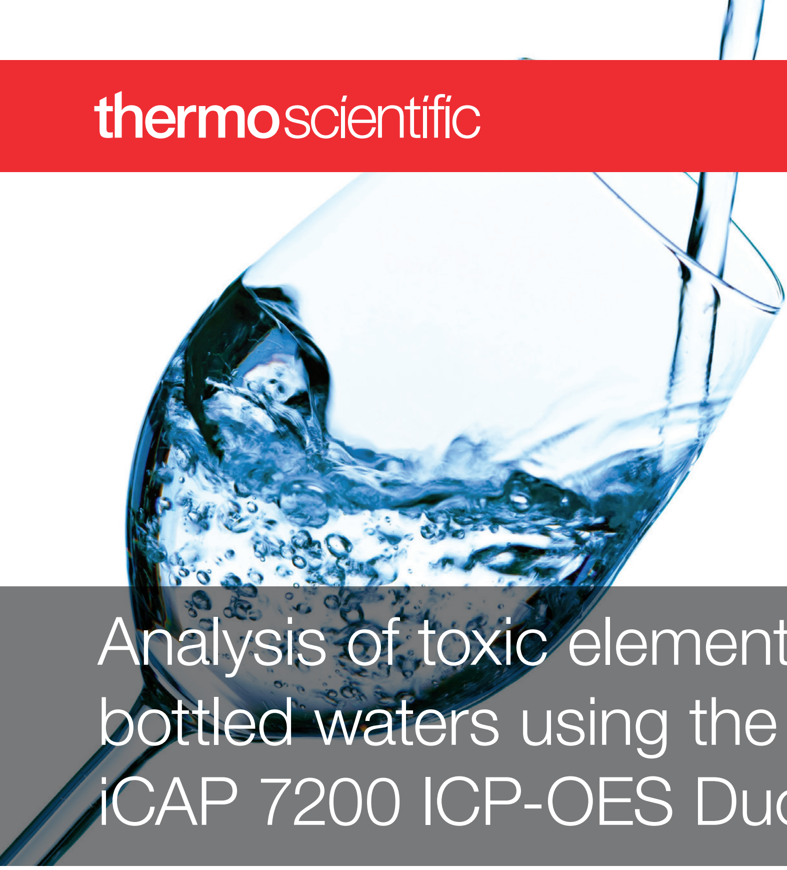

APPLICATION NOTE 43154

Analysis of toxic elements in drinking and bottled waters using the Thermo Scientific iCAP 7200 ICP-OES Duo

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Keywords
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Goal

This application note describes the analysis of several toxic elements in drinking and bottled waters using the Thermo Scientific iCAP 7200 ICP-OES Duo. The duo plasma enables excellent detection limits for toxic elements using axial view.

Introduction

The increase in popularity of bottled drinking water has prompted many new regulations which 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 decades which has driven 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).

Chinese regulations:

- GB 8537–2008 - Drinking 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

Indian regulations:

- IS 10500:2012 - Drinking Water
- IS 13428:2005 - Packaged natural mineral water
- IS 14543:2004 - Packaged drinking water (other than packaged natural mineral water)

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Table 1. Maximum permissible levels in mg·kg^{-1}.

Element	GB 8537-2008	GB 17324-2003	GB 5749-2006	GB 3838-2002 (I)[1]	IS 10500:2012	IS 13428:2005	IS 14543:2004
Arsenic	0.01	0.01	0.01	0.05	0.01	0.05	0.05
Cadmium	0.003	-	0.005	0.001	0.003	0.003	0.01
Chromium*	0.05	-	0.05	0.01	0.05	0.05	0.05
Copper	1	0.01	1	0.01	0.05	1	0.05
Iron	-	-	0.3	0.3	0.3	-	0.1
Lead	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Mercury	0.001	-	0.001	0.00005	0.001	0.001	0.001
Nickel	0.02	-	0.02	0.02	0.02	0.02	0.02
Zinc	0.2	-	1	0.05	5	5	5

[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.

Instrumentation

The Thermo Scientific™ iCAP™ 7200 ICP-OES Duo was used for the analysis. This is a compact dual view ICP-OES instrument based on the powerful core technologies of the Thermo Scientific iCAP 7000 Plus 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™ Qtegra™ Intelligent Scientific Data Solution™ (ISDS) Software incorporates various functions for simplified method development and easy post-analysis data manipulation.

Sample and standard preparation

A selection of drinking water samples (tap water and bottled water) were collected in China for analysis. In addition, 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)

The samples did not require any pre-treatment and were analyzed directly after preservation in 0.5% analytical grade nitric acid (HNO_3). Calibration standards were prepared in 0.5% HNO_3 at the following concentrations: 0, 50 and 100 µg·kg^{-1}. A QC check solution was prepared at 10 µg·kg^{-1} to check recovery rate and test the stability of the method.

Method development and analysis

A method was created with Qtegra ISDS Software and analytes added as indicated in Table 3. A standard sample introduction kit was used for the analysis as per the recommendations in the method notes. The method parameters are shown in Table 2.

Table 2. Methods parameters.

Parameter	Setting
Pump Tubing	Sample Tygon® orange/white Drain Tygon® white/white
Pump Speed	45 rpm
Nebulizer	Glass concentric
Nebulizer Gas Flow	0.19 MPa
Spray Chamber	Glass cyclonic
Auxiliary Gas Flow	0.5 L·min^{-1}
Coolant Gas Flow	12 L·min^{-1}
Center Tube	2 mm
RF Power	1150 W
Plasma View	Axial
Exposure Time	5 s

The samples were repeatedly analyzed in a single automated run over a period of 4 hours. Using the functionalities of Qtegra ISDS Software, a QC check was performed every 10 samples, recalibrating, recalculating and reacquiring from a previous sample whenever this check fails. A calibration was performed every 30 samples as per the requirements of the regulation.

Results

The samples were analyzed repeatedly in batches of 10 (2 of each of the 5 samples). Table 3 shows the averaged results of samples over the 4 hours and the method detection limits (MDLs). The concentrations found in all the samples were within the values outlined in the Chinese and Indian regulations. The MDLs are shown to be fit for purpose for this application. Nevertheless, the use of hydride generation accessories may be employed to further improve MDLs, particularly for mercury (to achieve sub μg·kg^{-1} levels) when required.

Table 3. Averaged results and method detection limits in μg·kg^{-1}.

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

The 10 μg·kg^{-1} QC check was used to check for recovery rates and drift during the run; which was found to be exceptionally stable as the chart in Figure 1 demonstrates. All QC recoveries were within 10% of their expected values throughout the 4 hour run.

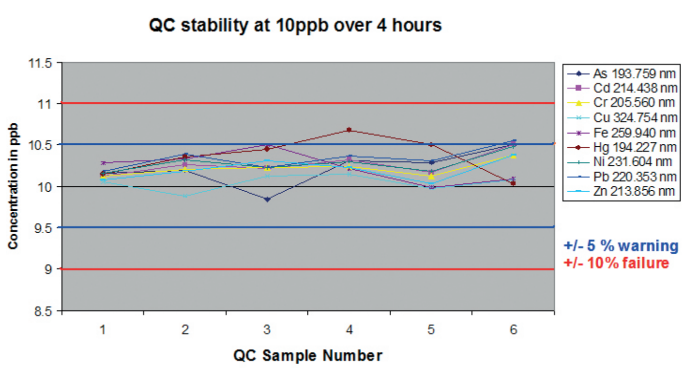

Figure 1. Stability of the 10 μg·kg^{-1} QC check over 4 hours.

Conclusion

The analysis of environmental samples is rapid and analyst friendly using the Thermo Scientific iCAP 7200 ICP-OES Duo. The powerful and innovative design features of this instrument allow both novice and experienced analysts to quickly generate excellent results which allows a highly cost efficient sample analysis regime.

Find out more at **thermofisher.com/ICP-OES**

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