Application Note: 41205

Analysis of Zinc and its Alloys by Optical Emission

ARL 3460 Metals Analyzer

Key Words

- ARL 3460
- Metals Analyzer
- Optical Emission
- Zinc

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 zinc 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.

Zinc and its alloys

Zinc and zinc alloys are used in four main applications:

- Corrosion protection of steel (galvanization)
- In diecasting as injection of small and complicated mechanical parts with very high precision and high throughput
- Among zinc containing alloys, copper base alloys such as brasses are large zinc consumers
- Chemical applications present as zinc oxide such as rubber, paints, ceramics and as a plant nutrient in agriculture

Almost half of the zinc consumed in the world is used for corrosion-protection coatings on iron and low-alloy steels.

Zinc anodes are also used to provide galvanic sacrificial protection in water.

Zinc foundry alloys are more and more used in numerous applications. A majority of casting alloys are Zn-Al alloys (eutectic at 4 %Al). They can go up to 27 % Al for higher-strength applications.

Titanium (0.1-0.15 %) with a small amount of copper and manganese improves the quality of the zinc material. These alloys are used for sheets and strips in architectural and building applications.

Alloys containing zinc, like brass, nickel silver, aluminum brass are manufactured using pure zinc.

ARL 3460 Metals Analyzer

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 possible 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:

MATERIAL	ANALYSIS TIME
Pure zinc and zinc alloys	35 s

Thermo SCIENTIFIC

Factory calibration (CARL)

Thermo Scientific optical emission spectrometers can be factory calibrated for zinc 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 zinc and zinc alloys:

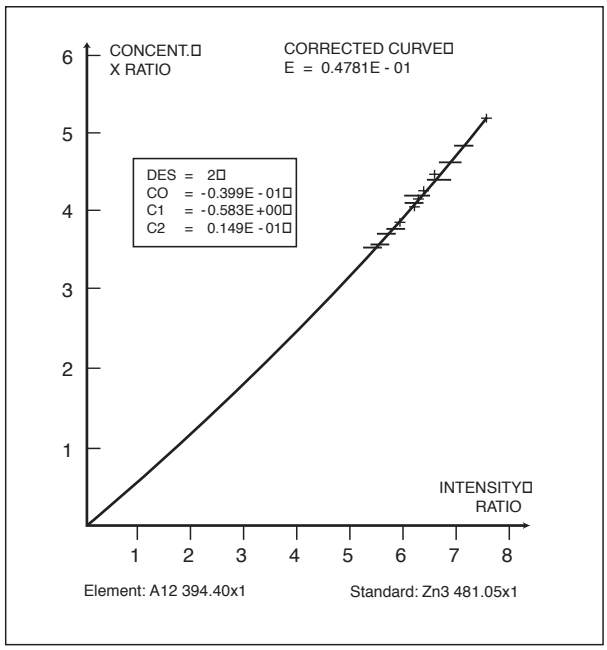
- Pure zinc
- Zn-Al (Al <4.7 %)
- Zn-Al-Cu (Al < 5.1 %; Cu <1.45 %)
- ZA8 - ZA12 (Al <13 %; Cu <3 %)
- ZA27 (Al <29 %; Cu 3 %)

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.

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 example shown below illustrates the significant improvement.



CARL calibration improvement

The table below shows some key elements and illustrates the accuracy of the Thermo Scientific factory calibration for a Zamak5 alloy:

El.	CALIBRATION CURVE RANGE [%]	NR. OF STANDARDS USED	STANDARD ERROR OF ESTIMATE SEE *[%]
Al	3.4 - 5.2	10	0.083
Cd	0.0001 - 0.03	10	0.00003
Cu	0.003 - 1.4	12	0.0149
Fe	0.0005 - 0.13	11	0.0029
Mg	0.0001 - 0.09	11	0.0017
Ni	0.0003 - 0.03	4	0.00002
Pb	0.0005 - 0.025	13	0.0003
Sn	0.0001 - 0.003	9	0.00013

CARL accuracy for a Zamak5 alloy

Performance guarantee

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

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

where:

X_i the individual readings

$\overline{X}_i$ 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 zinc 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.

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

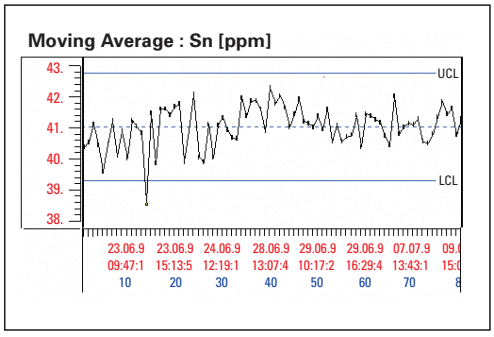
ELEMENT	Ag	Al	Cd	Cu	Fe	In	Mg	Mn	Ni	Pb	Sb	Si	Sn	Tl
TYPICAL DL [ppm]	**2**	**0.2**	**0.1**	**0.4**	**0.5**	**1.5**	**0.05**	**0.3**	**0.4**	**0.5**	**10**	**0.3**	**1.5**	**0.4**
GUARANTEED DL [ppm]	**≤ 4**	**≤ 0.5**	**≤ 0.3**	**≤ 1**	**≤ 1.5**	**≤ 2.5**	**≤ 0.1**	**≤ 0.8**	**≤ 1**	**≤ 1**	**≤ 20**	**≤ 1**	**≤ 3**	**≤ 0.6**
Level [ppm]	SD	SD	SD	SD	SD	SD	SD	SD	SD	SD	SD	SD	SD	SD
1			<0.1				<0.1							
2		0.3	<0.1				0.2	0.7						0.4
5		0.5	0.1	0.15	1		0.25	1	0.7	0.4		0.25		0.5
10	0.6	0.7	0.2	0.25	1.5	1	0.35	1.5	1	0.5		0.35	0.8	0.6
20	0.7	1.5	0.4	0.4	2	2	0.5	2	1.5	0.7		0.6	1.2	0.8
50	1	3	1	0.8	4	4	1	4	3	1.2	6	1.5	2.5	1.2
100	1.5	4	1.5	1.5	7	6	2	7	5	2	9	3	4	2
200		6	3	2.5	13	10	3	13	10	4	10		8	3
500		15	7	5	30	25	7		20	8	25		15	
1000		22		10	50	40	12		35	16	35		30	
Level %														
0.2		0.004		0.0015	0.01	0.008	0.002		0.006	0.003	0.005		0.0055	
0.5		0.01		0.0035	0.025	0.02			0.015	0.015	0.008		0.015	
1		0.015		0.0075	0.04						0.012		0.025	
2		0.025		0.015										
5		0.04		0.05										
10		0.06												
20		0.13												
30		0.22												

Remarks : This data applies when homogeneous samples are prepared by recommended sample preparation methods.
The precision given is typical performance. Guaranteed values will be 1.5 times higher.
For multibase instruments, some analytical performance may vary based on the analytical line selected.
Guaranteed DLs are calculated at 95% confidence limit.

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.

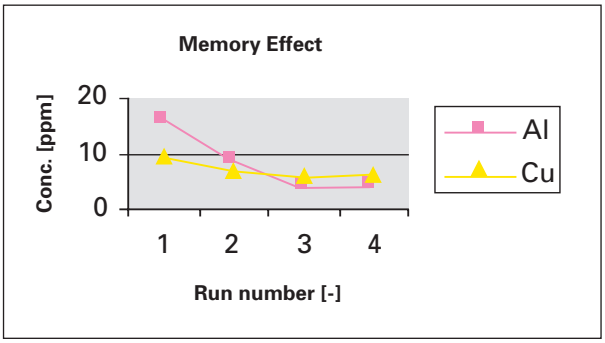
The example below shows the long term stability of one elements recorded over a period of 15 days without any intermediate drift correction. The values almost never went outside the control limits and no standardization was required.



Long term stability over a period of 15 days

Memory effects

There is almost no memory effect. For testing purposes, alloyed samples (one with 4 % Al, then another with 1 % Cu) were analyzed before a pure Zn sample. The levels of the pure Zn samples are obtained after 3 runs (figure 3).



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 continous 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 it's 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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