Synchronous Vertical Dual View (SVDV) for superior speed and performance

Technical Overview

5100 ICP-OES

What is Synchronous Vertical Dual View (SVDV)?

The Agilent 5100 ICP-OES revolutionizes ICP-OES analysis. It is designed to run your samples faster, using less gas, without compromising performance on your toughest samples. The 5100 SVDV features unique Dichroic Spectral Combiner (DSC) technology that selects and combines axial and radial light from a robust vertical plasma, in a single measurement covering the entire wavelength range. This capability, together with the high speed VistaChip II CCD detector and the innovative SVS 2+ switching valve, provides the fastest sample throughput and the lowest gas consumption per sample of any ICP-OES. Additional technologies such as the vertical torch with axial viewing and Cooled Cone Interface (CCI) also contribute to the 5100's ability to analyze high % Total Dissolved Solids (TDS) samples and an excellent linear dynamic range. Both of these performance benefits minimize the need for additional sample dilutions or multiple readings of the same sample, further improving sample throughput.

Both axial and radial views of the plasma in a single measurement

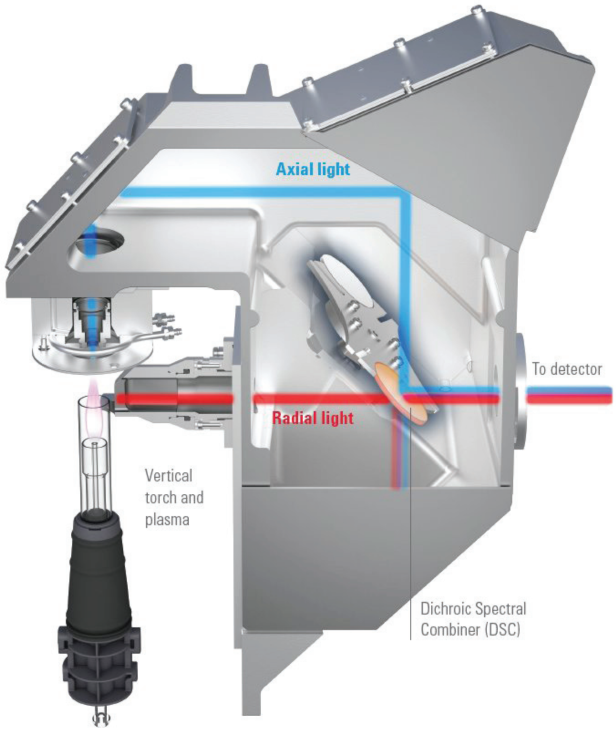

Figure 1. Schematic showing the emission from axial and radial plasma views synchronously converging onto the DSC with the combined emissions being transmitted into the polychromator optics.

Conventional Dual View (DV) ICP-OES instruments have forced users to make compromises, particularly in terms of robustness and speed. Most conventional dual view systems use a horizontal torch, rather than the more robust vertical torch orientation. This compromises torch lifetime, and also limits the matrix handling capability of the system. Speed is compromised due to the need to measure radial and axial views sequentially. The innovative design of the Agilent 5100 SVDV ICP-OES with DSC technology results in superior speed and performance compared to conventional DV ICP-OES instruments, by eliminating these 2 compromises.

The pre-optics of the 5100 SVDV enable both axial light (emissions from the central channel of the plasma) and radial light (emissions from a small section taken from the side of the plasma) to converge to a single point.

When the unique DSC component (Figure 1) is placed at the convergence of both paths of emitted light, a combination of axial and radial emissions of light are synchronously directed into the optics of the 5100 SVDV. Being able to read both the axial and radial light at the same time reduces sample-to-sample analysis time and ensures that the amount of argon consumed per sample is the lowest of any modern simultaneous ICP-OES.

In contrast, conventional 'simultaneous' DV instruments are compromised in the sample throughput they can achieve as they need to read axial and radial emissions sequentially. In the same method, the user nominates which elements and wavelengths are to be read axially and which elements and wavelengths are to be read radially. Consequently, two discrete readings of the same sample are required. Depending on the design of the conventional simultaneous DV instrument, it may be necessary to read the same sample up to four times for a complete analysis. For a benchmarked analysis like US EPA 200.7, where instrument performance is mandated, using similar sample introduction components, the Agilent 5100 SVDV ICP-OES is typically more than twice as fast and consumes half the volume of argon gas per sample compared to conventional 'simultaneous' DV instrumentation. Thanks to the superior optical design and custom VistaChip II CCD detector used on all 5100 configurations, the 5100 Vertical Dual View (VDV) configuration (and VDV operational mode) also consumes 30% less gas per sample compared to other 'conventional' DV systems.

The DSC component has been designed to enable specific wavelengths of light to be reflected and transmitted into the echelle based polychromator. This allows the wavelengths of elements at trace levels, like toxic elements, to be measured axially, while the wavelengths of elements that are typically present at elevated concentrations, like nutrient elements, are measured radially. Unwanted wavelengths of light are transmitted or reflected away, and do not enter the polychromator.

The unique features of the DSC ensure that the 5100 ICP-OES is ideally suited for the analysis of environmental samples, and food and agriculture samples, which typically contain elements like Na and K at elevated ppm levels and elements such as As, Cd, Pb and Se at trace ppb levels. All of these elements can be analyzed in a single measurement.

Typical performance

Linear dynamic range

The 5100 SVDV ICP-OES exhibits exceptional Linear Dynamic Range (LDR) for elements that normally suffer from Easily Ionized Element (EIE) interferences. Elements such as Na and K fall into this category.

Ionization interferences result from the presence of high concentrations of EIEs in samples, especially the common alkali elements, K and Na and, to a lesser extent, the alkaline earth elements, Ca and Mg. These elements have low ionization energies and are easily ionized in the plasma. If these elements are present at sufficiently high concentrations, the electron density within the plasma is increased to a level where the atomization – ionization equilibrium of other elements is affected. The effect EIEs have when present in samples at increasingly higher concentrations is either enhancement or suppression of the emission signal, resulting in the reporting of either false high or false low element concentrations.

Dedicated radial view instruments are largely able to avoid EIE interferences as the viewing height can be optimized to measure emissions in a part of the plasma where the alkali metals are less ionized, thus minimizing the suppression or enhancement effect.

Typically, conventional simultaneous DV instruments read EIE elements in radial view and trace elements in axial view, thereby taking two or more sequential measurements of the sample for a complete analysis of all elements. Using the DSC on the Agilent 5100 SVDV ICP-OES to measure both axial and radial light in one reading, means that elements which can suffer from EIE interferences can be measured radially while trace elements are being measured axially. This enables the elimination of EIE interferences for nutrient elements like Na and K, and at the same time, enables trace elements like As, Se, Cd and Pb to be determined, with no time penalty, low argon consumption per sample, accurate and precise data and an exceptional LDR (Figure 2).

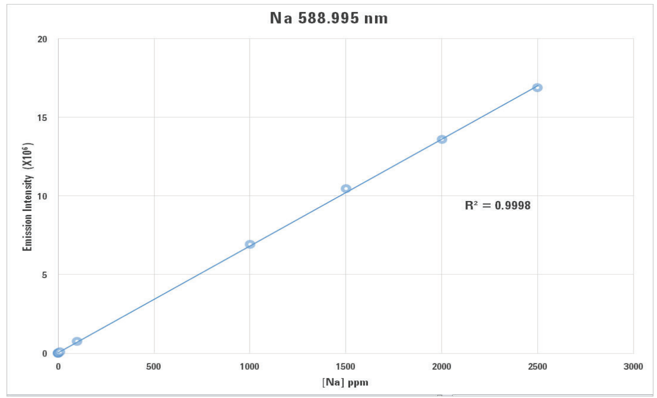

Figure 2. Na 589.995 nm, 0.1 - 2500 ppm Linear Dynamic Range when measured in SVDV mode.

An experiment to demonstrate this point has been performed and the resulting application note has been published (pn: 5991-4868EN, Analysis of animal food products using the Agilent 5100 SVDV ICP-OES). This application note shows very good high concentration recovery of Na and K and excellent recoveries on trace level analytes from a single analysis. A summary of the experimental results is shown in Table 1.

Table 1. Abbreviated data from Agilent application note 5991-4868EN. Recovery of major and minor elements in NIST Bovine Liver 1577 SRM, after microwave acid digestion.

Element	Certified value (mg/kg)	Measured value (mg/kg)	% Recovery
K 766	9700	9832	101
Na 589	2430	2410	99
Mn 257	10.3	9.8	96
Cd 228	0.27	0.26	96

Flexible modes of operation

For maximum flexibility and application coverage, the 5100 SVDV configuration with DSC technology is able to operate in four different modes (note, all 5100 configurations and operational modes use a robust vertical torch). The mode selector (Figure 3) positions the relevant optical component into the light path to enable the four modes:

- Synchronous Vertical Dual View (SVDV):
  Mode selector = DSC, enables axial and radial synchronously
- Vertical Dual View (VDV):
  Mode selector = Mirror/'Hole', enables axial and radial sequentially
- Dedicated Radial View (RV):
  Mode selector = 'Hole', enables radial only
- Dedicated Axial View (AV):
  Mode selector = Mirror, enables axial only

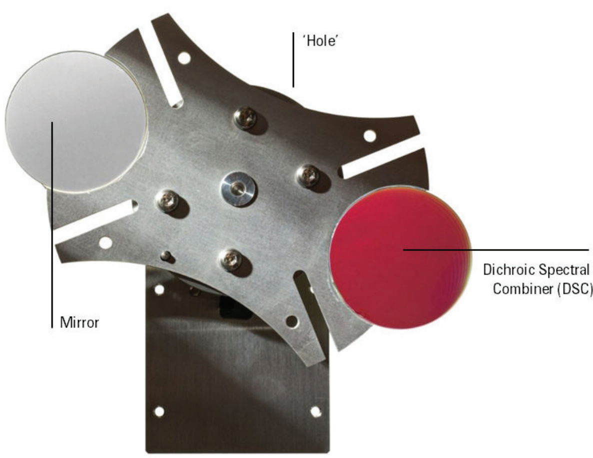

Figure 3. The mode selector component that enables the four modes of operation in the 5100 SVDV configuration.

Using a vertical torch with end-on (axial) and side-on (radial) pre-optics enables high total dissolved solids level samples to be analyzed all at the same time, while achieving ppb level sensitivity. This inherent capability enables laboratories to ensure future analysis requirements are covered in the one instrument.

Summary

ICP-OES is a mature technology that has been used for the elemental analysis of a wide range of sample types for more than 25 years. In recent times, ICP-OES operators have faced a choice of using a horizontal plasma for sensitivity or a vertical plasma to manage higher concentrations and complex sample matrices. A hybrid technology of 'simultaneous' DV ICP-OES instrumentation based on a horizontal torch has attempted to address this dilemma, but analytical compromise in the form of an inability to run elevated %TDS and the need to read the same sample multiple times, makes this a slow and expensive analysis choice.

The Agilent 5100 SVDV ICP-OES alleviates the need for compromise. DSC technology allows the 5100 to run axial and radial view analysis at the same time. This results in fast analysis times and reduced argon gas consumption plus higher precision as all wavelengths are measured in one reading. The vertical torch orientation used in the 5100 provides a high level of robustness allowing analysts to measure complex samples, including high %TDS samples as well as volatile organic solvents, with good long-term stability, while providing the sensitivity associated with axial mode on a horizontal plasma.

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