



Using Atomic Fluorescence Spectrometry for the determination of Mercury (Hg), Arsenic (As), Selenium (Se), Antimony (Sb) and Bismuth in Clinical Samples



The determination of toxic metals Hg, As and Sb in biological samples of humans is an important clinical screening procedure. Exposure of these metals from the diet, local surroundings and industrial & occupational processes can lead to serious and significant health issues.

Conversely Se is an essential element playing an important role in many metabolic processes. At elevated concentrations, however, Se has detrimental health effects and so clinical testing here determines both possible over exposure and deficiencies.

The most common clinical sample matrices that are analysed are blood and urine, but other samples, such as hair, fingernails and even bone may be evaluated.

Analysing the total concentration of these elements is important but, by no means, the whole story. Biological transport and toxicological properties critically depend on the form (species) in which they occur in the sample. As a consequence, trace element speciation, particularly for these toxic trace elements, is nowadays considered of major importance to establish more accurate risk factors to clinical health.

Coupling **Atomic Fluorescence Spectrometry (AFS)** with either cold vapour generation or hydride generation has been PSA's core competency for over 35 years. With the addition of analyte separation capabilities (which is becoming more routine) allowing for speciation studies, PSA offers powerful analytical tools to help contract laboratories, research teams and regulators alike with these clinical determinations.

AFS Analysers

- **Millennium Merlin & Excalibur**
(10.025 Total Hg - 10.055 Total As, Se, Sb, Bi & Te)

Limits of Detection	ng/L
Hg	0.01
As	2
Se	1
Sb	2
Bi	10
Te	10



- **Key User Benefits;**
 - Wide dynamic range
 - Low carryover – no flow cell
 - Robust
 - Easy to use and maintain
 - Rapid return on investment
 - Autosampler options

AFS Environmental Applications

(application notes & experimental details available on request)

- **Sample Matrices include;**
 - Blood
 - Plasma
 - Urine
 - Hair
 - Fingernails
 - Bone
 - Tissue



PSA systems offer ultimate detection performance, combined with ease of use and affordability.

- **Examples from our Applications Library**

Mercury in Clinical Samples

Blood mercury concentrations rapidly increase immediately after or during exposure. Analysis, therefore, needs to take place quickly to gain meaningful results. Organomercury species (the most toxic form) may be present in blood samples at relatively high concentrations compared to a urine sample from the same patient. Mercury concentrations in urine are very stable and sampling is much easier as it is non-invasive and urine acts as a good biomarker for those exposed to elemental or inorganic mercury compounds.

Hair readily incorporates methylmercury during formation and the concentration is directly proportional to the concentration in the blood. Once incorporated into hair the concentration remains fixed and stable for many years and forms a record of historical exposure.

Table 1. Total Mercury in Clinical Samples. Example data

Sample Type	Identification	Certified Value	Found Value
Whole Blood ug/L	Seronom 404107	3.0 (2.2-3.3)	3.22 +/- 0.39
Whole Blood ug/L	Seronom 404107	8.0 (6.7-8.4)	7.02 +/- 0.36
Urine ug/L	Seronom NO2525	37.7 - 42.9	40.6 +/- 0.04
Urine ug/L	Seronom 201205	40.2 +/- 2.6	40.0 +/- 0.39
Hair ug/g	GBW 07601	0.36 +/- 0.05	0.38 +/- 0.001
Hair ug/g	BCR RM 397	12.3 +/- 0.6	11.6 +/- 0.2



Arsenic, Selenium, Antimony and Bismuth in Clinical Samples

Tests are carried out on a variety of sample matrices to establish exposure and toxic concentrations, or in the case of Se, often to understand clinical element deficiencies. The type of sample matrix chosen for analysis act as biomarkers and can indicate current or historical element exposure.

Table 2. Total As, Se, Sb & Bi in Clinical Samples. Example data

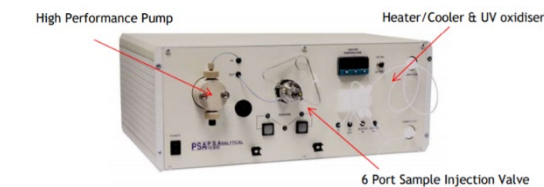
Sample type	Analyte	Identification	Certified Value	Found Value
Blood	Se ug/L	Seronorm 5053	93	94.33 +/- 0.30
Blood	Se ug/L	Seronorm 5056	82	83.28 +/- 4.00
Blood	As ug/L	Seronorm L3	30.4 +/- 7.3	29.6 +/- 1.4
Urine	As ug/L	Seronorm L2	110 - 258	153.6 +/- 9.6
Hair	Se ng/g	GBW07601	600 +/- 30	581 +/- 11
Hair	As ng/g	GBW07601	280 +/- 40	581 +/- 11
Hair	Bi ng/g	GBW07601	340 +/- 20	373 +/- 44
Hair	Sb ng/g	GBW07601	95 +/- 12	98 +/- 6
Liver Tissue	Se ug/g	NIST 1577b	0.73 +/- 0.06	0.737 +/- 0.004

AFS Speciation Studies

Metal transport and toxicological properties of these elements critically depend on the form (species) in which they occur in the sample. As a consequence, trace element **speciation**, particularly for toxic trace elements, is nowadays considered of major importance.

To increase the range of applications including speciation studies we employ a configurable chromatographic front end; the **Modular Interface (MI)**, which is equipped with LC pump, injection valve, UV cracker, heater and cooling modules. This simple interface couples directly to the **Millennium Merlin** or **Excalibur** for seamless speciation determinations.

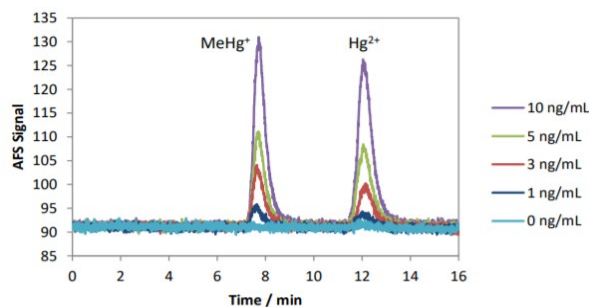
Modular Interface (MI) 10.820



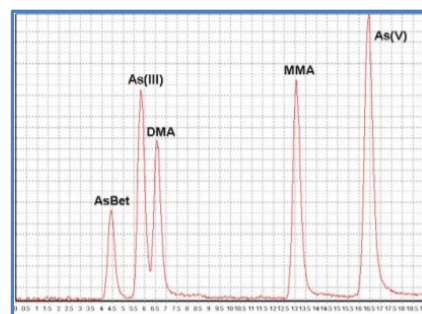
Examples from our applications library;

- Inorganic and methylmercury speciation

Sample type	Analyte	Identification	Certified Value	Found Value
Hair	MeHg ug/g	IAEA -086	0.258 +/- 0.021	0.251 +/- 0.001



- 5 arsenic species in spiked urine sample



HPLC-ICP-MS v HPLC- HG-AFS

The coupling of the ICP-MS with HPLC has a number of negative consequences for a busy laboratory:

- The system is tuned for single element analysis and cannot carry out normal high-speed, multi-element determinations.
- Speed is dependent on the chromatographic run times.
- Long run times consume large volumes of argon (30L/min).
- Severe polyatomic interferences are common and need to be managed carefully.
- A dedicated technician is normally employed to operate the HPLC-ICP-MS.

These issues are not experienced with the PSA approach.

For Further Details

PLEASE CONTACT US AT:

<http://www.psanalytical.com/information/inforeq.html>

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