The Analysis of a Zinc-Based Alloy

Application Note

Atomic Absorption

Authors

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Introduction

Atomic absorption spectrophotometry has found wide application in the routine determination of both the major, as well as most of the minor, constituents of non-ferrous metal alloys.

The suitability of the technique for the analysis of non-ferrous alloys is reflected by the large number of publications [1-17].

A description is given here of a method employed at Agilent Technologies for the analysis of zinc, aluminium, copper, iron, lead, and tin in a zinc-based alloy.

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Experimental

Alloy Sample Solutions

Approximately 1 g of the alloy sample is weighed out accurately into an acid-cleaned, dry 200 mL conical flask and the alloy is reacted with 30 mL of 30% v/v hydrochloric acid.

After the reaction has almost stopped the mixture is gently heated and 5 mL of concentrated nitric acid are slowly added.

The clear sample solution is cooled and transferred to a standard volumetric flask and diluted to exactly 100 mL with distilled water.

Aliquots of this sample solution may be further diluted, if necessary, in order to bring each metal into the appropriate concentration range for measurement by atomic absorption spectrophotometry.

For example,

A 1% solution of an alloy containing approximately	will contain approximately
65% Zn	6,500 ppm Zn
30% Al	3,000 ppm Al
5% Cu	500 ppm Cu
1% Fe, Pb, Sn	100 ppm Fe, Pb, Sn

Standard Solutions

Composite standard solutions are prepared which contain all the elements that are present in the sample. The concentration range of the standards is made to cover the expected concentration of the metals in the sample solutions.

Notes on Individual Determinations

Zinc
The use of the most sensitive analytical line for zinc (0.01 ppm Zn/1% Absorption) at 2138.6 Å would require a 5,000-fold dilution of the sample solution. Such a large dilution could introduce serious errors and lead to poor accuracy in the results.

It is preferable to carry out the atomic absorption measurements at the much less sensitive (8,400X) resonance line at 3075.9 Å, using an air-C_2H_2 flame.

The recommended concentration range for the Zn standards is from 2,000-10,000 ppm.

Aluminium
For the determination of aluminium the sample is diluted approximately 30–50-fold and the atomic absorption measurements are carried out at the most sensitive Al resonance line, the 3092.7 Å, 3092.8 Å doublet, using a N_2O-C_2H_2 flame.

Aluminium standards are prepared in the range 20–150 ppm Al.

Copper
The determination of copper in an air-C_2H_2 flame can be carried out at a number of Cu resonance lines.

The use of the most sensitive line at 3247.5 Å (0.04 ppm Cu/1% Absorption) would require an approximately 100-fold dilution of the sample solution, with standards in the range 2–8 ppm Cu. If burner rotation is employed to reduce the sensitivity then such a large dilution may not be necessary.

Use may also be made of the line at 3275 Å (sensitivity 0.14 ppm Cu/1% Absorption). In this case a 40–50-fold dilution of the sample solution has to be carried out. Standards should be in the range 5–20 ppm Cu.

Other resonance lines of even lower sensitivity at 2492 Å and at 2178.9 Å may also be employed.

Iron
For an alloy containing 0.10% Fe no further dilution of the sample solution is required.

The atomic absorption measurements are made at the most sensitive line (0. 08 ppm Fe/1% Absorption) at 2483.3 Å using an air-C_2H_2 flame.

The recommended range of standards is from 2–10 ppm Fe.

Lead
An air-C_2H_2 flame is used, together with the most sensitive Pb line (0.16 ppm Pb/1% Absorption) at 2170.0 Å. The use of scale expansion may be required.

The recommended range of standards is from 1–20 ppm Pb.

For samples containing less than 20 ppm Pb it is recommended that larger weights of sample be employed, for example, 2–3 g alloy/100 mL, in order to improve the accuracy of the measurements.

Tin
The best sensitivity may be obtained at the 2246.1 Å Sn resonance line, using either an air-C_2H_2 or an air-H_2 flame (0.4 ppm Sn/1% Absorption). However, in these relatively cool flames chemical interference problems are often encountered.

In order to overcome or, at least minimize chemical interferences the much hotter, although less sensitive (2.0 ppm Sn/1% Absorption), N_2O-C_2H_2 flame may be employed.

For samples containing less than 0.05% Sn it is recommended that large weights of sample be used, for example. 2–3 g alloy/100 mL, together with scale expansion.

The recommended range of standards is from 5–30 ppm Sn.

Some Typical Results

Approximate composition		Agilent Technologies analysis	
Zn	65%	Zn	64.6%
Al	30%	Al	29.59%
Cu	5%	Cu	4.88%
Fe	1%	Fe	0.10%
Pb		Pb	20 ppm
Sn		Sn	0.03 ppm
			99.22%.

Conclusion

The routine analysis of such non-ferrous alloys by atomic absorption spectrophotometry is relatively simple and rapid using equipment which has scale expansion and burner rotation facilities.

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