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The SCS 1 Silica Cation Separator is designed for use with nonsuppressed conductivity detection, or single-column ion chromatography (SCIC). This column is particularly suited for analysis of the common inorganic cations, ammonium, select alkanolamines,

and transition metals such as zinc and copper. The SCS 1 is recommended when extended calibration linearity for ammonium or alkanolamines is required. The IonPac® SCS 1 is targeted for applications in the power generation, chemical, petrochemical, and environmental industries.



Unique Carboxylate Cation Exchanger

The IonPac SCS 1 Silica Cation Separator is a unique hydrophilic, low-capacity weak cation exchanger designed for cation determinations using nonsuppressed conductivity detection.

Figure 1 shows the bonded phase bead structure of the IonPac SCS 1. The substrate for the IonPac SCS 1 is silica-based poly(butadiene-maleic acid) with a particle diameter of 4.5 μm . The substrate bead is coated with a unique carboxylic acid functionalized layer. The SCS 1 can be used with eluents of pH 2–7 and is compatible with typical organic solvents (such as acetonitrile and acetone) at concentration levels up to 100%. Note: Alcohols should be avoided.

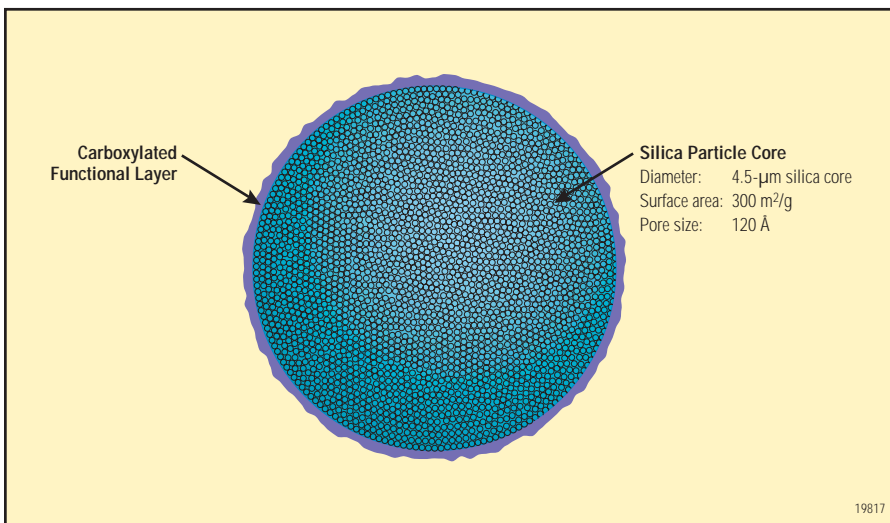


Figure 1. Structure of the IonPac SCS 1 Silica Cation Separator packing particle.

Determination of the Common Inorganic Cations plus Ammonium and Ethanolamine

Figure 2A illustrates the separation of the common inorganic cations plus ammonium and ethanolamine using the recommended operating conditions. When using 3 mM methanesulfonic acid at elevated temperature (30 °C) coupled with nonsuppressed conductivity detection, these analytes can be separated in approximately 28 min (analytical column only). Figure 2B shows the separation of the common inorganic cations plus ammonium and ethanolamine using the guard and analytical column. The analysis time is approximately 35 min when the guard is added to the IC system.

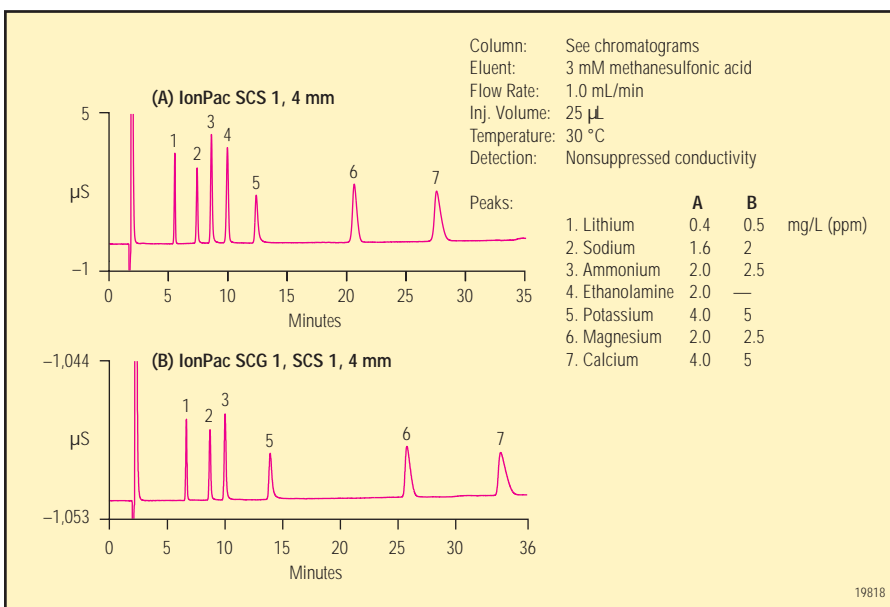


Figure 2. Determination of the common inorganic anions plus ammonium and ethanolamine using the IonPac SCS 1.

Determination of Trace Sodium in High Ethanolamine

An important application for the power industry is the ability to determine trace concentrations of sodium in the presence of high concentrations of ethanolamine. Figure 3 shows a simulated sample that contains 3000 ppb ethanolamine spiked with 0.25 ppb sodium. A sample volume of 3.0 mL was loaded onto a TCC-LP1 concentrator column using a DXP single-piston pump. The sodium peak is well resolved from the ethanolamine using 3 mM MSA eluent on the SCS 1 column.

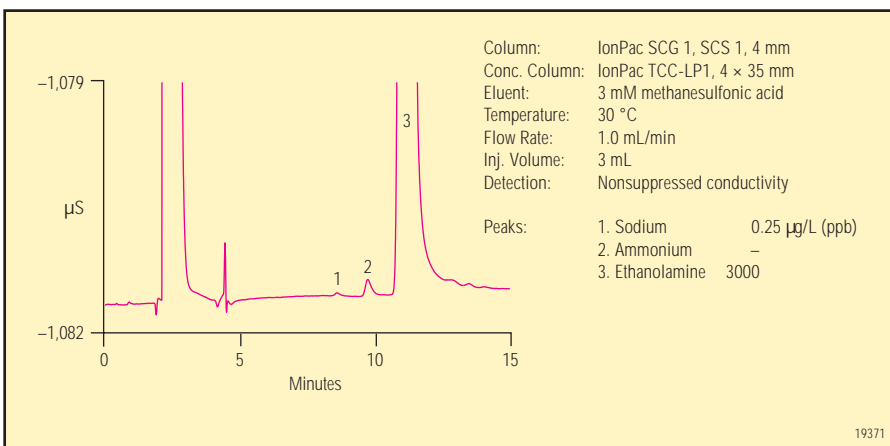


Figure 3. Determination of trace sodium in high ethanolamine using the IonPac SCS 1.

Determination of Trace Ammonium in High Sodium

Determining trace concentrations of ammonium in the presence of high concentrations of sodium is an important application for the environmental industry. Figure 4 illustrates the separation of trace-level ammonium in the presence of high sodium using 3 mM MSA eluent on the SCS 1 column. The maximum ratio determined for this column is 1,000:1 sodium to ammonium. The IonPac CS16 column with suppressed conductivity detection is recommended for larger concentration ratios of sodium and ammonium.

The IonPac SCS 1 can be used for regulatory compliance monitoring of alkali and alkaline earth cations and ammonium in water and wastewater. The SCS 1 meets or exceeds performance requirements of ASTM Method D6919-03 (see method for further details).

Determination of Alkanolamines and the Common Inorganic Cations in Chemical Process Solutions

Alkanolamines, including monoethanolamine, diethanolamine, and triethanolamine, are most commonly used individually but are also used in combination to optimize scrubber treatment efficiency for specific chemical processes. In large plants, different alkanolamines may be used in adjacent units to accommodate different scrubbing requirements. The SCS 1 has unique selectivity for alkanolamines and therefore can be used to resolve mixtures of these priority scrubber amines using a 3 mM MSA eluent at elevated temperature, as illustrated in the Figure 5. Note under these conditions, potassium and diethanolamine are not baseline resolved. Alternatively, by adding 10% acetonitrile to the 3 mM MSA eluent, these analytes can be resolved in approximately 22 min, as illustrated in Figure 6.

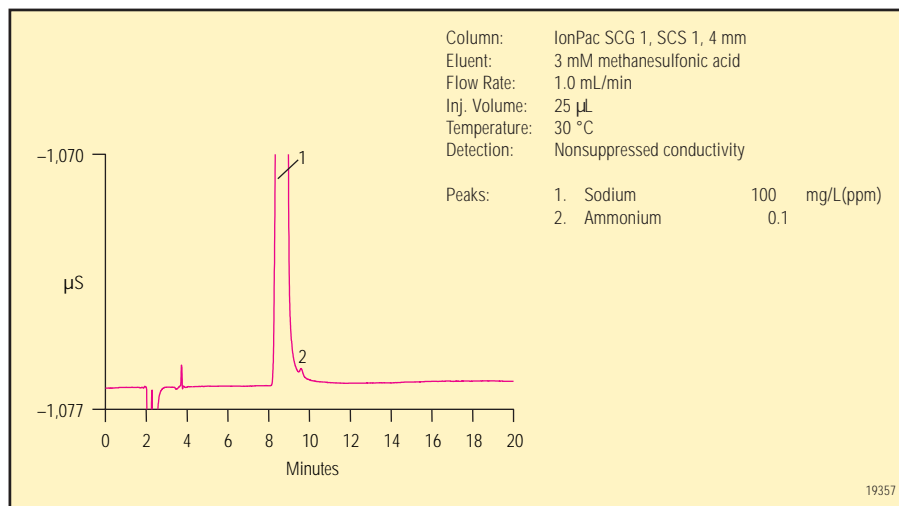


Figure 4. Determination of low concentrations of ammonium in high concentrations of sodium on the IonPac SCS 1 column.

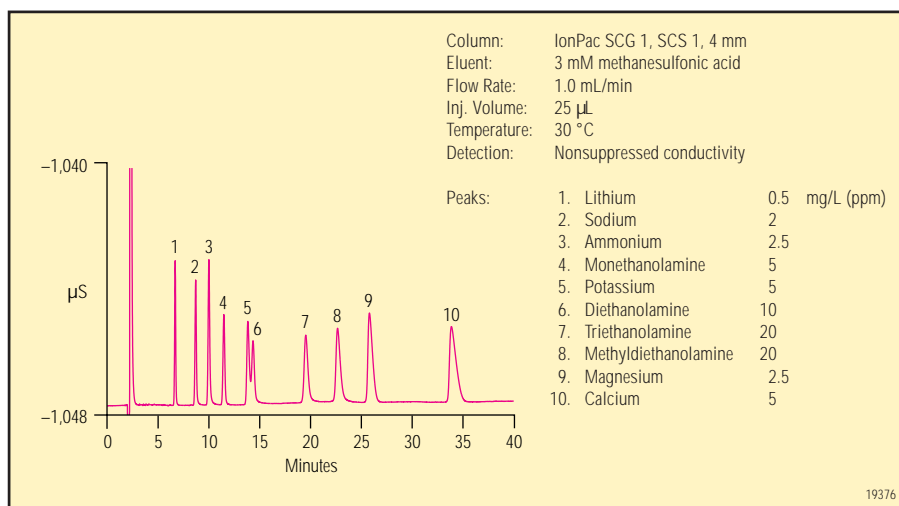


Figure 5. Determination of alkanolamines using the IonPac SCS 1.

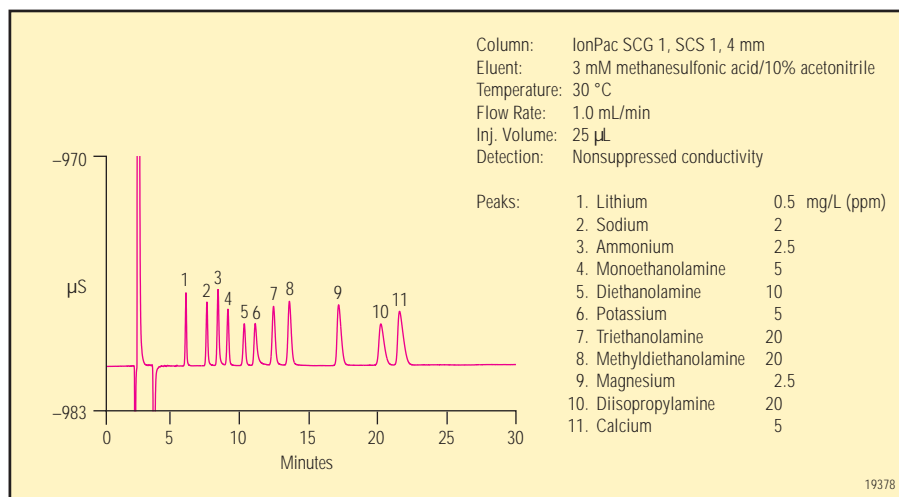


Figure 6. Determination of alkanolamines and diisopropylamine using the IonPac SCS 1.

Determination of Alkanolamines, Transition Metals, and the Common Inorganic Cations in Simulated Feed Water

Figure 7 illustrates an example of a 3-mL simulated feed water sample containing 7 ppm ethanolamine spiked with sub-ppm levels of common inorganic cations, diethanolamine, zinc, cobalt, and manganese. To achieve this separation, the 2.5 mM MSA eluent was modified with 0.8 mM oxalic acid to obtain the appropriate selectivity for this transition metal separation. All cations are well separated with the exception of magnesium and manganese.

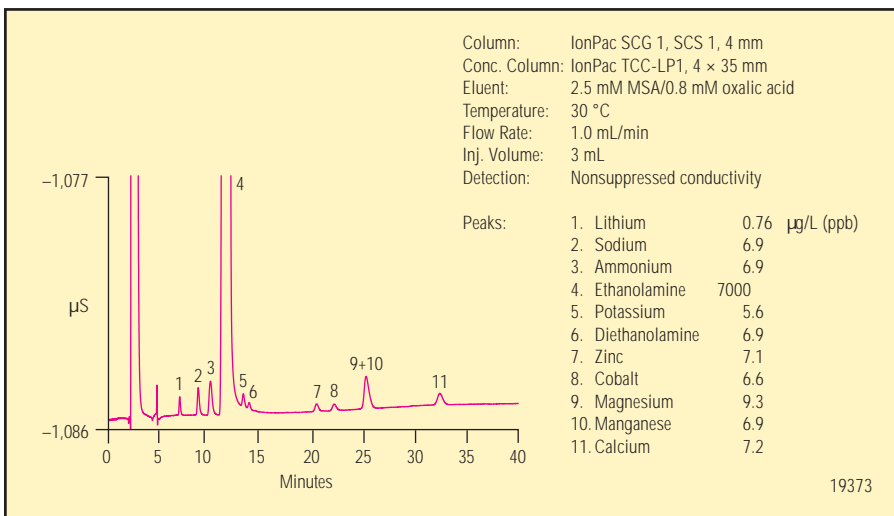


Figure 7. Determination of alkanolamines, transition metals, and the common inorganic cations using the IonPac SCS 1.

Determination of Transition Metals and the Common Inorganic Cations

Figure 8 shows the separation of the six transition metals and common inorganic cations in a single analysis at the ppm concentration level using a 25-µL loop injection. An optimized eluent of 4.0 mM tartaric acid and 2.0 mM oxalic acid is used to achieve the selectivity shown in this example. Also, using these eluent conditions, magnesium and manganese are well resolved.

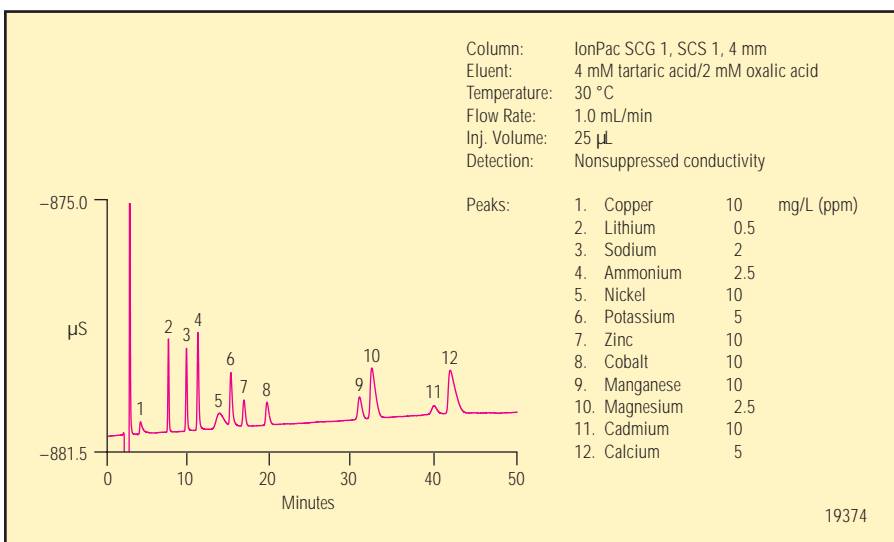


Figure 8. Determination of transition metals and the common inorganic cations using the IonPac SCS 1.

TABLE 1. LINEARITY AND MDLs USING SUPPRESSED CONDUCTIVITY DETECTION ^a				
Analyte	Range (mg/L)	Linearity (r ²)	Calculated MDL ^c (µg/L)	MDL Standard (µg/L)
Lithium	0.05–80	0.9999	0.19	1
Sodium	0.05–1000	0.9999	1.81	4
Ammonium ^b	0.05–40	0.9993	1.23	5
Potassium	0.05–80	0.9999	2.64	10
Magnesium	0.05–80	0.9999	1.00	5
Calcium	0.05–80	0.9998	1.09	5

^a Dionex ICS-2500 system with a 10-µL injection.

^b Quadratic fit.

^c MDL = $t_{s,99}$ where $t_{s,99} = 3.14$ for $n = 7$.

Performance Comparison of Nonsuppressed vs Suppressed Conductivity Detection

Tables 1 and 2 summarize the calibration data and method detection limits (MDLs) obtained for the common inorganic cations plus ammonium using the IonPac CS16 and SCS 1 columns, respectively. Tables 3 and 4 summarize the recommendations for use of nonsuppressed vs suppressed conductivity detection. For further information on the comparison of suppressed vs nonsuppressed conductivity detection for the analysis of common inorganic cations, specific alkanolamines, and transition metals, refer to Application Notes 157 and 158. For regulatory methods that require a linear fit for ammonium or weak amines, the IonPac SCS 1 Silica Cation Separator is the recommended column. For further information on this topic, refer to Application Note 157.

TABLE 2. LINEARITY AND MDLS USING NONSUPPRESSED CONDUCTIVITY DETECTION^a				
Analyte	Range (mg/L)	Linearity (r ²)	Calculated MDL ^b (µg/L)	MDL Standard (µg/L)
Lithium	0.05–50	0.9999	2.0	10
Sodium	0.25–250	0.9999	5.8	20
Ammonium	0.05–50	0.9999	10.9	25
Potassium	0.2–50	0.9999	30.0	100
Magnesium	0.2–50	0.9999	19.6	100
Calcium	0.2–100	0.9999	36.6	150

^a Dionex ICS-2000 system with a 10-µL injection.

^b MDL = $t_{s,99}$ where $t_{s,99} = 3.14$ for $n = 7$.

TABLE 3. NONSUPPRESSED VS SUPPRESSED CONDUCTIVITY DETECTION RECOMMENDATIONS	
Requirement	Recommended Mode
Sensitivity/Lowest MDLs	Suppressed Conductivity
Ammonium/Amine Linearity	Nonsuppressed Conductivity
Inorganic Cation Linearity	Suppressed Conductivity
Transition Metals	Nonsuppressed Conductivity
High-Ionic-Strength Samples	Suppressed conductivity

TABLE 4. LINEARITY AND MDLS USING NONSUPPRESSED CONDUCTIVITY DETECTION^A		
Feature	Nonsuppressed Conductivity Detection	Suppressed Conductivity Detection
Linearity for Inorganic Cations	Up to 3 orders of magnitude	Over 3 orders of magnitude
Linearity for Weak Bases, including Ammonium and certain Amines	Linear	Nonlinear (use quadratic curve)
MDLs for Cations	~2–37 µg/L	~0.2–2.6 µg/L
Sample pH Range	Up to 10 mM H ⁺ (pH 2)	Up to 100 mM H ⁺ (pH 1)
Gradient Elution	Not possible	Commonly used
Choice of Eluent	Strong/weak acids (only low conc.) No EG	Strong acids (high conc. possible) EG Compatible
Sample Ionic Strength	Low	High
Detection of Transition Metals	Yes (common cations may interfere)	No

IC System Operational Requirements

The IonPac SCS 1 Silica Cation Separator (4-mm i.d.) is recommended for operation using an ICS-1000 (with heater option), ICS-1500 or ICS-2000 IC systems. The IonPac SCS 1 (2-mm i.d.) is recommended for operation using the ICS-2500 IC system or the DX-800 Process Analyzer.

Eluent Delivery

The SCS 1 Silica Cation Separator should be used isocratically with hand-prepared bottled eluents. The use of the EG40/EG50 Eluent Generator with this column is not recommended, because noise will be higher than hand-prepared bottled eluents. Applications that require eluent gradients or proportioning from two or more eluent bottles are also not recommended. Without the use of a suppressor, the background shift and the noise will be quite significant, making quantification of the analytes difficult.

Temperature Control

The SCS 1 Silica Cation Separator can be used without long-term loss of performance at 30 °C with a 3 mM methanesulfonic acid (pH 2.5) eluent. We recommend not operating the SCS 1 at temperatures higher than 35 °C.

IonPac Mixer

An IonPac Mixer is required for use with the SCS 1 column. The IonPac Mixer is placed before the eluent inlet of the injection valve. The mixer averages any eluent concentration changes due to temperature fluctuation or pump pulsations. The eluent is mixed in this device before reaching the column and reduces the background noise by approximately two-fold.

SPECIFICATIONS

Dimensions:

IonPac SCS 1 Silica Cation Separator:	4 × 250 mm
IonPac SCS 1 Silica Cation Guard:	4 × 50 mm
IonPac SCS 1 Silica Cation Separator:	2 × 250 mm
IonPac SCS 1 Silica Cation Guard:	2 × 50 mm

Maximum Operating Pressure:

4000 psi

Mobile Phase Compatibility:

Acidic eluents (pH 2–7), 100% HPLC solvents, alcohols should be avoided

Substrate Characteristics:

Bead Diameter (µm): 4.5 µm (Silica)
Pore Size: 120 Å

Ion-Exchange Group:

Grafted carboxylic acid

Functional Group Characteristics:

Medium hydrophobic

Capacity (µeq/column):

4 × 250 mm analytical column:	318 µeq/col
4 × 50 mm guard column:	64 µeq/col
2 × 250 mm analytical column:	80 µeq/col
2 × 50 mm guard column:	16 µeq/col

Column Construction:

PEEK with 10-32 threaded ferrule-style end fittings. All components are nonmetallic.

ORDERING INFORMATION

In the U.S., call (800) 346-6390 or contact the Dionex regional office nearest you. Outside the U.S., order through your local Dionex office or distributor. Refer to the part numbers listed.

Note: Use of SRS 1 with Eluent Suppressors

The SCS 1 Silica Cation Separator will contaminate the suppressor and should not be used with an eluent suppressor in-line.

IonPac SCS 1 Silica Cation Separator

IonPac SCS 1 Silica Cation Separator (4 × 250 mm)	P/N 061521
IonPac SCS 1 Silica Cation Guard (4 × 50 mm)	P/N 061523
IonPac SCS 1 Silica Cation Separator (2 × 250 mm)	P/N 061520
IonPac SCS 1 Silica Cation Guard (2 × 50 mm)	P/N 061522
TCC-LP1 Cation Concentrator Column (4 × 35 mm)	P/N 046027
(for use with 4-mm and 2-mm columns)	
IonPac Mixer, 500 µL	P/N 061645
(required for low-noise operation)	



IonPac is a registered trademark of Dionex Corporation.



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* Designed, developed, and manufactured under an NSAI registered ISO 9001 Quality System.



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