Application Note: 43008

Analysis of Toxic Elements in Drinking and Bottled Waters using the Thermo Scientific iCAP 6200 ICP-OES

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Key Words

- iCAP 6200
- Method template
- Environmental analysis
- Drinking water
- Bottled water

Benefits in Brief

- Pre-loaded method template provides a simple, effective tool for routine environmental analysis
- Duo plasma enables best detection limits for toxic elements using axial view
- Regulatory compliance made easy with no requirement for method development

Introduction

The increase in popularity of bottled drinking water has prompted many new regulations which bottled water manufacturers must adhere to. These apply to the country in which the water is sold and consumed. China and India have seen a huge increase in the consumption of bottled water in the last decade which has prompted the contract analysis of toxic elements in these products to the following regulations in the respective countries (listed below with maximum limits expressed in Table 1). China:

- GB 8537:2008 - Governs the use of natural mineral water
- GB 17324:2003 - Hygienic standard of bottled purified water for drinking
- GB 5749:2006 - Standards for drinking water quality
- GB 3838: 2002 - Environmental Quality Standard for surface water standard limits

The Indian regulations are governed by the Bureau of Indian Standards (BIS – formerly named the Indian Standards Institution, ISI). These regulations are listed below and the maximum limits are highlighted in Table 1 for reference.

- BIS 10500:1991 - Specifies the drinking water requirements
- IS: 13428:1998 - Packaged Natural Mineral Water
- IS: 14543:2004 - Packaged Drinking Water

Instrumentation

The Thermo Scientific iCAP 6200 ICP-OES was used for the analysis. This is a compact dual view ICP instrument based on the powerful core technologies of the Thermo Scientific iCAP 6000 Series ICP-OES. The instrument achieves powerful analyte detection and provides a highly cost effective solution for routine analysis of liquids in laboratories with standard sample throughput requirements. The Thermo Scientific iTEVA Software incorporates several pre-loaded analysis-ready method templates (see Figure 1) to simplify method development and enables 'out-of-the-box' analysis with little or no requirement for method development.

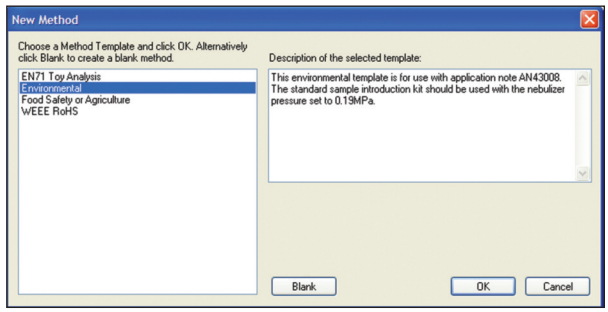

Figure 1: iTEVA method templates for the iCAP 6200.

Sample and standard preparation

A selection of drinking water samples (tap water and bottled water) were collected in China for analysis. In addition, a European bottled water was also tested for comparison. The samples are listed below:

- Tap water sample from Dingpu river area, Shanghai
- Tap water sample from Jinqiao lake area, Shanghai
- Waterman (packaged drinking water)
- Nestle (natural mineral water)
- Evian (natural mineral water)

	IS 13428:1998 - Packaged Natural Mineral Water	IS 14543:2004 - Packaged Drinking Water	BIS 10500:1991 - Drinking water	GB 5749:2006 - Drinking water	GB 8537:2008 - Natural mineral water	GB 17324:2003 - Bottled purified water	GB 3838: 2002 - Surface water standard limits (I)[1]
Arsenic	0.05	0.05	0.01	0.01	0.01	0.01	0.05
Cadmium	0.003	0.01	0.01	0.005	0.003	-	0.001
Chromium*	0.05	0.05	0.05	0.05	0.05	-	0.01
Copper	1	0.05	0.05	1	1	0.01	0.01
Iron	-	0.1	0.3	0.3	-	-	0.3
Lead	0.01	0.01	0.05	0.01	0.01	0.01	0.01
Mercury	0.001	0.001	0.001	0.001	0.001	-	0.00005
Nickel	0.02	0.02	-	0.02	0.02	-	0.02
Zinc	5	5	5	1	0.2	-	0.05

Table 1: Maximum permissible levels in ppm.

[1] For GB 3838, (I) refers to Class I categories, stated as mainly applicable to the source of water, National Nature Reserve.

* For Chinese regulations, chromium is defined as hexavalent chromium present.

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

Method Development

The Environmental Method Template was opened within the Thermo Scientific iTEVA Software – this contains all of the required method parameters and standard concentrations as listed in this note. A standard sample handling kit was used for the analysis as per the recommendations in the method notes. The method parameters are shown below in Table 1.

Parameter	Setting
Pump tubing	Sample tygon orange/white 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

Table 1: Method parameters.

The samples were repeatedly analyzed in a single automated run over a period of 4 hours. The Sequence Automation and Check Table functionality within the iTEVA Software were used to perform a QC check every 10 samples and a calibration after every 30 samples. Figure 2 below shows how the *Continuing Actions* were set up.

Continuing Actions:

	Operation	Frequency	Failure Action
1	QC 10 ppb	10	Calibrate, Re-Check, Re-Run Samples
2	Calibrate	25	None

Figure 2: Flexible sequence automation options in iTEVA.

Results

The samples were analyzed repeatedly in batches of 10 (2 of each of the 5 samples), followed by a QC check. Table 2 shows the averaged results of samples over the 4 hours and the method detection limits. The measured water samples are found to contain analyte concentrations that lie well within the Chinese and Indian regulations. The method detection limits are shown to be fit for purpose for this application. However, the use of hydride generation accessories may be employed to further improve method detection limits for mercury (to sub ppb levels) when required.

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

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

The 10 ppb QC check was used to check for recovery and drift during the run; this was found to be exceptionally stable as the chart below demonstrates. All QC recoveries are measured comfortably within 10 % of their expected values throughout the 4 hour run.

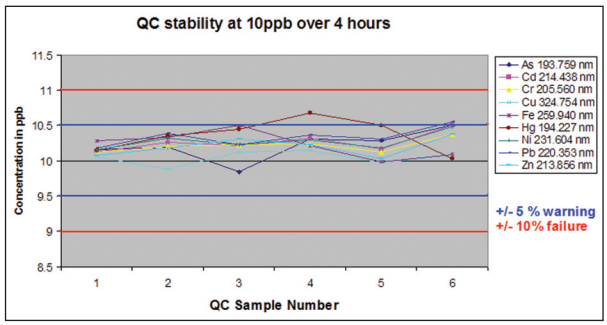

Chart 1: Stability of 10 ppb QC Check over hours.

Conclusion

The analysis of environmental samples is rapid and analyst friendly using the iCAP 6200 ICP-OES with the pre-loaded Environmental Method Template. The powerful and innovative design features of this instrumentation allow both novice and experienced analysts to quickly generate excellent results. The result is a highly cost efficient sample analysis regime.

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