APPLICATION BRIEF 73725

Low-cost determination of anions in municipal drinking water

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Introduction

Ion chromatography (IC) is a well-accepted technique for monitoring inorganic anions in water, including surface, ground, drinking, and waste waters. In the United States, water quality is regulated through the Safe Drinking Water Act (SDWA) and the Clean Water Act (CWA) and enforced through the United States Environmental Protection Agency (U.S. EPA).[1] IC methods have been approved by the EPA for compliance monitoring of inorganic anions in drinking water since the 1980s through U.S. EPA Method 300.1 that was updated in 1997 to U.S. EPA Method 300.[2] Various IC methods for water analysis have been demonstrated in Thermo Scientific™ Dionex™ application notes using standard or microbore flow rate columns with both carbonate/bicarbonate and hydroxide eluents.[3]

This work demonstrates the determination of inorganic anions in drinking water by IC using the Thermo Scientific™ Dionex™ IonPac™ AS22 column set on the Thermo Scientific™ Dionex™ Easion™ Ion Chromatography system in Displacement Chemical Regeneration (DCR) mode. Figure 1 shows a diagram of the setup. The Dionex Easion IC system is an integrated, single-channel low-cost IC system designed for isocratic applications with suppressed conductivity detection. Coupled to the Thermo Scientific™ Dionex™ AS-DV Autosampler, it provides a low-cost choice for routine water analysis.

Equipment and consumables

- Dionex Easion IC system
- Dionex AS-DV Autosampler
- Thermo Scientific™ Dionex™ Chromeleon™ 7.2.10 MuA Chromatography Workstation

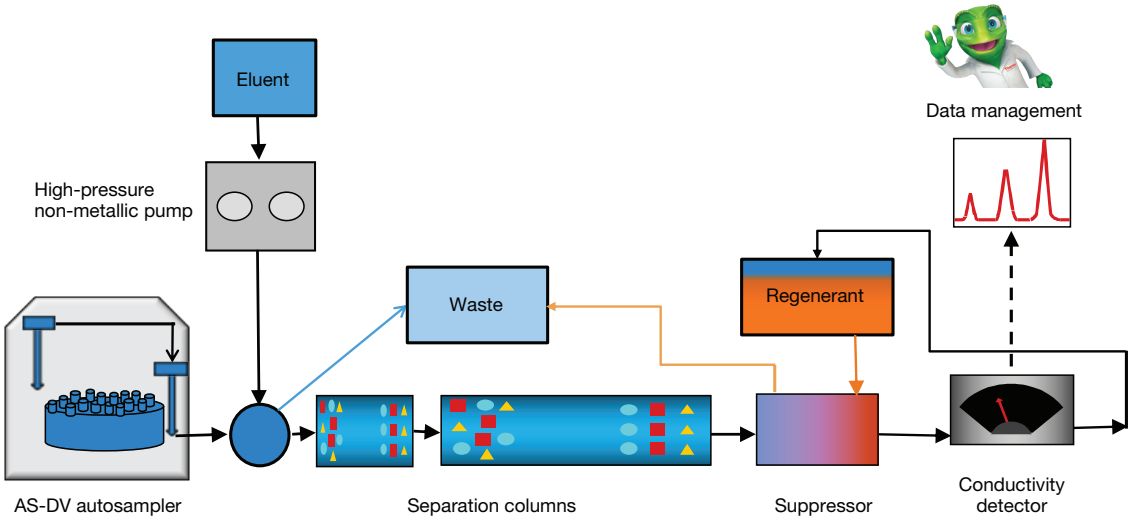


Figure 1. Illustration of an IC system in DCR mode.

Table 1. Consumables

Product name	Part no.
Thermo Scientific™ Dionex™ DCR Installation Kit for 4 mm column	056884
Thermo Scientific™ Dionex™ ACRS 500 Anion Chemically Regenerated Suppressor (4 mm)	085090
Thermo Scientific™ Dionex™ IonPac™ AS22 Guard Column (4 x 50 mm)	064139
Thermo Scientific™ Dionex™ IonPac™ AS22 Analytical Column (4 x 250 mm)	064141
Thermo Scientific™ Dionex™ Displacement Chemical Regeneration (DCR) Reagents	057559
Thermo Scientific™ Dionex™ AS22 Eluent Concentrate (100x)	063965
Thermo Scientific™ Dionex™ AS-DV Autosampler PoyVial (5mL) and filter cap (20 µm), 250 pack	038141

Experimental

All reagents (eluent, regeneration solution, and standard) were prepared with degassed deionized (DI) water with 18 MΩ-cm resistance or better.

Individual anion standard stock solutions (1000 mg/L) were prepared by dissolving sodium or potassium salts (A.C.S. reagent grade or better) in DI water. Aliquots of these standard were combined and diluted with DI water to prepare mixed calibration standards (Table 2).

A drinking water sample was collected locally. No filtration was needed as filter caps were used on the Dionex AS-DV autosampler vials.

The chromatography conditions are listed in Figures 2 and 3.

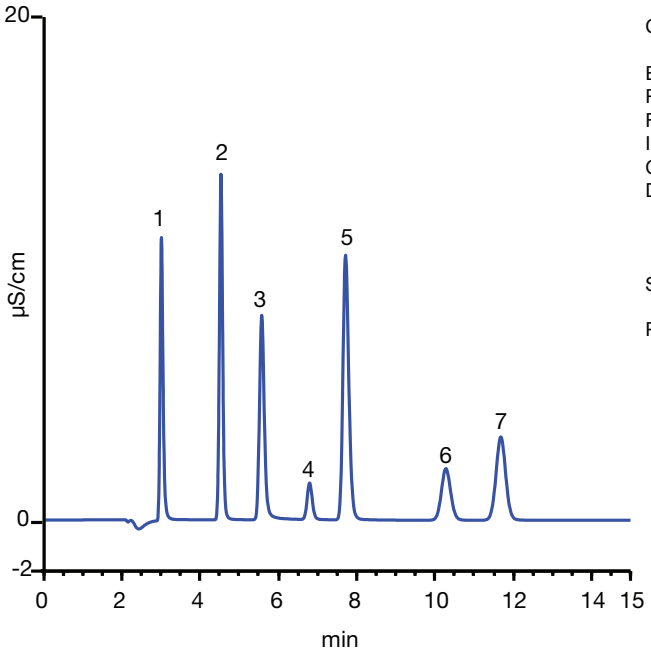
Table 2. Calibration standards (mg/L)

Level	1	2	3	4	5	6	7	8
Fluoride	0.1	1	5	10	20	-	-	-
Chloride	0.2	2	10	20	40	50	100	200
Nitrite-N	0.1	1	5	10	20	-	-	-
Bromide	0.1	1	5	10	20	-	-	-
Nitrate-N	0.1	1	5	10	20	-	-	-
Phosphate-P	0.1	1	5	10	20	-	-	-
Sulfate	0.2	2	10	20	40	50	100	200

Results and discussion

Figure 2 shows a separation of inorganic anions within 15 min using the Dionex IonPac AS22 column. As this figure shows, seven inorganic anions are well resolved. The Dionex IonPac AS22 column can be used for compliance monitoring of inorganic anions in water.

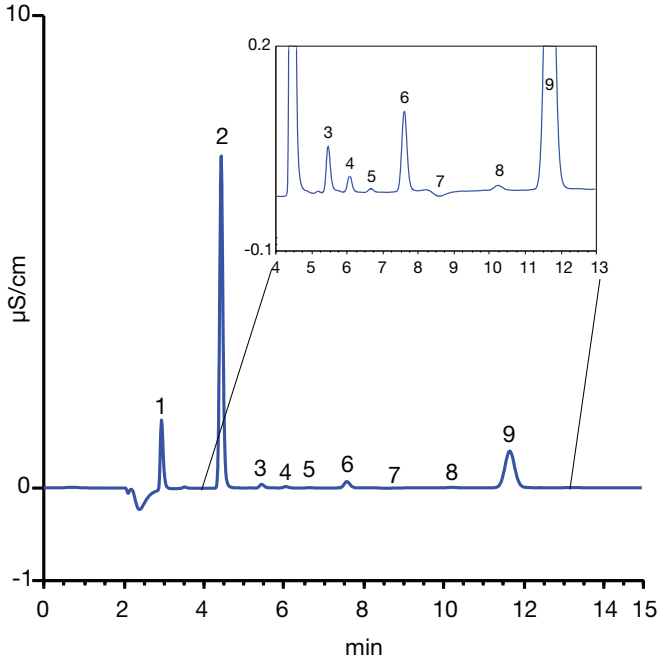
Figure 3 shows the determination of inorganic anions in a drinking water sample. Among the common anions, fluoride, nitrate, and nitrite are regulated with the Maximum Contaminant Level (MCL) for fluoride at 4 mg/L, nitrite at 1 mg/L, and nitrate at 10 mg/L. The results show that the drinking water sample contains chloride (3.41 mg/L), sulfate (1.65 mg/L) with less than 1 mg/L of fluoride (0.57 mg/L), nitrite-N (0.04 mg/L), bromide (0.02 mg/L), nitrate-N (0.05 mg/L), and phosphate-P (0.01 mg/L), which meet the safety criteria.



Columns:	Dionex IonPac AG22, 4 x 50 mm and Dionex IonPac AS22, 4 x 250 mm
Eluent:	4.5 mM Na_2CO_3 / 1.4 mM $NaHCO_3$
Regenerant:	50 mM sulfuric acid
Flow rate:	1.2 mL/min
Inj. volume:	25.0 µL (full loop)
Column temp.:	Ambient
Detection:	Suppressed conductivity, Dionex ACRS 500 Suppressor (4mm), in DCR mode.
Sample:	A mixed anions standard

Peaks:		min	mg/L
1	Fluoride	3.0	5.0
2	Chloride	4.5	10.0
3	Nitrite	5.6	5.0
4	Bromide	6.8	5.0
5	Nitrate	7.7	5.0
6	Phosphate	10.3	5.0
7	Sulfate	11.7	10.0

Figure 2. Separation of common anions using the Dionex IonPac AS22 column.



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Regenerant:	50 mM sulfuric acid
Flow rate:	1.2 mL/min
Inj. volume:	25.0 µL (full loop)
Column temp.:	Ambient
Detection:	Suppressed conductivity, Dionex ACRS 500 Suppressor (4mm), in DCR mode
Sample:	A municipal drinking water sample

Peaks:		min	mg/L
1	Fluoride	3.0	0.57
2	Chloride	4.5	3.41
3	Nitrite	5.6	0.04
4	Unknown	6.1	n.a
5	Bromide	6.8	0.02
6	Nitrate	7.7	0.05
7	Carbonate	~8.5	n.a
8	Phosphate	10.3	0.01
9	Sulfate	11.7	1.65

Figure 3. Analysis of municipal drinking water using the Dionex IonPac AS22 column.

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Linearity and precision

Table 3. Linearity obtained using the Dionex IonPac AS22 column with a 25.0 µL injection

Analyte	Range (mg/L)	Coefficient of determination *(r^2)
Fluoride	0.1-20	1.000
Chloride	0.2-200	0.999
Nitrite-N	0.1-20	0.999
Bromide	0.1-20	1.000
Nitrate-N	0.1-20	0.997
Phosphate-P	0.1-100	0.998
Sulfate	0.2-200	0.999

* Calibration type is linear and ignore origin.

Table 3 shows the calibrations are linear for the inorganic anions with r^2 from 0.997 to 1.

Conclusion

This work shows the determination of inorganic anions in a drinking water sample using the Dionex Easion IC system in DCR mode. The integrated Dionex Easion IC system coupled with the Dionex AS-DV autosampler provides a simple and low-cost instrument setup for routine determination of inorganic anions in drinking water.

References

1. National Primary Drinking Water Regulations https://www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations (Accessed May 27, 2020.)
2. Method 300.1. The Determination of Inorganic Anions in Water by Ion Chromatography; rev 1.0; USEPA, Office of Water: Cincinnati, OH, 1997. https://www.epa.gov/sites/production/files/2015-06/documents/epa-300.1.pdf (Accessed May 27, 2020.)
3. Inorganic anions Analysis by EPA 300.0 & 300.1 https://www.thermofisher.com/us/en/home/industrial/environmental/environmental-learning-center/contaminant-analysis-information/anion-analysis/common-anions-analysis-epa-300-0-300-1.html (Accessed May 27, 2020.)

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