Cost-Effective Determination of Inorganic Anions and Cations in Municipal Drinking Water Using Capillary Ion Chromatography

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Introduction

The determination of common inorganic anions and cations in drinking water is one of the most important applications of ion chromatography (IC) worldwide. IC has been approved for compliance monitoring of inorganic anions in United States (U.S.) drinking water since the mid-1980s, as described in U.S. Environmental Protection Agency (EPA) Method 300.0.[1] Many other industrialized countries have similar health and environmental standards and a considerable number of regulatory IC methods have been published worldwide (e.g., in Germany, France, Italy, and Japan). In addition, many standards organizations, including the International Organization for Standardization (ISO), American Society for Testing and Materials (ASTM), and American Water Works Association (AWWA), have validated IC methods for the determination of inorganic anions in drinking water.[2,3] The concentration of some anions in drinking water are regulated due to their toxic effects. For example, high levels of fluoride can cause skeletal and dental fluorosis, and nitrite and nitrate can cause methemoglobulinemia, which can be fatal to infants. Other common anions, such as chloride and sulfate, are considered secondary contaminants and can affect odor, color, and certain aesthetic characteristics in drinking water.

IC methods for dissolved alkali and alkaline earth metals and ammonia in drinking water are also important. Drinking water is frequently monitored for the presence of sodium under the U.S. EPA Safe Drinking Water Act. Ammonium is commonly a required target analyte for wastewater discharge permits, and is monitored in process wastewaters.

This study describes the determination of inorganic anions and cations in drinking water using the Thermo Scientific™ Dionex™ ICS-5000 capillary IC system. Scaling down from standard bore to capillary scale brings many benefits to IC analysts. Capillary Thermo Scientific Dionex Reagent-Free™ IC systems deliver fast turnaround from sample submission to results by reducing eluent preparation, system startup, and equilibration times. Perhaps most importantly, the system can be left on and ready for analysis at any time because of its low consumption of eluent (15 mL of source water a day). Having the system always on and ready for analysis significantly streamlines the workflow in IC. An always-on system maintains stability and requires less frequent calibrations. The amount of waste generated is significantly decreased and the eluent generation cartridge producing the eluent lasts 18 months under continuous operation mode, which translates into reduced overall cost of ownership.

Figure 1 shows the determination of inorganic anions in drinking water using capillary IC. The inorganic anions were separated on the Thermo Scientific Dionex IonPac™ AS19 capillary column and detected by suppressed conductivity detection. All anions were separated and eluted within 13 min. The relative standard deviation of peak area for each analyte was 0.6% when 60 injections were evaluated within 24 h.

Figure 2 shows the determination of inorganic cations in drinking water using capillary IC. The inorganic cations were separated on the Dionex IonPac CS12A capillary column and detected by suppressed conductivity detection. All cations of interests were determined within 12 min.

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Column: Dionex IonPac AG19, AS19, Capillary, 0.4 mm
Eluent: KOH (RFIC-EG)
Gradient: 15 mM from 0 to 7 min, 15–60 mM from 7 to 18 min
Flow Rate: 10 µL/min
Inj. Volume: 0.4 µL
Col. Temp.: 30 °C
Detection: Suppressed conductivity, Thermo Scientific Dionex ACES™ Anion Capillary Electrolytic Suppressor
Sample: Municipal drinking water undiluted

Peaks: 1. Chloride 106 mg/L
2. Nitrate 2.8
3. Sulfate 30

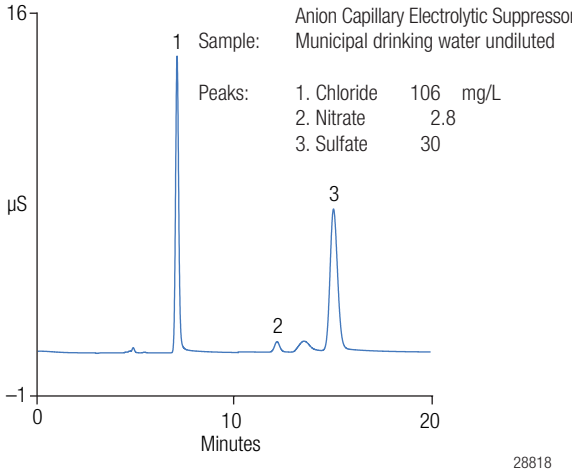

Figure 1. Anions in municipal drinking water on the Dionex IonPac AS19 capillary column.

Column: Dionex IonPac CG12A, CS12A, Capillary, 0.4 mm
Eluent: MSA (RFIC-EG)
Gradient: 6–65 mM from 0 to 30 min
Flow Rate: 10 µL/min
Inj. Volume: 0.4 µL
Col. Temp.: 40 °C
Detection: Suppressed conductivity, Thermo Scientific Dionex CCES™ Cation Capillary Electrolytic Suppressor
Sample: Municipal drinking water undiluted

Peaks: 1. Sodium 3.3 mg/L
2. Ammonium 0.11
3. Potassium 0.25
4. Magnesium 0.37
5. Calcium 2.9

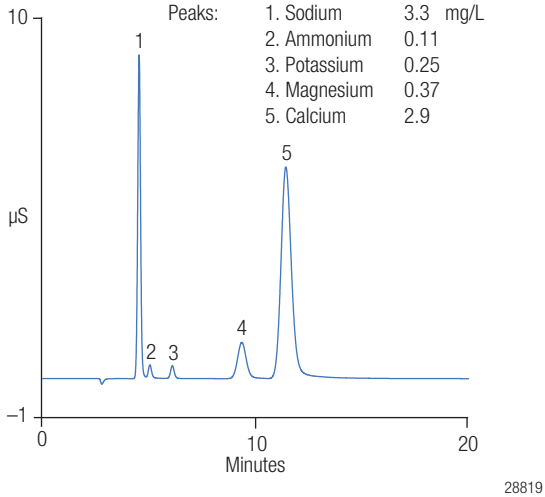

Figure 2. Cations in municipal drinking water on the Dionex IonPac CS12A capillary column.

Conditions

The Dionex ICS-5000 capillary system, Thermo Scientific Dionex AS-AP Autosampler, and Thermo Scientific Dionex Chromeleon™ Chromatography Data System software are used in this experiment. All experimental parameters are listed in Figures 1 and 2.

Sample Preparation

Analyze municipal drinking water by capillary IC without sample pretreatment.

Conclusion

The introduction of the capillary Reagent-Free IC systems redefine the IC workflow for determination of inorganic anions and cations, providing enhanced mass sensitivity and ease of use.[4] These systems are a great solution for routine characterization of water samples with the always on, always ready capability simplifying the overall IC workflow.

References

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3. *Standard Test Methods for Anions in Water by Chemically Suppressed Ion Chromatography;* D4327-97, Vol. 11.01; American Society for Testing and Materials; West Conshohocken, PA; 1999; pp 420–427.
4. Dionex Corporation (now part of Thermo Scientific), *Mass Sensitivity of Capillary IC Systems Explained.* Technical Note 90, LPN 2649, Sunnyvale, CA, 2011.

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AB70453_E 08/16S