Online Determination of Arsenic in Drinking Water using the PSA 10.256

Application Note APP188

Introduction

Arsenic is a toxic element which can lead to adverse health effects in humans when consumed. Short term exposure to arsenic can lead health issues such as nausea, vomiting, skin issues and cramps. More severe issues are caused by long term exposure, including development of cancers.

The most common reason for long term exposure is contaminated drinking water, where the affected population are unaware of its presence. Contamination is generally thought to be caused by human activity – most commonly through the mining or agriculture industries. It is also worth noting that arsenic is a naturally occurring element commonly found in soils, so contamination can happen naturally. Globally, authorities are becoming more aware of the issues of arsenic contamination, and so limits are being set to reduce levels of arsenic in drinking water. In the UK, the limit is set at 10 µg/L (ppb).

In this application note, we demonstrate the analysis of water samples using PSA's new Online system, the 10.256 Online Excalibur. The system uses hydride generation – atomic fluorescence spectroscopy to detect arsenic in samples. Tap water from a UK supply was tested, and spiked with As(V) to determine the conversion efficiency to As(III).

PSA 10.256 Online Excalibur and Principle of Operation

Figure 1 shows a schematic drawing of the PSA 10.256 Online Excalibur. The Online Excalibur incorporates the same detection technology as proven Millennium Excalibur, utilizing Hydride Generation – Atomic Fluorescence Spectroscopy to detect arsenic. This method of detection boasts great sensitivity, selectivity and linearity. Figure 2 shows the linear calibration generated using the 10.256. The concentrations used for the calibration were 5, 10 and 25ppb.

The new system favours a batch analysis approach over the previous continuous analysis approach of the 10.255. Accurate volumes of reagents and samples are pulled onto the system using a syringe pump. Reagents are only used when the instrument runs a sample, making the instrument easy to configure if a result is needed less frequently. For this application, 2.5ml of sample was used and acidified with 5ml HCl. The sample was transferred to a UV digestion vessel where all organic arsenic compounds were broken down via photolysis. Before the 15 minute digestion period, 1ml of a KI pre-reductant is added to ensure conversion of all arsenic species to arsenite – As(III). Arsenite more readily forms a hydride thus increasing the fluorescence yield.

The digested sample is then pumped to the GLS where 1ml of reductant is added to form a gaseous hydride of arsenic. The carrier gas then carries the hydride to a flame in the detector. Arsenic is atomised in the flame, and excited using a boosted discharge hollow cathode lamp to give a result.

Reagents and gases used for this application are shown in Table 1.

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Figure 1 Schematic of PSA 10.256 Online Excalibur

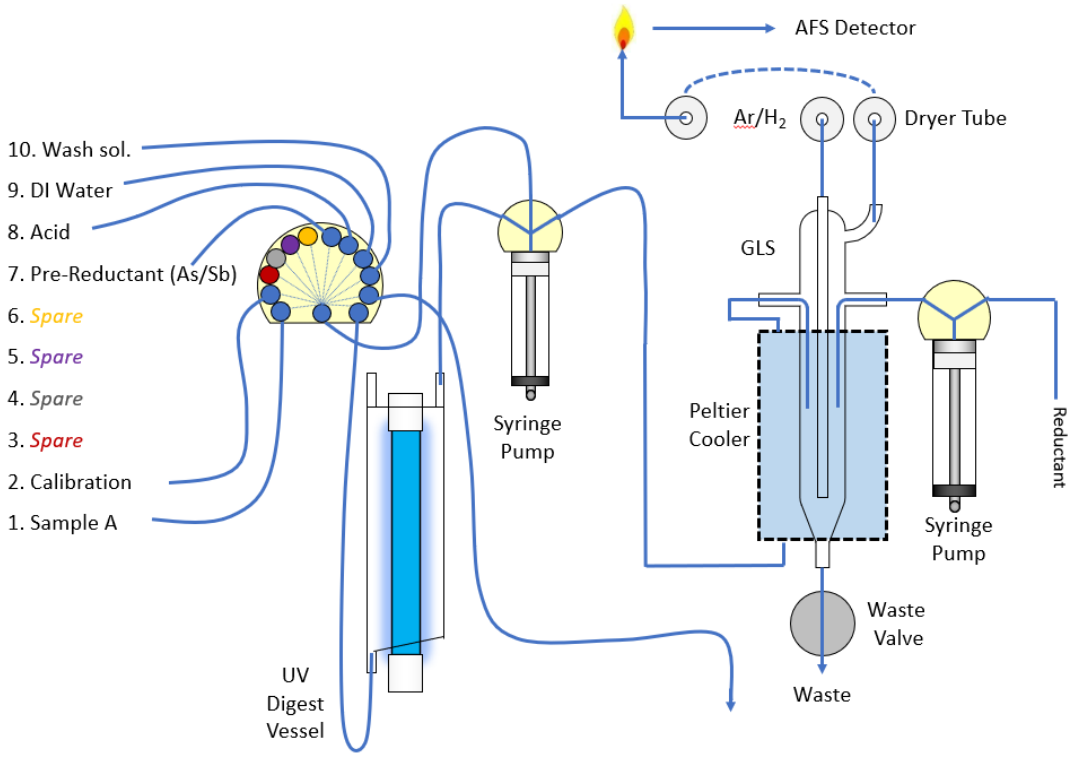

Figure 2 PSA 10.256 Arsenic Calibration

Channel	Conc.	Pk Height	Pk Area	Include	Res %	Res Conc	Temp(°C)
7	0	1.17161	17.88212	yes	0.00000	-0.31564	NA
1	5	23.72510	877.87604	yes	1.42104	0.07105	NA
2	10	48.77058	1733.65356	yes	4.31335	0.43133	NA
3	25	113.41818	4029.74976	yes	-0.74698	-0.18674	NA

Fit Type: Least Squares
Slope: 159.65157
Reslope %:
Y Intercept: 68.27461
Measurement Mode: Area
Correlation Coefficient: 0.99954
Unit: ppb (µg L-1)

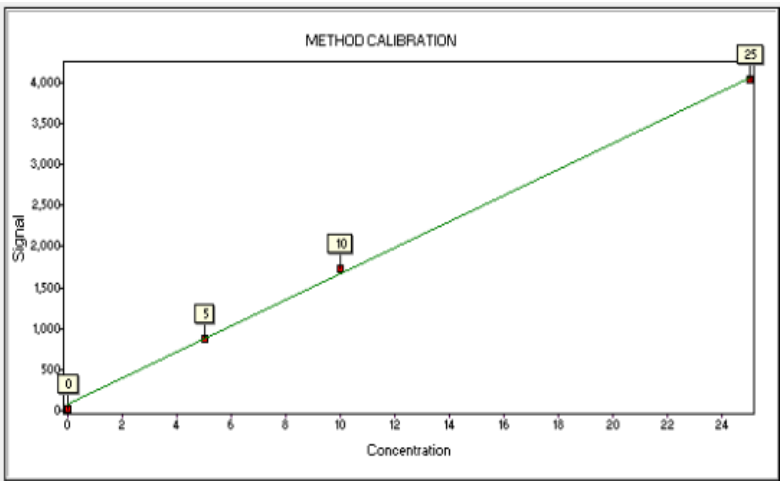

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Table 1 Reagent and Gas Information

Parameter	Condition
Acid	50% v/v Hydrochloric acid
Reductant	0.7% m/v Sodium Borohydride, 0.4% m/v Sodium Hydroxide, 0.3% m/v EDTA
Pre-reductant	25% m/v Potassium Iodide, 5% m/v L-ascorbic acid
Standards	Made in 1% v/v Hydrochloric acid solution using As(III) stock solution
Carrier Gas	Argon @ 3 Bar g, 99.99%+ purity
Dryer Gas	Instrument air @ 4 Bar g, clean dry and oil free
Fuel Gas	Hydrogen @ 0.7 Bar g, 99.99%+ purity

Results and Discussion

The results obtained are summarised in table 2. The data shows the concentration in a tap water sample from a UK supply. This includes a sample spiked with 20 ppb of As(V) to show to conversion efficiency to As(III). The data shows an excellent recovery of As(V) spikes.

Table 2 Summary of Data

Description	Online Result (ppb)	Recovery (%)
Tap Water	0.046 ± 0.08	-
Tap Water + As(V) spike	19.807 ± 0.78	99.04

Conclusions

Arsenic in drinking water is an important application which can affect the health of millions around the world. The PSA 10.256 Online Excalibur has the capability to accurately monitor the concentration of total arsenic in water samples. The online chemistry along with the UV digestion vessel allows for the efficient conversion of all arsenic species to As(III). This instrument is ideally suited for water treatment plants to ensure the working condition of the treatment process.

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