TECHNICAL NOTE 000041

Reduce your metals analysis cost with the Thermo Scientific iCAP PRO Series ICP-OES

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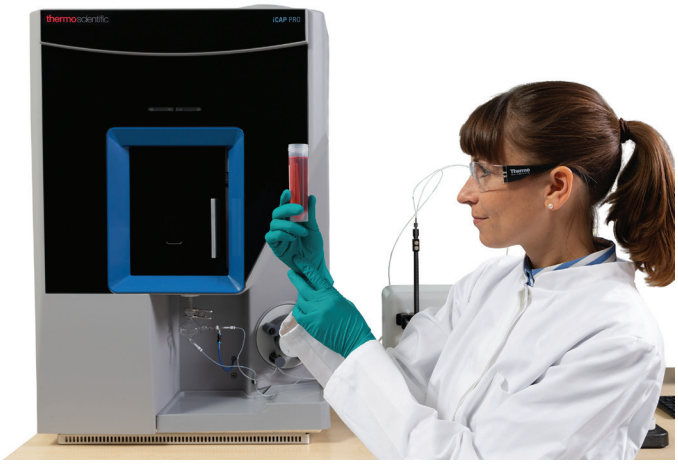

Introduction

Analysis of trace elements takes place in many analytical laboratories, with applications ranging from evaluation of toxic elements in drinking water to assessment of major elements in metal alloys. Despite these fundamental differences in applications, the need to provide cost-effective analysis is a key consideration for laboratories when purchasing any instrumentation. In addition to the initial capital costs of purchase, the lifetime operating costs of the instrument should also be considered.

The Thermo Scientific™ iCAP™ PRO Series ICP-OES has been designed with instrument lifetime running costs in mind. The instruments in the series have features that deliver inherently low running costs and, depending upon sample throughput requirements, have a range of tools to increase instrument productivity.

Consumables costs

The cost of consumables is key to ensuring low instrument running costs. This can be achieved by reducing the number of consumable items associated with running an instrument and the frequency of replacing these items. The torch of an ICP-OES is an example of a commonly replaced consumable. The iCAP PRO Series ICP-OES uses a quartz semi-demountable torch that requires periodic replacement of the torch body and center tube components. Typically these would require replacement at different intervals; therefore, by having these two items as separate components it allows for cost-effective replacement. In addition, the Thermo Scientific iCAP PRO XP ICP-OES Radial and the Thermo Scientific iCAP PRO XPS ICP-OES Radial are provided with a ceramic D-Torch. The ceramic D-Torch typically has a lifetime of years, which significantly reduces costs associated with torch replacement, when compared to a quartz torch. Optional ceramic torches can be purchased for all modes of the iCAP PRO Series ICP-OES.

Operating cost

A major operating cost associated with all ICP-OES instruments is argon gas. Argon is used for the plasma gas flows of an ICP-OES and is also often used to purge the optical path of the instrument to remove air and ensure good sensitivity in the UV region of the spectrum; this is important to detect low quantities of arsenic, selenium, etc. Therefore, a simple way to reduce ICP-OES operating costs is to reduce the amount of argon that is used. This can be achieved in two ways:

- By designing an instrument that consumes argon at a reduced rate, and
- By decreasing the time that the instrument spends consuming argon. That is, by making the analytical process faster.

The iCAP PRO Series ICP-OES employs a combination of these approaches. The iCAP PRO Series ICP-OES typically uses a flow rate of only 12 L·min^{-1} of argon for its main plasma gas flow (sometimes referred to as the coolant gas flow), compared to a typical flow rate of 15 L·min^{-1} for most other ICP-OES instruments. All ICP-OES instruments typically use about 0.5 L·min^{-1} each for the auxiliary flow and the nebulizer flow. Lower gas flows can be used for the plasma gas flow (down to 8 L·min^{-1}); however, this approach severely limits the matrix handling capability and sensitivity, as low RF power must be used with these lower gas flows. Since the plasma/coolant gas flow also protects the torch, a lower flow may lead to torch damage such as fractures or cracks, resulting in more frequent replacement.

In addition to the low plasma gas flow rates, the purge flow rate must also be considered. The iCAP PRO Series ICP-OES allows the use of nitrogen as a purge gas, which is typically more cost effective than argon. All models in the iCAP PRO Series ICP-OES range have a unique gas distribution system that minimizes the purge gas (argon or nitrogen). The gas distribution system works by purging the detector, the polychromator, and the Purged Optical Pathway (POP) interface with a single gas distribution system that consumes a total of 1.4 L·min^{-1} in low gas operation mode or 3.4 L·min^{-1} in standard gas operation mode.

Other commercially available ICP-OES instruments typically use purge gas flows of between 3.5 and 8 L·min^{-1}. Although these differences may seem small, for laboratories running their ICP-OES for 5 hours a day, the savings can be significant. Table 1 shows that by using an iCAP PRO Series ICP-OES, over the course of a year you can potentially save 475,200 L in purge gas.

Table 1. Purge gas savings in liters compared to the iCAP PRO Series ICP-OES when running in low gas mode. One working day is assumed to be 5 hours, 1 week is assumed to be 5 working days, 1 working month is assumed to be 4 working weeks, and 1 working year is assumed to be 12 working months.

	Duration of use			
Purge gas saved in liters compared to the iCAP PRO Series ICP-OES operating in low gas mode	**1 day**	**1 week**	**1 month**	**1 year**
iCAP PRO Series ICP-OES in standard gas mode	600	3,000	12,000	144,000
ICP-OES with 3.5 L·min^{-1} of purge	630	3,150	12,600	151,200
ICP-OES with 8 L·min^{-1} of purge	1,980	9,900	39,600	475,200

Cost reduction from an increase in productivity

As already discussed, ICP-OES instruments typically use 16 L·min^{-1} of argon. Reductions in the time the plasma is on will reduce the overall usage of argon. The iCAP PRO XP ICP-OES and the iCAP PRO XPS ICP-OES both have a start-up time of just five minutes. This means analysis can start just five minutes after switching the plasma on, compared to other ICP-OES instruments, which typically require 20 to 45 minutes of warm-up time during which the plasma is consuming more than 16 L·min^{-1} of argon.

A reduction in sample analysis time will also have a positive effect on argon consumption. The iCAP PRO Series ICP-OES utilizes intelligent Full Range (iFR) mode, which captures the entire spectrum in one measurement per plasma view (axial or radial). This results in one measurement taking place for radial instruments and two for the dual view instruments (if both axial and radial view are required).

When the iCAP PRO Series ICP-OES instruments are used in conjunction with advanced autosampler accessories, such as Teledyne® CETAC® *ASXPRESS® PLUS* Rapid Sample Introduction System or the ESI SC-*FAST*™ automated sample introduction system, typical sample analysis times are reduced from over 2 minutes per sample to as low as 45 seconds per sample. These productivity enhancements can equate to a time savings of up to 75% for analyses comprising an equivalent number of replicate measurements per sample for a multi-element run spanning the full wavelength range.

Collectively, the inherently low gas usage and the productivity enhancements of iCAP PRO Series ICP-OES instruments can produce dramatic running cost savings when compared to other ICP-OES instruments on the market. When added up over the expected lifetime of the product, these savings can be significant.

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Illustration of lifetime cost savings

The operating lifetime of the average ICP-OES instrument in a typical contract laboratory environment can be up to 10 years. Over the course of this period, the costs of running the instrumentation are considerable. The following illustration is intended to highlight why careful consideration of the running costs of an ICP-OES, in addition to the initial instrument purchase costs, are extremely important.

Hypothetical example

A laboratory with moderate sample throughput is considering a replacement ICP-OES purchase. The laboratory runs 100 samples per day, 5 days of the week, with a multielement method that requires three replicate measurements per sample and takes 3 minutes per sample with their current ICP-OES. The operator leaves the plasma on for an average of 1 hour per day prior to starting the run, meaning that the plasma is operated for 30 hours per week, consuming a total of 32,400 L of argon.

In this example, an iCAP PRO XP ICP-OES fitted with a standard autosampler provides productivity enhancing features to enable analysis of 100 samples in approximately 150 minutes. This translates to a requirement for the plasma to be operated for 13 hours per week, consuming 12,900 L of argon, in comparison to the current described 30-hour regime.

Over the lifetime of the instrument, this would amount to a potential savings of over $24,500 in argon (based on argon costing $0.00245 per liter).

This can be further reduced with the use of an advanced sample introduction system, such as the Teledyne CETAC *ASXPRESS PLUS* Rapid Sample Introduction System or the ESI SC-*FAST* sample introduction system.

This cost savings is calculated solely from gas consumption rates associated with the above-described analysis regime. Further potential savings associated with reduced service costs and reductions in non-productive downtime, which could also be considerable when compared with older ICP-OES instruments, are excluded here.

Conclusion

The Thermo Scientific iCAP PRO Series ICP-OES instruments have low cost of analysis enabled through reduced analysis times, efficient argon usage, and advanced consumables with extended lifetimes.

- Consumables such as the ceramic D-Torch have significantly extended lifetimes, reducing costs associated with consumables.
- Analysis times are optimized by using iFR analysis mode and can be further optimized using a sample introduction accessory, such as the Teledyne CETAC *ASXPRESS PLUS* Rapid Sample Introduction System or the ESI SC-*FAST* sample introduction system.
- Argon usage is minimized through quick start up and efficient purging of the compact polychromator, as well as short analysis times. This can save over $24,500 in argon costs over the lifetime of the instrument when compared to other ICP-OES instruments.

Find out more at **thermofisher.com/ICP-OES**

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