Quality assurance in wat

Determination of selected elements using ICP-OES

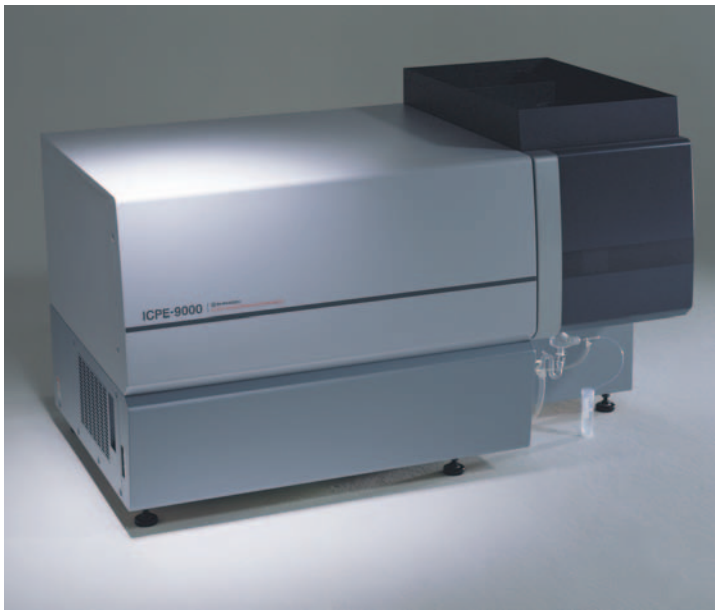

Figure 1: ICPE-9000

Atomic spectrometry is frequently applied for accurate quantification of elements in the trace and ultra-trace range. Modern analytical systems such as atomic absorption spectrometers for sequential analysis of selected elements or ICP (inductively-coupled plasma) spectrometers for simultaneous multi-element analysis enable fully automatic operation and high sample throughput.

Monitoring of limiting or threshold values according to the European Drinking Water Directive and the German Waste Water Levy Act as well as the Effluent Charges Act requires reliable and rapid measurement and determination of relevant parameters using spectroscopic methods. Simultaneous ICP spectrometry has proven to be an extraordinarily important technology for the quantitative determination of element concentrations, and enables accurate determination of major-, minor- and trace elements in water analysis.

According to the most recent version of the European Drinking Water Directive from January 2003, the limiting and threshold values for certain elements have been reduced. The limiting value for lead was reduced from 0.05 to 0.01 mg/L, as lead has been shown to be especially toxic to children and adolescents as well as to pregnant women. Monitoring of copper in drinking water has also been stepped up and the reference value for copper was reduced from 3 mg/L to 2 mg/L. Although copper is a commonly distributed metal in the environment and is an essential trace element for humans, it can lead to severe health problems in infants and toddlers after prolonged exposure at concentrations as low as 10 mg/L.

Reducing the nickel limiting value from 0.05 mg/L to 0.02 mg/L should assure that nickel contamination levels of drinking water do not lead to further increase in the already common nickel allergies in humans.

Simultaneous multi-element analysis

A Shimadzu ICPE-9000 system featuring a wide dynamic range and high sample throughput was used for the determination of water samples (Figure 1). This simultaneous ICP with CCD detector (charge-coupled device) is equipped with a unique optical system that sets new standards with respect to performance and speed.

The ICP-9000 system uses a plasma torch to vaporize liquid samples, and the atoms and ions released are excited and subsequently emit radiation. The emitted radiation is processed by the optical system and detected via

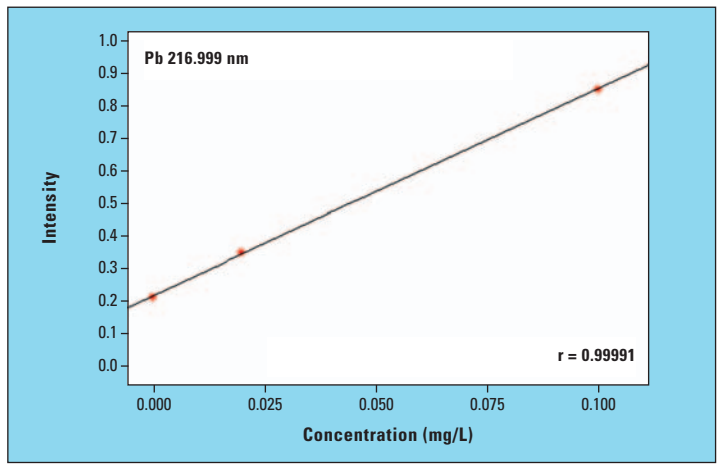

Figure 2: Calibration curve for lead

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the CCD detector, whereby the emission spectra of all elements under investigation are recorded. The high sensitivity of the detector assures accurate resolution, even for closely neighboring emission lines such as copper (213.60 nm) and phosphorus (213.62 nm). The intensity of the radiation is proportional to the concentration of the elements present in the sample.

Quantitative determination of the elements is carried out using calibration curves of multi-element standards. Figure 2 shows the calibration curve of lead in the concentration range up to 100 µg/L. The elements chromium, copper, cadmium, manganese and nickel are also analyzed in the same concentration range whereby sample injection was carried out using an ultrasonic nebulizer (optional). For the determination of boron, calcium, magnesium and sodium, a coaxial nebulizer was used. The instrumental parameters are summarized in Table 1.

To validate the analytical results, the reference material JAC 0032 (River water standard material JAC 0032, JSAC: The Japan Society for Analytical Chemistry) was analyzed under the same conditions as the water samples. As shown in Table 2, the experimental data correspond closely with those obtained for the certified reference material.

Continuous monitoring of drinking water in accordance with international standards, such as the European Drinking Water Directive, provides end-users with the highest possible assurance of consistent drinking water quality. Shimadzu's ICPE-9000 multi-element spectrometer is a modern tool that ensures reliable determination of all relevant parameters in water quality monitoring.

We will gladly send you further information. Please note the appropriate number on your reply card. **Info 316**

ICPE-9000	Coaxial nebulizer	Ultrasonic nebulizer
RF Generator performance	1.2 KW	1.0 KW
Cooling gas	10 L/min	8 L/min
Plasma gas	0.6 L/min	0.6 L/min
Carrier gas	0.7 L/min	0.6 L/min
Plasma torch	Standard	Standard
Configuration	Axial	Axial

Table 1: Instrumental parameters

Element	Reference standard JAC 0032	
	Experiment	Certificate
Pb µg/L	9.7	9.9 ± 0.2
Cr µg/L	10.1	10.1 ± 0.2
Cd µg/L	1.0	1.00 ± 0.02
Cu µg/L	10.3	10.5 ± 0.2
Fe µg/L	56.4	57 ± 2
Mn µg/L	5.4	5.4 ± 0.1
Zn µg/L	10.9	11.3 ± 0.4
B µg/L	60.3	59 ± 2
Al µg/L	61.2	61 ± 2
Ni µg/L	9.9	10.2 ± 0.3
Mo µg/L	0.4	– –
Ca mg/L	12.3	12.5 ± 0.2
Mg mg/L	2.8	2.86 ± 0.04
Na mg/L	4.4	4.5 ± 0.1

Table 2: Comparison of measuring results (concentrations in µg/L, Ca, Mg and Na in mg/L)