Increase productivity for environmental sample analysis using the SVS 2+ Switching Valve System for Agilent 5100 SVDV ICP-OES

Technical Overview

Achieve higher productivity

Laboratories that work to standard or regulatory guidelines for the analysis of trace metals in environmental samples by ICP-OES typically test large numbers of samples on a daily basis. The Agilent SVS 2+ is an innovative switching valve system that is positioned between the spray chamber and the peristaltic pump (or autosampler) of the spectrometer. The SVS 2+ is configured to increase ICP-OES sample throughput and decrease sample turnaround time, reducing operating costs in high-throughput labs.

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The SVS 2+ switching valve system provides:

- Fast, accurate results—the SVS 2+ immediately rinses the sample introduction system while the next sample is presented to the instrument. Introduction of excess sample into the spraychamber is eliminated, reducing sample carry-over.
- Higher productivity—combined with Agilent's fast autosampler, the SPS 4 Sample Preparation System, productivity is more than doubled.
- Time savings—the SVS 2+ is compatible with other high capacity autosamplers, each holding up to 700 samples, for overnight operation.
- Reduced costs—shorter analysis times per sample requires less argon usage. More efficient handling of complex sample matrices extends the life-time of consumable items further reducing operating costs.
- Extended torch lifetime—the SVS 2+ limits the amount of sample that reaches the torch, reducing torch degradation.
- Robustness—the SVS 2+ is ideal for challenging sample matrices. The metal-free liquid flow path is suitable for samples containing strong acids such as hydrofluoric acid, organic solvents and high levels of dissolved solids.

The SVS 2+ is compatible with the Agilent 5100 Synchronous Vertical Dual View (SVDV) ICP-OES [1]. The SVS 2+ more than doubles the productivity of the 5100 making it the most productive commercially available ICP-OES and is highly cost-effective for high throughput laboratories.

Performance characteristics

Long term stability

An Agilent 5100 SVDV ICP-OES using a vertical torch with axial and radial pre-optics enables the analyst to measure complex samples such as environmental samples with good long term stability. Stability over a long sampling period means that costly quality control (QC) failures and reruns can be minimized, leading to an increase in productivity.

The long term stability plot shown in Figure 1 was determined by analyzing a sludge Standard Reference Material (SRM) WEPAL-ISE 859 every 10 samples for eight hours. The measured concentration of each element in the sample solution must be within ±10% of the certified true value, as the sample result trends are a measure of the stability of the instrument. The 5100 SVDV ICP-OES shows excellent stability over eight hours with recovery for all elements within 10% of the certified true value. Figure 1 shows that conditions remain stable over the duration of the eight hour period. The precision for all 31 elements was between 0.5 to 2% RSD variation. Less than 6% deviation was obtained for most of the elements. This demonstrates the robust sample handling capability of the vertically-oriented plasma.

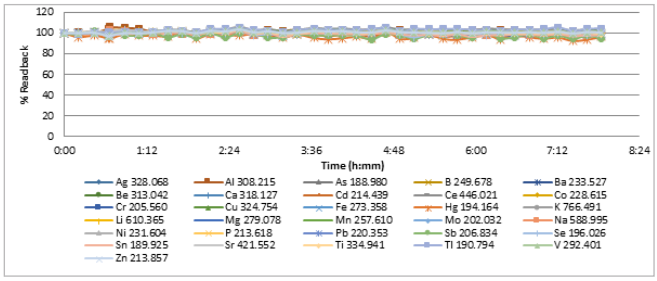


Figure 1. Stability test over 8 hours for 31 elements in a sludge SRM sample

Reduced sample-to-sample cycle times

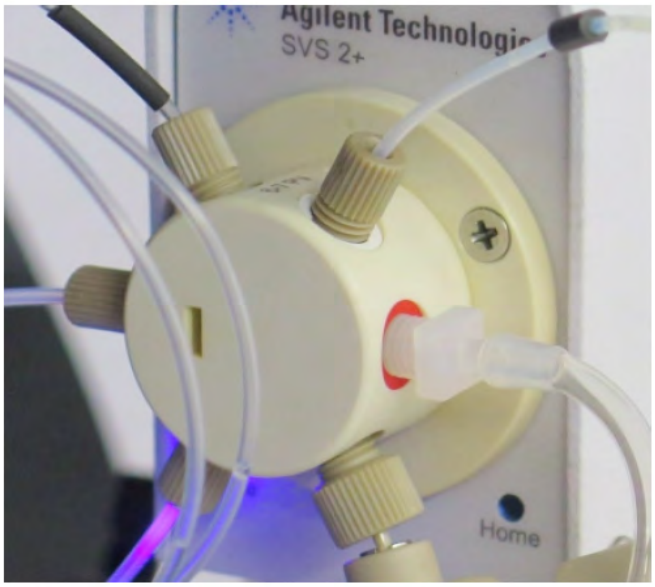


Figure 2. Agilent SVS 2+ Switching Valve System showing the 7 port switching valve (6 ports plus a slot for a T-connector).

The SVS 2+ Switching Valve System has a 7 port switching valve (Figure 2) that more than doubles the productivity of the 5100 ICP-OES by reducing sample uptake, stabilization times, and rinse delays.

The SVS 2+ includes a positive displacement pump that can reach up to 500 rpm and rapidly pumps sample through the sample loop, while at the same time rinses the sample introduction system.

The SVS 2+ also features an internal T-piece within the valve, reducing dead volume and providing online addition of internal standard solutions. A bubble injector automatically injects bubbles after the sample is loaded into the loop, isolating the sample from the rinse solution. This reduces the volume of sample required for measurement, as tailing (or dilution) effects are minimized. Combined, these features provide the additional benefits of faster stabilization of the analyte signal prior to measurement, and reduced washout times.

High-throughput laboratories typically measure more than 30 elements per sample and analyze, hundreds, even thousands of samples every day. Table 1 shows the comparison between SVDV and VDV operating mode with and without the SVS 2+ switching valve and SPS 4 autosampler. Typical sample-to-sample measurement time is greatly reduced using the 5100 SVDV ICP-OES

Table 1. Typical operating parameters for high-throughput analysis without and with the SVS 2+ and SPS 4 autosampler

	5100 ICP-OES without the SVS 2+ and SPS 4		**5100 ICP-OES with the SVS 2+ and SPS 4**	
	SVDV	VDV	SVDV	VDV
Operation	Time (s)		Time (s)	
Move autosampler probe to sample	3	3	3	3
Sample uptake/loading delay	15	15	0	0
Instrument stabilization delay	10	10	10	10
Sample measurement time	40	60	40	60
Move autosampler probe to rinse	3	3	-	-
Autosampler probe rinse time	30	30	0	0
Instrument delay	4	9	4	9
Total time	105	130	57	82
Analysis time saving:				
SVDV with SVS 2+ vs SVDV	48			
SVDV vs VDV	25			
SVDV with SVS 2+ vs VDV	73			

with a SVS 2+ and a SPS 4 autosampler, compared to more conventional VDV ICP-OES. A reduction of 73 seconds in analysis time makes it possible to analyze a sample every 57 seconds, or 505 samples over an 8 hour day.

Figure 3 shows the improved productivity of the Agilent 5100 SVDV ICP-OES when coupled with the SPS 4 autosampler and SVS 2+ accessory.

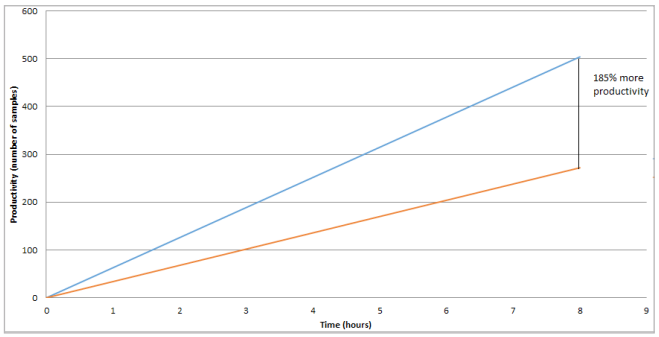


Figure 3. Productivity of the Agilent 5100 SVDV ICP-OES with (blue line) and without (orange line) the SPS 4 autosampler and SVS 2+ valve accessory.

SVS 2+ productivity gains

In order to compare the sample uptake, measurement, and rinse profiles with and without an SVS 2+ valve system coupled to an ICP-OES, a 100 mg/L manganese solution was analyzed. Typical timelines are shown in Figure 4. The profiles show a dramatic increase in productivity with the SVS 2+ valve system in place, while maintaining consistent data quality.

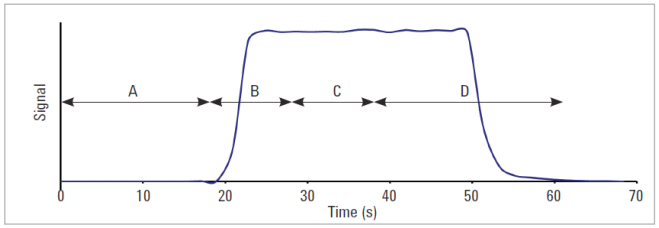
Modes of operation

The SVS 2+ switching valve system has two software triggered valve positions:

1. The first position allows the sample to be quickly loaded into a sample loop using a positive displacement pump operating up to 500 rpm. The sample is loaded and is ready to be aspirated into the plasma for measurement.

2. The controlling software then triggers the valve to switch and inject the sample into the ICP-OES.

ICP-OES analytical timeline without SVS 2+



ICP-OES analytical timeline with SVS 2+

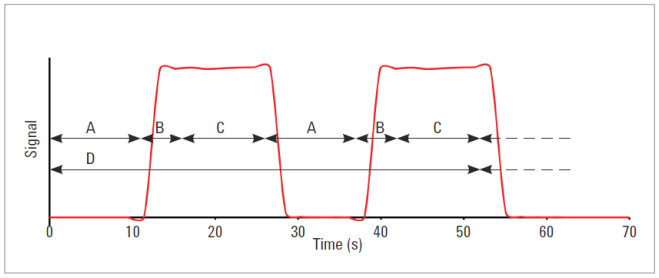


Figure 4. Comparison of the sample uptake, measurement, and rinse profiles of 100 mg/L Mn without an SVS 2+ (top, 61 seconds) and with the SVS 2+ (bottom, 28 seconds). Timeline positions are: A: Sample uptake; B: Stabilization; C: Measurement; and D: Rinsing.

In a typical ICP-OES analysis without an SVS 2+, the sample is fast-pumped into the plasma, the pump speed is then reduced to normal speed for the duration of the measurement. To allow the plasma to re-equilibrate at normal pump speed, a stabilization time of 10-15 s is required prior to measurement. However, fast pumping samples is not normally used with a switching valve system due to destabilization of the plasma caused by changes in sample flow from high to low which may result in an unstable signal. Using the SVS 2+ the flow of solution into the plasma remains constant. A positive displacement pump operating at high speed is used to fill the sample loop while the sample loop is disconnected from the plasma resulting in a continuous flow of solution through the nebulizer. This ensures better plasma stability and allows much shorter stabilization delays to be used. The addition of a 3 second rinse time with fast pump (optional) is sometimes required if high levels of adsorbing elements, such as boron, magnesium, manganese, and molybdenum, are present in the sample.

When using a SVS 2+ you can use a reduced uptake delay, stabilization delay or combination of the two. Ten seconds is usually sufficient to load the sample loop, inject the sample into the plasma and achieve a stable signal (typical operating conditions used for the SVS 2+ are listed in Table 1). Conventional ICP-OES systems operating without the SVS 2+ would typically require an additional 25 seconds to perform the same function. Also, as the sample does not make contact with peristaltic pump tubing prior to being aspirated into the plasma using the SVS 2+, this results in reduced sample carryover.

Summary

For laboratories looking to maximize the productivity of ICP-OES analysis, the Agilent 5100 ICP-OES coupled to the innovative SVS 2+ switching valve delivers exceptional sample throughput and the lowest gas consumption per sample of any ICP-OES, while ensuring consistent and reproducible results.

Using a Agilent SVS 2+ switching valve with an Agilent 5100 SVDV ICP-OES and Agilent SPS 4 autosampler reduces sample analysis time by 48 s—from 105 s per sample without the SVS 2+ to 57 s with the SVS 2+. This 185% productivity gain is achieved without compromising accuracy, precision or stability.

References

1. Synchronous Vertical Dual View (SVDV) for superior speed and performance, Agilent publication 2014, 5991-4853EN

2. High throughput, low cost analysis of environmental samples according to US EPA 6010C using the Agilent 5100 SVDV ICP-OES, Agilent publication 2015, 5991-5921EN

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