

Recent Advances in Anion-Exchange Stationary Phases Designed for Use with Carbonate Eluent Systems

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INTRODUCTION

In the area of ion chromatography of anions, carbonate-based eluent systems have long been the mainstay. There have been a number of columns introduced over the years for the analysis of the oxyhalide anions and common anions utilizing carbonate eluents. A variety of different synthetic methods had been used to prepare such columns including electrostatic attachment of a colloidal anion-exchange film, free radical grafting to a high surface area porous polymeric substrate and chemical modification of preformed polymeric media. In this note, we present a novel approach to the preparation of an anion-exchange material suitable for use with carbonate eluent systems and primary amine allowing considerable synthetic flexibility in controlling column capacity.

In this paper we will describe use of such stationary phases which are suitable for the determination of environmental anions including oxyhalide anions and common anions using a carbonate eluent system. The application of these new columns to a variety of real samples will be demonstrated.

EXPERIMENTAL CONDITIONS

All the separations were performed on the IonPac® AG22, AS22, AG23, and AS23 2- and 4-mm columns (Dionex, Sunnyvale, California) and on a modular DX-500 IC System (Dionex) equipped with a GP40 Gradient Pump, LC30 Chromatography Oven, CD20 Conductivity Detector with a DS3 conductivity cell and an ASRS® ULTRA II 4 mm in auto recycle mode. Chromeleon® 6.7 Chromatography Management Software (Dionex) was used for system control and data processing.

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RESULTS AND DISCUSSION

Resin Bead Structure of IonPac AS22 and AS23

Porous substrate particles prepared from styrenic monomers are surface sulfonated to create a hydrophilic adhesion layer. After this process, an anion-exchange condensation polymer with “dendrimer-like” features (Figure 1) is grown from the surface by successively treating the surface, first with a reaction mixture containing both a primary amine and diepoxide monomer, followed by alternating reaction cycles with just the diepoxide monomer, and then just the primary amine. By following this reaction sequence, the column capacity doubles with each successive treatment of diepoxide monomer.

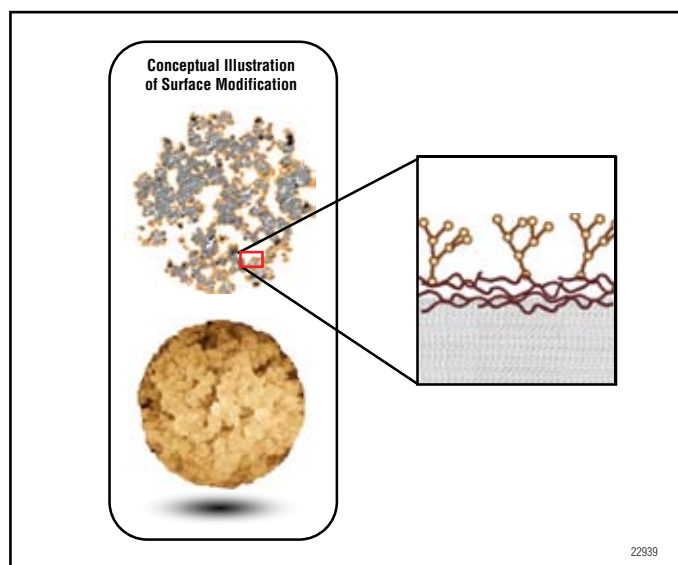


Figure 1. Structure of an IonPac AS22 and AS23 packing particle.

The IonPac AS22 and AS23 stationary phases offer a unique advantage for the location of the carbonate peak. Unlike other stationary phases, the carbonate peak can be placed anywhere between nitrite and sulfate depending upon the pH of the eluent as shown in Figure 2 using IonPac AS22 column.

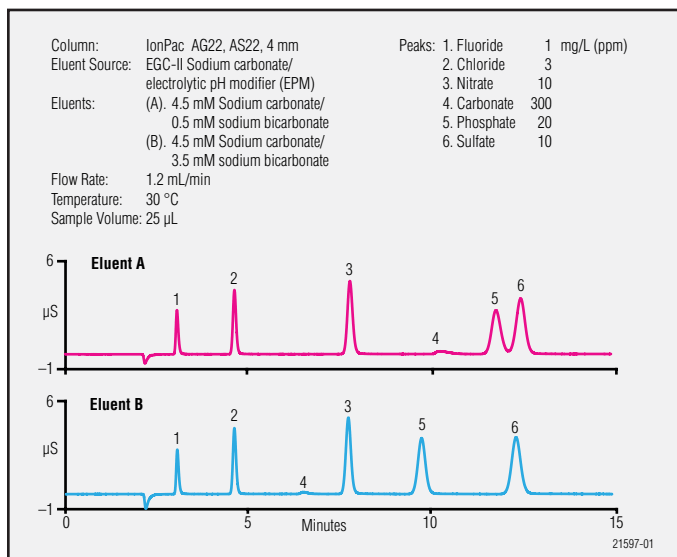


Figure 2. Effect of eluent pH on IonPac AS22 selectivity.

IonPac AS22 for the Analysis of Inorganic Anions

The IonPac AS22 provides excellent separation of fluoride, chloride, nitrite, bromide, nitrate, carbonate, phosphate, and sulfate using an isocratic carbonate/bicarbonate eluent and suppressed conductivity. Solvent compatibility permits easy column cleanup after the analysis of samples with hydrophobic components.

Figure 3 shows the analysis of Municipal drinking water using the IonPac AG22 and AS22 columns. All the inorganic anions are well separated including carbonate. Notice that this column also offers good separation for not only common inorganic anions, but also for oxyhalides such as chlorate.

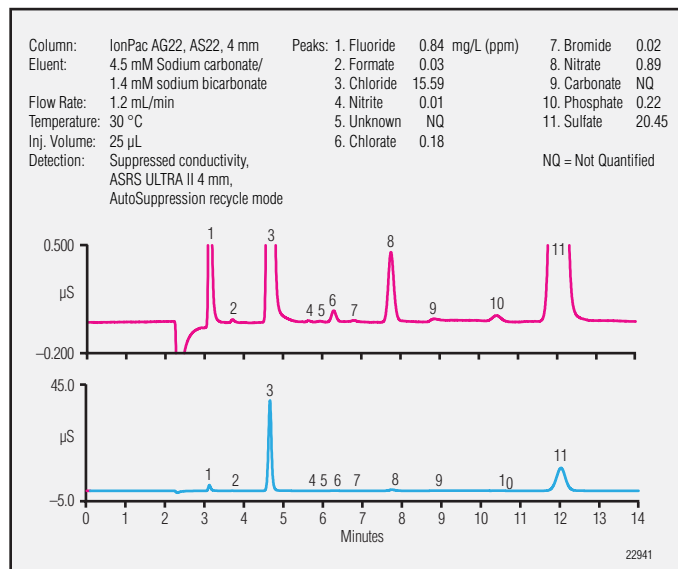


Figure 3: Determination of inorganic anions in a municipal drinking water sample on an IonPac AS22 column.

Figure 4 shows the analysis of carbonated drinking water using the IonPac AG22 and AS22 columns. After one half hour of simple sonication of the carbonated drinking water, all the common anions are well separated from the carbonate peak.

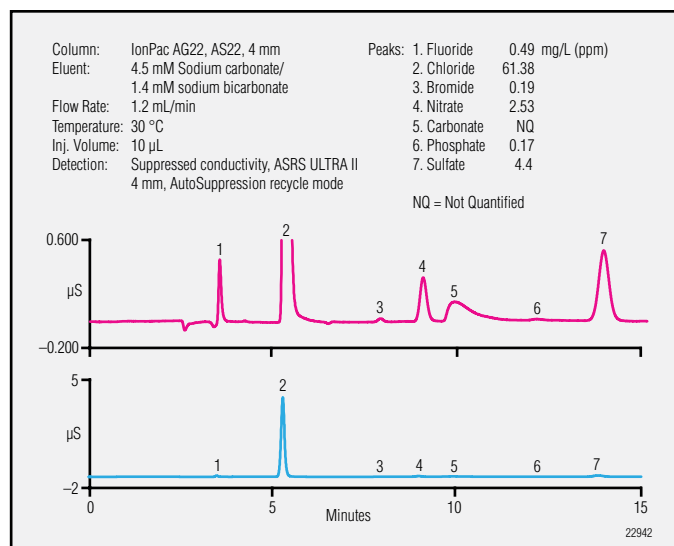


Figure 4. Determination of inorganic anions in carbonated water on an IonPac AS22 column.

The IonPac AS22 is suitable for separations requiring faster analysis of inorganic anions in simple sample matrices as shown in Figure 5. Common inorganic anions can be separated in approximately 8 min on an AS22 2-mm column using a flow rate of 0.5 mL/min.

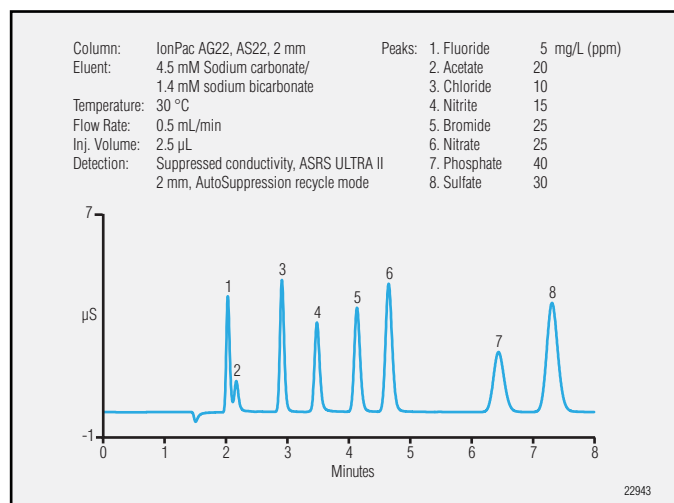


Figure 5. Fast analysis of common anions using IonPac AS22 column.

IonPac AS23 for the Analysis of Oxyhalides and Inorganic Anions

The IonPac AS23 is designed for the separation of oxyhalides and common inorganic anions including carbonate in a variety of sample matrices. These analytes can be easily separated in approximately 23 min using an isocratic carbonate/bicarbonate eluent and suppressed conductivity. Solvent compatibility permits easy column cleanup after the analysis of samples with hydrophobic components.

Figure 6 shows the analysis of simulated drinking water using IonPac AG23 and AS23 column. The lower detection limits can be achieved for the oxyhalides by making a large loop injection of the sample.

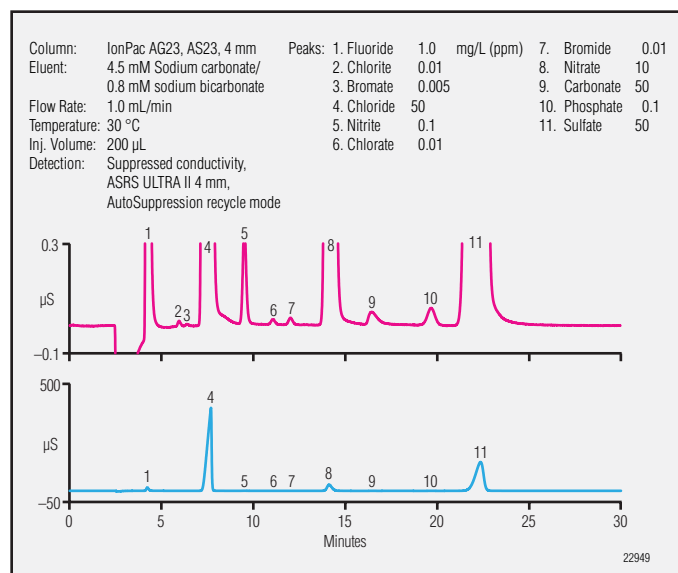


Figure 6. Determination of trace concentrations of bromate using the IonPac AS23 column with a large-loop injection.

Figure 7 shows the analysis of the Municipal drinking water using the IonPac AG23 and AS23 columns. Notice carbonate is well separated from rest of inorganic anions and oxyhalides.

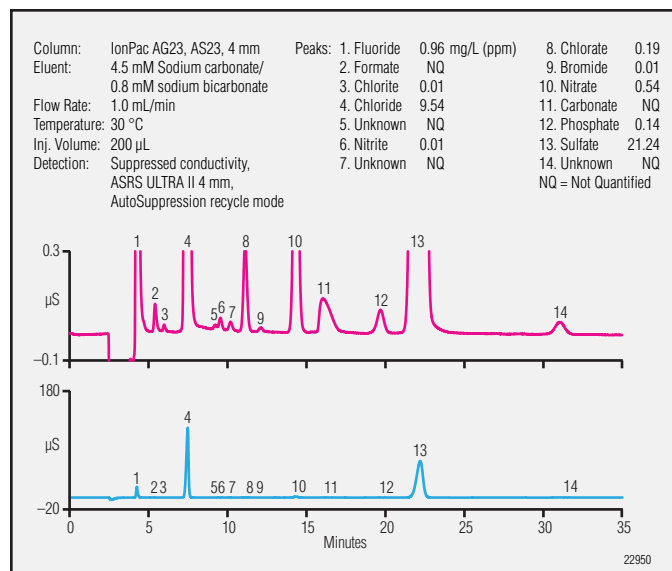


Figure 7. Determination of oxyhalides and inorganic anions in a municipal drinking water sample using an IonPac AS23 column.

CONCLUSIONS

The AS22 and AS23 stationary phases offer a unique advantage of controlling the location of the carbonate peak (a common contaminant) based on the pH of the eluent.

The IonPac AS22 column offers excellent separation of common inorganic anions along with carbonate in less than 12 min. The AS22 can offer faster analysis speed by using higher flow rates.

The IonPac AS23 is the best column for the analysis of oxyhalides and common inorganic anions including carbonate. The high capacity of the AS23 allows the use of a large sample loop to lower the detection limits for the oxyhalides.

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