3 steps to reduce the argon cost-per-sample for ICP-OES analysis

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If you are focused on minimizing the cost-per-sample for your environmental lab, you are probably looking for every saving you can achieve.

Argon use is a major contributor to overall operating costs, so reducing the amount you consume is an attractive target for potential savings.

Calculating the cost of the argon used for ICP-OES analysis might seem easy, but many people fall into the trap of thinking that plasma gas flow rate is a direct indicator of gas consumption.

While flow rate is an important factor, it can't be considered on its own. Analysis time is also critical.

Here are three simple steps you can take to understand your current argon use—and then reduce it.

Step 1: Determine your current argon consumption per sample

Calculate baseline argon consumption for a method using the interactive worksheet below.

	Parameter	Where to find the information	Enter values here	
A	**Method gas flows**	Open your method file in the instrument control software and locate the values for:		
		Plasma Flow	»	L/min
		Auxiliary Flow	»	L/min
		Nebulizer Flow	»	L/min
		Total **torch** gas flow:		L/min
B	**Optical purge flows***	Check the instrument's documentation for details about the optics purge gas flows being used. This information may be in the installation guide or operation manuals or you might have to call a Service Technician to get the numbers. Only enter a value if argon is being used.	»	L/min
C	**Plasma warmup time**	Time how long it takes for the instrument **to** be ready for analysis after you ignite the plasma.	»	min
D	**Plasma warmup gas consumption**	(A+B) x C		L
E	**Analysis time**	Time how long it takes for the analytical run to be completed for a typical sample workload. This is from the start of the run, including calibration, through all your samples.	»	min
F	**Analysis gas consumption**	(A+B) x E		L
G	**Total gas consumption**	D+**F**		L
H	**Number of samples**	How many solutions (standards, QCs and samples) were in the run you timed in row E?	»	
I	**Gas consumption per sample**	G/H		L/sample

You can use this worksheet when comparing methods or instruments.
Determining the numbers for a specific method is a valuable way to assess an instrument.

** Nitrogen or argon are often specified as being suitable as the purge gas. Check the connections to your instrument to determine which gas is being used. Also, make sure that you find out if there are multiple optical purge flows, e.g., one for the polychromator and another for the detector. This calculator is for argon only, so if you are using nitrogen as the purge gas do not enter a value for B in the table above.*

Step 2: Understand the factors that impact your gas use

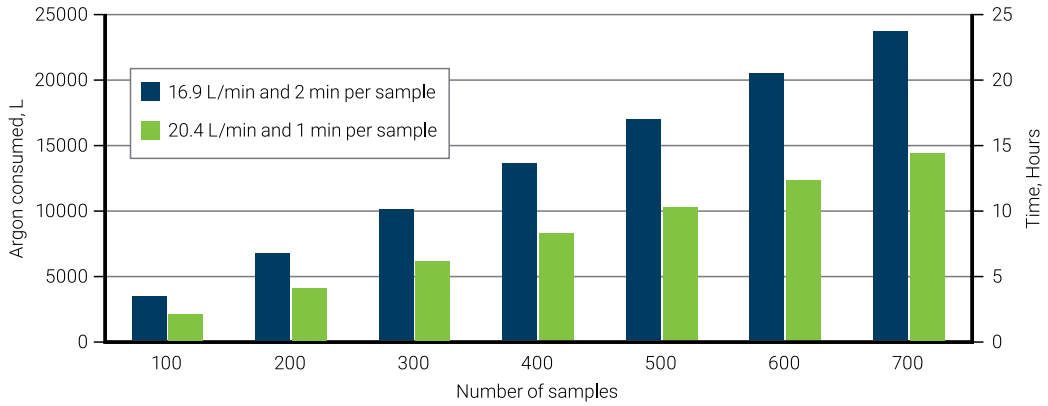
Flow rate ≠ gas consumption

The true measure of gas consumption is liters of argon per sample. You calculated your current baseline gas consumption per sample in the previous step. Let's now look at the factors that affect that number.

Using the US EPA 200.7 method as an example: It outlines requirements for analysis of 31 elements in water and wastes using ICP-OES.

Obviously, there are two main factors that impact the gas consumption when you do an analytical run using this method: the total gas flow, and the time it takes to analyze each sample.

The graph below shows how these two variables impact the total volume of argon consumed for different sample batch sizes.



As the graph shows, reducing the analysis time has a massive impact on the total argon consumed, even if the total gas flow rate is higher.

The gas savings you can achieve depend on several factors: the method you use; the elements you need to quantify; and other factors such as the precision you need to achieve. However, there are adjustments you can make to reduce your analysis time and your gas flow rate. These adjustments are covered in the next section.

If you halve your analysis time, you can reduce your argon use by nearly 40%, even if your argon flow rate is 20% higher.

Step 3: Explore other ways to reduce gas consumption

Speed up analysis

How easy is it to reduce your analysis time? Ultimately, the design of your instrument sets an upper limit on analytical speed.

A typical method measures major elements using a radial viewing of the plasma, while the elements present at lower concentrations are measured using an axial view. Your instrument will take a fixed time to change from one plasma view to the other. Instruments that measure both views at the same time offer a significant advantage. Even with the constraint of changing plasma views, there are other adjustments that will reduce your analysis time:

- ☑ If your instrument takes time to switch between the two plasma views, you should review the plasma views you are using for each element. If you are using a method supplied with the instrument, you may need to optimize it for your sample types. Try to use the same plasma view for as many elements as you can. You will need to balance this with the required sensitivity, precision, accuracy, and limits of detection.
- ☑ Determine if there's a software feature that monitors the washout of a sample and moves to the next sample when the rinse has been sufficient—eliminating the need for a fixed rinse time. If your samples vary in concentration, there's no point in using a long rinse time for the low concentration samples—that's just wasting time.
- ☑ Install a switching valve to reduce sample uptake and rinse times.
- ☑ Locate the autosampler close to the instrument. This will reduce the autosampler capillary length and thus, the time required to pump samples to the nebulizer.
- ☑ If your instrument is easily meeting sensitivity and limit of detection requirements, reduce the read time per replicate. Alternatively, set a longer read time only for those elements that need extra signal.
- ☑ Rather than specifying a range for the replicate read time, set the read time to the shortest time that achieves the sensitivity and limit of detection needed.
- ☑ If you are easily achieving the required precision, consider reducing the number of replicates per sample.

Step 3: Explore other ways to reduce gas consumption

Other adjustments to try

- If you are using argon to purge the instrument optics and don't need to measure low UV wavelengths, consider using the lowest flow setting to minimize gas use.
- Use nitrogen as the optics purge gas, as it is cheaper than argon. The savings you make may quickly make up for the cost of installing another gas line.
- Use a software function that turns off the purge gas at the end of an analysis.
- Determine if there's a software function that will automatically turn off the plasma if there are extended periods of inactivity.
- Adjust the gas settings in your method. Start with the default flows and assess if they can be lowered. Typically, water samples with low dissolved solids can easily be run with a lower plasma gas flow setting. After you have adjusted the plasma flow, you can optimize the nebulizer gas flow to achieve the sensitivity that is needed. The general principle to follow is that UV wavelengths give better sensitivity if the nebulizer flow is reduced. The opposite is the case for visible wavelengths. Typically, there are higher concentrations of Group 1 and 2 elements in environmental samples, so a compromise on sensitivity may be acceptable for those elements. The auxiliary gas flow protects he torch, so it is not recommended to vary this flow setting.

Learn more

About the Agilent 5110 ICP-OES:
www.agilent.com/chem/5110icpoes

About ICP-OES supplies:
www.agilent.com/chem/icp-oes-supplies

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Published in the USA, February 6, 2018
5991-8685EN

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