



# Highly stable performance of the Thermo Scientific iCAP 7000 Plus Series ICP-OES Radial for aqueous, organic and high dissolved solids sample matrices

## Keywords

Aqueous, High dissolved solids, Long-term stability, Organics, Performance, Radial

## Introduction

Routine analysis typically has a focus on reducing cost and time as well as increasing operator efficiency. To meet these requirements, stable and reliable performance of analytical instrumentation is critical. Stable performance reduces quality control failures and the need to recalibrate which saves operational costs such as gas and time spent by the analyst at the instrument. The Thermo Scientific™ iCAP™ 7000 Plus Series ICP-OES includes advanced technologies to maintain long term analytical stability. The technologies used to achieve this include:

- A high efficiency, free-running, 27.12 MHz solid state RF generator, which provides rugged and reliable performance of the plasma,
- Mass Flow Controllers (MFCs), which are utilized to stabilize the plasma conditions, and
- A polychromator, thermally stabilized to  $38\pm 0.1^{\circ}\text{C}$ , leading to high stability of the optical system.

## Instrumentation

To demonstrate its suitability for a wide range of applications, the Thermo Scientific iCAP 7400 ICP-OES Radial instrument was selected to analyze a simple aqueous, an organic (oil) and a more challenging high dissolved solids (salt) sample over a typical workday's time span of 12 hours. Different sample introduction set ups were used for the analyses of the differing sample types, including the use of an ESI *pergo* Argon Nebulizer Gas Humidifier for the analysis of the salt solution. Method parameters and instrumentation can be found in Table 1. The iCAP 7400 ICP-OES Radial was used in conjunction with a Teledyne CETAC ASX-560 Autosampler for all analyses.

## Sample preparation

Three different multi-element solutions were prepared for this analysis:

1. The aqueous stability test solution (50  $\mu\text{g}\cdot\text{kg}^{-1}$  of Be, Cd, Mn and 5  $\text{mg}\cdot\text{kg}^{-1}$  of Al, Ba, Cu, Fe, K, P and Zn) was prepared from single element standards (1000  $\text{mg}\cdot\text{kg}^{-1}$ , SPEX CertiPrep Group, Metuchen, US) in an acidic matrix (2%  $\text{HNO}_3$ , Fisher Chemical, Loughborough, UK),
2. The organics stability test solution (1  $\text{mg}\cdot\text{kg}^{-1}$  of all elements) was prepared from Conostan<sup>®</sup> S-21+K oil standard (100  $\text{mg}\cdot\text{kg}^{-1}$ , SCP SCIENCE, Baie-D'Urfé, Canada) in Conostan<sup>®</sup> PremiSolv<sup>™</sup> ICP Solvent and,
3. The salt stability test solution was prepared with the same elements and the same concentrations as the aqueous stability test solution, but in a different matrix (2%  $\text{HNO}_3$  and 8% Na, prepared from NaCl 99.99 Suprapur<sup>®</sup>, Merck KGaA, Darmstadt, Germany).

## Method development and analysis

The Thermo Scientific<sup>™</sup> Qtegra<sup>™</sup> Intelligent Scientific Data Solution<sup>™</sup> (ISDS) Software was used to create LabBooks that contained sensitive wavelengths for each of the elements of interest (Table 2). These wavelengths were free from interferences and were selected using the intuitive wavelength selection tool of the Qtegra ISDS Software. The method parameters used for all three analyses can be found in Table 1. The plasma was ignited and the instrument allowed to warm up for a period of 15 minutes before each long term analysis. The individual stability test solutions were then analyzed over a period of 12 hours.

## Results

All results were normalized to the intensity of the first sample and are referred to as the recovery in percentage. No drift corrections via an internal standard were performed. Highly stable performance of the measurement is demonstrated in Figures 1-3. They show that excellent long term stability was achieved over a time span of 12 hours with all elements having recoveries within  $\pm 10\%$ , and most of the analytes, especially for the aqueous and the salt sample, showing recoveries even better than  $\pm 5\%$ . The average RSD of the replicates is  $\leq 1\%$  for most of the analytes, only a few element lines show slightly higher values of up to 1.3% (Table 2).

Table 1. Method parameters for the three different matrices.

Parameter	Setting		
	Aqueous Matrix	Organic Matrix	Salt Matrix
Pump Tubing (Standard Pump)	Sample Tygon <sup>®</sup> orange/white Drain Tygon <sup>®</sup> white/white	Sample SolventFlex orange/white Drain SolventFlex white/white	Sample Tygon <sup>®</sup> orange/white Drain Tygon <sup>®</sup> white/white
Pump Speed	40 rpm	40 rpm	50 rpm
Nebulizer	Concentric glass	V-groove	PEEK Mira Mist <sup>®</sup>
Nebulizer Gas Flow	0.55 L·min <sup>-1</sup>	0.4 L·min <sup>-1</sup>	0.55 L·min <sup>-1</sup>
Spray Chamber	Cyclonic	Baffled cyclonic	Baffled cyclonic
Auxiliary Gas Flow	0.5 L·min <sup>-1</sup>	1.5 L·min <sup>-1</sup>	0.6 L·min <sup>-1</sup>
Coolant Gas Flow	12 L·min <sup>-1</sup>	12 L·min <sup>-1</sup>	14 L·min <sup>-1</sup>
Center Tube	2 mm	1 mm	2 mm
RF Power	1150 W	1150 W	1250 W
Exposure Time	UV 15 s, Vis 5 s	UV 15 s, Vis 5 s	UV 15 s, Vis 5 s

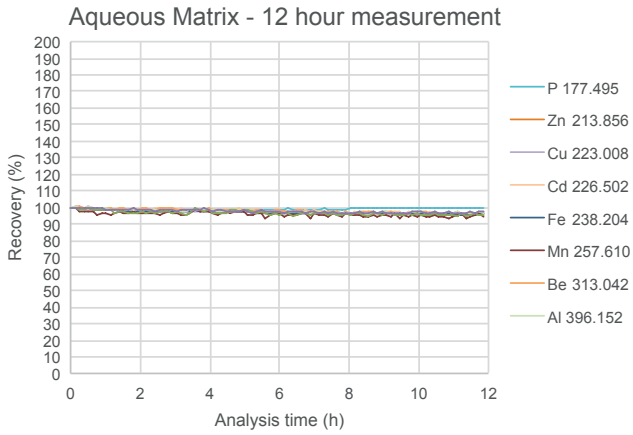


Figure 1. Percentage recoveries of a 12 hour measurement of different elements in an aqueous matrix with no drift corrections applied.

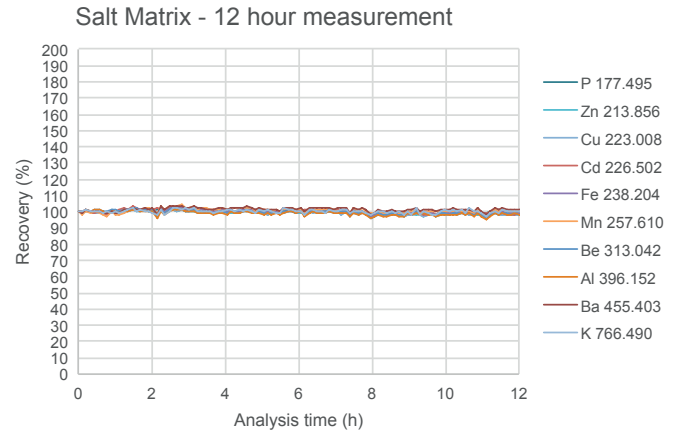


Figure 3. Percentage recoveries of a 12 hour measurement of different elements in a salt matrix with no drift corrections applied.

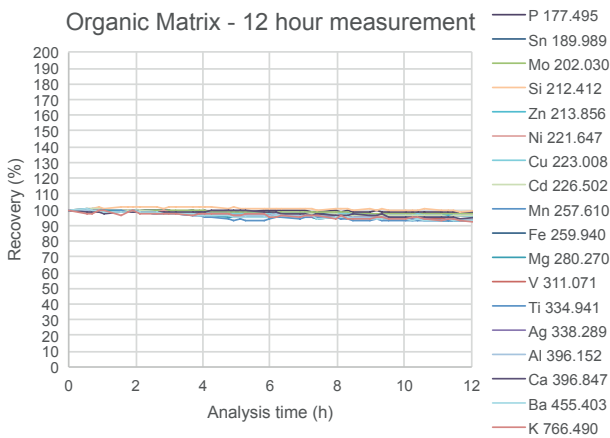


Figure 2. Percentage recoveries of a 12 hour measurement of different elements in an organic matrix with no drift corrections applied.

Table 2. Average RSDs of replicates and recovery range for stated element wavelengths in %. As described in sample preparation, the different matrices contained different sets of elements.

Element and wavelength (nm)	Aqueous matrix		Organic matrix		Salt matrix	
	Average replicates RSD (%)	Recovery range (%)	Average replicates RSD (%)	Recovery range (%)	Average replicates RSD (%)	Recovery range (%)
Ag 338.289	-	-	0.6	93.0 - 100.0	-	-
Al 396.152	0.5	96.2 - 110.3	0.5	94.4 - 100.0	0.7	95.2 - 101.2
Ba 455.403	1.0	94.7 - 100.0	0.4	93.0 - 100.3	0.5	98.2 - 103.9
Be 313.042	0.6	96.4 - 100.5	-	-	0.5	96.0 - 102.4
Ca 396.847	-	-	0.3	94.2 - 100.0	-	-
Cd 226.502	1.1	95.3 - 100.2	0.1	95.7 - 100.6	0.8	97.3 - 103.2
Cu 223.008	0.2	95.5 - 100.0	0.3	95.8 - 100.0	0.4	95.9 - 101.7
Fe 238.204	0.5	95.5 - 100.2	0.3	94.1 - 100.0	0.5	96.4 - 103.0
K 766.490	0.6	96.0 - 100.0	1.3	92.5 - 100.0	1.3	96.9 - 102.9
Mg 280.270	-	-	0.3	93.2 - 100.0	-	-
Mn 257.610	1.2	93.4 - 100.0	0.3	92.8 - 100.4	0.9	97.3 - 104.2
Mo 202.030	-	-	0.2	97.1 - 100.4	-	-
Ni 221.647	-	-	0.2	95.6 - 100.5	-	-
P 177.495	0.2	98.3 - 100.0	0.3	98.0 - 100.0	0.4	96.6 - 101.9
Si 212.412	-	-	0.4	98.9 - 101.6	-	-
Sn 189.989	-	-	0.5	95.8 - 100.6	-	-
Ti 334.941	-	-	0.3	93.0 - 100.0	-	-
V 311.071	-	-	0.3	93.8 - 100.0	-	-
Zn 213.856	0.2	96.0 - 100.0	0.1	96.0 - 100.0	0.3	95.8 - 101.5

## Conclusion

The Thermo Scientific iCAP 7000 Plus Series ICP-OES makes routine analysis highly efficient. Due to its capability of delivering stable and reliable results over measurement periods of a whole work day, operator costs and down-time due to recalibration are lowered to a minimum. With the need of regular recalibration minimized (although it is possible to automatically set these up within Qtegra ISDS Software), a higher sample throughput is obtained and the cost per analysis reduced.

In addition to the demonstrated analytical stability, the integrated Qtegra ISDS Software allows for vastly reduced method development time, both for experienced and inexperienced users. For laboratories seeking maximum productivity the iCAP 7000 Plus Series ICP-OES together with Qtegra ISDS Software offers a highly cost effective solution.

Find out more at [thermofisher.com/ICP-OES](https://thermofisher.com/ICP-OES)

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