SmartNotes

What are the benefits of AA and what is it suitable for?

I have been a routine user of atomic absorption (AA) to analyze my samples for many years. However, my instrument is old and needs to be replaced.

Should I purchase another AA?

Since you have been working for many years quite happily with AA, it would make a lot of sense to continue with this option.

As you already know, it is a very simple technique to work with and fits well with your routine analysis requirements. Your application only requires the analysis of a few elements and a moderate number of samples so AA offers you the best option in terms of capital cost versus analytical performance.

Nevertheless, a modern AA instrument has a number of significant benefits over the system that you currently use. The instrument is operated with a comprehensive suite of software unlike your old manual instrument making it easier to use. Its automation allows you to get consistent performance day to day, independently from the operator. The instrument also has a more comprehensive interlock and control system so it will be easier to use, when compared to older instruments.

Figure 1. Thermo Scientific iCE 3000 Series AA Instrument.

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Will I need to make any changes to my lab for installation?

A new AA will not require any additional services from what you have now for your current system so it is very unlikely that you will need to change anything.

You will need to be sure that your gas supplies meet modern safety regulations and in particular that the acetylene supply has been made with the correct materials and fitted with flame arrestors.

Operating pressures for the gases will be very similar to those you currently use although it is recommended that you use a dual stage regulator for the acetylene to maintain best flame stability over a wide range of flow rates.

You will need a fume extraction duct to remove toxic combustion products but again it is very likely that your current installation will be adequate.

Finally, you should notice an improvement in the amount of bench space required for the instrument. The Thermo Scientific™ iCE™ 3000 Series AA Instruments (Figure 1) are among the most compact available and take up around 60% of the space of your old system.

Will my operating costs increase with a new AA?

Your operating costs will not increase. In fact you may find that you are able to reduce your costs compared to your current system.

Although the overall cost will depend on your local situation it is very likely that the cost for your complete analysis will be reduced compared to your current AA. The iCE 3000 Series AA Instruments have been designed with running costs in mind, the gas control systems are particularly efficient resulting in a gas flow reduction of around 40% compared to other instruments.

Almost all the elements that you need to measure can be analyzed using an air/acetylene flame. Even Ca and Cr which you now measure with a nitrous oxide flame can be analyzed with an air/acetylene flame thereby reducing cost.

Of the elements commonly measured by AA you would only need to use a nitrous oxide flame to analyze Al, Si, Ti and V.

Would a new AA be more difficult to use for my operators?

A new AA will not be more difficult to use for your operators. In fact it should be much easier than your current system. The iCE 3000 Series AA Instruments are fully controlled by an intuitive and powerful the Thermo Scientific SOLAAR software package. This makes them easier and safer to operate.

The software includes a comprehensive range of Wizards covering all of the common operations a user needs to perform, these guide the operator step by step through each operation and greatly reduce the learning curve. A simple response is required to each step to quickly build up an analysis sequence and ensure that nothing is missed.

All element parameters are linked to the element name, hence when an element is selected for analysis parameters such as wavelength, bandpass, measurement time, flame type and gas flows are set automatically. This greatly simplifies method setup and avoids mistakes. The parameters can be manually adjusted if required and there is an extensive on line help and cookbook provided for guidance.

Instrument hardware setup and optimization is fully automated which improves day to day consistency and avoids the risk of mistakes being made. Functions such as hollow cathode lamp alignment, wavelength peaking, burner height, and flame conditions can all be optimized automatically and the optimum value stored in a method for use on subsequent occasions.

Can I use my existing lamps?

The iCE 3000 Series AA Instruments uses industry standard hollow cathode lamps with a 37mm base so it is very likely your existing lamps will fit. Thermo Scientific hollow cathode lamps are available as “coded” and “non-coded”. Although they are the same physical size the coded version has additional connection pins in the base.

When a coded hollow cathode lamp is installed into the instrument the element name is automatically recognized and all operating parameters will be set automatically. This greatly simplifies operation, avoids any mistakes being made and reduces the time required to set up an analysis sequence.

If a non-coded lamp or one from another supplier is to be used then it is possible for the operator to manually enter the element and operating parameters as required.

How long do I need to wait before starting my analysis?

The spectrometers used in the iCE 3000 Series AA Instruments are able to operate over the wavelength range 180-900 nm, although As at 193.7 nm is typical the lowest wavelength that is routinely used.

At these wavelengths attenuation of the signal by air absorption are not a problem and hence AA spectrometers are not typically purged or evacuated.

This is a significant benefit is terms of reducing the delay before an analysis can be started. It is very common to switch on the instrument, and after a delay of only 1 to 2 minutes for the flame to stabilize, the analysis can be started.

This makes AA a particularly attractive technique for applications where sample numbers are not high but when a sample needs to be analyzed the result must be available quickly e.g. QA/QC of a finished product.

How will the sensitivity and detection limits compare to my current instrument?

Performance in AA is improved by maximizing the signal to noise ratio. This in turn is largely dependant on the efficiency of the optical spectrometer and sample introduction system.

The iCE 3000 Series AA Instruments utilize high efficiency optical designs with a minimum number of reflections to improve the energy throughput of the system. They feature a novel Stockdale optical design that has a moving mirror for the reference beam. This results in 100% of the hollow cathode lamp energy being used for either sample or reference measurements giving single beam performance with double beam stability.

The optical beam is directed to a pencil beam focussed to a point mid way along the length of the burner. This results in very intense energy at the maximum density of the atom cloud produced in the flame maximizing the absorption signal.

The sample introduction system has a low dead volume spraychamber with the waste outlet at the rear away from the nebulizer. It contains both an impact bead and a flow spoiler to minimize the size of the aerosol droplets which reach the flame. This reduces instability in the flame and improves the efficiency of the atomization.

These innovations in the design result in an instrument that gives class leading sensitivity and detection limit performance.

What is the optimum sample throughput and number of elements?

AA is an extremely flexible technique and has the ability to determine a wide range of elements in a large number of different sample types.

However, it is a single element technique i.e. only one element is measured at a time before changing parameters and measuring the next element. This limits the capability for applications which require a large number of elements to be determined in a large number of samples.

Each element analysis can be very fast, typically around 12 to 15 seconds for 3 repeat measurements. This would equate to a theoretical maximum throughput of around 240 samples per hour if a single element were to be determined.

Multi-element hollow cathode lamps are available containing up to 4 different elements within the same lamp. This increases the possibilities for multi-element analysis, especially since up to 6 hollow cathode lamps can be installed in the iCE 3000 Series AA Instruments at the same time.

In this case, it is possible to set up a multi-element sequence where each element will be measured in turn with the hollow cathode lamp being repositioned and instrument parameters automatically set for the next element. It would take around 30 seconds for each element to be set up for analysis which has the effect of reducing the theoretical maximum number of samples to around 25 per hour if 10 elements were to be determined.

It is extremely unlikely that AA would be used for this level of work load. A more typical work load for AA would be 50 samples each for 5 to 7 elements.

How do I know my results are ok?

As with all analysis techniques there are a large number of variables that can influence the quality of the data produced ranging from sample preparation to analysis measurement.

In order to be sure that the iCE 3000 Series AA instruments are performing to their factory specification and producing correct data there are Calibration Verification Units (CVU) available that will automatically check performance.

Inside the CVU housing are a number of absorbance filters and gauzes used to check instrument functionality. For customers working in a regulated environment (such as an accredited pharmaceutical laboratory) the filters are certified and calibrated to a primary set of traceable master filters.

The CVU is positioned by the operator in the optical path in place of the burner and an automatic software routine is initiated. The instrument will then run through a series of tests to check functions such as wavelength accuracy, optical resolution, mirror repeatability, lamp peaking, absorbance accuracy and background correction performance.

On completion of the test a report is produced which can be kept along with instrument maintenance records for proof that the instrument is working correctly.

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What are the most suitable application areas for AA?

The main strengths of AA are that it is a mature, well understood technique that has been widely used for many years around the world. The instrumentation is simple, relatively low cost and can be installed in most situations.

It is a very easy technique to use, has relatively few interferences and has reasonably good sensitivity for most elements. This means that there is a lot of published methodology available covering a huge range of applications.

It is best suited to low throughput applications where the number of elements and samples to be measured each day is for example 50 samples each for 5 to 7 elements.

Other techniques offer lower detection limits and better dynamic range, hence AA is best suited to determining concentrations around 0.5 to 50 ppm, although higher concentrations can be measured after dilution and some elements can be measured at trace levels.

AA is particularly good at measuring the alkali elements, mainly due to the relatively low temperature of the flame which reduces the level of ionization compared to alternative techniques such as Inductively Coupled Plasma – Optical Emission Spectroscopy (ICP-OES).

Extremely low detection limits can be achieved for example Li, Na and K are 0.7, 3.7, 0.9 µg·L respectively.

Core application areas for AA include routine QA/QC, food and beverage, toy safety, metallurgy, plating bath monitoring, fertilizers and environmental analysis.

Find out more at **thermofisher.com/AAS**

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