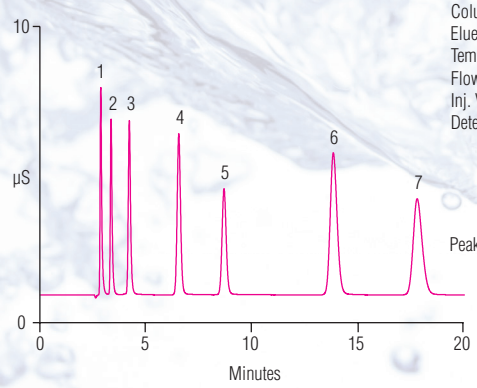
Thermo Scientific Dionex IonPac AS16 Anion-Exchange Column

The Thermo Scientific™ Dionex™ IonPac™ AS16 column is a high-capacity, hydroxide-selective, anion-exchange column optimized for the determination of polarizable anions including thiosulfate, iodide, thiocyanate, and perchlorate in a variety of sample matrices. Using an isocratic sodium or potassium hydroxide eluent, polarizable anions can be determined in less than 20 min. The Dionex IonPac AS16 column is ideal for the determination of trace perchlorate in drinking water and ground water matrices. With an isocratic hydroxide eluent, perchlorate can be determined in 10 min. The Dionex IonPac AS16 column is the column specified in U.S. EPA Method 314.0 and Method 314.1 (Primary Method) for the determination of trace perchlorate in drinking water. The Dionex IonPac Cryptand C1 Concentrator Column is the specified concentrator column for sample preconcentration in U.S. EPA Method 314.1.

Isocratic Separation of Polarizable Anions and Inorganic Anions Using a Sodium Hydroxide Eluent on the 4 mm Dionex IonPac AS16 Column



Column:	Dionex IonPac AG16, AS16 (4 × 250 mm)
Eluent:	35 mM sodium hydroxide
Temperature:	30 °C
Flow Rate:	1 mL/min
Inj. Volume:	10 µL
Detection:	Suppressed conductivity, Thermo Scientifc™ Dionex™ ASRS™ ULTRA II 4 mm Suppressor, AutoSuppression, recycle mode

Peaks:		
	1. Fluoride	2.0 mg/L (ppm)
	2. Chloride	3.0
	3. Sulfate	5.0
	4. Thiosulfate	20.0
	5. Iodide	20.0
	6. Thiocyanate	20.0
	7. Perchlorate	30.0

The Superior Performance Dionex IonPac AS16 Anion-Exchange Column

- Optimized hydrophilic resin for the isocratic separation of polarizable anions.
- Recommended for analysis of drinking water and groundwater matrices for perchlorate.
- Specified column in U.S. EPA Method 314.0 and Method 314.1 (Primary Method).
- Use the Dionex IonPac Cryptand C1 Concentrator column for sample preconcentration.
- Use with eluent generator (EG) for simplified Reagent-Free™ Ion Chromatogrphy (RFIC™) system operation. Requires only a deionized water source to produce sodium or potassium hydroxide eluent.
- Either sodium or potassium hydroxide EG can be used with Method 314.0. Method 314.1 requires the use of sodium hydroxide EG.
- Eluent suppression using the Thermo Scientific™ Dionex™ AERS™ 500 Anion Electrolytically Regenerated Suppressor or Thermo Scientific™ Dionex™ ACES™ 300 Anion Capillary Electrolytic Suppressor provides RFIC system operation with low backgrounds and enhanced analyte sensitivity.
- Ideal for analysis of polyphosphates and polycarboxylates.
- High-capacity: 170 µeq per column (4 × 250 mm).
- Large-loop injection for easy ppb level determinations (e.g., perchlorate in drinking and ground water).
- Compatible with organic solvents to enhance analyte solubility, modify column selectivity, and for effective column cleanup.
- Available in three formats (4 × 250 mm, 2 × 250 mm and 0.4 × 250 mm) supporting flow rates from 3.0 to 0.03 mL/min.

Thermo SCIENTIFIC

High-Efficiency Particle Structure

The Dionex IonPac AS16 column packing material is a unique structure composed of a highly crosslinked core and a Thermo Scientific™ Dionex™ MicroBead™ anion-exchange layer attached to the surface as illustrated in Figure 1. The substrate for the Dionex IonPac AS16 column is a 9 µm-diameter macroporous resin bead, consisting of ethylvinylbenzene crosslinked with 55% divinylbenzene.

The anion-exchange layer is functionalized with very hydrophilic quaternary ammonium groups. The latex bead anion-exchange layer has a controlled thickness, which results in excellent mass transfer characteristics and consequently very high-efficiency peaks.

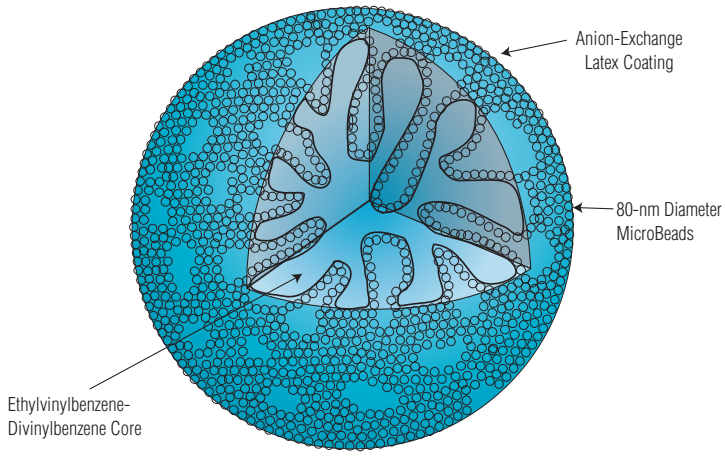


Figure 1. Macroporous resin with anion-exchange functionalized latex layer.

Economical Capillary Operation

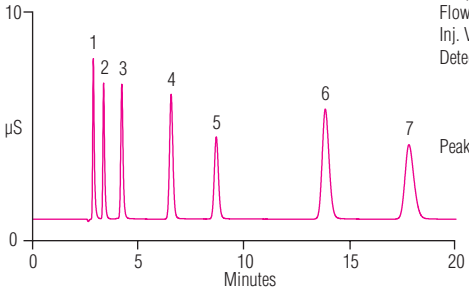
The Dionex IonPac AS16 column is available in the 0.4 mm i.d. format for capillary operation to offer the advantage of reduced operating costs.

- Ideal for limited sample volumes due to higher mass sensitivity.
- One hundred fold reduction in eluent consumption and waste disposal.
- 4 mm applications can be directly transferred to the 0.4 mm format by reducing flow rate by 100 fold.
- Used for 2D-IC method for trace level perchlorate in drinking water.

Isocratic Separation of Polarizable Anions

The Dionex IonPac AS16 column has been optimized for the fast, isocratic determination of polarizable anions such as thiosulfate, iodide, thiocyanate, and perchlorate. Figure 2 shows the isocratic separation of the polarizable anions using a 35 mM sodium hydroxide eluent.

Typical applications for the Dionex IonPac AS16 column include trace perchlorate in environmental samples, such as drinking and groundwater. The Dionex IonPac AS16 column is also optimized for the determination of thiosulfate, iodide, and thiocyanate in chemical samples, including scrubber solutions, process streams, and brines.



Column:	Dionex IonPac AG16, AS16 (4 × 250 mm)
Eluent:	35 mM sodium hydroxide
Temperature:	30 °C
Flow Rate:	1 mL/min
Inj. Volume:	10 µL
Detection:	Suppressed conductivity, Dionex ASRS ULTRA II, 4 mm Suppressor, AutoSuppression, recycle mode

Peaks:		
	1. Fluoride	2.0 mg/L (ppm)
	2. Chloride	3.0
	3. Sulfate	5.0
	4. Thiosulfate	20.0
	5. Iodide	20.0
	6. Thiocyanate	20.0
	7. Perchlorate	20.0

Figure 2. Isocratic separation of polarizable anions and inorganic anions using a sodium hydroxide eluent on the 4 mm Dionex IonPac AS16 column.

Determination of Trace Perchlorate in Drinking Water and Ground Water Matrices

Perchlorate (initially as ammonium perchlorate), which is widely used in the manufacture of rocket propellants, munitions, fireworks, and road flares has been found in drinking water in areas where aerospace materials and munitions have been manufactured and tested. Perchlorate is a potential health concern, because it may interfere with the production of thyroid hormones. A simple, isocratic method has been developed using the high-capacity Dionex IonPac AS16 column to determine trace levels of perchlorate in drinking water matrices.

Figure 3 shows the determination of trace perchlorate in a drinking water sample, using a large-loop injection, with an isocratic hydroxide eluent coupled with suppressed conductivity detection. Low-µg/L (ppb) levels of perchlorate can easily be quantified using a 1.0-mL injection loop on a 4 mm Dionex IonPac AS16 column. Figure 4 shows the analysis of low level perchlorate in the presence of a high-ionic-strength matrix using a large loop injection on the Dionex IonPac AS16 Capillary column.

A new U.S. EPA Method has been developed for the determination of trace perchlorate in drinking water matrices. U.S. EPA Method 314.1 (Primary Method) specifies the Dionex IonPac AS16 column and the Dionex IonPac Cryptand C1 Concentrator column. Figure 5 shows the determination of trace perchlorate in a drinking water sample using sample preconcentration with the Dionex IonPac Cryptand C1 Concentrator column with a sodium hydroxide eluent coupled with suppressed conductivity detection. The Dionex IonPac Cryptand C1 Concentrator column is used with sodium hydroxide eluent to allow optimum concentrator capacity control. At high concentrations of sodium, the Dionex IonPac Cryptand C1 Concentrator column has high capacity but at lower concentrations the capacity decreases and the analytes can be eluted. Figure 6 illustrates the system flow path for the determination of trace perchlorate according to U.S. EPA Method 314.1.

Low µg/L (ppb) levels of perchlorate can easily be quantified using the Dionex IonPac AS16 column and a 2 mL sample preconcentration as shown in Figure 5.

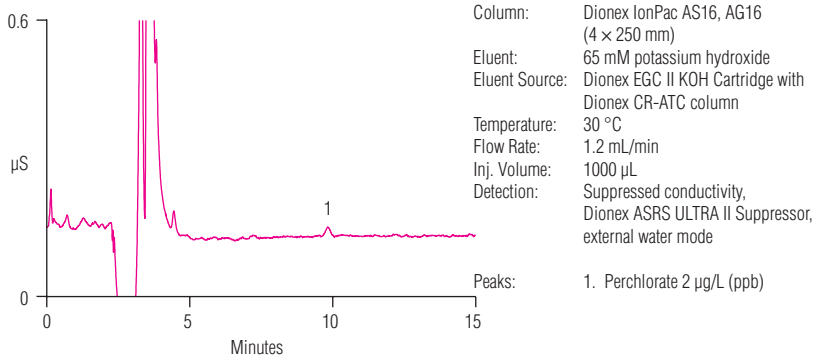


Figure 3. Determination of trace perchlorate in drinking water using a large loop injection with 65 mM KOH on a 4 mm Dionex IonPac AS16 column as described in U.S. EPA Method 314.0. Using this specialized method for perchlorate, other anions in the sample are eluted quickly and do not interfere with the perchlorate peak.

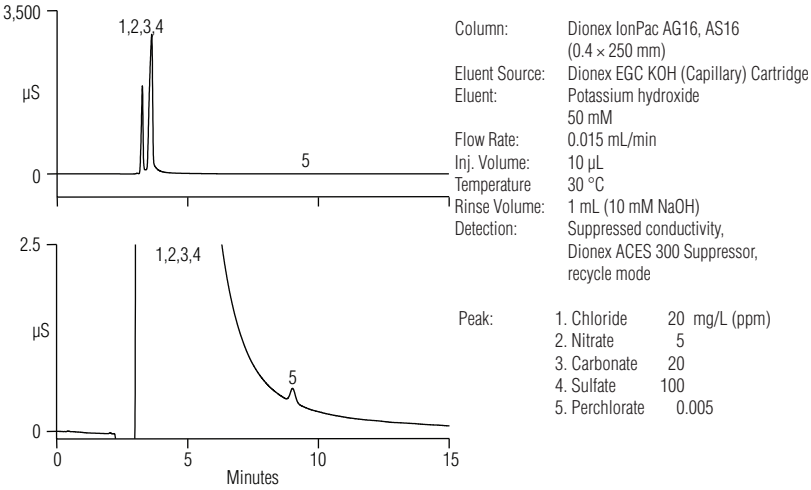


Figure 4. Analysis of low level perchlorate using a large loop injection on the Dionex IonPac AS16 Capillary Column.

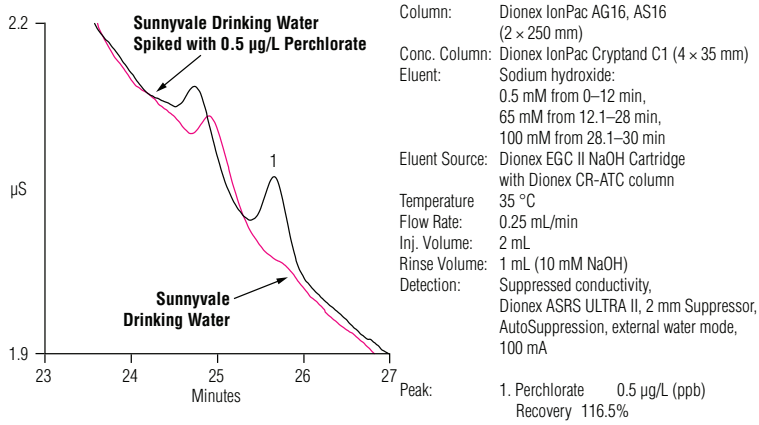


Figure 5. Determination of trace perchlorate in drinking water using the Dionex IonPac AS16 column following concentration on a Dionex IonPac Cryptand C1 Concentrator column as described in U.S. EPA Method 314.1.

Two-Dimensional Ion Chromatography for Analysis of Trace Perchlorate

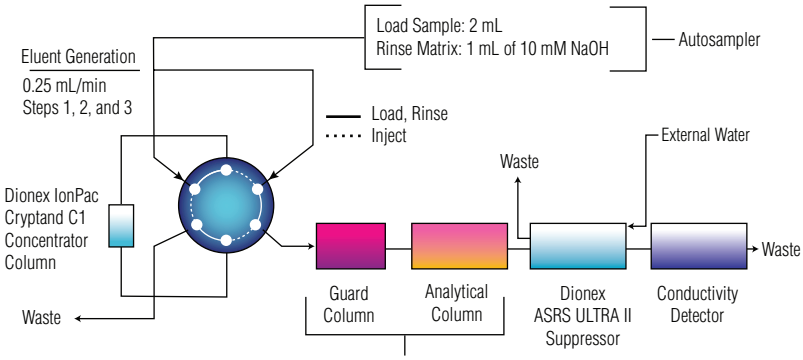
Trace perchlorate (ppb level) in the presence of high-ionic-strength matrices can be analyzed using a Two Dimensional-Matrix Elimination Ion Chromatography (2D-MEIC) instrument configuration with the Dionex IonPac AS20 Analytical column (2 × 250 mm) in the first dimension and the Dionex IonPac AS16 Capillary column (0.4 × 250 mm) in the second dimension. There are several advantages of using the 2D-ME approach.

First, a large-volume of high-ionic-strength matrix can be injected onto the high-capacity Dionex IonPac AS20 Analytical column, which has a higher selectivity for perchlorate relative to the matrix ions.

Second, the perchlorate peak which is partially resolved from the matrix in the first dimension is focused onto a concentrator column, the Thermo Scientific™ Dionex™ IonSwift™ MAC-200 Concentrator Column. The hydroxide eluent is suppressed to water, which provides the ideal environment for ion-exchange retention and focusing.

Third, the second dimension column, the Dionex IonPac AS16 Capillary column has a smaller cross-sectional area relative to the Dionex IonPac AS20 Analytical column, thus the detection sensitivity is enhanced.

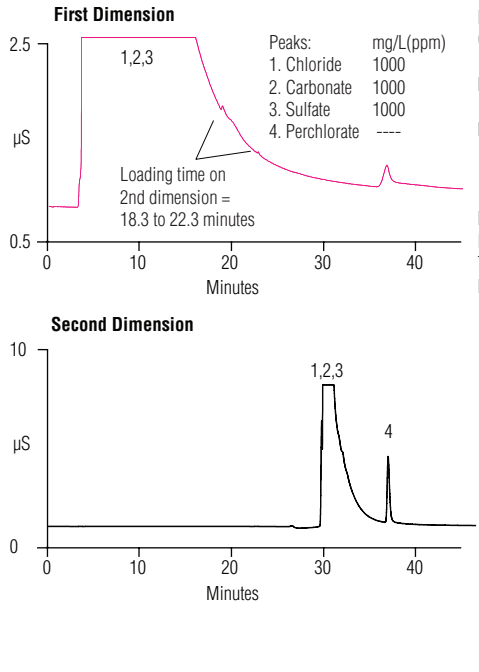
Finally, combining two different chemistries in two column dimensions enables analyte selectivity and sensitivity not possible when using a single chemistry and dimension. Figure 7 shows chromatography from both dimensions. In the top chromatogram the Dionex IonPac AS20 column effluent is diverted to the concentrator column from 18.2 to 21.2 min. This concentrated aliquot is then separated on the Dionex IonPac AS16 Capillary column as shown in the bottom chromatogram. Figure 8 shows the 2D-MEIC system configuration diagram for the analysis of perchlorate.



NaOh Eluent Generation			
Step	Function	Conc.	Time
1	Perchlorate Transfer	0.5 mM	12 min
2	Analysis	65 mM	16 min
3	Column Cleanup	100 mM	2 min

Primary Method—Dionex IonPac AG16, AS16 (2 × 250 mm)
Confirmatory Method—Dionex IonPac AG20, AS20 (2 × 250 mm)

Figure 6. System flow path for trace perchlorate in drinking water.



First Dimension

Column:	Dionex IonPac AG20/AS20 (2 × 250 mm)
Eluent Source:	Dionex EGC III KOH Cartridge
Eluent:	Potassium hydroxide 0-30 min, 35 mM 30-40 min, 60 mM 40-45 min, 35 mM
Flow Rate:	0.25 mL/min
Inj. Volume:	500 µL
Temperature:	30 °C
Detection:	Suppressed conductivity, Dionex ASRS 300 Suppressor, external water mode

Second Dimension

Column:	Dionex IonPac AG16/AS16 (0.4 × 250 mm)
Eluent Source:	Dionex EGC KOH (Capillary) Cartridge
Eluent:	Potassium hydroxide 65 mM
Flow Rate:	10 mL/min
Inj. Volume:	1000 µL
Temperature:	30 °C
Concentrator:	Dionex IonSwift MAC-200
Detection:	Suppressed conductivity, Dionex ACES 300 Suppressor, external water mode

Figure 7. 2D-IC analysis of trace perchlorate using the Dionex IonPac AS20 microbore column and the Dionex IonPac AS16 Capillary column.

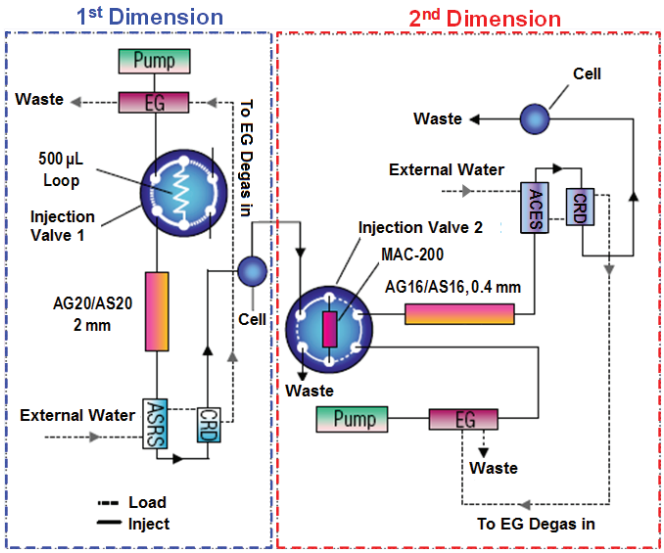


Figure 8. Schematic diagram of 2D system for the determination of trace concentrations of perchlorate.

Gradient Separation of Polarizable Anions and Inorganic Anions

The Dionex IonPac AS16 column was designed for the determination of polarizable anions including thiosulfate, iodide, thiocyanate, and perchlorate. However, the Dionex IonPac AS16 column also provides excellent separation of a wide variety of other anions as shown in Figure 9.

With a potassium hydroxide gradient, 20 inorganic anions and polarizable anions are easily separated in approximately 25 minutes. Peak shape and efficiency are greatly improved for the polarizable anions on the Dionex IonPac AS16 column. Note that bromide and nitrate coelute on the Dionex IonPac AS16 column. For applications where bromide and nitrate are analytes, please refer to the Thermo Scientific Dionex IonPac AS20 Column Product Specification Sheet.

Gradient Separations as Simple as Isocratic Runs with the Eluent Generator

The EG produces high-purity potassium or sodium hydroxide eluent electrolytically from water, eliminating the need for eluent preparation. The hydroxide eluent produced is free of carbonate contamination. The use of carbonate-free hydroxide eluents results in minimal baseline shifts during hydroxide gradients yielding lower background conductivities and lower detection limits for target analytes as shown in Figure 9.

Dionex IonPac AS16 Column for Polyphosphates Using Gradient Elution

Polyphosphates are widely used in a variety of industries. They are used for pharmaceutical and detergent formulations, water treatment applications to decrease water hardness, and in cleansers and fertilizers. Polyphosphates are also commonly used as food additives to control pH, to sequester metal ions, and to increase the ionic strength of solutions. Using a potassium hydroxide gradient on the Dionex IonPac AS16 column, low molecular weight polyphosphates can be separated in less than 10 min. Figure 10 shows the use of the Dionex IonPac AS16 column for the separation of polyphosphates in a detergent sample. Figure 11 shows the separation of ploy-phosphates using the Dionex IonPac AS16 Capillary column.

Column:	IonPac AG16, AS16 (4 × 250 mm)	Peaks:	1. Fluoride	2.0 mg/L (ppm)	11. Carbonate 20.0
Eluent:	Potassium hydroxide, 1.5 mM from 0 to 7 min to 10 mM at 13 min		2. Acetate	10.0	12. Sulfate 10.0
			3. Propionate	10.0	13. Selenate 10.0
			4. Formate	10.0	14. Iodide 20.0
Eluent Source:	EGC II KOH Cartridge with Dionex CR-ATC column		5. Chlorite	10.0	15. Thiosulfate 20.0
			6. Bromate	10.0	16. Chromate 20.0
Temperature:	30 °C		7. Chloride	5.0	17. Phosphate 20.0
Flow Rate:	1.5 mL/min		8. Nitrite	10.0	18. Arsenate 20.0
Inj. Volume:	10 µL		9. Nitrate	10.0	19. Thiocynate 20.0
Detection:	Suppressed conductivity, Dionex ASRS 300 ULTRA II, 4 mm Suppressor, AutoSuppression, recycle mode		10. Selenite	10.0	20. Perchlorate 20.0

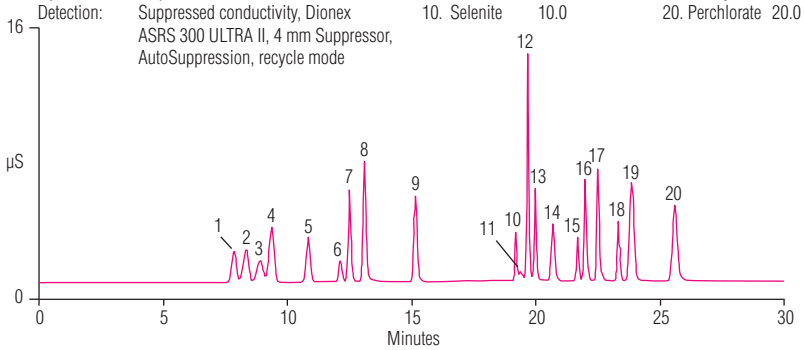
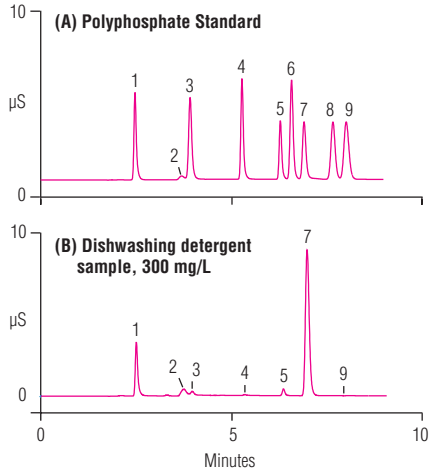


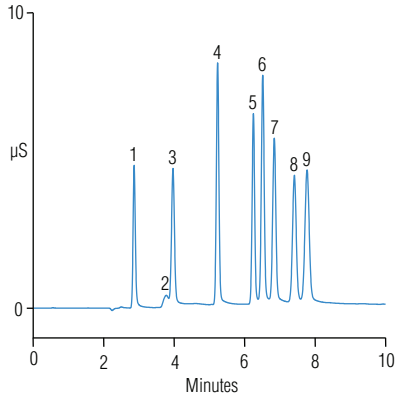
Figure 9. Determination of polarizable anions and inorganic anions using a potassium hydroxide gradient delivered with an Eluent Generator using the 4-mm Dionex IonPac AS16 column.



Column:	Dionex IonPac AG16, AS16 (4 × 250 mm)
Eluent:	25 mM potassium hydroxide for 1.7 min to 65 mM in 2.5 min
Eluent Source:	Dionex EGC II KOH Cartridge with Dionex CR-ATC column
Temperature:	30 °C
Flow Rate:	1.5 mL/min
Inj. Volume:	10 µL
Detection:	Suppressed conductivity, Dionex ASRS ULTRA II, 4 mm Suppressor, AutoSuppression, recycle mode

Peaks:	A	
1. Chloride	3	mg/L (ppm)
2. Carbonate	—	
3. Sulfate	5	
4. Phosphate	10	
5. Pyrophosphate	10	
6. Trimetaphosphate	10	
7. Tripolyphosphate	10	
8. Tetrametaphosphate	10	
9. Tetrapolyphosphate	10	

Figure 10. Separation of polyphosphates on the 4 mm Dionex IonPac AS16 column using a potassium hydroxide gradient delivered with an Eluent Generator.



Column:	Dionex IonPac AG16/AS16 (0.4 × 250 mm)
Eluent Source:	Dionex EGC KOH (Capillary) Cartridge
Eluent:	Potassium hydroxide 25 mM from 0 to 0.5 min, 25 mM to 65 mM from 0.5 to 3 min
Flow Rate:	15 µL/min
Inj. Volume:	0.4 µL
Temperature:	30 °C
Detection:	Suppressed conductivity, Dionex ACES 300 Suppressor, recycle mode

Peaks		
1.Chloride	3	mg/L
2. Carbonate	—	
3. Sulfate	5	
4. Phosphate	10	
5. Pyrophosphate	10	
6. Trimetaphosphate	10	
7. Tripolyphosphate	10	
8. Tetrametaphosphate	10	
9. Tetrapolyphosphate	10	

Figure 11. Gradient separation of inorganic anions and polyphosphates using the Dionex IonPac AS16 Capillary column.

Dionex IonPac AS16 Column for Highly Charged Anions Using Gradient Elution

The separation of highly charged anions such as polycarboxylates is possible using gradient elution on a Dionex IonPac AS16 column. The high hydroxide selectivity on the Dionex IonPac AS16 column resin permits elution of these highly charged anions at lower hydroxide concentrations than on other anion-exchange columns.

System Requirements and Recommendations

System Requirements

The Dionex IonPac AS16 Capillary column is recommended for use with the Thermo Scientific Dionex ICS-5000⁺ or Thermo Scientific Dionex ICS-4000 Capillary HPIC system. The Dionex IonPac AS16 analytical column is recommended for use with the Dionex ICS-2100 or Dionex ICS-5000⁺ RFIC system equipped with an eluent generator. The Dionex IonPac AS16 Analytical column can also be used with older Thermo Scientific Dionex IC systems equipped with an EG or a Thermo Scientific™ Dionex™ RFC-30 Reagent-Free Controller. The EG is used to automatically produce potassium hydroxide gradients from deionized water.

Suppressor Recommendations

For optimum ease-of-use and performance, the Dionex IonPac AS16 column should be used with the Dionex AERS 500 Anion Electrolytically Regenerated Suppressor or the Dionex ACES 300 Anion Capillary Electrolytic Suppressor.

Anion Trap Columns

When using the EG for eluent delivery, a Thermo Scientific Dionex CR-ATC Continuously Regenerated Anion Trap Column should be installed between the eluent generator cartridge (EGC) and the degas module. As an alternative for 4 mm and 2 mm systems, a Dionex IonPac ATC-HC column can be installed between the pump outlet and the EGC inlet. Alternatively, when using a manually-prepared sodium hydroxide gradient with the Dionex IonPac AS16 column, the Dionex IonPac ATC-3 column should be installed between the gradient pump and the injection valve to remove anionic contaminants from the eluent.

Concentrator Columns

For concentrator work with a 2 mm or 4 mm Dionex IonPac AS16 column, use the: Dionex IonPac AG16 guard column; Dionex IonPac Ultra Trace Anion Concentrator Columns (Dionex IonPac UTAC-ULP1, UTAC-XLP1, UTAC-ULP2, or UTAC-XLP2) or Trace Anion Concentrator Column (Dionex IonPac TAC-ULP1) when a single piston pump such as the Thermo Scientific Dionex AXP Auxiliary Pump (pulse damper required) is used for sample delivery. In addition to the concentrator columns listed above, use the Dionex IonPac UTAC-LP1, UTAC-LP2 or TAC-LP1 when the sample is delivered using a syringe or a low-pressure autosampler, e.g., the Thermo Scientific Dionex AS-DV Autosampler. For concentrator work with a 0.4 mm capillary column, use the Dionex IonPac AG16 Capillary Guard Column or the Dionex IonSwift MAC-100 Concentrator Column. For 2D-IC applications, use the Dionex IonSwift MAC-200 Concentrator Column.

SPECIFICATIONS	
Dimension	Dionex IonPac AS16 Analytical Column (2 × 250 mm) and (4 × 250 mm)
	Dionex IonPac AG16 Guard Column (2 × 50 mm) and (4 × 50 mm)
	Dionex IonPac AS16 Capillary Column (0.4 × 250 mm)
	Dionex IonPac Capillary Guard Column (0.4 × 50 mm)
Maximum Operating Pressure	4000 psi
Mobile Phase Compatibility	pH 0–14; 0–100% HPLC solvents
Substrate Characteristics	
Analytical Column	Supermacroporous resin
Bead Diameter (µm)	9.0
Pore Size	2000 Å
Crosslinking (%DVB)	55%
Guard Column	Microporous resin
Bead Diameter (µm)	13.0
Pore Size	<10 Å
Crosslinking (%DVB)	55%
Latex Characteristics	
Functional Group	Alkanol quaternary ammonium ion
Latex Crosslinking	1%
Latex Diameter	80 nm
Hydrophobicity	Ultralow
Capacity	
42.5 µeq	(2 × 250 mm analytical column)
0.875 µeq*	(2 × 50 mm guard column)
170 µeq	(4 × 250 mm analytical column)
3.5 µeq*	(4 × 50 mm guard column)
1.7 ueq	(0.4 × 250 mm capillary column)
0.035 ueq*	(0.4 × 50 mm capillary guard column)
Column Construction	PEEK with 10–32 threaded ferrule-style end fittings.
	All components are nonmetallic.
	*Guards are packed with a low-capacity microporous resin.

Ordering Information

For more information or to place an order, contact the Thermo Scientific Dionex Products office nearest you or your local distributor. Phone numbers and addresses for worldwide subsidiaries can be found in the About Us section of www.thermoscientific.com/dionex.

IonPac Columns	Part Number
Dionex IonPac AS16 Analytical Column (4 × 250 mm)	055376
Dionex IonPac AG16 Guard Column (4 × 50 mm)	055377
Dionex IonPac AS16 Analytical Column (2 × 250 mm)	055378
Diones IonPac AG16 Guard Column (2 × 50 mm)	055379
Dionex IonPac AS16 Capillary Column (0.4 × 250 mm)	082315
Dionex IonPac AG16 Capillary Guard Column (0.4 × 50 mm)	082316
Anion Trap Columns	**Part Number**
Dionex CR-ATC Continuously Regenerated Anion Trap Column (for use with systems equipped with an eluent generator or Dionex RFC-30 Reagent-Free Control)	060477
Dionex CR-ATC Continuously Regenerated Anion Trap Column (for use with capillary anion columns)	072078
Dionex IonPac ATC-3 4 mm (9 × 24 mm) Anion Trap Column (for use with 4 mm columns)	059660
Dionex IonPac ATC-3 2 mm (4 × 3 5 mm) Anion Trap Column (for use with 2 mm columns)	079932
Dionex IonPac ATC-HC (9 × 75 mm) Anion Trap Column (for use with the Thermo Scientific Dionex EG40 Eluent Generator)	059604
Trace Anion Concentrator Columns	**Part Number**
Dionex IonPac TAC-2 Trace Anion Concentrator (3 × 35 mm)	043101
Dionex IonPac TAC-LP1 Trace Anion Concentrator (4 × 35 mm)	046026
Dionex IonSwift MAC-100 Monolith Anion Concentrator (0.5 × 80 mm) (for use with capillary IC)	074702
Dionex IonSwift MAC-200 Monolith Anion Concentrator (0.75 × 80 mm) (for use with 2D-IC applications)	075461
Dionex IonPac TAC-LP1 Trace Anion Concentrator (4 × 35 mm)	046026
Dionex IonPac TAC-ULP1 Trace Anion Concentrator (5 × 23 mm)	061400
Dionex IonPac UTAC-LP1 Ultra Trace Anion Concentrator Low Pressure (4 × 35 mm)	063079
Dionex IonPac UTAC-ULP1 Ultra Trace Anion Concentrator Ultra Low Pressure (5 × 23 mm)	063475
Dionex IonPac UTAC-XLP1 Ultra Trace Anion Concentrator Extremely Low Pressure (6 × 16 mm)	063459
Dionex IonPac UTAC-LP2 Ultra Trace Anion Concentrator Low Pressure (4 × 35 mm)	079917
Dionex IonPac UTAC-ULP2 Ultra Trace Anion Concentrator Ultra Low Pressure (5 × 23 mm)	079918
Dionex IonPac UTAC-XLP2 Ultra Trace Anion Concentrator Extremely Low Pressure (6 × 16 mm)	072781

www.thermoscientific.com/dionex

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Germany +49 6103 408 1014
India +91 22 6742 9494
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Japan +81 6 6885 1213
Korea +82 2 3420 8600
Latin America +1 561 688 8700
Netherlands +31 76 579 55 55
New Zealand +64 9 980 6700
Norway +46 8 556 468 00
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