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Environmental Trace Element Analysis

Latin America Seminar Tour
June 2007

Why Trace Element Analysis in the Environment?

- Knowledge of the concentration of metallic species in the environment has been important for the last 35 years, since the first environmental legislation
- Measurements are made in materials such as drinking water, natural waters, waste waters, solid wastes, soils, sediments, and biota
- Various analytical techniques have been used to make these measurements



Contaminated Sites



Drinking Water



Wastes



Natural Waters

Typical Environmental Samples

- Contain significant levels of matrix components
 - E.g. Ca, Na, Mg, K, SO₄, Cl, PO₄, Fe, Al etc.
- Causes problems for the analysis
 - Transport effects
 - Suppression effects
 - Deposition on instrument components
 - Spectral Interferences



What is Measured and at What Levels of Interest? - 1)

Potable Water

- Directive 98/83/EC analytes and performance requirements
- Sample prep: add ~1% HNO₃, oven digest at 78°C
- Typical solids content 200-500 ppm

Contaminant	Parametric Value	Trueness % of PV	Precision % PV	LoD
Al	200	10	10	20
Sb	5	25	25	0.2
As	10	10	10	1
B	1000	10	10	100
Cd	5	10	10	0.5
Cr	50	10	10	5
Cu	2000	10	10	200
Fe	200	10	10	20
Pb	10	10	10	1
Mn	50	10	10	5
Hg	1	20	10	0.05
Ni	20	10	10	2
Se	10	10	10	1
Na	200000	10	10	20000
SO ₄	250000	10	10	25000

What is Measured and at What Levels of Interest?

- 2) Natural Waters, Wastewaters

- Compliance with the Water Framework Directive 2000/60/EC
- Typical analytes and required LoDs for water monitoring
- Sample prep: add ~1% HNO₃, oven digest at 78°C
- Typical solids content 200-10000 ppm

Contaminant	Typical Required LoD (ug/L)
Li	100
Be	1
B	1000
Na	1000
Mg	1000
Al	10
P	1000
SO4	1000
K	1000
Ca	1000
V	1
Cr	1
Mn	1
Fe	10
Co	1

Contaminant	Typical Required LoD (ug/L)
Ni	0.1
Cu	0.1
Zn	0.1
As	0.1
Se	0.1
Sr	100
Mo	0.1
Ag	0.1
Cd	0.1
Sn	0.1
Sb	0.1
Ba	10
Hg	0.02
Pb	1
U	1

What is Measured and at What Levels of Interest?

- 3) Soils

- Compliance with member state legislation on soil contamination and waste disposal
- UK: MCERTs analytes and performance requirements
- Sample prep: aqua regia digestion
- Solids content dependant on digestion and dilution: 1000-20,000 ppm

Parameter	Trueness %	Precision %	Guideline LoD (mg/kg) *
Sb	15	7.5	1
As	15	7.5	1
Ba	10	5	10
Be	10	5	0.1
B (water soluble)	10	5	10
Cd	10	5	0.5
Co	10	5	5
Cu	10	5	5
Cr	10	5	5
Fe	10	5	-
Pb	10	5	5
Mn	10	5	-
Hg	10	5	0.1
Mo	10	5	5
Ni	10	5	2
Se	15	7.5	1
Tl	10	5	-
V	10	5	5
Zn	10	5	5

*from 2001 Proposal

What is Measured and at What Levels of Interest?

- 3) Saline Waters

- Compliance with Water Framework Directive and Bathing Water Directive (76/160/EEC)
- Typical analytes and required LoDs for saline water monitoring
- Sample prep: dilute and acidify to ~0.1% with HNO₃ – take care with contamination
- Typical solids content: ~35,000 ppm

Contaminant	Typical Required LoD (ug/L)
Be	0.1
B	1
Al	1
V	0.1
Cr	0.1
Mn	0.1
Fe	0.1
Co	0.1
Ni	0.1
Cu	0.1
Zn	0.1
As	0.1
Se	0.1
Mo	0.1
Ag	0.1
Cd	0.1
Sn	0.1
Sb	0.1
Hg	0.02
Pb	0.1
U	0.1

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iCAP 6000 Series – Environmental Applications Performance



How can we use iTEVA to help with method development for different applications?

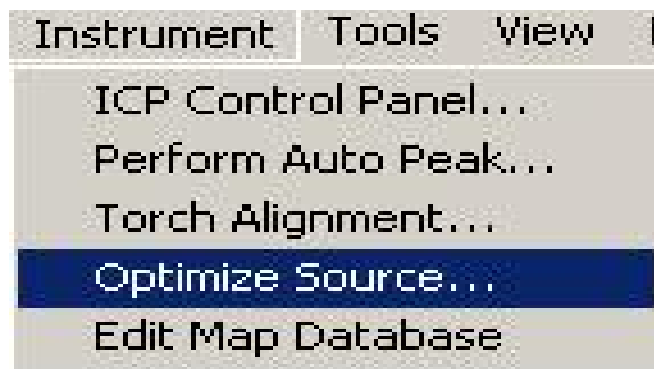
- iCAP 6500 Series allows automated method development using the “Optimise Source” routine
- The automated routine requires no user input except to aspirate a method solution
- Let’s see how this can help with a specific EPA method for soils and sludges - 6010, and its method development



Method specific software optimization packages

- Source optimization enables unattended method development with a simple automated routine
- Automatically optimizes RF power, Nebuliser gas flow, Pump speed, Coolant gas flow, Auxiliary gas flow (Radial Viewing Height is also included for Radial Instruments)

Example using EPA 6010 method for Soils and Sludges analysis



Source Optimization for EPA methods

Optimize Source

Please aspirate a solution containing all the elements you wish to take part in the optimization.

By default, the source conditions for all lines in the method will be optimized.

Choose 'Select Lines' to optimize a subset of these lines.

Optimize For:

Best Signal
Best Signal
Best SBR
Best DL

RF Power
750 1350 750 - 1350 W

Nebulizer Gas Flow
0.30 1.50 0.0 - 1.5 L/min

Pump Speed
30 125 0 - 125 rpm

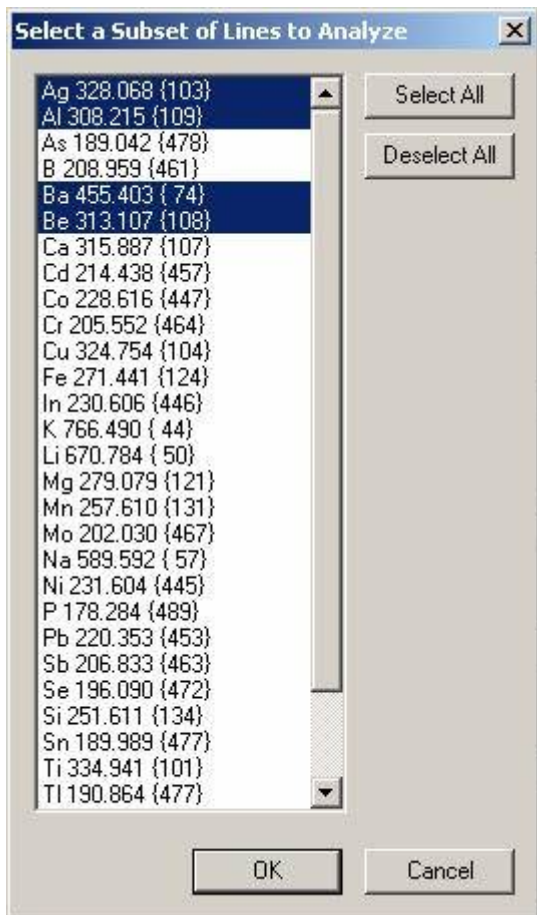
Coolant Gas Flow
12 20 10 - 20 L/min

Auxiliary Gas Flow
0.2 2.0 0 - 2 L/min

Run Select Lines... Close

- Optimize every parameter automatically – with user defined parameters
- Simply aspirate a method solution
- Optimize for Best Signal, Best Signal/Noise Ratio or Best DL (Best DL used in this case)

Source optimization continued..

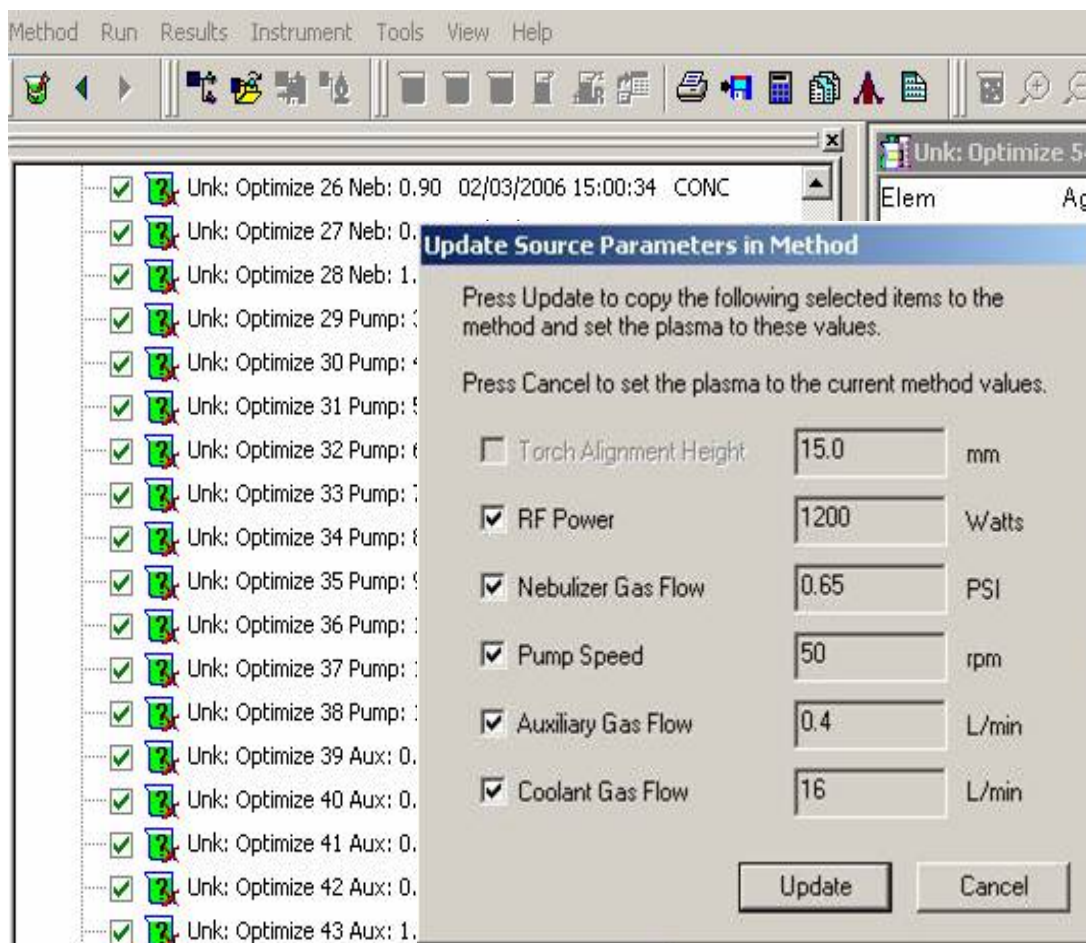


The analyst can specify which elements to optimize the method :

- choose your critical elements with the click of a button
or
- optimize for all elements in the method
- For this EPA Method, all elements were optimized (except Internal Standards Yttrium and Indium)

Source optimization continued..

- On completion, the analyst is presented with the results of the procedure
- The optimized values are displayed with the option to update the method



Source optimization concluded

The screenshot displays the 'Source Settings' window with the following parameters:

- Plasma Settings:** Includes a 'Get Current Conditions' button.
- Sample Pump:**
 - Flush Pump Rate: 50 rpm (range 0-125 rpm)
 - Analysis Pump Rate: 50 rpm (range 0-125 rpm)
 - Pump Stabilization Time: 0 s (range 0-1000 s)
 - Pump Tubing Type: Tygon Orange/White
- Source Settings:**
 - Wavelength Range: Low / Both (High is unchecked)
 - RF Power: 1200 W (range 750-1350 W)
 - Auxiliary Gas Flow: 0.4 L/min (range 0-2 L/min)
 - Nebulizer Gas Flow: 0.65 L/min (range 0.0-1.5 L/min)
 - Coolant Gas Flow: 16 L/min (range 10-20 L/min)

- The optimized values are automatically updated into the method
- As the procedure does not require any analyst input, it was run unattended
- The EPA 6010 method was optimized for all parameters (using default settings) and all 29 elements in 40 minutes!

Environmental Analysis: Why iCAP?

- Sensitivity
 - Even 15s integration yields superior d.l.s to competitor instruments
- Stability
 - Essential for long runs
- Ease of use
 - QC software, Reporting (compatible with MARRS, Labworks, STI, LIMS etc)
 - Supports extended rack autosampler
- Dual View
 - Axial for Traces e.g. Cd, Pb, etc
 - Radial for Majors e.g. Na, Mg, K, Ca, Fe
- Full wavelength coverage allows selection of appropriate wavelength for expected concentration
- Matrix Tolerance
 - Solid State generator, swing frequency



Detection limits

- 6500 Duo
- Optimised nebuliser pressure, pump speed & viewing height (radial)
- Plasma parameters
 - RF power 1000
 - Coolant flow 12 lpm
 - Auxiliary flow 0.5 lpm
 - Nebuliser flow 0.55 lpm
 - Pump speed 45rpm
 - 60 and 15 seconds integration time

		iCAP 6500	
Element	Line	DL (60s) <i>µg/L</i>	DL (15 s) <i>µg/L</i>
Al	167.0	0.034	0.12
As	189.0	0.98	2.9
Ba	455.0	0.0099	0.03
Ca	393.0	0.0027	0.0028
Cd	214.4	0.032	0.072
Co	228.6	0.18	0.51
Cu	324.7	0.25	0.39
K	766.4	0.13	0.60
Mg	279.5	0.0025	0.0067
Mn	257.6	0.026	0.075
Na	589.5	0.062	0.37
Pb	220.3	0.55	1.1
Zn	202.5	0.050	0.09

Environmental (aqueous) including regulated protocols

Application Note: 40766

Determination of trace elements in soils and sediments

Key Words

- ICP
- iCAP 6500 Duo
- EPA Method 8016
- Microwave digestion
- Sample storage
- Soils

Application Note: 40836

US EPA SW-846 Method 6010B using an iCAP 6500 Duo

Introduction
The treatment of an... subsequent release... the region of... and rigorous... the water table... into our soil... contribute to crop... determination of... soil analysis is... the possible cont... traditionally been... due to its... Dissolution with a... for soils and... advantage of rapid... sample volume with

Key Words

- ICP
- iCAP 6500
- Environmental Analysis
- SW-846 Method 6010B
- US-EPA



Instrument conditions used for analysis are shown in Table 1 below.

Parameter	Setting
Nebulizer	Glass Conosonic
Spray Chamber	Glass Cyclonic
Center tube	2 mm
Pump tubing (Type)	Sample: Orange-White Drain: White-White
Nebulizer Gas Flow	0.7 L/min
Plasma Gas Flow	12 L/min
Auxiliary Gas Flow	0.5 L/min
RF Power	1160 W
Sample Flush Time	45 s
Pump Speed	45 rpm
Integration Time	Low (168-210 nm): 15 s High (210-847 nm): 5 s

Table 1. Instrument Parameters used for the analysis

Introduction.
The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) OF 1981 gave the US Environmental Protection Agency responsibility for cleanup of hazardous waste disposal sites. In order to assess the potential contamination and monitor cleanup of these sites, the EPA created the Contract Laboratory Program. This program directed the collection of routine environmental laboratory analytical data, to assure that quality standards were met.

Routine samples are analyzed using a fixed set of protocols with specified quality assurance and control measures.

This application note describes the performance of the iCAP 6500 Duo for EPA method 6010B. The method is suitable for the determination of 31 elements in ground waters, TCLP & EP extracts, industrial and organic wastes, soils, sludges, and sediments. All samples except filtered groundwater need to be digested prior to analysis using EPA method 3050b or similar.

Experimental

The iCAP 6000 series uses a Charged Injection Device (CID) detector offering greater photosensitive area and lower noise for improved detection limits and better stability.

The CID detector is a non-blooming device and has the ability to measure high concentrations of matrix elements and low levels of contaminants at the same time without saturation.

Calibration standards were prepared in 5% v/v HCl and 1% v/v HNO₃ at concentrations selected to cover the desired range for each element. Elements were separated as specified in 6010b to minimize interference.

Quality control solutions were run at intervals specified by the method and any necessary corrective actions were taken automatically.

The iCAP 6500 Duo allows for elements expected at low concentration to be read axially where the best sensitivity is required; the radial view was used for elements at higher concentration or for those elements that suffer from easily ionized element interference.

An internal standard of 5 ppm scandium was automatically added on-line with the internal standard mixing kit. Details of sample drags and plasma view for each of the analyte and internal standard elements are shown in Table 2. The analyte elements were referenced to an internal standard wavelength at the same slit and plasma view.

DUO iCAP

Regulated and unregulated Protocols analysed

CRMS used to test accuracy

Guidelines for EPA Methods following exact protocols with ICVs, CCVs, QCs and Interference checks

EPA SW-846, Method 6010B

- The method is suitable for the determination of 31 elements in ground waters, TCLP & EP extracts, industrial and organic wastes, soils, sludges, and sediments
- All samples except filtered groundwater need to be digested prior to analysis using EPA method 3050b or similar

Parameter	Setting	
Nebulizer	Glass Concentric	
Spray Chamber	Glass Cyclonic	
Center tube	2 mm	
Pump tubing (Tygon)	Sample Orange- White	Drain White-White
Nebulizer Gas Flow	0.7 l/min	
Plasma Gas Flow	12 l/min	
Auxiliary Gas Flow	0.5 l/min	
RF Power	1150 W	
Sample Flush Time	45 s	
Pump Speed	45 rpm	
Integration Time	Low (166 -230 nm) 15 s	High (230-847 nm) 5 s

Table 1: Instrument Parameters used for the analysis

Results – ICV's and CCV's

Element	Initial Cal Check (ICV) (mg/L)		Continuing Cal Check (CCV) (mg/L)	
	Actual	Measured	Actual	Measured
Ag	0.5	0.495	1	0.998
Al	2.5	2.553	25	25.520
As	1.0	1.019	5	5.190
Ba	0.5	0.490	5	4.862
Be	0.5	0.481	2.5	2.410
Ca	10.0	10.140	25	25.100
Cd	0.5	0.510	5	4.985
Co	0.5	5.02	5	4.909
Cr	0.5	0.46	5	4.849
Cu	0.5	0.488	5	4.951
Fe	5.0	5.060	25	24.870
K	10.0	9.935	25	25.220
Mg	6.0	6.014	25	25.120
Mn	0.5	0.494	5	4.855
Na	10.0	10.000	25	25.300
Ni	0.5	0.501	5	4.902
Pb	1.0	1.006	5	4.895
Sb	1.0	1.000	5	9.933
Se	1.0	1.008	10	10.020
Tl	1.0	1.028	10	9.566
V	0.5	0.500	5	4.909
Zn	1.0	1.020	5	4.954

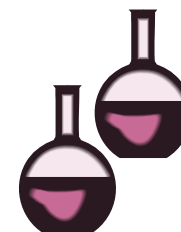
Table 5: Calibration Checks

- The calibration blank readback must be within 3 times the method detection limit for each element
- ICV's and CCV's must be within 10 % of the actual values
- The standard deviation of a minimum of 2 re-samples of each verification solution must be less than 5 %
- Repeated every 10 samples

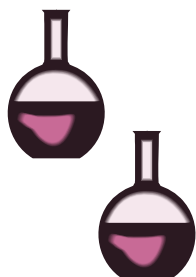
Results 2 - Interference checks

- Interference checks were required to correct for known interferences by spiking 0.05 to 1 mg/l of the analyte of interest into a 250 mg/l solution of the interfering elements

Pb	220.353 nm	Al, Fe
Sb	206.833 nm	Al, Fe
Se	196.090 nm	Al, Fe
Tl	190.856 nm	Al, Fe



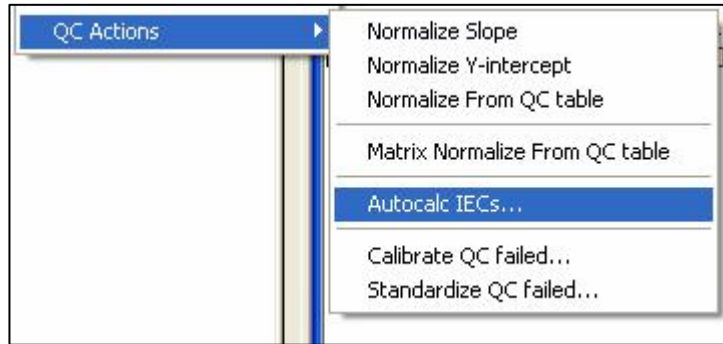
- Checks must read back within 20% of the true value



Element mg/L	ICSA (mg/L)	ICSAB (mg/L)	Target Value (mg/L)	% Recovery
Pb	0.005	0.059	0.051	115.7
Sb	0.004	0.667	0.585	114.0
Se	0.004	0.060	0.051	117.6
Tl	0.001	0.096	0.096	100.0

Conclusions – Environmental analysis

- Interferences corrected for using iTEVA's automatic IEC function



- Sensitive enough for EPA methods, MDLs below required level
- Proven methods with supporting data

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AA and Continuous Flow Vapour Generation for Environmental Applications

Hydride Generation Analysis

- Hydride generation – elements which form gaseous hydrides:
Sb, As, Bi, Se, Te, Sn - HGAAS
- Hg – Cold Vapour, CVAAS
- Acidified sample solution is reacted with NaBH_4 producing the analyte hydride, which is carried on a stream of argon carrier gas to the atomizer
- The hydride decomposes in the atomizer the elemental form and can be measured

			B	C	N	O	F
			Al	Si	P	S	Cl
Cu	Zn	Ga	Ge	As	Se	Br	
Ag	Cd	In	Sn	Sb	Te		
Au	Hg	Tl	Pb	Bi	Po	At	
Gd	Tb	Dy	Ho	Er	Tm	Yb	

Now for the science.....

- Acidify sample
- Mix with reductant
 - *Sodium borohydride NaBH₄*
- Analyte reduced to gaseous hydride
 - $As^{3+} + BH_4^- + H^+ \rightarrow AsH_3 \text{ (gas)} + BO_3 + H_2$
- Gaseous analyte hydride separated from liquid reagents
 - *Gas liquid separator device*
- Gaseous analyte hydride carried into heated cell
 - *Inert (e.g. Ar, N₂) used to transport it*
- Analyte atomised, and AA signal measured

Hydride V's Flame

- Reasons for poor flame sensitivity for hydride group elements:
 - Low intensity HCL's
 - Absorption by flame gases
 - Inefficiencies in sample intro eg. Nebulisation
- Improved sensitivity and reduced noise result in detection limits typically 1000x better than those achieved by conventional flame analysis.
- Typical Environmental applications:
 - As in drinking water
 - Se in wastewaters
 - Hg in soils and sludges
 - As in seawater
 - Hg in drinking water



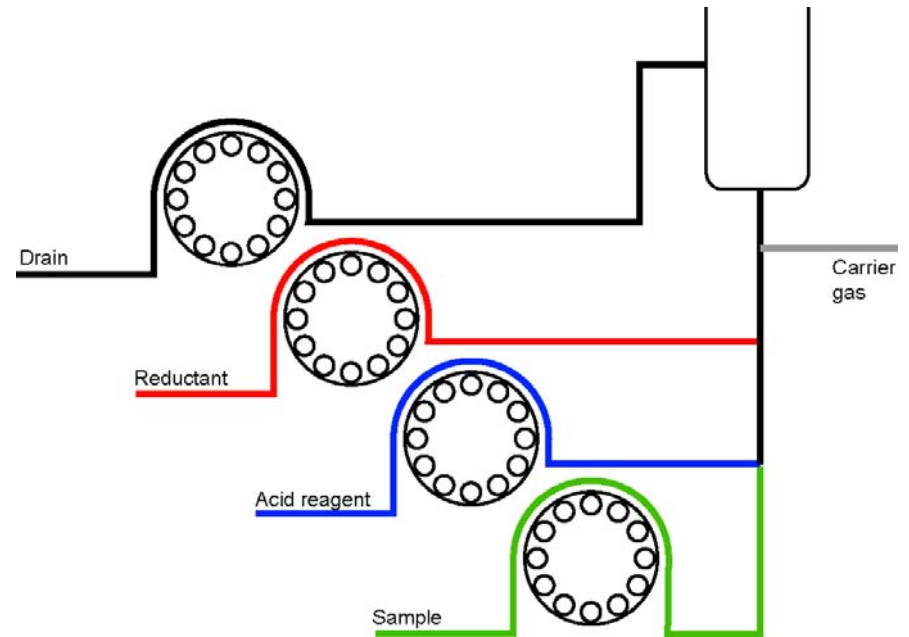
VP100 Vapour System

- New, stylish design
 - Maintains AA Thermo family appearance
- Full automation
 - All functions controlled through software
- Quick and Simple Installation and Plumbing
 - Colour coded channels
 - Single mains power lead
 - Single RS232C connection to spectrometer
 - Compatible with all SOLAAR supported auto-samplers



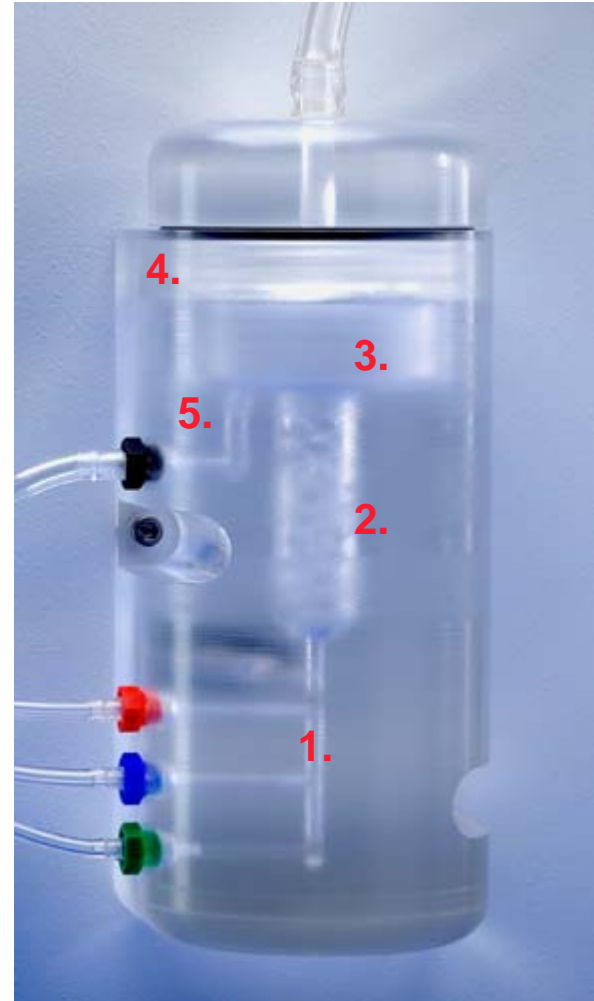
VP100 – Principle of operation

- 4 Channel peristaltic pump
 - Channel 1 – Reductant
 - Channel 2 – Acid Reagent
 - Channel 3 – Sample
 - Channel 4 – Drain
- Benefits:
 - Independent Acid Reagent and Sample channels remove the requirement for separate Stabilise and Baseline delays
 - Faster Operation
 - No changeover valve required
 - Better reliability



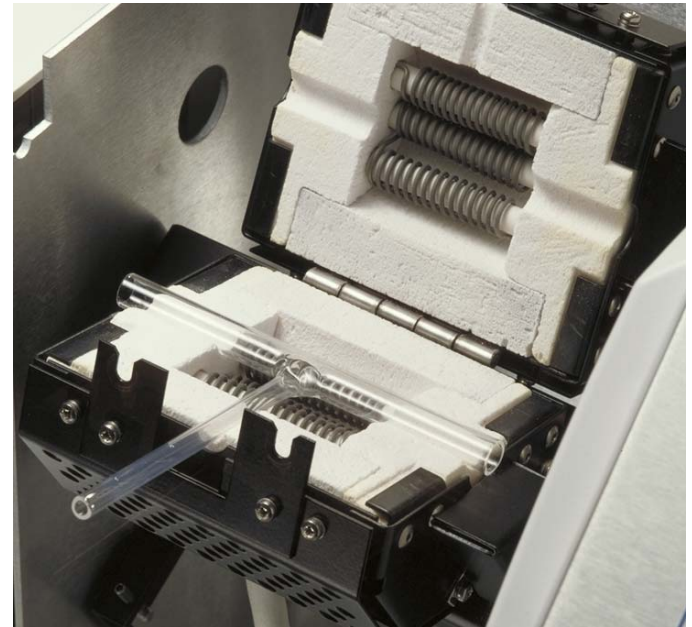
VP100 – Gas Liquid Separator

- Sophisticated new design
- Provides:
 - Mixing manifold (1)
 - Reaction zone (2)
 - Phase separation zone (3)
 - Semi-permeable membrane (4)
 - Pumped drain (5)
- Solid, robust, inert material
 - *Difficult to damage, easy to clean*
- Translucent
 - *See what is happening!*



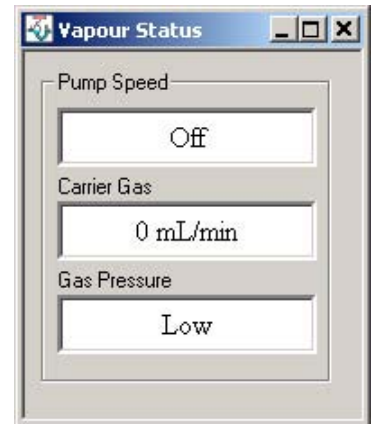
EC90 – Electrically Heated Cell

- Gaseous hydrides generated by the VP100 are atomised in an air/acetylene flame-heated silica T-cell, mounted above the burner.
- Alternatively use the EC90 to electrically heat the silica T-cell:
 - *Improved stability/precision*
 - *Atomisation temperature control and optimisation are improved.*
 - *Safer – no flame required, unattended operation is possible*
 - *Allows vapour measurements to be made on non-flame instruments*



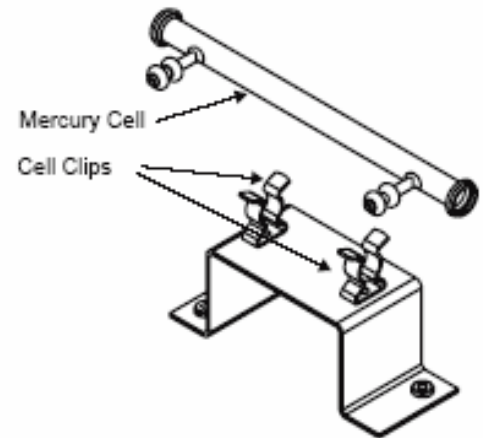
VP100 – Software and Safety

- Operation is fully integrated into SOLAAR software
- Parameters are set on Vapour page of Method
 - Stabilise time, Pump speed and Carrier Gas flow rate
 - Default 'cookbook' values are provided for all hydride elements
- Real time status is reported on new Vapour Status window
 - Includes Pump Speed, Gas Flow and Gas Pressure status
- Pump drive is hardware interlocked with gas flow
 - Pump cannot operate unless carrier gas is flowing
 - Prevents accumulation of hydrogen and hydride gases
- Safe shutdown
 - Carrier gas flow maintained for 10 seconds after pump stops
 - Hydrogen and hydrides safely flushed away.



Mercury Measurements

- Mercury requires no special prereduction sample preparation, two possible reaction mechanisms:
 - 1) Sodium Borohydride (NaBH_4)
 - 2) Stannous Chloride (SnCl_2)
- The VP100 has been designed to perform mercury analyses with both reduction routes.
- No change is required to the hardware – the same GLS performs equally well with either approach.
- A mercury cell is used to increase the path length, which improves the sensitivity by approximately 1.3x, compared with the general purpose 'T' shaped silica cell.

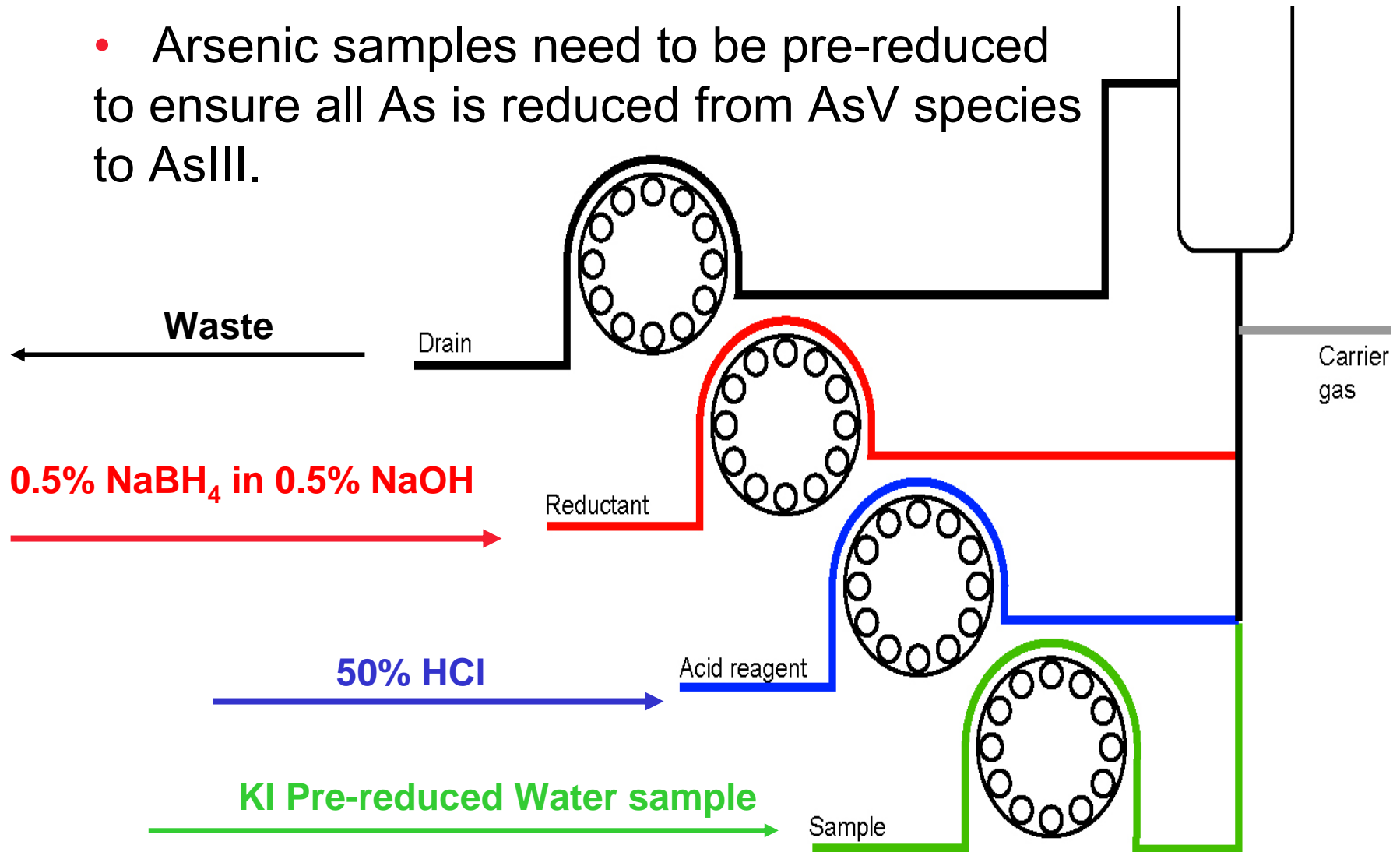


VP100 – Sensitivity and Detection Limits

	CC (ug/L)	DL (ug/L)
Arsenic	0.20	0.04
Selenium	0.40	0.1
Antimony	0.29	0.06
Tellurium	0.69	0.05
Bismuth	0.36	0.1
Tin	0.44	0.01
Mercury	0.26	0.06

Example Application : As in sea / drinking water

- Arsenic samples need to be pre-reduced to ensure all As is reduced from AsV species to AsIII.



SOLAAR VP100 Method

Method - Seawater (As)

General Sequence Spectrometer Vapour/SFI Calibration QC

Action Solution ID As Seawater (As)

Calibration

Sample 1

Sample Details

Sample ID Sample Mass

NASS-2 16.0000

Element

Measurement Mode: Absorption

Number of Resamples: 3

Fast Resamples

Measurement Time (s): 4.0

Wavelength (nm): 193.7

Lamp Current (%): 75

Bandpass (nm): 0.2

Optimise Spectrometer Parameters

Signal: Continuous

Transient Peak Measurement

Measure From (s): 0.00 To: 4.00

Method - As

General Sequence Spectrometer Vapour/SFI Calibration QC

Method: Normal, Segmented Curve Fit

Use Stored Calibration

Concentration Units: µg/L

Standards: 3 Default Ratios

Standard Concentrations

Master Standard Conc: 10

1	2.000	6	0.000
2	5.000	7	0.000
3	10.000	8	0.000
4	0.000	9	0.000
5	0.000	10	0.000

Scaling Factor: 1

Scaled Units: µg/L

Method - Seawater (As)

General Sequence Spectrometer Vapour/SFI Calibration QC

Vapour

Vapour Mode: Flame Heating

Acetylene Fuel Flow (L/min): 1.0

Furnace Temperature (°C): 900

Vapour Kit: VP100

Burner Height (mm): 13.7

Measurement Delay (s): 50

VP90/FI90/VP100

Standby Delay (s): 20

Stabilise Delay (s): 40

Baseline Delay (s): 40

Carrier Gas Flow (mL/min): 200

Pump Speed (rpm): 40

The parameters specified above must be set up manually on the VP90 or FI90.

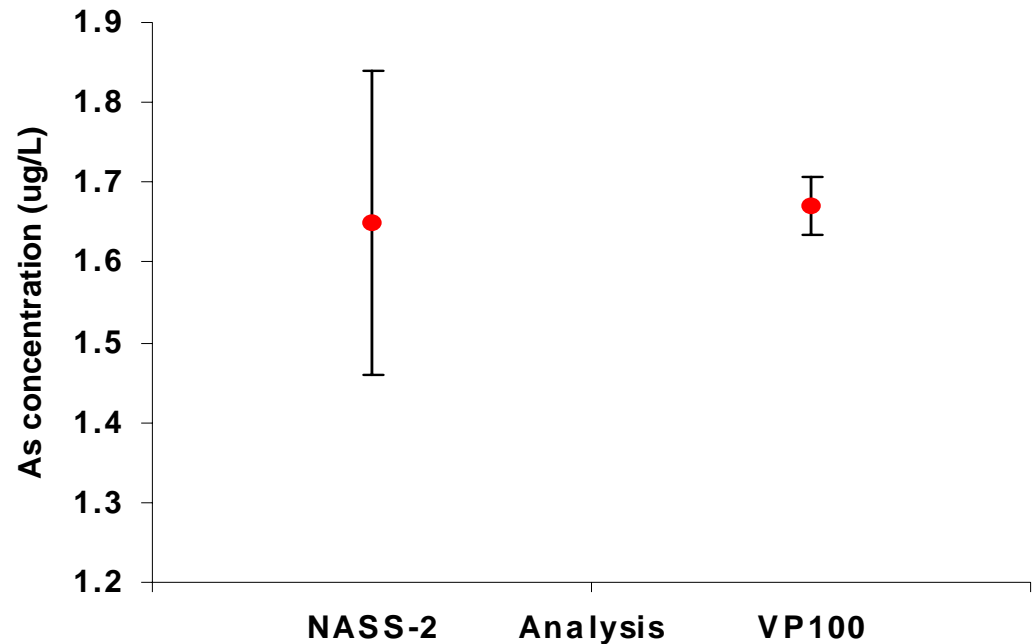
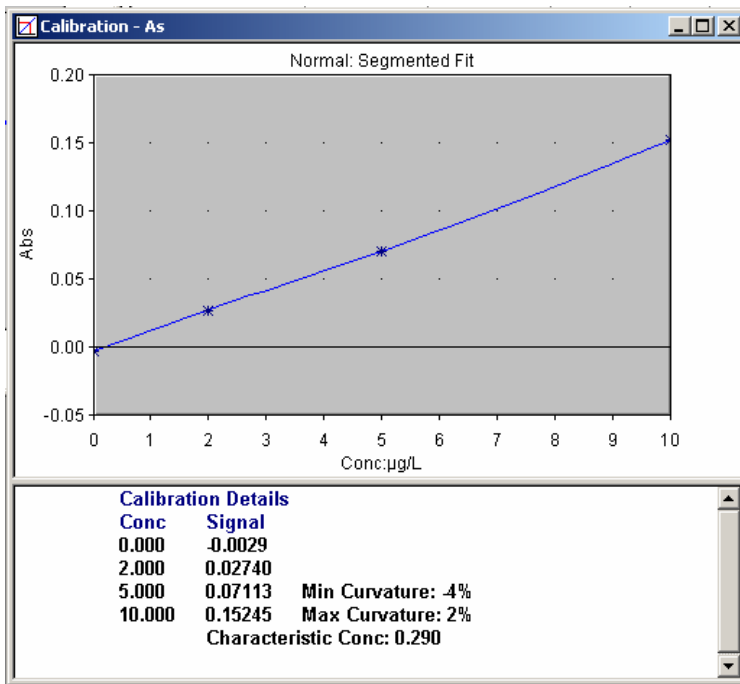
OK Cancel Help

- VP100 parameters controlled by the software

CRM – Seawater Recovery

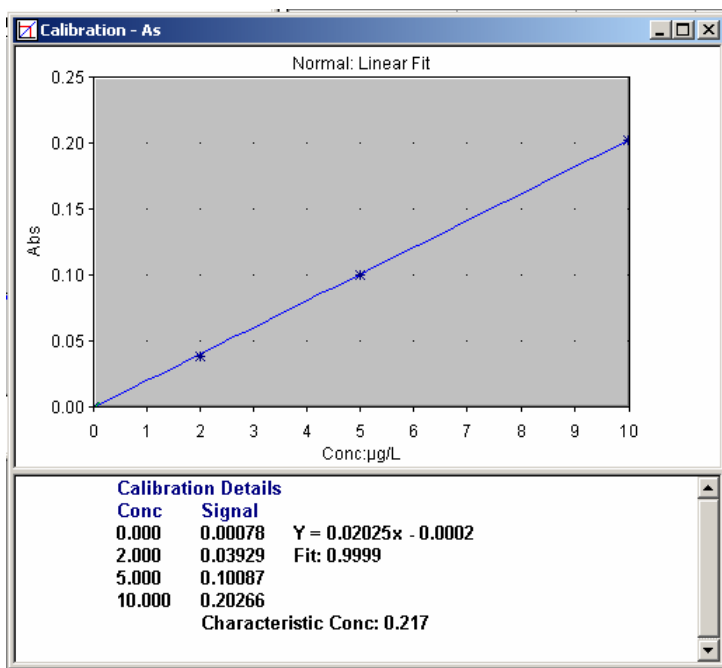


- NASS –2 Near-shore seawater CRM
- The certified result for this element is $1.65\mu\text{g/L} \pm 0.19\mu\text{g/L}$.
- VP100 result - mean arsenic content of $1.673\mu\text{g/L} \pm 0.04\mu\text{g/L}$. (1 standard deviation)



As in Drinking water

- Cambridge (UK) Tap water samples were spiked with 0.25, 0.5, 1.0 and 2.0 $\mu\text{g/L}$ of As and the spike recovery was calculated.
- Perfect linearity for the calibration curve
- Average spike recovery for As was $103.2 \pm 2.6\%$



Sample	Spike Recovered
Tap water + 0.25ppb As	0.27ppb As
Tap water + 0.50ppb As	0.48ppb As
Tap water + 1.0ppb As	1.03ppb As
Tap water + 2.0ppb As	2.13ppb As

More Information

Application Note:
AN40688_E

The analysis of environmental materials by Atomic Absorption Spectrometry

Key Words

- AAS
- Environmental
- Atomic Absorption Spectrometry
- Overview

Introduction

In the field of laboratory analysis, environmental applications have long been a number one priority for many laboratories.

The present concern about global warming, and the desire to clean up the environment for the benefit of everyone, have produced many new pieces of legislation governing the permitted discharges into waters, the air and on to the land. This increased level of legislation is being enacted by various authorities with a number of key agencies, such as the Environmental Protection Agency in America and the EEC Commission in Europe, leading the way. Such legislation places a responsibility on every organisation to monitor the condition of the local

environment, for its compliance with a law. Atomic absorption spectrometry will verify the type



Application Note:
AN40729

Method Guide - As in Potable waters

Key Words

- Arsenic
- Arsenic absorption
- Hydride generation
- HCAAAS
- Potable water

Principle:

The sample is pre-reduced using a mixture of potassium iodide and L-ascorbic acid. Arsenic is determined by Hydride Generation Atomic Absorption Spectrometry (HGAAAS) using the VFI100 Continuous Flow Vapour System.

Reagents:

Hydrochloric acid (AnalaR grade, 50% w/v)
Sodium borohydride solution (AnalaR grade, 0.5% m/v in 0.5% m/v sodium hydroxide)

Pre-reducing solution (AnalaR grade, 10% m/v potassium iodide + 10% m/v L-ascorbic acid)

Arsenic water standard (1000 µg/L)

Arsenic sub-stock standard solution (200 µg/L)

Transfer 0.2 mL of arsenic water standard solution to a 1 L volumetric flask and add 10 mL of pre-reducing solution, then dilute to volume with deionised water.

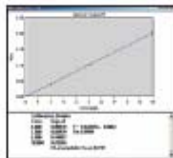
Working standards

Transfer 0, 1.0, 2.5 and 5.0 mL of the arsenic sub-stock standard solution into a series of 100 mL volumetric flasks. Add 10 mL of deionised water and 10 mL of hydrochloric acid to each flask and dilute to volume with deionised water. The working standards will contain 0, 2, 5 and 10 µg/L of arsenic.

Sample Preparation:

Into a test tube, add 16.0 mL of drinking water sample, 2.0 mL of concentrated hydrochloric acid and 2.0 mL of the pre-reducing solution and mix thoroughly. Allow the mixture to stand for 1-2 hours at room temperature.

The sample will then be ready for analysis. Tap water samples were spiked with 0.25, 0.5, 1.0 and 2.0 µg/L of As and the spike recovery was calculated.



Application Note:
AN40728

Method Guide - As in Seawater

Sample Preparation:

A mixture of potassium iodide and L-ascorbic acid is determined by Hydride Generation Atomic Absorption Spectrometry using the VFI100 Continuous Flow Vapour System.

Into a test tube, add 16.0 mL of seawater sample, 2.0 mL of concentrated hydrochloric acid and 2.0 mL of the pre-reducing solution and mix thoroughly. Allow the mixture to stand for 1-2 hours at room temperature. The sample will then be ready for analysis.

Instrument Parameters:

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Conclusions

- Legislation and methods have developed for the monitoring and measurement of elements in many environmental matrices
- Tools for performing these analyses are available:
 - AA great for single element work
 - ICP great for fast multi-element analysis of dirty samples
 - ICP-MS great for fast multi-element analysis at low-medium concs.
- Speciation is an area of growing interest
 - Chromatography coupled with ICP-MS is a very powerful technique for this

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