

Improved Detection for Axial-Viewing Inductively Coupled Plasma- Atomic Emission Spectrometry (ICP-AES) with the CETAC Marin-5 Enhanced Nebulizer System

INTRODUCTION

Contemporary axial-viewing ICP-AES instruments enable rapid trace level detection (ppb and sub-ppb) for most elements. Conventional pneumatic nebulizers used with most ICP-AES instruments are only 2% to 3% efficient, so detection of difficult elements such as As, Pb, Sb, Se, and Tl may require signal enhancement.

The coupling of a contemporary axial-viewing ICP-AES instrument with the CETAC Marin-5 Enhanced Nebulizer System can help lower detection limits by up to a factor of 5 or more. The Marin-5 uses a conventional concentric nebulizer and a heated spray chamber / desolvation system to enhance analyte transport to the ICP-AES. This technical note will show the improvement in analyte signal and instrument detection limits.



CETAC Marin-5 Enhanced Nebulizer System



Marin-5 with PerkinElmer Optima 5300DV ICP-AES

EQUIPMENT

ICP-AES Instrument:	PerkinElmer Optima 5300DV ICP-AES with standard glass concentric nebulizer and cyclonic spray chamber
Enhanced Nebulizer Accessory:	CETAC Marin-5 with Glass Expansion MicroMist glass concentric nebulizer

OPERATING CONDITIONS

	Std. Concentric Nebulizer	CETAC Marin-5
ICP Power	1300 W	1300 W
Plasma gas flow	15 L/min	15 L/min
Auxiliary gas flow	0.2 L/min	0.2 L/min
Nebulizer gas flow	0.62 L/min	0.76 L/min
Torch position	-2	-4
Sample uptake rate	1.5 mL/min (pumped)	0.49 mL/min (self-aspirated)
Sample viewing	axial	axial
Integration time	20s	20s
Heater temperature	NA	125°C
Cooler temperature	NA	3°C

NA = not applicable

ANALYTE SIGNAL INTENSITY

A comparison of analyte signal intensity for 22 elements at 200 µg/L with and without the Marin-5 is given in the table below. Signal is improved in a range of 2.5 to 6.2 times, with an average improvement factor of 3.9. Note that sample uptake with the Marin-5 is only 0.5 mL/min, which is 1/3 of the standard nebulizer.

Element	λ (nm)	Standard Nebulizer	CETAC Marin-5	Factor
Ag	328.068	68410 (0.07)	358100 (0.24)	5.2
Al	396.153	26180 (0.17)	107850 (0.32)	4.1
As	188.979	779 (1.42)	2587 (1.20)	3.3
Ba	233.527	43300 (0.09)	162770 (0.14)	3.7
Be	313.107	1223200 (0.07)	5079000 (0.09)	4.1
Bi	223.061	2432 (1.13)	12000 (0.80)	4.9
Cd	226.502	53980 (0.06)	162100 (0.18)	3.0
Co	228.616	16340 (0.53)	57690 (0.14)	3.5
Cr	267.716	43750 (0.06)	171720 (0.15)	3.9
Cu	324.752	71500 (0.06)	424100 (0.28)	5.9
Fe	259.939	60920 (0.05)	239300 (0.07)	3.9

Element	λ (nm)	Standard Nebulizer	CETAC Marin-5	Factor
Mn	257.610	221300 (0.05)	854600 (0.14)	3.8
Mo	202.031	7483 (0.51)	32700 (0.21)	4.3
Ni	231.604	21880 (0.54)	73720 (0.13)	3.3
Pb	220.353	4452 (0.40)	14540 (0.52)	3.2
Sb	206.836	1110 (1.07)	4720 (0.53)	4.2
Se	196.026	948 (1.17)	2950 (0.25)	3.1
Sn	189.927	2665 (0.96)	9520 (1.54)	3.5
Ti	334.940	203230 (0.06)	1012560 (0.20)	4.9
Tl	190.801	910 (1.28)	3490 (0.75)	3.8
V	292.402	64080 (0.08)	290470 (0.20)	4.5
Zn	206.200	26140 (0.64)	64840 (0.30)	2.5

% RSD in ()

DETECTION LIMITS

Detection limits are based on 3x the standard deviation of the blank concentration after calibration with the 200 µg/L multi-element standard; concentration units are µg/L (ppb). Note that standard solution was pumped to the ICP-AES when using the standard nebulizer / spray chamber while self-aspiration was used for the Marin-5. Detection limits are lowered by a factor of 2 to 8, with As, Cd, Pb, Sb, Se, and Tl showing improvement factors of 6, 2.9, 5.3, 4, 3.4, and 7.5, respectively. System noise and/or reagent blank limitations are possible factors in low or no improvement in Be and Mn detection limits.

Element	λ (nm)	Standard Nebulizer	CETAC Marin-5	Factor
Ag	328.068	0.3	0.06	5
Al	396.153	0.6	0.1	6
As	188.979	2.5	0.4	6
Ba	233.527	0.1	0.05	2
Be	313.107	0.03	0.05	0.6
Bi	223.061	3.2	0.4	8
Cd	226.502	0.2	0.07	2.9
Co	228.616	0.4	0.1	4
Cr	267.716	0.2	0.08	2.5
Cu	324.752	0.2	0.04	5
Fe	259.939	0.2	0.06	3.3

Element	λ (nm)	Standard Nebulizer	CETAC Marin-5	Factor
Mn	257.610	0.05	0.03	1.7
Mo	202.031	0.5	0.08	6.2
Ni	231.604	0.4	0.1	4
Pb	220.353	1.6	0.3	5.3
Sb	206.836	2.8	0.7	4
Se	196.026	3.1	0.9	3.4
Sn	189.927	1.7	0.4	4.2
Ti	334.940	0.06	0.03	2
Tl	190.801	3.0	0.4	7.5
V	292.402	0.3	0.05	6
Zn	206.200	0.2	0.05	4

3 x (std.dev. blank conc.)

SUMMARY

The CETAC Marin-5 is a cost-effective accessory to enable significant enhancement in absolute analyte signal and lower detection limits for axial-viewing ICP-AES. Sample consumption is also considerably reduced (>60%), minimizing sample waste.