

IonPac® AS11 and AS11-HC Anion-Exchange Columns



The IonPac AS11 anion-exchange column provides fast profiling of inorganic anions and organic acid anions using sodium hydroxide or potassium hydroxide gradient elution. The IonPac AS11-HC is a high-capacity anion-exchange column with selectivity similar to the AS11 column. The AS11-HC is designed to resolve a large number of organic acids and inorganic anions in complex matrices using sodium or potassium hydroxide gradient elution. The AS11-HC is ideal for the determination of trace components and for profiling organic acids in uncharacterized samples.

IonPac AS11 Features

Using a hydroxide gradient of 0.2 to 38 mM sodium hydroxide, the AS11 column separates a large number of inorganic anions and organic acids in approximately 15 min, as illustrated in Figures 1A and 1B.

Peak broadening and overloading can occur when higher concentrations of analytes are injected onto the AS11 column, as shown in Figure 1A. These problems can be eliminated by diluting the sample before injection, as shown in Figure 1B. Conversely, the high-capacity AS11-HC column allows more concentrated samples to be directly injected without overloading the column or affecting peak shape, as illustrated in Figure 1C.

The AS11 also provides rapid elution of strongly retained ions such as iodide, thiocyanate, and thiosulfate in complex matrices.

IonPac AS11-HC Features

The high-capacity AS11-HC column allows the injection of more concentrated samples without overloading and peak broadening. The AS11-HC provides improved separation over the AS11 column for monovalent carboxylic acids, including quinate, lactate, acetate, propionate, formate, and butyrate. A wide range of organic acids and inorganic anions can be separated in approximately 40 min using a sodium hydroxide gradient at a controlled temperature of 30 °C, as illustrated in Figure 1C.



Key Applications

The AS11 and AS11-HC columns are solvent-compatible, which allows for anion-exchange selectivity control and easy column cleanup after the analysis of complex matrices. Typical applications include the determination of organic acids and inorganic anions in diverse sample matrices including:

- Fruit juices and wines
- Foods and beverages
- Fermentation and process solutions
- Chemical additives
- Chemical process solutions
- Wastewater
- Brines
- Power plant waters

Economical Microbore Operation

The IonPac AS11 and AS11-HC columns are available in the 2-mm format for microbore operation to offer the advantage of reduced operating costs.

- Ideal for limited sample volumes due to higher mass sensitivity.
- Three- to fourfold reduction in eluent consumption.
- 4-mm applications can be directly transferred to the 2-mm format by reducing flow rate by fourfold.

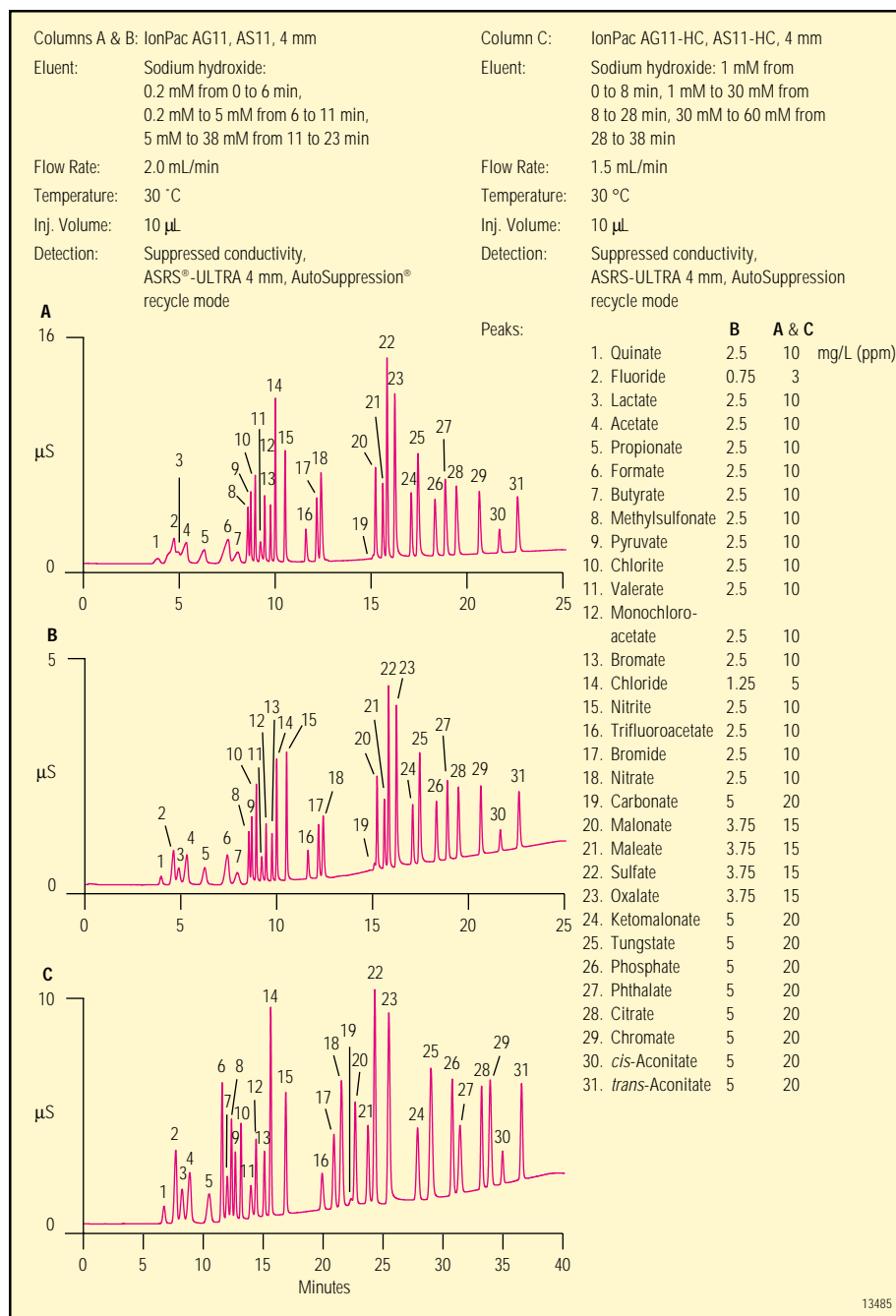


Figure 1. Comparison of the AS11 and AS11-HC columns for the separation of a wide range of organic acids and inorganic anions using sodium hydroxide gradient elution. The high-capacity AS11-HC provides excellent peak shape for early-eluting anions.

High-Efficiency Particle Structure

The IonPac AS11 and AS11-HC column packings have unique structures composed of a highly crosslinked core and a MicroBead® anion-exchange layer attached to the surface, as shown in Figures 2 and 3. The substrate for the IonPac AS11 is a 13- μm diameter microporous resin bead. The AS11-HC column substrate is a 9- μm diameter macroporous resin bead. Both columns are composed of ethylvinylbenzene crosslinked with 55% divinylbenzene.

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

Solvent-Compatible Packing

Because the IonPac AS11 and AS11-HC columns are 100% HPLC solvent compatible, organic solvents can be used for efficient column cleanup or to enhance sample solubility. Time and expense can be saved through the elimination of time-consuming sample preparation steps. This feature allows complex matrices to be analyzed with minimal sample preparation and extends the utility of the column to new applications requiring solvents. Adding organic solvents to the eluent modifies column selectivity and enables the elution of nonpolar analytes or contaminants from the column.

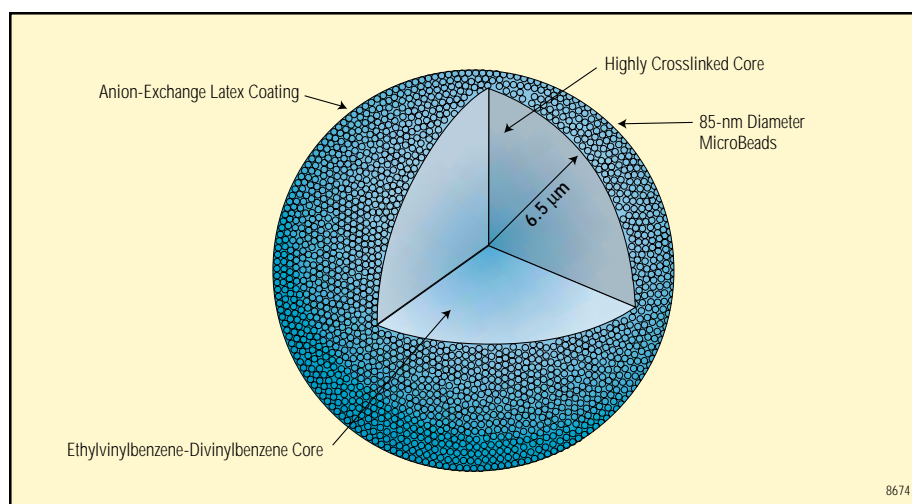


Figure 2. Structure of an IonPac AS11 packing particle.

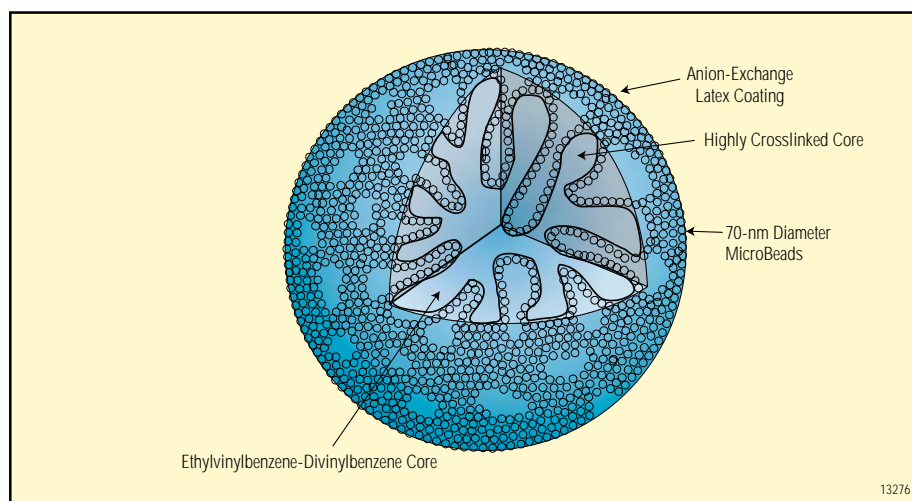


Figure 3. Structure of an IonPac AS11-HC packing particle.

IonPac AS11 Column for Fast Gradient Profile of Organic Acid Anions

The IonPac AS11 column provides fast profiling of organic acids and inorganic anions using sodium or potassium hydroxide gradient elution. The AS11 column is ideal for the determination of organic acids and inorganic anions at similar concentrations or organic acids in well-characterized samples. Mono-, di-, and trivalent organic acids as well as inorganic anions can be separated in approximately 15 min using a sodium or potassium hydroxide gradient.

Determination of Short-Chain Organic Acids

Weakly retained organic acids and inorganic anions commonly encountered in the food, beverage, biopharmaceutical, chemical, and power industries can be determined in a single run using the AS11-HC column. Resolution of monovalent organic acids and improved peak shape are two benefits of the high capacity of the AS11-HC.

Increased Flexibility for Methods Development

The solvent compatibility of the IonPac AS11 and AS11-HC columns permits the use of HPLC organic solvents in the eluent to modify ion-exchange selectivity. Both hydroxide concentration gradients and organic solvent gradients combined with elevated temperature can be used to achieve optimum resolution of closely eluting analyte pairs. The retention of the more hydrophobic member of the unresolved pair is decreased more by the addition of solvent, which improves resolution. Figure 4 illustrates the effect of solvent on selectivity of monovalent and divalent organic acids on the AS11 and AS11-HC columns. The AS11 and AS11-HC columns can be operated at ambient or elevated temperatures. The use of a controlled column temperature ensures reproducible results.

IonPac AS11-HC for Monovalent and Divalent Organic Anions

The AS11-HC column provides improved separation of monovalent and divalent organic acids and inorganic anions using a sodium or potassium hydroxide gradient at a controlled temperature of 30 °C. Because higher eluent concentrations can be used to separate monovalent anions, the higher capacity allows injection of more concentrated samples without overloading and provides improved peak shapes for monovalent organic acids in complex matrices, as illustrated in Figure 1.

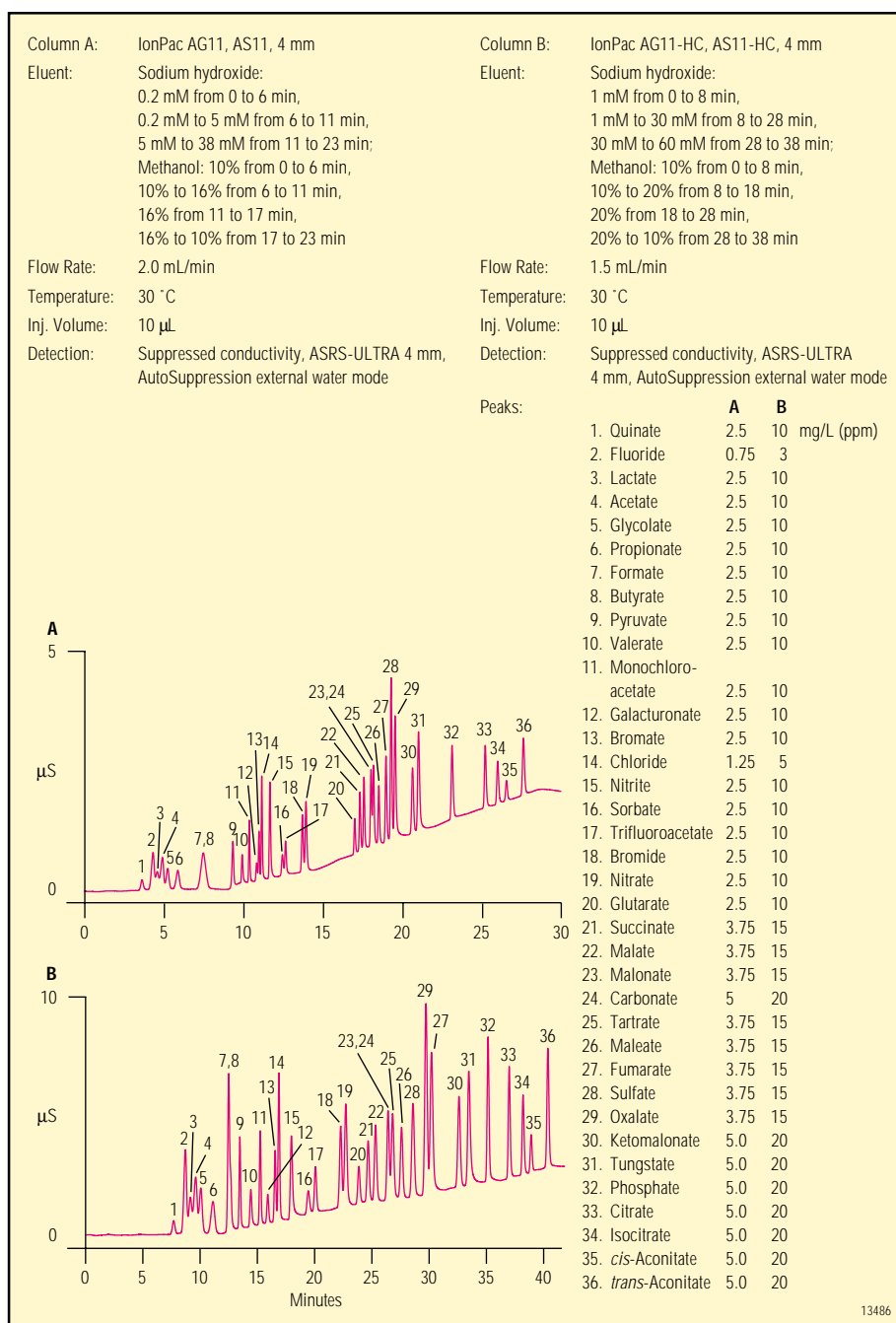


Figure 4. Effect of solvent on AS11 and AS11-HC selectivity.

IonPac AS11-HC for Trace Inorganic and Organic Acid Anions Using a Large-Loop Injection

The high-capacity AS11-HC allows large injections of high ionic strength samples without loss of peak efficiencies and eliminates the need for sample dilution. High capacity allows for the determination of trace inorganic anions and organic acids using a large-loop injection. Figure 5 illustrates the separation of inorganic anions and organic acids using a large-loop injection with a sodium hydroxide gradient at a controlled temperature of 30 °C. Low ppb levels of these analytes can easily be determined using a 1.0 mL injection loop on a 2-mm microbore system.

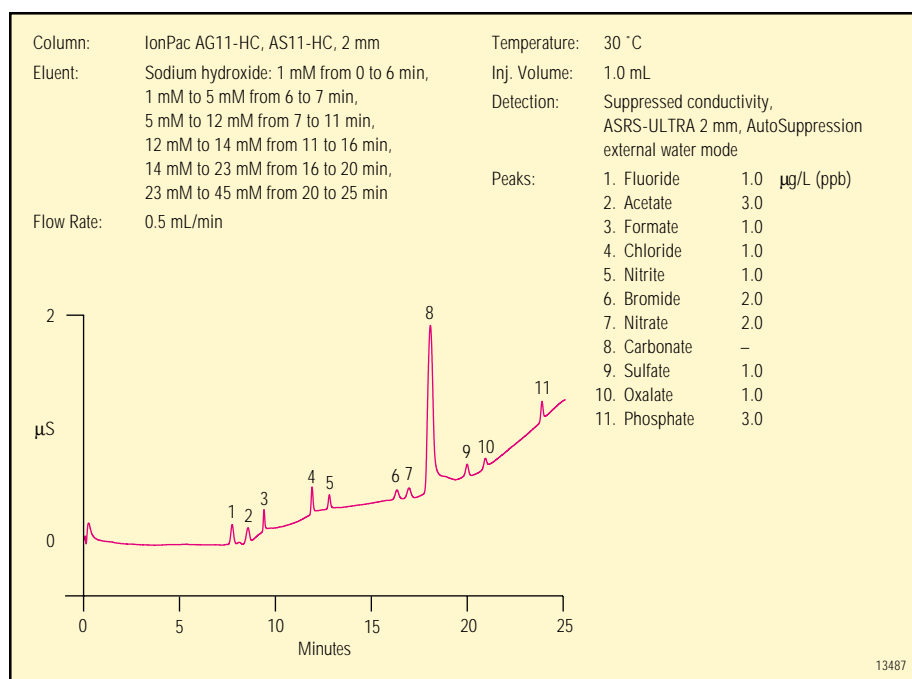


Figure 5. Separation of inorganic anions and organic acids using a large-loop injection on the microbore (2 mm) AS11-HC column.

Determination of Carboxylic Acids in Complex Matrices

The AS11-HC column can be used to monitor the organic acid and inorganic anion content in the quality control of foods, wines, and beverages. The high capacity of the AS11-HC makes it an ideal column for the analysis of organic acids and inorganic anions in complex matrices. Samples high in ionic strength can be directly injected onto the AS11-HC and do not cause overloading problems or poor peak shapes for monovalent organic acids (e.g., lactate, acetate, propionate, formate, and butyrate). Figure 6 compares the AS11 and the AS11-HC columns for the analysis of beer. The AS11-HC column shows improved peak shapes for the monovalent organic acids. Butyrate is an important indicator of deterioration of foods and beverages and can be easily separated from formate on the AS11-HC column with a sodium hydroxide gradient/methanol gradient step change.

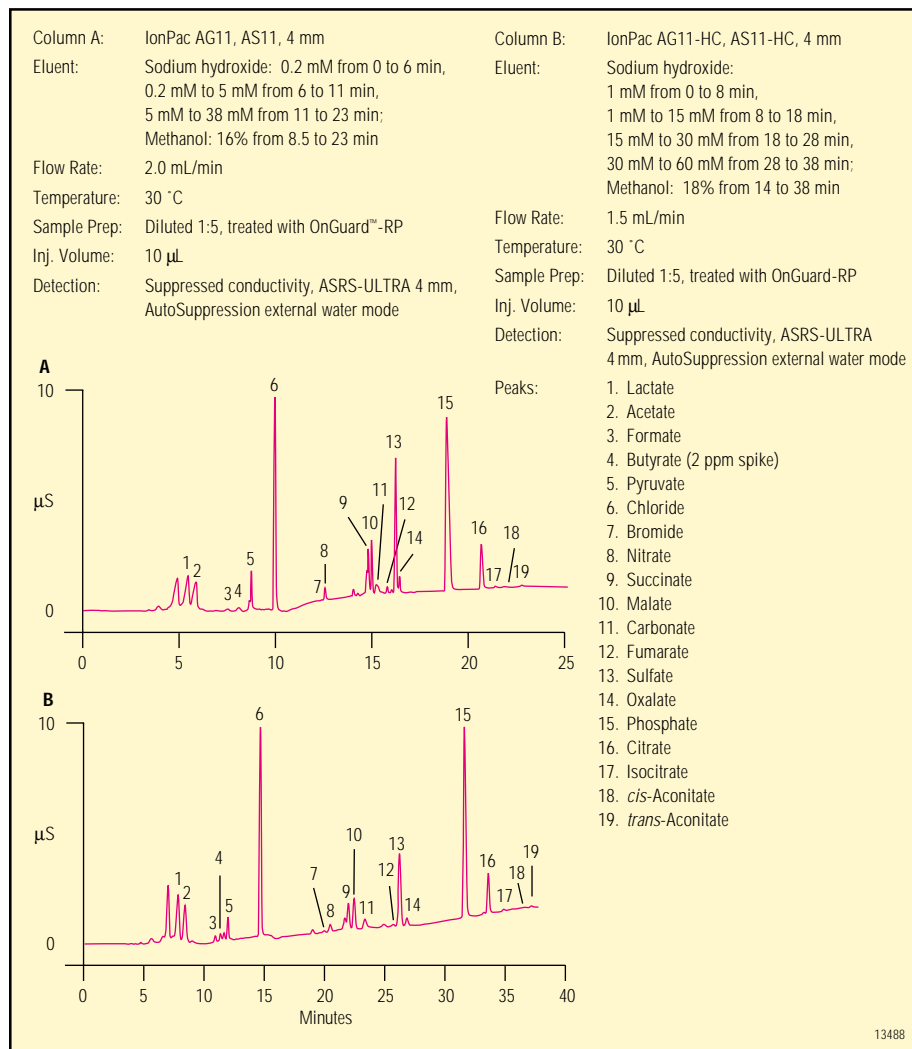


Figure 6. Comparison of the AS11 and AS11-HC columns for the analysis of beer spiked with 2 mg/L (ppm) butyrate.

Figures 7 and 8 illustrate the separation of organic acids and inorganic anions in red wine and apple juice using the AS11-HC column. The AS11-HC column provides improved resolution over the AS11 column for components with widely varying concentration ratios. The AS11-HC column resolves succinate and malate, even at very different concentrations, as shown in Figure 8.

IonPac AS11-HC for Organic Acids and Inorganic Anions in Fermentation Broths

Monitoring fermentation broths is necessary for process control, because many ingredients resulting from metabolic processes affect yield or quality of the desired fermentation products. Inorganic anions maintain osmolarity and provide co-factors for biosynthesis. Certain organic acids are waste products, and their accumulation inhibits cell growth or product yields.

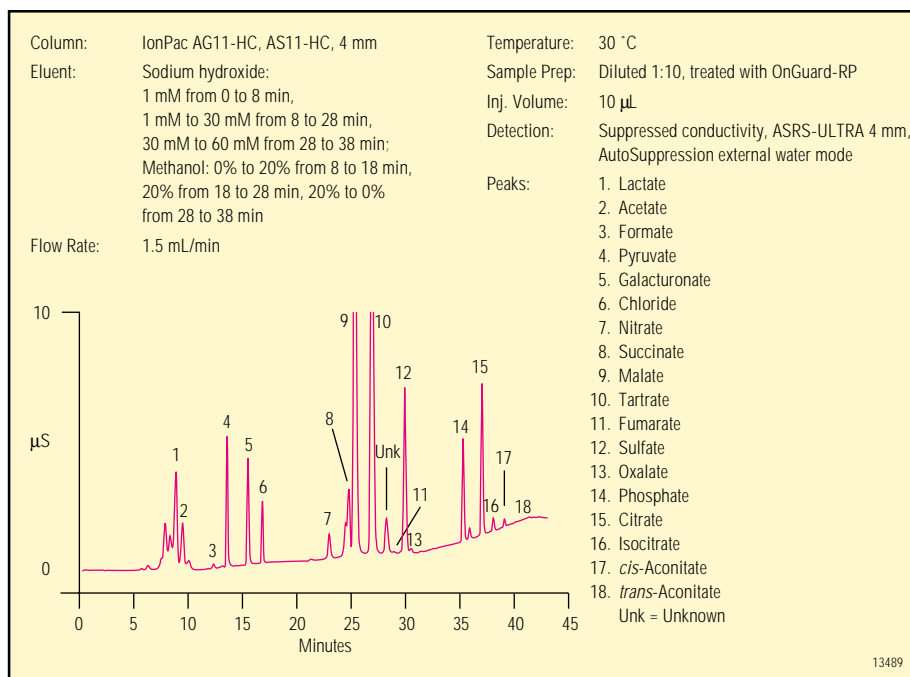


Figure 7. Analysis of red wine using the AS11-HC column.

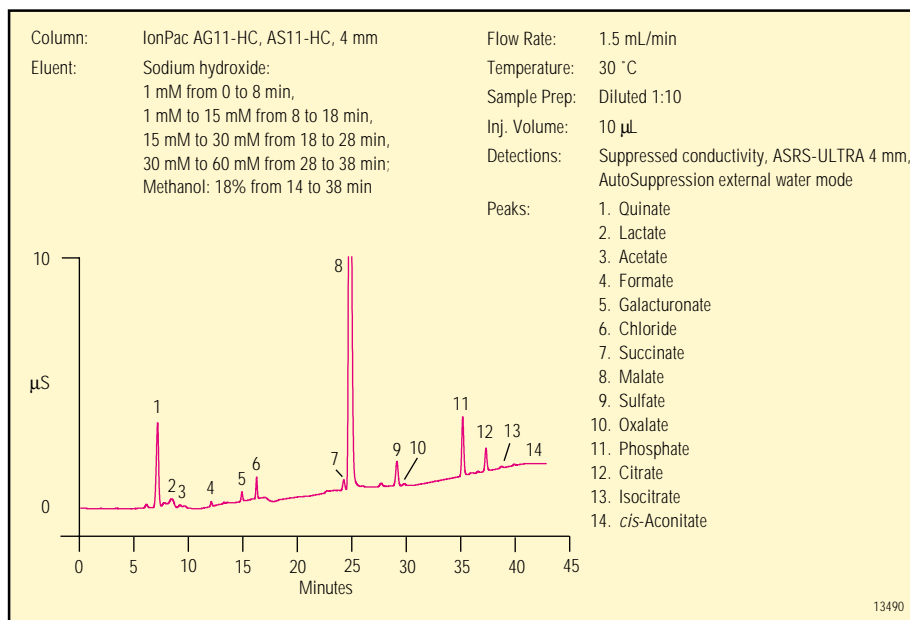


Figure 8. Analysis of apple juice using the AS11-HC column.

The high capacity of the AS11-HC column allows for the determination of a number of inorganic anions and organic acids in fermentation broths. Figure 9 illustrates the separation of common fermentation broth anions using the IonPac AS11-HC column with a sodium hydroxide gradient at a controlled temperature of 30 °C.

Gradient Separations as Simple as Isocratic Runs with the EG40 Eluent Generator

The EG40 Eluent Generator produces high-purity potassium hydroxide eluent electrolytically, eliminating the need for eluent preparation. Only a source of deionized water is required. The potassium hydroxide eluent produced is free of carbonate contamination. The use of carbonate-free hydroxide eluents minimizes baseline shifts during hydroxide gradients which provides greater retention time reproducibility, lower background conductivity, and lower detection limits for target analytes.

Figure 10 illustrates the gradient separation of inorganic anions and organic acids in grape juice on an IonPac AS11-HC using a potassium hydroxide gradient delivered by an EG40 Eluent Generator.

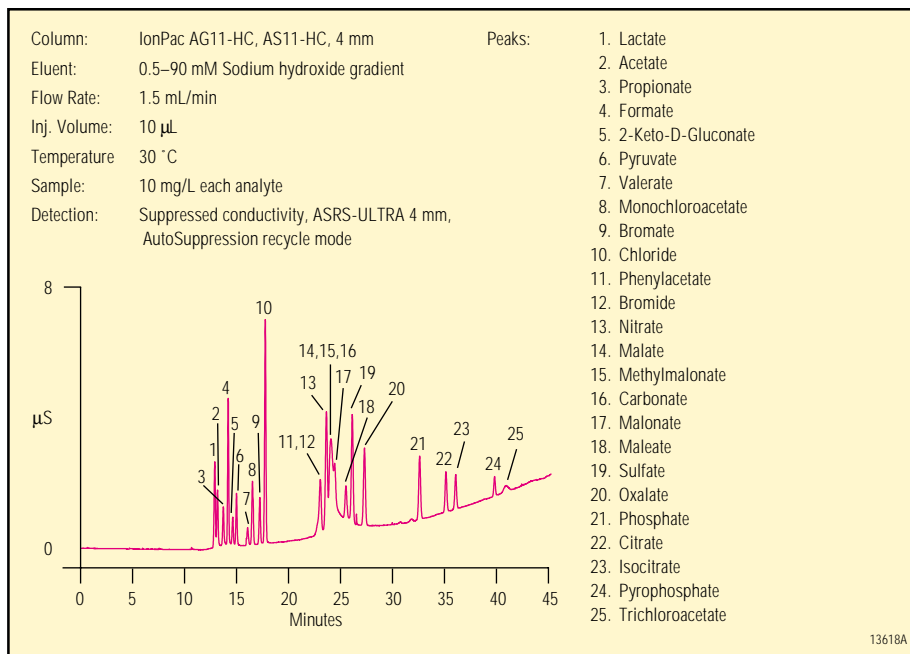


Figure 9. Separation of common fermentation broth anions using the IonPac AS11-HC column.

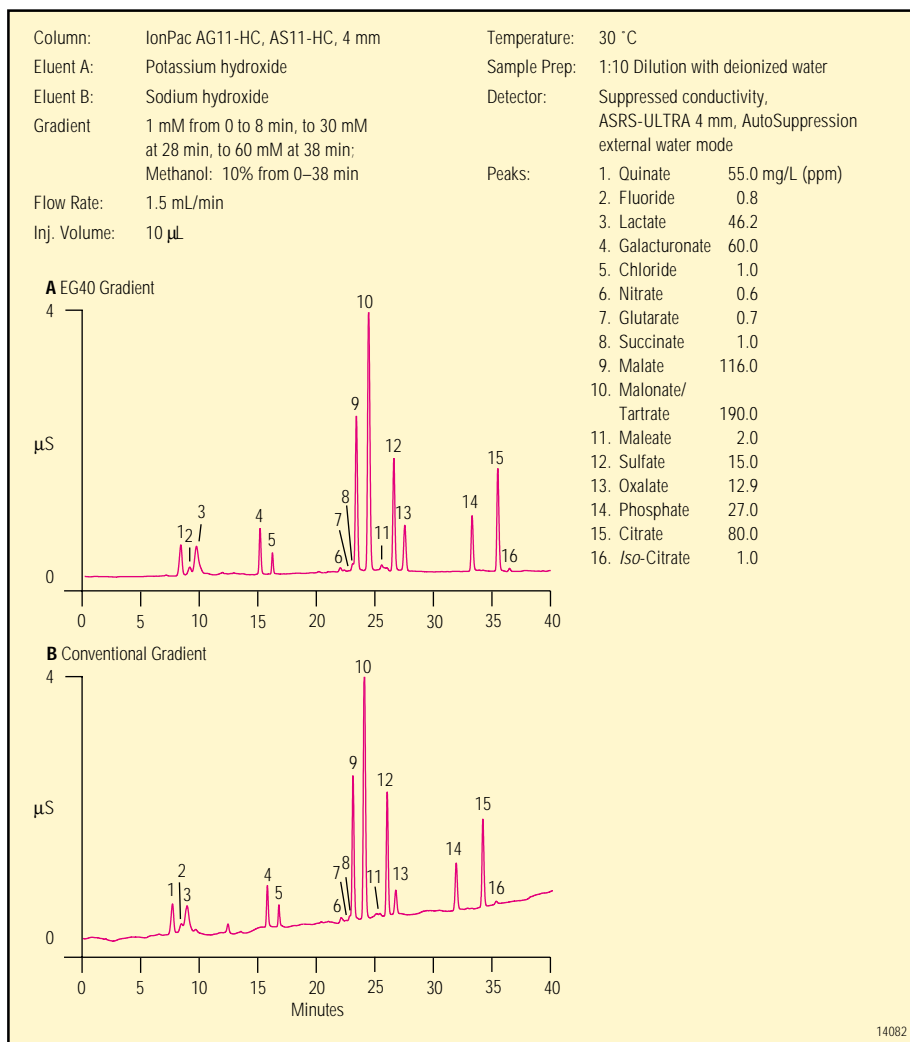


Figure 10. Analysis of grape juice on an IonPac AS11-HC column using a potassium hydroxide gradient delivered by an EG40 Eluent Generator.

Figure 11 illustrates the use of the IonPac AS11 column with the EG40 Eluent Generator for an application of interest to the food industry, determination of sorbate, a sweetener used in cake frosting. In this example, a potassium hydroxide gradient is used to elute sorbate in less than 6 min and also resolve other inorganic anions and organic acids present in cake frosting.

AS11 for Anions in Hydrogen Peroxide

Fabricators of electronic components use hydrogen peroxide during the manufacturing process. Monitoring chemical reagents for anionic impurities is important because the anionic contaminants can cause corrosion when present in manufacturing solutions. A method has been developed using the AS11 column to determine inorganic anions in stabilized hydrogen peroxide. Figure 12 illustrates the separation of the anionic contaminants in hydrogen peroxide using a large-loop injection with a sodium hydroxide gradient.

AS11-HC for Trace Anions in Methanesulfonic Acid

Monitoring anionic contaminants in chemical reagents is an important quality control function for specialty chemical manufacturers. The high-capacity AS11-HC column is ideal for determining trace anions in concentrated acids. Figure 13 illustrates the separation of trace chloride and sulfate in concentrated methanesulfonic acid using the AS11-HC column. Chloride and sulfate can easily be determined down to the low ppb level with good peak shape even in the presence of high concentrations of methanesulfonic acid.

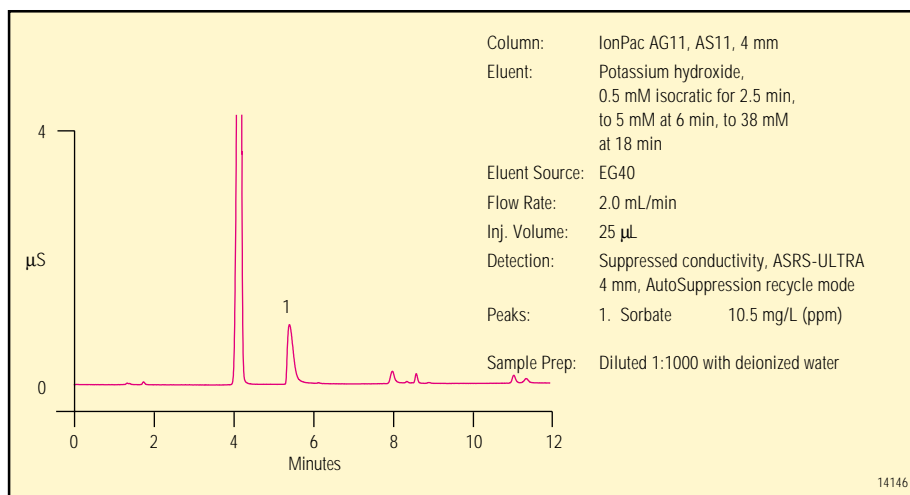


Figure 11. Analysis of sorbate in cake frosting on an IonPac AS11 column using a potassium hydroxide gradient delivered by an EG40 Eluent Generator.

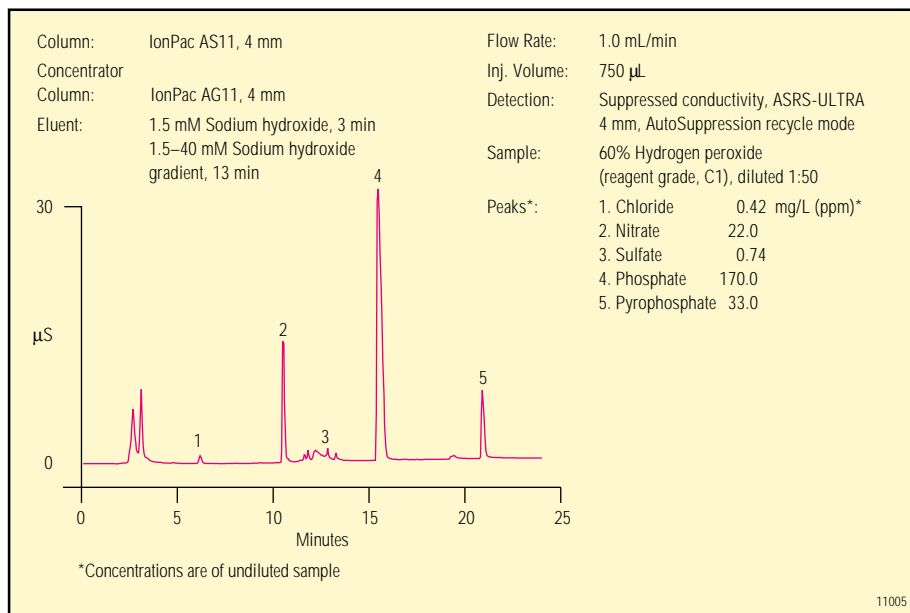


Figure 12. Determination of anions in 60% stabilized hydrogen peroxide using the IonPac AS11 column.

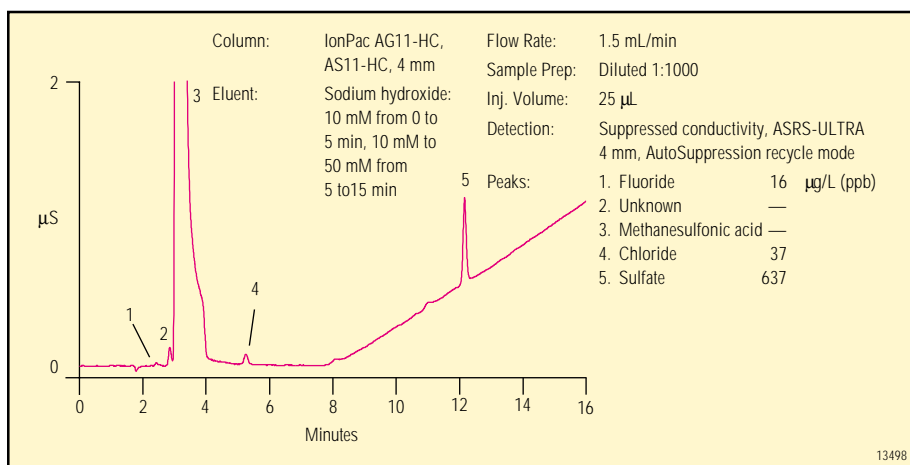


Figure 13. AS11-HC for trace anions in concentrated methanesulfonic acid.

AS11 Column for Polarizable Anions

The AS11 column separates polarizable anions in complex matrices. As shown in Figure 14, for highly retained hydrophobic anions such as iodide, perchlorate, thiocyanate, and thiosulfate, retention times can be significantly decreased and peak efficiencies improved by using eluents containing organic solvents. This approach is ideal for the determination of iodide, perchlorate, thiocyanate, and thiosulfate. The IonPac AS16 is recommended for this separation without the use of solvents in the eluent.

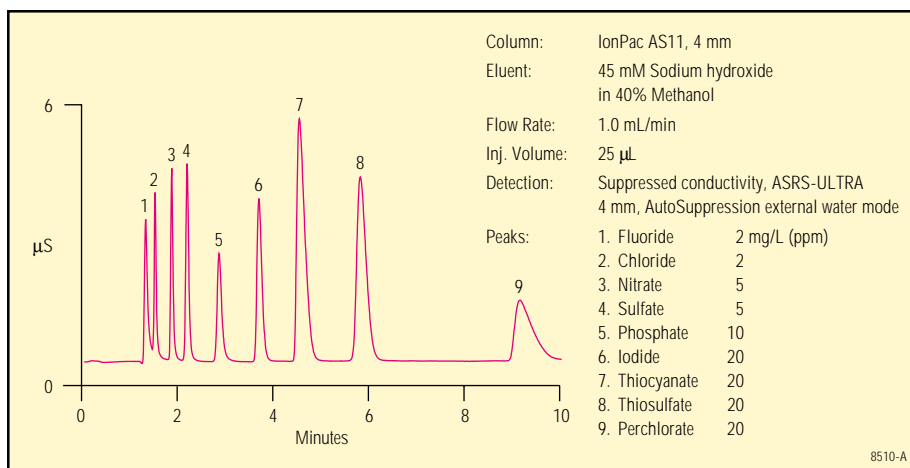


Figure 14. Separation of common inorganic anions, including iodide, perchlorate, thiocyanate, and thiosulfate, using the AS11 column.

AS11 Column for Highly Charged Anions

The determination of highly charged anions such as polyphosphates or polycarboxylates is possible using gradient elution on a 2-mm or 4-mm IonPac AS11. As shown in Figure 15, the high hydroxide selectivity on the IonPac AS11 resin permits elution of these ions at lower hydroxide concentrations than are possible on the OmniPac® PAX-100, permitting the use of either 2-mm or 4-mm columns. The IonPac AS11 column is ideal for the determination of polyphosphates, polycarboxylates, and polysulfonates.

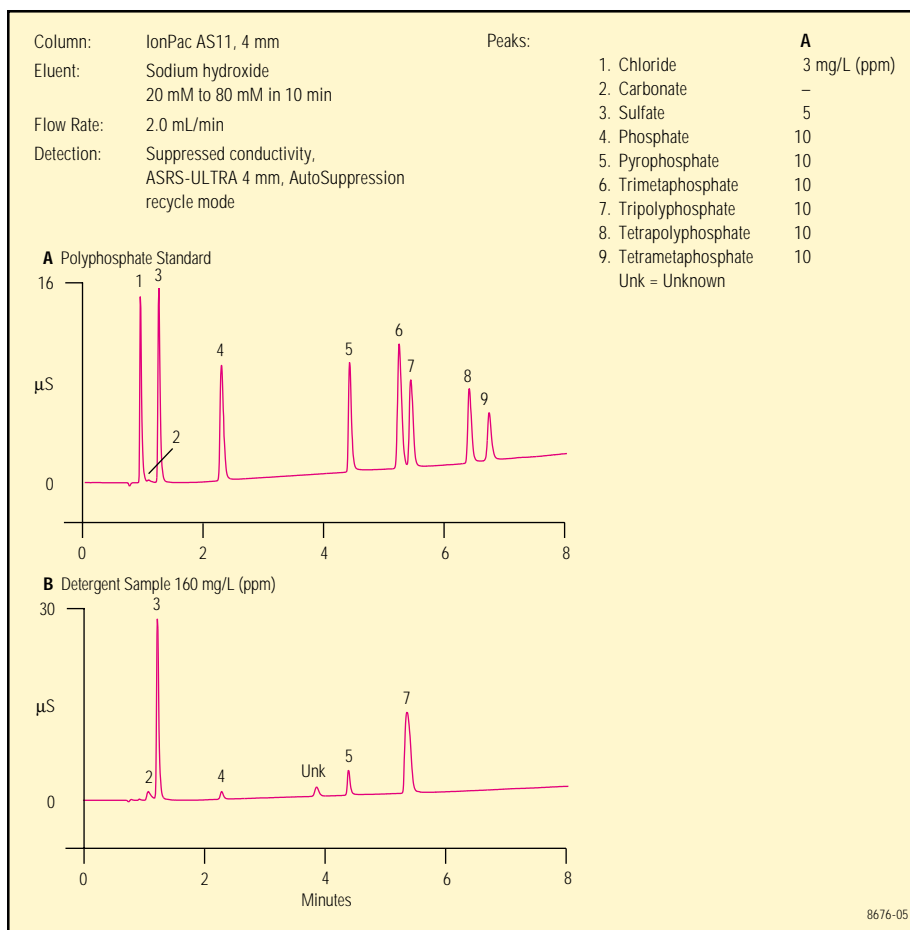


Figure 15. Separation of polyphosphates in detergent.

COLUMN SELECTION TABLE

Analytes	Recommended Column
Fast profiling of mono-, di-, and trivalent organic acids and inorganic anions in well-characterized samples	AS11
High resolution of mono- and divalent organic acids	AS11-HC
Monovalent organic acids (lactate, acetate, propionate, formate, butyrate)	AS11-HC
Trace components in complex matrices using large loop injection	AS11-HC
Organic acids and inorganic anions in high ionic strength matrices	AS11-HC
Organic acids in high ionic strength matrices (inorganic anions elute in void)	ICE-AS6 or ICE-AS1
Aromatic acids with conductivity detection	AS11
Polarizable anions (iodide, thiocyanate, thiosulfate, perchlorate)	AS11 or AS16
Polyphosphates, polycarboxylates, and polysulfonates	AS11 or AS16
Preservatives (benzoate, citrate, sorbate)	AS11-HC

SPECIFICATIONS

<i>IonPac AS11 Column</i>	<i>IonPac AS11-HC Column</i>
Dimensions:	Dimensions:
IonPac AS11 Analytical: 2 x 250 mm and 4 x 250 mm	IonPac AS11-HC Analytical: 2 x 250 mm and 4 x 250 mm
IonPac AG11 Guard: 2 x 50 mm and 4 x 50 mm	IonPac AG11-HC Guard: 2 x 50 mm and 4 x 50 mm
Maximum Operating Pressure: 27 MPa (4000 psi)	Maximum Operating Pressure: 27 MPa (4000 psi)
Mobile Phase Compatibility: pH 0–14; 0–100% HPLC solvents	Mobile Phase Compatibility: pH 0–14; 0–100% HPLC solvents
Substrate Characteristics:	Substrate Characteristics:
Bead Diameter: 13 µm	Bead Diameter: 9.0 µm
Pore Size: Microporous, <10Å	Pore Size: 2000Å
Crosslinking (%DVB): 55%	Crosslinking (%DVB): 55%
Latex Characteristics:	Latex Characteristics:
Functional Group: Alkanol quaternary ammonium ion	Functional Group: Alkanol quaternary ammonium ion
Latex Crosslinking: 6%	Latex Crosslinking: 6%
Latex Diameter: 85 nm	Latex Diameter: 70 nm
Hydrophobicity: Very Low	Hydrophobicity: Medium Low
Capacity:	Capacity*:
11 µeq (2 x 250 mm Analytical)	72.5 µeq (2 x 250 mm Analytical)
45 µeq (4 x 250 mm Analytical)	290 µeq (4 x 250 mm Analytical)
Column Construction:	Column Construction:
PEEK with 10–32 threaded ferrule-style end fittings. All components are nonmetallic.	PEEK with 10–32 threaded ferrule-style end fittings. All components are nonmetallic.

* IonPac AG11-HC guard is packed with a microporous, pellicular resin with a capacity of 1.75 µeq (2 x 50 mm guard column) and 7 µeq (4 x 50 mm guard column). The latex selectivity is identical to the analytical columns.

Ordering Information

For optimum ease-of-use and economy, the IonPac AS11 and AS11-HC columns should be used with the ASRS® Anion Self-Regenerating Suppressor.

When performing sodium hydroxide gradient anion-exchange applications on the AS11 and AS11-HC, an Anion Trap Column (ATC-3) should be installed between the gradient pump and the injection valve to remove anionic contaminants from the eluent. The EG40 Eluent Generator is used to automatically produce potassium hydroxide gradients using a deionized water source. When using the EG40 Eluent Generator for trace anion determinations, the ATC-HC column should be installed between the pump outlet and the inlet of the EluGen cartridge.


For 4-mm concentrator work, use the appropriate guard (IonPac AG11 or AG11-HC) or TAC Concentrator column when a single piston pump such as the DQP or DXP pump is used for sample delivery. Use the TAC-LP1 Concentrator column when the sample is delivered with a syringe or with an autosampler such as the AS40 or AS50. For 2-mm concentrator work, use the appropriate guard (IonPac AG11 or AG11-HC) when a single piston pump such as the DQP or DXP pump is used for sample delivery.

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 following part numbers.

IonPac AS11 Analytical Column (4 x 250 mm).....	P/N 44076
IonPac AG11 Guard Column (4 x 50 mm).....	P/N 44078
IonPac AS11 Analytical Column (2 x 250 mm).....	P/N 44077
IonPac AG11 Guard Column (2 x 50 mm).....	P/N 44079
IonPac AS11-HC Analytical Column (4 x 250 mm).....	P/N 52960
IonPac AG11-HC Guard Column (4 x 50 mm).....	P/N 52962
IonPac AS11-HC Analytical Column (2 x 250 mm).....	P/N 52961
IonPac AG11-HC Guard Column (2 x 50 mm).....	P/N 52963
ATC-3 4-mm (9 x 24 mm) Anion Trap Column	P/N 59660 (for use with 4-mm columns)
ATC-3 2-mm (4 x 3 5 mm) Anion Trap Column	P/N 59661 (for use with 2-mm columns)
ACT-HC (9 x 75 mm) Anion Trap Column	P/N 59604 (for use with the EG40 Eluent Generator)
IonPac TAC-2 Trace Anion Concentrator (3 x 35 mm).....	P/N 43101
IonPac TAC-LP1 Trace Anion Concentrator (4 x 35 mm).....	P/N 46026



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