

Flexible sample introduction with the Multimode Sample Introduction System

Technical Overview



Minimize the downtime associated with hydride/non-hydride change-overs

Agilent's Multimode Sample Introduction System (MSIS) is an innovative accessory for ICP-OES and MP-AES that allows sample introduction via either vapor generation or nebulization modes, or both modes at the same time. It eliminates the need to swap between a standard spraychamber and a dedicated vapor generation accessory, saving you setup and analysis time and thus keeping your lab as productive as possible.

The MSIS is compatible with current and previous Agilent ICP-OES and MP-AES instruments.



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Key benefits

The MSIS:

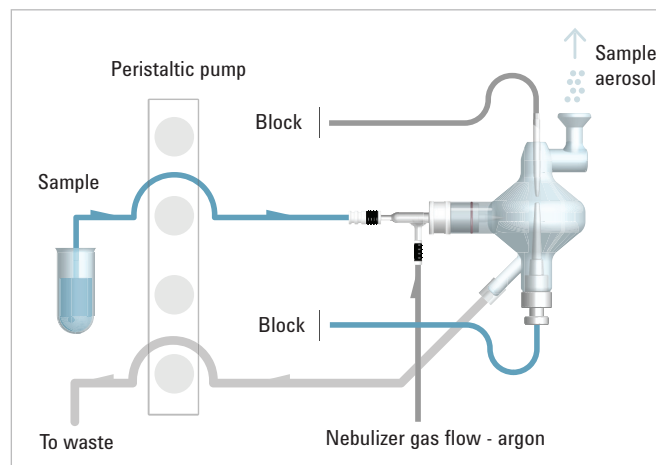
- Allows the analyst to quickly switch between conventional nebulization and vapor generation or measure both modes at the same time
- Removes the need to turn off the plasma and change the sample introduction system, and then re-analyze samples, usually after a different pretreatment. This is an enormous time saver if both hydride and non-hydride elements frequently need to be measured
- Offers similar detection limits to both conventional nebulization for non-hydride elements and conventional vapor generation for hydride elements
- Demonstrates excellent calibration linearity, allowing the measurement of concentrations up to 1000 µg/L with ICP-OES

Modes of operation

The MSIS allows three modes of operation: conventional nebulization, vapor generation and dual mode. The following describes the MSIS operation modes for ICP-OES. Operation of the MSIS on MP-AES is identical, but nitrogen is used as the nebulizer gas.

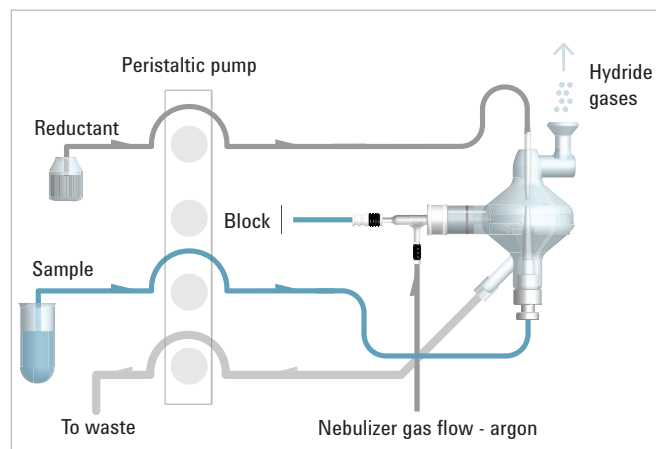
Conventional Nebulization mode

In this mode, the reductant tubing and the hydride sample tubing are blocked. As with normal ICP-OES operation, the sample aerosol is carried by argon gas into the plasma for analysis.



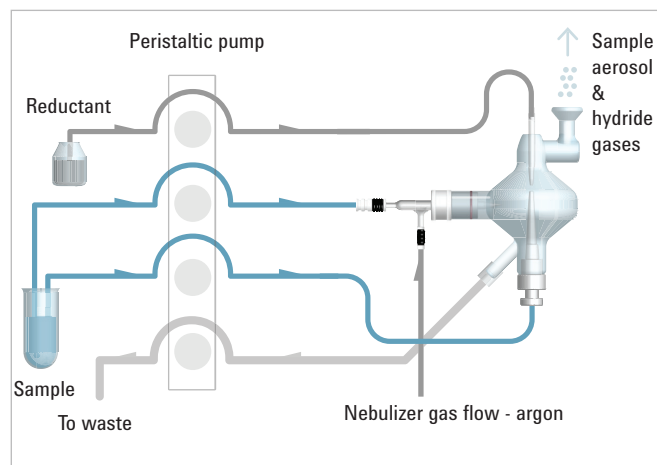
Vapor Generation mode

In this mode, the sample tubing to the nebulizer is blocked and the sample is pumped into the bottom of the spraychamber. The reductant is pumped into the top of the spraychamber and hydride generation occurs. The resulting gaseous hydride is then carried by the argon gas from the nebulizer into the plasma for analysis.



Dual mode

In this mode, all tubing is left unblocked and both the sample aerosol and the gaseous hydride are carried into the plasma by argon gas. This allows the simultaneous analysis of both hydride elements e.g. As, Hg, Se and Sn and conventional elements e.g. Cd, Co, Cr, Fe.



Performance characteristics

Detection limits

The analysis of hydride elements is sensitive to the chemistry employed for the hydride generation—particularly the acid concentration. Table 1 shows the detection limits achieved on ICP-OES when measuring five hydride elements using the MSIS in Vapor Generation mode and Dual mode, with different acid concentrations.

It is clear that in general, the optimum chemistry conditions for each hydride element gives the lowest detection limit. Detection limits achieved for the same elements when analyzed together under two compromising chemistry conditions (50% HCl or 4% HCl and 1% L-Cysteine) are comparable to those achieved under optimum conditions. This shows that it is possible to achieve highly sensitive and accurate single and multi-element hydride analysis using the MSIS with correct acid matrix selection.

Table 1. Comparison of Detection Limits for hydride elements when using different chemistries. All measurements performed on an Agilent SVDV ICP-OES, fitted with the MSIS.

MSIS Mode	Vapor generation mode (single element) (µg/L)	Vapor generation mode (multi-element) (µg/L)	Hydride mode (multi-element) (µg/L)	Dual-mode (µg/L)	Dual-mode (µg/L)
Element & wavelength	Optimum chemistry	50 % HCl	4% HCl + 1% L-Cysteine	50% HCl	4% HCl + 1% L-Cysteine
As 188.980 nm	0.14 (1 % L-Cysteine in 2.5 % HCl)	0.2	0.25	0.23	0.4
Hg 193.164 nm	0.073 (5 % HCl + 5 % HNO ₃)	0.07	0.086	0.037	0.051
Sb 206.834 nm	0.12 (1% L-Cysteine in 5 % HCl)	1.4	0.13	0.7	0.075
Se 196.026 nm	0.2 (50 % HCl)	0.16	0.8	0.1	2.5
Sn 189.925 nm	0.35 (3 % HCl)	1.6	0.1	1.5	0.29

Table 2 shows the detection limits achieved for non-hydride elements under the same two chemistry conditions, using an Agilent SVDV ICP-OES with the MSIS in Dual mode. Excellent detection limits were achieved and the acid concentration was found to have little impact on the analysis of the non-hydride elements, as the MSIS detection limits were similar to those achieved using a standard sample introduction system for most elements. This shows the ability of the MSIS to measure both hydride and non-hydride elements at the same time.

Table 2. Detection Limits for non-hydride elements using the MSIS in Dual mode, with two different chemistries. All measurements performed on an Agilent SVDV ICP-OES.

Element & wavelength	50% HCl (µg/L)	4% HCl and 1% L-Cysteine (µg/L)
Cd 214.439 nm	0.24	0.22
Co 238.892 nm	0.51	0.51
Cr 267.716 nm	0.36	0.32
Cu 327.395 nm	1.7	0.33
Fe 259.940 nm	0.66	0.52
Mn 257.610 nm	0.069	0.056
Mo 202.032 nm	0.66	0.64
Ni 231.604 nm	1.2	1.0
P 213.618 nm	4.6	4.1
Pb 220.353 nm	2.4	2.7
Zn 213.857 nm	0.36	0.25

Linearity

All hydride elements showed excellent linearity up to 1000 µg/L on ICP-OES, well above the standard calibration range used for routine hydride analysis. Figure 1 shows the calibration curve for Hg (194.164 nm), using the MSIS in Vapor generation mode. This is indicative of the calibration graphs for each of the other hydride elements.

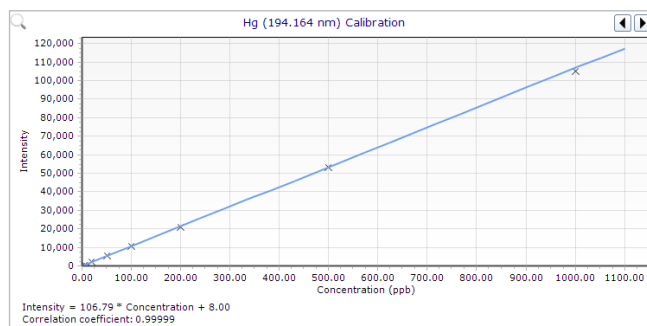


Figure 1. Calibration curve of Hg 194.164 nm, using an Agilent SVDV ICP-OES with the MSIS in Vapor generation mode.

More information

Further information is available in Agilent's White paper: Simultaneous analysis of hydride and non-hydride-forming elements via ICP-OES, Agilent publication number 5991-6445EN.

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