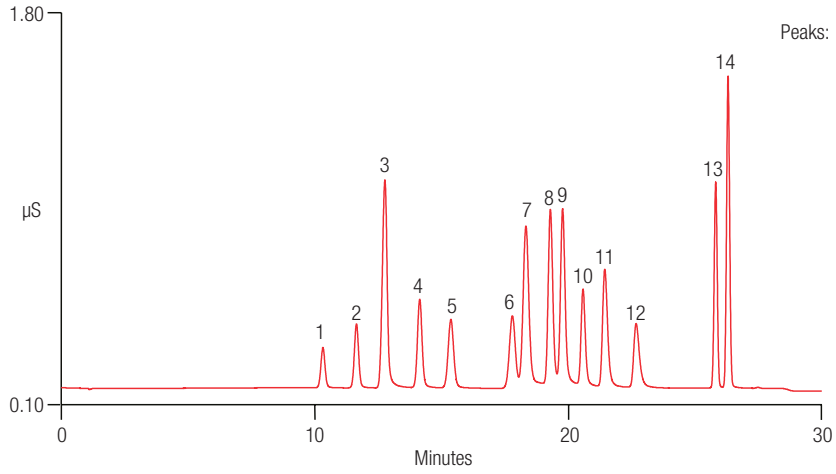
Ion chromatography

Thermo Scientific Dionex IonPac CS17 Cation-Exchange Column

Separation of alkylamines and the Group I and II cations using the Dionex IonPac CS17 column



Peaks:		
1.	Lithium	0.03 mg/L (ppm)
2.	Sodium	0.10
3.	Ammonium	0.34
4.	Potassium	0.25
5.	Ethylamine	0.50
7.	tert-Butylamine	1.25
8.	sec-Butylamine	1.25
9.	iso-Butylamine	1.25
10.	n-Butylamine	3.75
11.	1,2-Dimethylpropylamine	1.00
12.	Di-n-propylamine	1.00
13.	Magnesium	0.14
14.	Calcium	0.34

Obtain excellent peak shapes for hydrophobic amines without the use of solvent using the Thermo Scientific™ Dionex™ IonPac™ CS17 Cation-exchange Column.

The Dionex IonPac CS17 cation-exchange column is designed for the separation of hydrophobic and polyvalent amines including biogenic amines, alkylamines and diamines-using simple aqueous eluents and elevated temperatures. This column offers improved peak shape for most Thermo Scientific™ Dionex™ IonPac™ CS14, CS15 and CS16 amine applications without the use of solvent.

The Dionex IonPac CS17 column is a universal column for the separation of polyvalent and hydrophobic amines in complex sample matrices. Minimal baseline shifts and enhanced analyte sensitivity are obtained using the Thermo Scientific™ Dionex™ Cation Self-Regenerating Suppressor (CSRS 300). Operation is simplified with a Thermo Scientific™ Dionex™ Reagent-Free™ Ion Chromatography (RFIC™) System and a Thermo Scientific™ Dionex™ Eluent Generator (EG), which require only a deionized water source to produce methanesulfonic acid (MSA) eluent. Sample matrices include environmental waters, power plant waters treated with ammonium, morpholine, or ethanolamine, chemical additives, chemical process solutions, scrubber solutions, plating baths and solvents. The Dionex IonPac CS17 column is available in standard bore and microbore formats allowing flow rates from 0.25–1.60 mL/min.

Highlights

- Separation of polyvalent and hydrophobic amines in complex sample matrices without the use of solvent
- Improved peak shapes over the Dionex IonPac CS17, CS15 and CS16 applications using simple aqueous gradients
- Available in standard bore and microbore formats

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Unique carboxylate cation exchanger

The Dionex IonPac CS17 column is a unique, hydrophilic, moderate capacity carboxylate-functionalized cation exchanger that provides excellent selectivity and peak shape for amines. Figure 1 shows the resin bead structure of the Dionex IonPac CS17. The resin bead consists of a highly crosslinked core. The substrate for this column is a macroporous resin bead (7 µm diameter) consisting of ethylvinylbenzene, crosslinked with 55% divinylbenzene.

The Dionex IonPac CS17 resin bead is produced using a novel grafting technology. This new technology employs a grafted nonfunctional coating on the resin surface and pores with the cation-exchange polymer grafted onto this nonfunctional coating. This novel technology reduces hydrophobic interactions with the analytes and resin surface, resulting in excellent mass transfer characteristics which provides very high efficiency peaks.

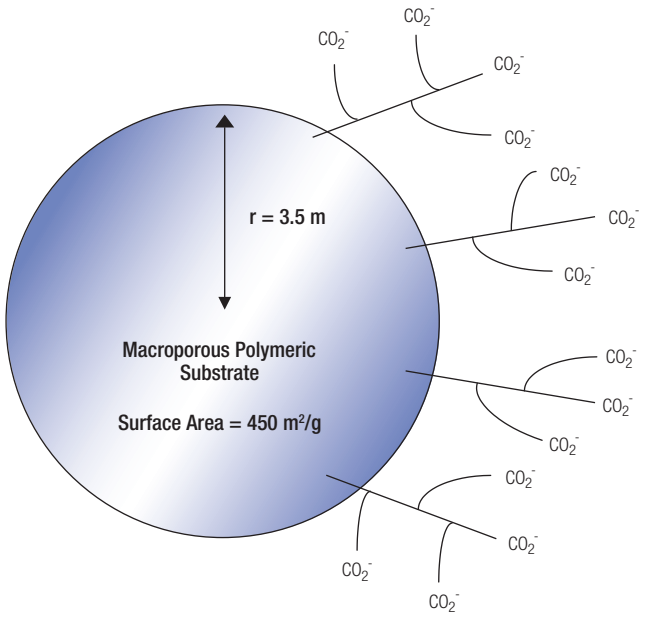

Figure 1. Structure of a Dionex IonPac CS17 packing particle.

The power of gradient elution

Figure 2 illustrates improved resolution among adjacent peaks using gradient or step-change elution instead of isocratic elution. Gradient elution improves the resolution among the first five eluting peaks, the four monovalent cations, and dimethylamine. By using the EG, a Thermo Scientific™ Dionex™ Cation Trap Column (Dionex CTC) or Thermo Scientific™ Dionex™ Continuously Regenerated Cation Trap Column II (Dionex CR-CTC II) and the Dionex IonPac CS17 column, the baseline shift is minimal when stepping from a low to high eluent concentration, thus providing simplified peak integration and quantification of the analytes. Moderately hydrophobic amines, such as triethylamine, can be eluted efficiently without addition of organic solvent to the eluent.

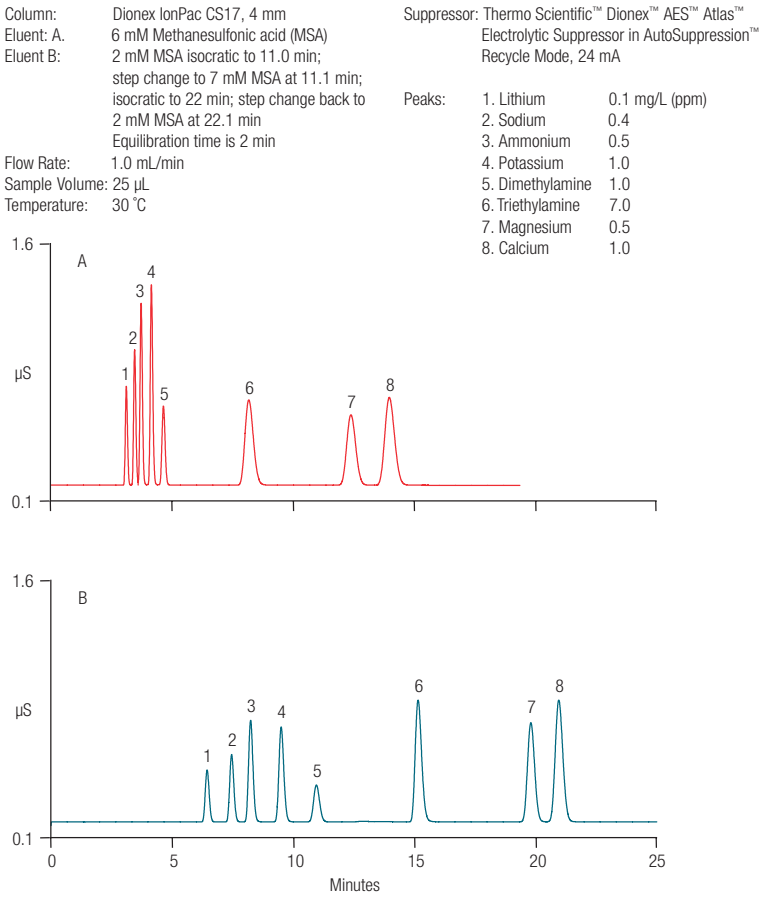

Figure 2. Separation of Group I and II cations and methylamines using a step-change elution and the Dionex IonPac CS17 column.

Determination of biogenic amines and Group I and II cations

Biogenic amines—including putrescine, cadaverine, spermine, spermidine, and histamine—are indicators of food spoilage. As illustrated in Figure 3, the Dionex IonPac CS17 column can easily separate the biogenic amines and Group I and II cations using an aqueous eluent without added organic solvent. Good peak efficiencies and symmetries are shown when the column is operated with a simple acidic gradient at elevated temperature.

Biogenic amines can easily be determined in complex food matrices using the Dionex IonPac CS17 column with suppressed conductivity detection. Amperometric detection can also be used to detect these compounds. This detection mode provides improved specificity for oxidizable amines, including the biogenic amines. Inorganic cations present in the sample are not detected using this method, and high concentrations do not interfere with the quantification of the amines.

Columns:	Dionex IonPac CG17, CS17, 2 mm	Peaks:	1. Lithium	10 µg/L (ppb)
Eluent:	3 mM MSA isocratic to 3.5 min;		2. Sodium	40
	3 mM to 6 mM MSA gradient at 12 min;		3. Ammonium	50
	isocratic to 15 min; gradient to 40 mM MSA		4. Potassium	100
	at 20 min, isocratic to 24 min; step change		5. Magnesium	50
	back to 3 mM MSA at 24.1 min		6. Calcium	100
	Equilibration time is 2 min		7. Putrescine	1000
Flow Rate:	0.40 mL/min		8. Cadaverine	600
Sample Volume:	25 µL		9. Histamine	600
Temperature:	40 °C		10. Spermidine	200
Suppressor:	Thermo Scientific™ Dionex™ CSRS ULTRA™ 2 mm Cation Self-Regenerating Suppressor™, AutoSuppression Recycle Mode, 100 mA		11. Spermine	400

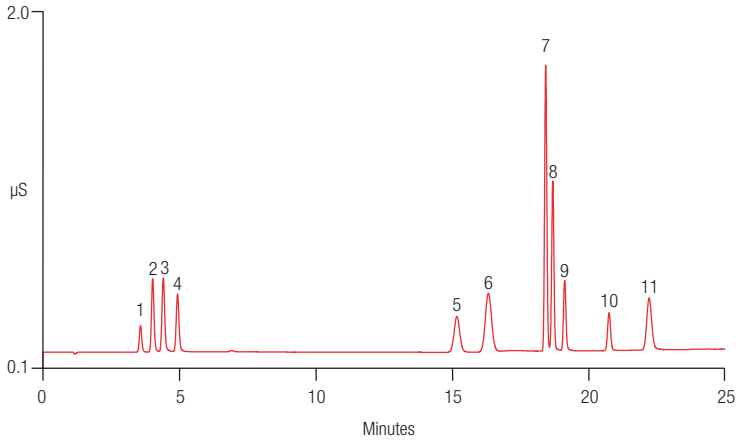

Figure 3. Determination of biogenic amines and the Group I and II cations using the Dionex IonPac CS17 column.

Determination of amine additives in power plant and boiler waters

Ethanolamine is one of the most widely used corrosion prevention additives in power plant waters. Hydrazine, (H_2NNH_2) is a powerful reducing agent used in the power industry as an oxygen scavenger to reduce turbine corrosion present in µg/L (ppb) concentrations. The moderate capacity, hydrophilic Dionex IonPac CS17 column solves the difficult resolution problem of separating hydrazine from ammonium and ethanolamine.

Morpholine, 2-diethylaminoethanol, and cyclohexylamine are added to water as vapor-phase corrosion inhibitors in steam-generating plants and for other boiler applications. Concentrations of these amines must be monitored to maintain optimum levels. Using the Dionex IonPac CS17 column with suppressed conductivity, separation, detection, and quantitation of these amines are easily achieved using an MSA gradient at elevated temperature, as illustrated in Figure 4.

Columns:	Dionex IonPac CG17, CS17, 2 mm
Eluent:	0.5 mM to 0.7 mM MSA gradient at 25 min; step change to 4 mM MSA at 25.1 min; isocratic to 27 min; step change to 6.5 mM MSA at 27.1 min; isocratic to 37 min; step change back to 0.5 mM MSA at 37.1 min Equilibration time is 2 min
Flow Rate:	0.35 mL/min
Sample Volume:	25 µL
Temperature:	30 °C
Suppressor:	Dionex Cation Atlas Electrolytic Suppressor in AutoSuppression Recycle Mode, 8 mA

Peaks:		µg/L (ppb)
	1. Lithium	25
	2. Sodium	100
	3. Ammonium	125
	4. Hydrazine	1000
	5. Ethanolamine	250
	6. Potassium	250
	7. 2-(2-aminoethoxy) ethanol	1000
	8. 5-amino-1-pentanol	500
	9. Morpholine	1000
	10. 2-diethylamino ethanol	1000
	11. Cyclohexylamine	1000
	12. Magnesium	125
	13. Calcium	250

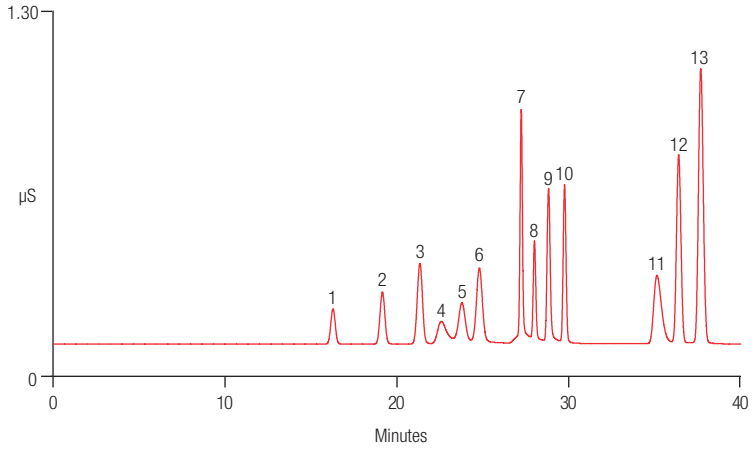

Figure 4. Determination of power plant amine additives using the Dionex IonPac CS17 column.

Determination of alkanolamines in power plant waters and scrubber solutions

Alkanolamines—including mono-, di-, and triethanolamine—are most commonly used individually or in any combination to optimize the efficiency of the scrubber treatment for a specific chemical process. In large plants, different alkanolamines may be used in adjacent units as tracers for leakage problems. The Dionex IonPac CS17 column resolves all combinations of these scrubber amines using a methanesulfonic acid gradient and elevated temperature (See Figure 5).

Column:	Dionex IonPac CS17, 4 mm
Eluent:	0.5 mM to 0.8 mM MSA gradient at 25 min; step change to 9 mM MSA at 25.1 min; isocratic to 35 min; step change back to 0.5 mM MSA at 35.1 min Equilibration time is 2 min
Flow Rate:	1.4 mL/min
Sample Volume:	25 µL
Temperature:	30 °C
Suppressor:	Dionex Cation Atlas Electrolytic Suppressor in AutoSuppression Recycle Mode, 43 mA

Peaks:		mg/L (ppm)
	1. Lithium	0.1
	2. Sodium	0.4
	3. Ammonium	0.5
	4. Ethanolamine	0.5
	5. Potassium	1.0
	6. Diethanolamine	1.0
	7. Triethanolamine	18.0
	8. Magnesium	0.5
	9. Calcium	1.0

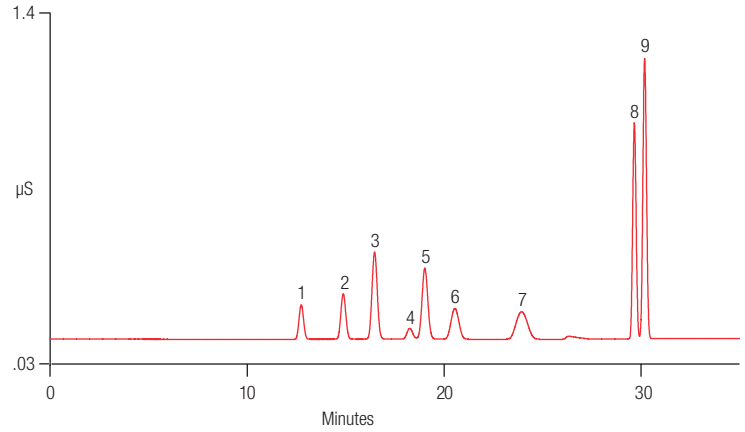

Figure 5. Determination of alkanolamines using the Dionex IonPac CS17 column.

Determination of alkylamines and the Group I and II cations

Lithium, sodium, ammonium, potassium, magnesium and calcium and low-molecular-weight alkylamines can be easily separated using an organic solventfree eluent. The alkylamines elute with good peak efficiencies and symmetries using a simple acidic gradient and elevated temperature, as illustrated in Figure 6.

Determination of diamines in complex sample matrices

The unique hydrophilic cation-exchange surface of the Dionex IonPac CS17 column allows the separation of lithium, sodium, ammonium, potassium, magnesium and calcium, and alkyl diamines with an organic solvent-free eluent. The diamines elute after the six common cations with good peak efficiencies and symmetries using a simple acidic gradient and elevated temperature. Figure 7 illustrates the excellent selectivity for the diamines. Despite the gradient change from 3 mM to 40 mM methanesulfonic acid, the baseline shift is undetected. Alkyl diamines larger than 1,10-decanediamine are not soluble in aqueous solutions, and therefore require the addition of organic solvent to the eluent when they are present in the sample.

Columns:	Dionex IonPac CG17, CS17, 2 mm
Eluent:	0.5 mM to 1.1 mM MSA gradient at 12 min; gradient to 1.3 mM MSA at 16 min; gradient to 10 mM MSA at 25 min; isocratic to 27 min; step change back to 0.5 mM MSA at 27.1 min Equilibration time is 2 min
Flow Rate:	0.40 mL/min
Sample Volume:	25 µL
Temperature:	40 °C
Suppressor:	Dionex Cation Atlas Electrolytic Suppressor in AutoSuppression Recycle Mode, 13 mA

Peaks:		mg/L (ppm)
1.	Lithium	0.03
2.	Sodium	0.10
3.	Ammonium	0.34
4.	Potassium	0.25
5.	Ethylamine	0.50
7.	tert-Butylamine	1.25
8.	sec-Butylamine	1.25
9.	iso-Butylamine	1.25
10.	n-Butylamine	3.75
11.	1,2-Dimethylpropylamine	1.00
12.	Di-n-propylamine	1.00
13.	Magnesium	0.14
14.	Calcium	0.34

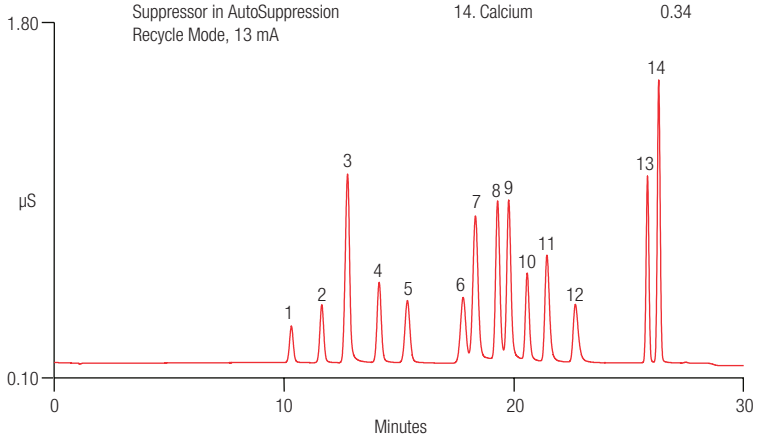

Figure 6. Separation of alkylamines and the Group I and II cations using the Dionex IonPac CS17 column.

Columns:	Dionex IonPac CG17, CS17, 2 mm
Eluent:	3 mM MSA isocratic to 3.5 min; 3 mM to 6 mM MSA gradient at 12 min; isocratic to 15 min; gradient to 40 mM MSA at 20 min, isocratic to 24 min; step change back to 3 mM MSA at 24.1 min Equilibration time is 2 min
Flow Rate:	0.40 mL/min
Sample Volume:	25 µL
Temperature:	40 °C
Suppressor:	Dionex CSRS ULTRA 2 mm Cation Self-Regenerating Suppressor, AutoSuppression Recycle Mode, 100 mA

Peaks:		A	B	
1.	Lithium	5	–	µg/L (ppb)
2.	Sodium	65	16	
3.	Ammonium	89	4	
4.	Potassium	47	8	
5.	Magnesium	24	–	
6.	Calcium	56	18	
7.	Ethylenediamine	–	200	
8.	1,2-propanediamine	500	–	
9.	1,6-hexanediamine	250	–	
10.	N,N-diethylenediamine	–	200	
11.	1,7-heptanediamine	125	–	
12.	N,N,N,N-tetramethyl-ethylenediamine	–	200	
13.	1,8-octanediamine	250	–	
14.	3,3-diaminopropylamine	–	200	
15.	1,9-nonanediamine	375	–	
16.	1,10-decanediamine	375	–	

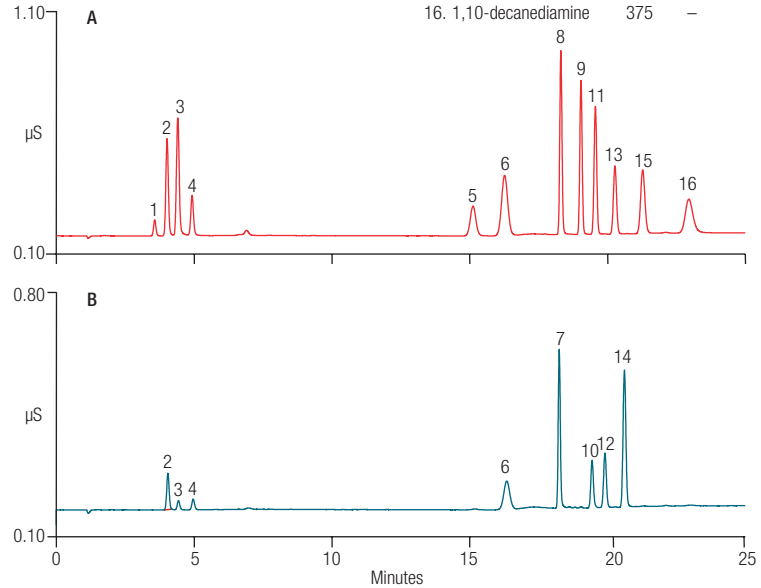

Figure 7. Determination of diamines and the Group I and II cations using the Dionex IonPac CS17 column.

Solvent-compatible packing

The Dionex IonPac CS17 column is 100% solvent-compatible, including alcohols. Adding solvent to the eluent modifies column selectivity and facilitates the elution of nonpolar analytes or contaminants from the column. Solvent can be used to enhance sample solubility, reduce retention times, and improve peak shapes of hydrophobic amines. Time and expense can be saved by eliminating time-consuming sample preparation steps. This feature allows analysis of complex sample matrices with minimal preparation.

System recommendations

The Dionex IonPac CS17 column in suppressed conductivity mode is recommended for use with the Thermo Scientific™ Dionex™ Reagent-Free™ Ion Chromatography (RFIC™) systems equipped with an EG, or with older Dionex IC systems equipped with an EG or a Thermo Scientific™ Dionex™ RFC-30 Reagent-Free Controller. The eluent generator is used to automatically produce methanesulfonic acid gradients from deionized water.

Suppressors

For optimum ease of use and performance, the Dionex IonPac CS17 analytical column can be used with the Dionex CSRS 300.

Cation trap columns

When using the eluent generator, a Dionex CR-CTC II continuously regenerated cation trap column for concentration should be installed between the eluent generator cartridge and the eluent generator degas module. Alternately, a Dionex CTC cation trap column can be installed between the gradient pump and the injection valve to remove cationic contaminants from the eluent.

Concentrator columns

For trace analysis, use the Thermo Scientific™ Dionex™ IonPac CG17 Guard Column when a single-piston pump such as the Thermo Scientific™ Dionex™ AXP is used for sample delivery. Use one of the Thermo Scientific™ Dionex™ Trace Cation Concentrator columns (Dionex TCC-LP-1, TCC-ULP1, or TCC-XLP1) when using a syringe or autosampler.

Specifications	
Dimensions	Dionex CS17 Analytical Columns: 2 × 250 mm and 4 × 250 mm
	Dionex CG17 Guard Columns: 2 × 50 mm and 4 × 50 mm
Maximum operating pressure	4,000 psi
Mobile phase compatibility	Acidic eluents, 100% HPLC solvents, including alcohols
Substrate characteristics	Bead Diameter: 7 µm
	Crosslinking (%DVB): 55%
Ion-exchange Group	Grafted carboxylic acid
Functional group characteristics	Very low hydrophobic
Capacity	1,450 µeq/column (4 × 250 mm)
	290 µeq/column (4 × 50 mm)
	363 µeq/column (2 × 250 mm)
	73 µeq/column (2 × 50 mm)
Column construction	PEEK with 10–32 threaded ferrule style end fittings
	All components are nonmetallic

Ordering information

To order in the U.S., call 1-800-346-6390, or contact the Thermo Fisher Scientific office nearest you. Outside the U.S., order through your local Thermo Fisher Scientific office or distributor. Refer to the following part numbers.

Description	Part number
Dionex IonPac CS17 Columns	
Dionex IonPac CS17 Analytical Column (4 × 250 mm)	060557
Dionex IonPac CG17 Guard Column (4 × 250 mm)	060560
Dionex IonPac CS17 Analytical Column (2 × 250 mm)	060561
Dionex IonPac CG17 Guard Column (2 × 50 mm)	060563
Trap columns	
Dionex CR-CTC II Continuously Regenerated Cation Trap Column	066262
Dionex CTC-1 Cation Trap Column (9 × 24 mm) for use with the 4 mm columns	040192
Dionex CTC Cation Trap Column (4 × 35 mm) for use with the 2 mm columns	043132
Cation Concentrator Columns	
Dionex TCC-LP1 Low Pressure Trace Cation Concentrator (4 × 35 mm) for use with the 2 mm and 4 mm columns	046027
Dionex TCC-ULP1 Ultratrace Cation Concentrator-Ultra Low Pressure (5 × 23 mm)	063783
Dionex TCC-XLP1 Ultratrace Cation Concentrator-Extremely Low Pressure (6 × 16 mm)	063889

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