1	1	0.1
20	0.2	1.5	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.5	0.2	1	1	0.5
50	0.5	1.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	0.5	1	1	1
100	1	2	1	1	1	2	1	1	1	1	2	1	2	2	2
200	2	3	2	2	3	4	2	2	2	2	5	2	4	4	
500	5	5	5	5	7	10		5	5	5	7	5	7	7	
1000	10	10	10	10	10	20		10	10	10	15	10	10	10	
Level %															
0.2	0.0015							0.0015	0.0015	0.0025	0.0025				
0.3	0.004								0.0040	0.0030	0.004				
0.5										0.0040	0.006				
1.										0.0060	0.010				
2.										0.015	0.02				
3.										0.02					
4.										0.03					
5.										0.03					
10.										0.07					

ELEMENT	Mg	Mn	Na	Ni	P	Pb	Sb	Si	Sn	Sr	Ti	V	Zn	Zr
TYPICAL DL [PPM]	0.02	0.2	0.07	0.25	1.8	0.3	0.8	0.3	1.6	0.05	0.06	0.2	0.8	0.1
GUARANTEED DL [PPM]	<0.05	<0.4	<0.3	<0.6	<4	<0.6	<1.5	<0.7	<3.2	<0.08	<0.15	<0.3	<1.5	<0.2
Level [ppm]	SD	SD	SD	SD	SD	SD	SD	SD	SD	SD	SD	SD	SD	SD
10	0.2	0.2	0.1	0.1	1	0.5	1	0.2	0.2	0.1	0.25	0.5	1	0.2
20	0.5	0.5	0.2	0.2	1.2	0.5	1.2	0.2	0.25	0.2	0.5	0.5	1.2	0.2
50	0.5	0.5	0.5	0.5	1.5	1	2	0.5	0.5	0.5	1	0.8	2	0.5
100	1	1	1	1	2	2	3	1	1	1	2	1.3	3	1
200	2	2		2		5	4	3	3	2	4	2.6	4	2
500	5	5		5		8	8	7	7	5	10	5	8	5
1000	10	10		10		10	10	10	10	10	20	10	10	10
Level %														
0.2	0.0020	0.0012		0.002		0.002	0.004	0.0016	0.002		0.004		0.002	
0.3	0.0030	0.0020		0.003		0.003	0.006	0.002	0.003		0.006		0.004	
0.5	0.0045	0.0030		0.005		0.005		0.004	0.005				0.005	
1.	0.0060	0.006		0.01				0.006	0.012				0.006	
2.	0.015	0.012		0.02				0.016					0.012	
3.	0.025							0.02					0.02	
4.	0.03							0.025					0.03	
5.	0.03							0.03					0.03	
10.	0.09							0.04						
15.								0.07						

Remarks: This data applies when homogeneous samples are prepared by recommended sample preparation methods.
 For multibase instruments, some analytical performance may vary based on the analytical line selected.
 Guaranteed DLs are calculated at 95 % confidence limit.

Performance guarantee

Our company guarantees the values shown in Table 1 on previous page using homogeneous samples and recommended sample preparation methods. The precision is calculated from the formula:

$$SD (1s) = \pm \sqrt{\frac{\sum_{i=1}^{i=n} (X_i - \bar{X}_i)^2}{n - 1}}$$

where:

X_i the individual readings

\bar{X}_i the arithmetic means of the individual readings

n the number of determinations

The precision given is typical performance, guaranteed values will be 1.5 times higher. The precision is based upon 10 successive measurements. The DL (Detection Limit) is defined as three times the standard deviation in intensities at the lowest point multiplied by the slope of the curve at zero concentration measured on a pure aluminum sample. The lower limits of quantification (LLQ) are alloy dependent and are defined in the calibration menus.

The performance list will be updated as improvements are announced. Please contact your nearest Thermo Fisher Scientific representative or consult our web site at www.thermo.com/oes for the most recent values.

Conclusion

The ARL 3460 has all the total system features which meet the critical needs of the metals analysis markets:

- Unmatched hardware for stability and reliability
- Excellent performance in detection limits, precision, accuracy, stability and analysis time
- Most advanced software technology with HTML/Internet simple to use tools
- Easy operation by unskilled worker or research chemist
- Widest range of metals analysis
- Adaptable to the automatic Sample Manipulation System: ARL SMS-2000
- Advanced technical/service support
- Laboratory accreditation guidance
- Immediate access to parts inventory

All these features allow you to optimize your productivity and to achieve the shortest payback times:

- Your investment costs are reduced thanks to the exceptional and widely recognized instrument lifetime and to the continuous upgrade possibilities (software and hardware)
- Your production costs are reduced by the fact that more accurate and reproducible analyses are available faster
- Your production costs are reduced by the increased instrument availability thanks to its high stability and drift corrections being less frequently required
- Your operating and maintenance costs are reduced through low consumption of drift correction samples, and through simple maintenance
- Your overall cost management is reduced by optimum utilization of materials and extremely low running costs compared to other methods

With its over 70 years of experience and history of innovative technology, our company has become the world leader in OES metals analysis. We work with our customers to improve the efficiency of their analytical tasks and thereby increase productivity.

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

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