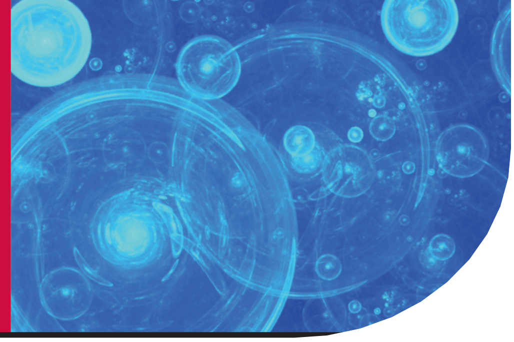

# Analysing for Toxic Elements in Tap and Bottled Drinking Water Using ICP-OES

***Over the last decade, there has been a remarkable increase in the popularity of bottled drinking water. Bottled water manufacturers have capitalised on public concerns about tap water quality and have implemented marketing activities aimed at convincing consumers that bottled water is purer and safer than tap water. According to the 2008 Global Bottled Water report produced by Zenith International, Asia/Australasia represents the largest regional market with a 26.5% share [1]. It has been forecast that the notable rise of Asia's middle classes will expand the global bottled water market to an annual consumption of 280 billion liters by 2012 [2].***

> ***"As the matrix was very clean and deionised water was used to make up the calibration standards, the typical detection limits for the instrument were employed as the method detection limits"***

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Tap and bottled drinking water normally contains small amounts of toxic elements. These amounts can increase owing to a number of reasons, including agricultural practices (such as the use of pesticides containing heavy metals), industrial waste and the leaching of toxic elements from containers that come in contact with water. As long as toxic elements exist in low levels, they don't pose a significant health threat. However, excess concentrations of these compounds can cause serious health problems such as liver and kidney failure, cancer and reproductive difficulties.

Increasing tap and bottled drinking water safety concerns have prompted the introduction of strict legislation with which water companies and bottled water manufacturers must comply. Bottled water regulations, in particular, apply to the country in which the water is purchased and consumed. As a result, bottled water manufacturers must adhere to multiple international regulations specifying maximum limits for toxic elements.

## Regulations

In Europe, the 98/83/EC [3] drinking water directive sets quality standards for drinking water intended for human consumption, covering a range of microbiological, chemical and organoleptic parameters for which maximum limits are specified. The directive is applicable to all water either in its original state or after treatment, intended for drinking, cooking, food preparation or other domestic purposes, regardless of its origin and whether it is supplied from a distribution network, a tanker or in bottles. The rule does not apply to natural mineral waters. Under the 98/83/EC directive, member states must regularly monitor drinking water quality and provide consumers with relevant adequate and up-to-date information. The objective of the directive is to ensure that drinking water is wholesome and clean and to protect the health of consumers in the European Union from the adverse effects of any contamination.

Directive 2009/54/EC [4] sets out rules governing the exploitation and marketing of natural mineral waters. The regulation specifies the treatments to which such waters may be subjected, as well as the substances from which waters must be free. Further provisions regard packaging and labeling. The primary purpose of the directive is to protect the health of consumers, to prevent consumers from being misled and to ensure fair trading. Under the legislation, natural mineral water springs may be exploited and their waters bottled only in accordance with specific safety measures to avoid any possibility of contamination. Periodic quality checks must be performed and if during exploitation it is found that water is polluted, the person exploiting the spring must immediately suspend all exploitation, particularly the bottling process, until the cause of pollution is eradicated.

The list, concentration limits and labeling requirements for the constituents of natural mineral waters that may present a risk to public health are established by the 2003/40/EC [5] directive. Constituents referred to in the directive must be present in the water naturally and may not result from contamination at source. According to the rule, natural mineral waters that contain constituents exceeding the specified maximum limits shall be subjected to separation treatments.

In China and India, a set of regulations are being enforced to safeguard public health. The Chinese GB 8537:2008 rule governs the use of natural mineral water, the GB 17324:2003 is the hygienic standard of bottled purified water for drinking, GB

5749:2006 sets the standards for drinking water quality and GB 3838: 2002 is the environmental quality standard for surface water standard limits. The Indian regulations are governed by the Bureau of Indian Standards (BIS) under BIS 10500:1991 specifying the drinking water requirements, IS: 13428:1998 for packaged natural mineral water and IS: 14543:2004 for packaged drinking water.

To achieve regulatory compliance, water suppliers and bottled water manufacturers need a highly accurate technique for the dependable analysis of toxic elements in water.

## ICP-OES

Inductively coupled plasma optical emission spectrometry is an elemental analysis technique that offers a dynamic linear range and measures all elements in a sample down to levels of 1ppb and lower. The method is capable of screening up to 60 elements in a single sample run within less than one minute.

The samples can be analysed in a wide range of aqueous or organic matrices. ICP-OES utilises a high temperature plasma source, which atomises the sample and excites the atoms. This causes an emission of photons, with each element in the sample emitting different and specific wavelengths.

The technique measures the intensity of these individual wavelengths and the quantity of each element present in the sample is then calculated from the observed intensity. The measurements can be made sequentially or simultaneously.

Latest advancements in ICP-OES have seen the introduction of pre-loaded, analysis-ready hardware parameters and software environmental method templates.

Environmental method templates provide a simple, rapid and cost-effective tool for routine analysis of toxic elements in tap and bottled water samples. Regulatory compliance is facilitated with no requirement for method development.

A variety of tap and bottled waters were analysed for toxic elements using a new ICP-OES method to demonstrate the technique's superior capabilities for this type of analysis.

## Experimental

A dual view compact Thermo Scientific iCAP 6200 ICP-OES instrument was used for the analysis. The instrument is powered by Thermo Scientific iTEVA ICP software suite, which incorporates a pre-loaded analysis-ready environmental method template *(Figure 1)* to simplify method development and enable 'out-of-the-box' analysis with little or no requirement for method development.

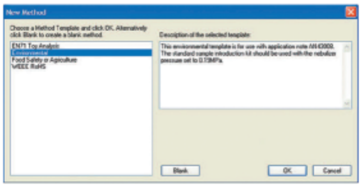



*Figure 1. iTEVA method templates for the iCAP 6200*

## Sample and Standard Preparation

A selection of Chinese tap and bottled drinking waters were chosen for the analysis. A European bottled water which imports into China was also tested for compliance.

A total of five samples were selected, including a tap water sample from Dingpu river area, Shanghai; a tap water sample from Jinqiao lake area, Shanghai; Waterman packaged drinking water; Nestle natural mineral water and Evian natural mineral water.

The samples did not require any pre-treatment and after preservation in 0.5% $HNO_3$, they were analysed directly. Calibration standards were prepared in 0.5% $HNO_3$ at concentrations of 0, 50 and 100 ppb. A QC check solution was used at 10 ppb to test the recovery and stability of the method.

## Method Development

The environmental method template, containing all of the required method parameters and standard concentrations required for this experiment, was opened in the software.

A standard sample handling kit was used for the analysis as per the recommendations in the method. The method parameters are shown in *Table 1*.

*Table 1. Method parameters*

| Parameter | Setting |
|---|---|
| Pump tubing | Sample tygon orange/white<br>Drain tygon white/white |
| Pump rate | 45 rpm |
| Nebulizer | Glass concentric |
| Nebulizer gas flow | 0.19 MPa |
| Spraychamber | Glass cyclonic |
| Auxiliary gas flow | 0.5 L/min |
| Coolant gas flow | 12 L/min |
| Center tube | 2 mm |
| RF power | 1150 W |
| Integration times | Axial 15 seconds |

The samples were repeatedly analysed in a single automated run over a period of four hours. Using the software's sequence automation and check tables, a QC check was analysed after every 10 samples and a calibration was performed after every 25 samples. *Figure 2* shows how the Continuing Actions were set up.

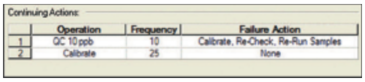



*Figure 2. Flexible sequence automation options in iTEVA*

## Results and Discussion

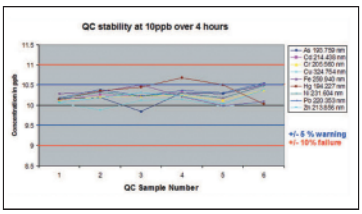
The samples were analysed repeatedly in batches of 10 (two of each of the five samples), followed by a QC check. As the matrix was very clean and deionised water was used to make up the calibration standards, the typical detection limits for the instrument were employed as the method detection limits. *Table 2* demonstrates the averaged results of samples over the four hours and the method detection limits. All of the results were well below the requirements of both the Chinese and Indian regulations with all of the method detection limits shown to be suitable for the analyses. The only exception was mercury in relation to the GB 3838: 2002 regulation, which is too low to quantify when aspirated directly.

*Table 2. Averaged results and method detection limits (MDL) in ppb*

| Element and Wavelength | MDL | Dingpu River | Jinqiao Lake | Waterman | Nestle | Evian |
|---|---|---|---|---|---|---|
| As 193.759 nm | 2.14 | <DL | 1.27 | <DL | <DL | <DL |
| Cd 214.438 nm | 0.07 | <DL | <DL | <DL | <DL | <DL |
| Cr 205.560 nm | 0.21 | <DL | <DL | <DL | <DL | <DL |
| Cu 324.754 nm | 0.39 | <DL | 1.52 | <DL | <DL | <DL |
| Fe 259.940 nm | 0.25 | 1.14 | 1.53 | 0.41 | 0.78 | 0.74 |
| Hg 194.227 nm | 0.66 | <DL | <DL | <DL | <DL | <DL |
| Ni 231.604 nm | 0.36 | 1.05 | 0.57 | <DL | <DL | <DL |
| Pb 220.353 nm | 1.06 | <DL | <DL | <DL | <DL | <DL |
| Zn 213.856 nm | 0.19 | <DL | <DL | <DL | <DL | <DL |

The 10 ppb QC check was used to check for recovery and drift during the run and it was found to be exceptionally stable as *Chart 1* demonstrates. For all elements, with the exception of one mercury QC, the QC recovery was within 5% of the expected value over the four-hour analysis period. As the limits were set to +/- 10% failure, with a warning flag at +/- 5%, all of the QCs passed and did not require further actions within the run.

*Chart 1. Stability of 10 ppb QC Check over 4 hours*




## Conclusion

Advanced ICP-OES technology combines pre-loaded analysis-ready hardware parameters and an environmental software method template to achieve efficient, rapid and analyst friendly detection of toxic elements in tap and bottled drinking water. The technique allows novice and experienced analysts to generate excellent results with minimum investment of time while also enabling a highly cost-efficient sample analysis regime. Regulatory compliance is easily achieved without the need for method development.

## References

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*[2]. Global Water News, Asian Middle Classes' Thirst for Bottled Water Will Pull Trigger on an Eastern Blue Gold Rush, http://globalwaternews.com/?p=330*

*[3]. COUNCIL DIRECTIVE 98/83/EC of 3 November 1998 on the quality of water intended for human consumption, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:1998:330:0032:0054:EN:PDF*

*[4]. DIRECTIVE 2009/54/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 18 June 2009 on the exploitation and marketing of natural mineral waters, http://www.fsai.ie/uploadedFiles/Legislation/Food_Legisation_Links/Water/Dir2009_54.pdf*

*[5]. COMMISSION DIRECTIVE 2003/40/EC of 16 May 2003 establishing the list, concentration limits and labeling requirements for the constituents of natural mineral waters and the conditions for using ozone-enriched air for the treatment of natural mineral waters and spring waters, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2003:126:0034:0039:EN:PDF*

# Rapid Diagnosis of Pathogenic Legionella Species


**Oxoid** has launched Xpect™ Legionella, a rapid immunochromatographic test for the direct detection of Legionella pneumophila serogroups 1 and 6 antigen in human urine samples.

Pneumonia caused by Legionella pneumophila (Legionnaires' Disease) was first recognised in 1977 after an outbreak among attendees at the 1976 American Legion convention. Since then infection by Legionella spp. has been found to be an important cause of community-acquired and nosocomial pneumonia. The number of cases of Legionnaires' Disease reported by the European Working Group for Legionella Infections has increased in recent years. In 2007, 946 cases were reported, compared to 360 in 2000. In the UK, figures have more than doubled with 236 cases reported in 2007, compared to 107 in 2000.

Due to the epidemic potential and high case fatality rate of Legionnaires' Disease, surveillance is important to detect, control and prevent further outbreaks. The use of Xpect Legionella allows early diagnosis and rapid initiation of antibiotic therapy. Xpect Legionella demonstrates excellent sensitivity and specificity, can be stored at room temperature, and is easy to use and interpret. A positive test is indicated by two black lines; one in the Test region and one in the Control region. A negative test is indicated by only one black line in the Control region.

Circle no. 88

# Launch of New $CO_2$ Incubators


**Esco** announced the launch of its new range of CelCulture® $CO_2$ Incubators – world-class $CO_2$ incubators with the technologies and compliance to prove it. Key features include: precise parameter control; robust contamination control with ULPA filtration system and 90°C moist heat decon cycle; direct heat and air jacket design with 8 heaters grouped into 3 zones; gentle yet effective forced convection; intuitive interfaces; and intelligent data and event logger with 16MB built-in flash memory, all supported by Esco's solutions and sales and service representatives based worldwide.

CelCulture® incubators offers VivoCell™ precise temperature, $CO_2$ control and high humidity; CelSafe™ contamination control system for proactive and reactive protection; user-friendly software interface; and an easy to clean and service design. "The launch of our $CO_2$ incubator line marks a major milestone in Esco's development as a controlled environment laboratory equipment solutions provider," said XQ Lin, Esco Vice President. "Being a world leader in biological safety cabinets, we expect to be able to package our safety cabinets and incubators to offer a total cell culture solution."

Circle no. 89