Ultra-high speed analysis of soil extracts using an Advanced Valve System installed on an Agilent 5110 SVDV ICP-OES

Application note

Food safety and agriculture

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Introduction

Laboratories are constantly looking to improve productivity and reduce operating costs by increasing sample throughput and minimizing overheads. Agricultural labs typically deal with high quantities of samples, however, higher analysis speeds normally create some sort of analytical compromise, such as reduced precision.

The Agilent 5110 ICP-OES, combined with the fully integrated Advanced Valve System (AVS) [1], does not compromise speed or precision. It is designed to deliver faster, cost effective and simpler sample analysis and is ideal for high throughput labs.

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The AVS combined with the 5110's Synchronous Vertical Dual View (SVDV) capability and Vista chip II detector covering all wavelengths in a single reading, allows the analysis of samples at ultra-high speeds, without compromising performance. This high speed sample throughput equates to a low cost-per-analysis, as shorter analysis times per sample results in less argon usage.

The Agilent Advanced Valve System (AVS 6/7) provides:

- Ease-of-use: the AVS is easy to setup and use as it is fully integrated within the ICP-OES hardware and controlled through the ICP Expert software. The ICP Expert software incorporates an AVS parameter calculator to assist with setup and method development. The AVS is designed for simple assembly and disassembly, facilitating simple routine maintenance, maximizing instrument up time.
- Uncompromising performance: Controlled bubble injection reduces sample uptake, stabilization times, and rinse delays to deliver the highest analytical precision.
- Speed: The robust high speed positive displacement pump also decreases uptake time, ensuring the sample loop can be filled quickly and effectively. A pre-emptive rinse means the autosampler probe moves while the loop is still filling. This starts autosampler probe rinse and valve rinse before the sample is even injected and decreases the total run time.

This application note describes the ultra-high speed analysis of micronutrients Cu, Fe, Mn, Zn, Co, Ni and heavy metals Cd and Pb in a DTPA extracted soil sample using the Agilent 5110 Synchronous Vertical Dual View (SVDV) ICP-OES fitted with an integrated Advanced Valve System (AVS 6) six port switching valve, based on another 5110 ICP-OES DTPA application method [2].

Experimental

Instrumentation

All measurements were performed using an Agilent 5110 SVDV ICP-OES fitted with an AVS 6 port valve and configured with an SPS 4 autosampler. The sample introduction system consisted of a SeaSpray nebulizer, double-pass cyclonic spray chamber and a 1.8 mm i.d injector torch. Tables 1 and 2 list the operating conditions used for the ICP-OES and the AVS 6 (Figure 1).

Figure 1. The Agilent Advanced Valve System (AVS) six port valve

Table 1. Agilent 5110 SVDV ICP-OES instrument and method parameters

Parameter	Setting
Replicates	1
Pump speed	25 rpm
Read time	1 s
Rinse time	0 s
RF power	1.20 kW
Stabilization time	2 s
Viewing mode	SVDV
Viewing height	8 mm
Nebulizer flow	0.70 L/min
Plasma flow	12.0 L/min
Aux flow	1.0 L/min
SPS 4 autosampler rinse pump control speed	Fast

Table 2. Agilent AVS 6 settings

Parameter	Setting
Loop volume	0.25 mL
Pump rate: Valve uptake	40 mL/min
Pump rate: Inject	28 mL/min
Valve uptake delay	2.6 s
Bubble injection time	2.6 s
Preemptive rinse time	1.0 s

Sample preparation

The procedure used to prepare the soil samples for analysis is typical for DTPA extraction and is described in a previous study [2].

Results and discussion

Stability

The stability of the Agilent 5110 SVDV ICP-OES with integrated AVS 6 and SPS 4 autosampler was evaluated by analyzing a DTPA soil extract solution 120 times. Good precision was obtained, with all elements achieving < 3.4 %RSD over the duration of the run (Table 3 and Figure 2).

Table 3. Precision data for the repeated (n=120) measurement of 8 elements in a soil extract

Results	Cd 214.439 nm	Co 228.615 nm	Cu 324.754 nm	Fe 234.350 nm	Mn 293.305 nm	Ni 231.604 nm	Pb 220.353 nm	Zn 213.857 nm
Mean (mg/L)	0.021	0.135	1.29	18.6	1.42	0.175	0.811	0.254
%RSD	3.06	2.35	2.27	1.70	2.03	3.36	3.06	1.94

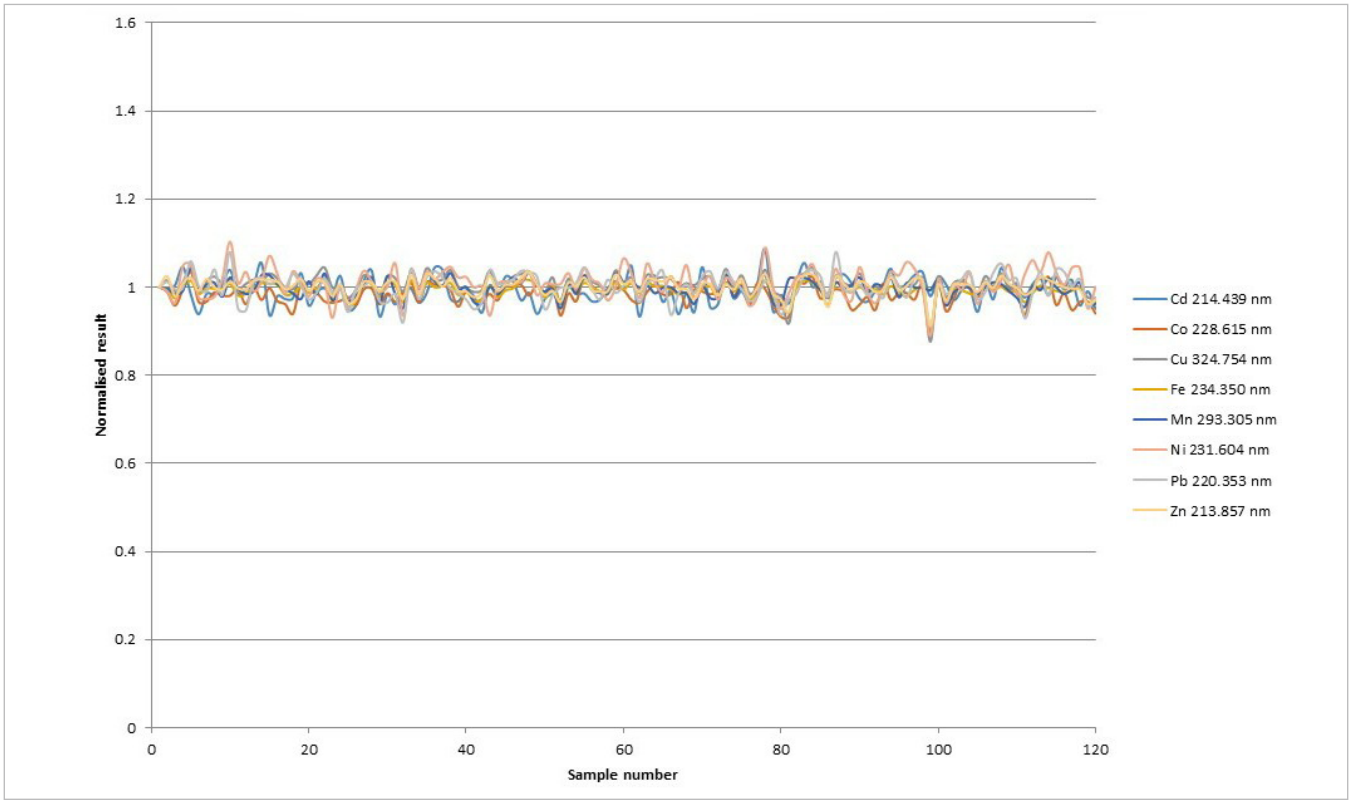

Figure 2. Stability plot from the repeated (n=120) measurement of 8 elements in a DTPA soil extract using a 5110 SVDV ICP-OES with AVS 6

Sample time and argon usage
The 5110 with AVS 6 analyzed 120 samples and 6 standards in under 25 minutes. This equates to an average sample-to-sample run time of 11.7 seconds and an Ar consumption of only 3.4 L. Since only 1 mL of sample was used, the need for multiple extractions was avoided. This is ideal for hydroscopic soil samples, which supply very little extract. Furthermore, such efficient analysis of complex matrices extends the life of consumable items, further reducing operating costs.

Conclusions

Agilent's 5110 SVDV ICP-OES with its vertical torch not only provides the robustness required for the determination of DTPA extracted soil samples over long sampling periods but delivers exceptionally fast analysis times, without any compromise in analytical performance.

When fitted with a fully integrated AVS and the use of an SPS 4 autosampler the 5110 was able to achieve:

- Very fast analysis times with an average of 11.7 seconds per sample.
- Excellent precision with < 3.4 % RSD for all elements over the duration of a 120 sample analytical run.
- Very low Ar consumption of < 3.4 L/sample.

By significantly improving sample analysis times, the 5110 SVDV ICP-OES fitted with AVS and SPS 4 autosampler cuts the cost-per-analysis which is an important consideration of high throughput labs.

References

1. AVS technical overview, Agilent publication, 2016, 5991-6863EN

2. Elizabeth Kulikov, Determination of elemental nutrients in DTPA extracted soil using the Agilent 5110 SVDV ICP-OES, Agilent publication, 2016, 55991-6854EN

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