PRODUCT MANUAL

EGC II K_2CO_3 Cartridge

Electrolytic pH Modifier

EGC Carbonate Mixer

DIONEX

IC | HPLC | MS | EXTRACTION | PROCESS | AUTOMATION

PRODUCT MANUAL

FOR THE

EGC II K_2CO_3 CARTRIDGE

EGC II K_2CO_3 CARTRIDGE, P/N 058904

ELECTROLYTIC pH MODIFIER (EPM)

EPM, P/N 063175

EGC CARBONATE MIXER

EGC CARBONATE MIXER, 2-mm, P/N 063443
EGC CARBONATE MIXER, 4-mm, P/N 061686

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GUIDE TO IMPORTANT INFORMATION

Several icons are used throughout this document to emphasize important points. The symbols are shown below, along with the purpose of the information.

SAFETY

Safety information can help prevent bodily harm.

WARNING

Warning information can help prevent equipment harm.

CAUTION

Caution information can help prevent problems.

NOTE

Note information can help with tips for improved use.

1. INTRODUCTION

The Dionex Eluent Generator (EG) is capable of generating high purity acid, base, and salt eluents online at the point of use utilizing only deionized (DI) water as the carrier. The use of EG in Ion Chromatography (IC) offers several significant advantages. Mainly, separations can be performed using only DI water as the carrier and the need to prepare eluent is eliminated. Eluent Generators produce high purity, contaminant free eluents online. The use of these high purity eluents can significantly improve the performance of IC methods.

Dionex offers four Eluent Generator Cartridges (EGC II) for anion separations.

a. EGC II KOH cartridge for generation of potassium hydroxide (KOH)
b. EGC II NaOH cartridge for generation of sodium hydroxide (NaOH)
c. EGC II LiOH cartridge for generation of lithium hydroxide (LiOH)
d. EGC II K_2CO_3 cartridge for generation of potassium carbonate (K_2CO_3)

Dionex also offers one Eluent Generator Cartridge for cation separations.

e. EGC II MSA cartridge for generation of methanesulfonic acid (MSA)

1.1. EluGen II K_2CO_3 Cartridge and EPM Principle of Operation

The Potassium Carbonate Eluent Generator Cartridge (EGC II K_2CO_3) is the heart of the electrolytic carbonate eluent generation process. Figure 1 shows the principle of electrolytic generation of carbonate eluents. Carbonate eluents are generated by using an EGC II K_2CO_3 cartridge. The EGC II K_2CO_3 cartridge consists of an electrolyte reservoir and a high-pressure eluent generation chamber, which are connected together through an ion exchange connector. The ion exchange connector contains two sections: a cation exchange section and an anion exchange section.

The cation exchange section is located directly above the cathode and the anion exchange section is located directly above the anode in the eluent generation chamber. To generate a potassium carbonate solution, deionized water is pumped into the eluent generation chambers and a DC electrical current is applied to the anode and cathode of the device. Water is reduced to form OH^- ions and hydrogen gas at the cathode.

$$\mathbf{2\ H_2O + 2\ e^- \rightarrow 2\ OH^- + H_2\uparrow\ (at\ cathode)}$$

Water is oxidized to form H^+ ions and oxygen gas at the anode.

$$\mathbf{H_2O - 2e^- \rightarrow 2\ H^+ + 1/2\ O_2\uparrow\ (at\ anode)}$$

Under the applied electrical field, potassium ions in the electrolyte reservoir migrate across the cation exchange connector and combine with the hydroxide ions produced at the cathode through the reduction of water to form a KOH solution. In the meantime, carbonate ions migrate across the anion exchange connector and combine with H^+ ions produced at the anode through the oxidation of water to form a carbonic acid solution. The potassium hydroxide solution reacts with the carbonic acid solution to form a potassium carbonate (K_2CO_3) solution, which can be used as the eluent in ion chromatography. The concentration of K_2CO_3 formed is directly proportional to the applied DC current and inversely proportional to the flow rate of DI water going through the eluent generation chamber.

When the EGC II K_2CO_3 cartridge is combined with an Electrolytic pH Modifier (EPM), eluents of carbonate and bicarbonate can be generated electrolytically. The EPM consists of a cation exchange bed that is fitted with an anode at its outlet. The inlet end of the device is connected to a cathode through the cation exchange connector. A DC current is applied to the EPM to remove a controlled amount of potassium ions which are forced to migrate across the cation exchange connector. The displaced potassium ions move toward the cathode and combine with hydroxide ions to form a solution of potassium hydroxide, which is directed to waste. In the meantime, hydronium ions generated at the anode converts carbonate into bicarbonate. The net reaction is shown in Figure 2. Therefore, by controlling the applied current, the pH of the incoming potassium carbonate eluent can be modified to form a potassium carbonate and bicarbonate solution for use as the eluent in IC separations.

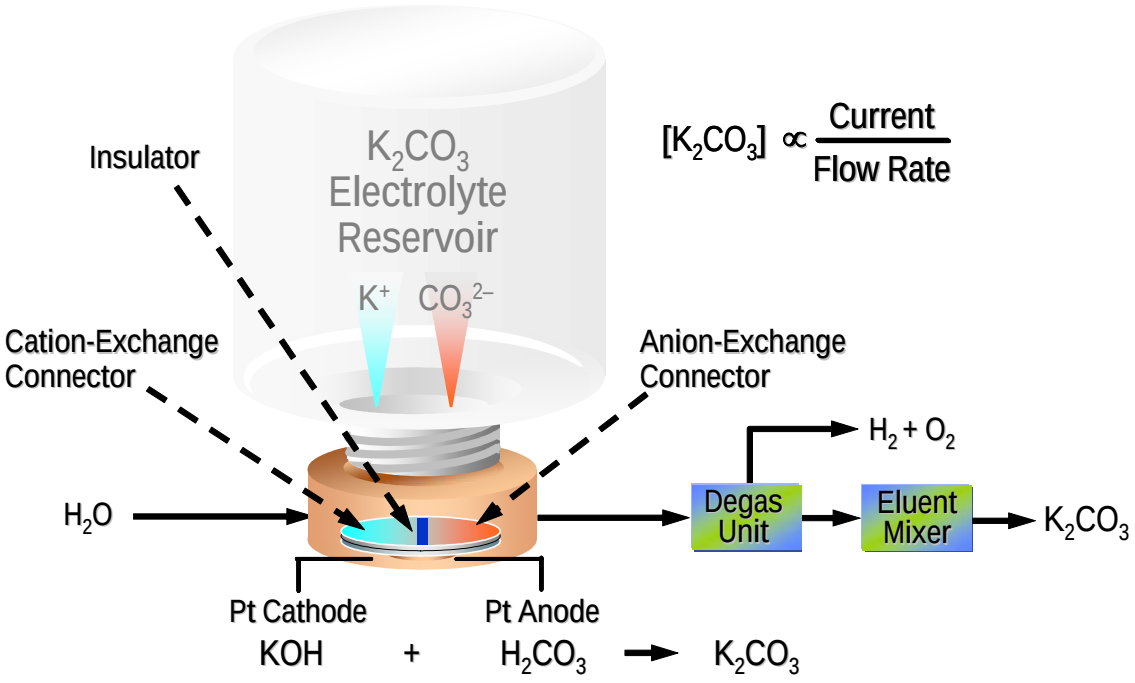


FIGURE 1
Electrolytic Generation of Carbonate Eluents
Using an EGC II K_2CO_3 Cartridge

Table 1 summarizes the common anion exchange separation columns and standard eluent conditions. The EGC II K_2CO_3 cartridge, combined with EPM, can be used to generate K_2CO_3/$KHCO_3$ Eluents for use in separation of anionic analytes using these columns.

TABLE 1
Eluent Composition Used for Carbonate and Bicarbonate Selective Columns

Product	Eluent	
	K_2CO_3	$KHCO_3$
AS9-HC	9 mM K_2CO_3	N/A
AS4A-SC	1.8 mM K_2CO_3	1.7 mM $KHCO_3$
AS12A	2.7 mM K_2CO_3	0.3 mM $KHCO_3$
AS14	3.5 mM K_2CO_3	1.0 mM $KHCO_3$
AS14A	8.0 mM K_2CO_3	1.0 mM $KHCO_3$

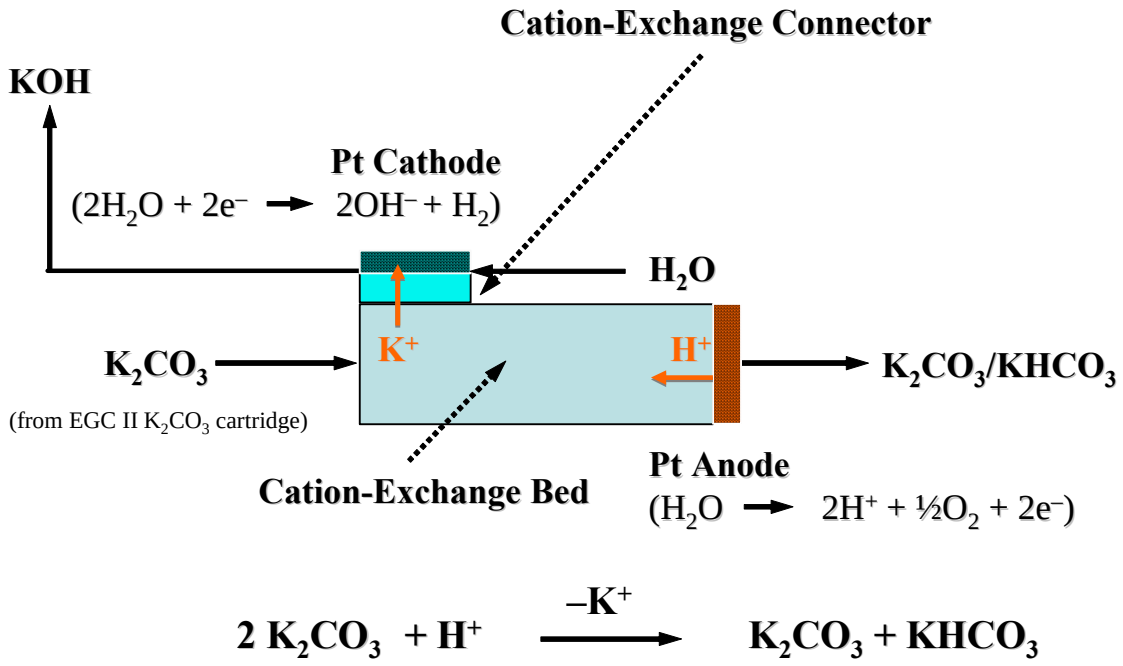


FIGURE 2
Electrolytic Generation of K_2CO_3/$KHCO_3$ Eluents Using an EGC II K_2CO_3 Cartridge and EPM

1.2. System Flow Diagram

1.2.1. EGC II K_2CO_3 Cartridge Only

Figure 3 shows the plumbing schematic for electrolytic generation of carbonate eluent only using an EGC II K_2CO_3 cartridge in an ion chromatography system. The EGC II K_2CO_3 Cartridge and EGC Carbonate Mixer are shipped in separate boxes. The EGC Carbonate Mixer is used to provide sufficient mixing of the KOH and H_2CO_3 formed from the cathode chamber and anode chamber of the EGC II K_2CO_3 cartridge, respectively. The EGC degas assembly is installed inside the EG-3000 enclosure at the factory.

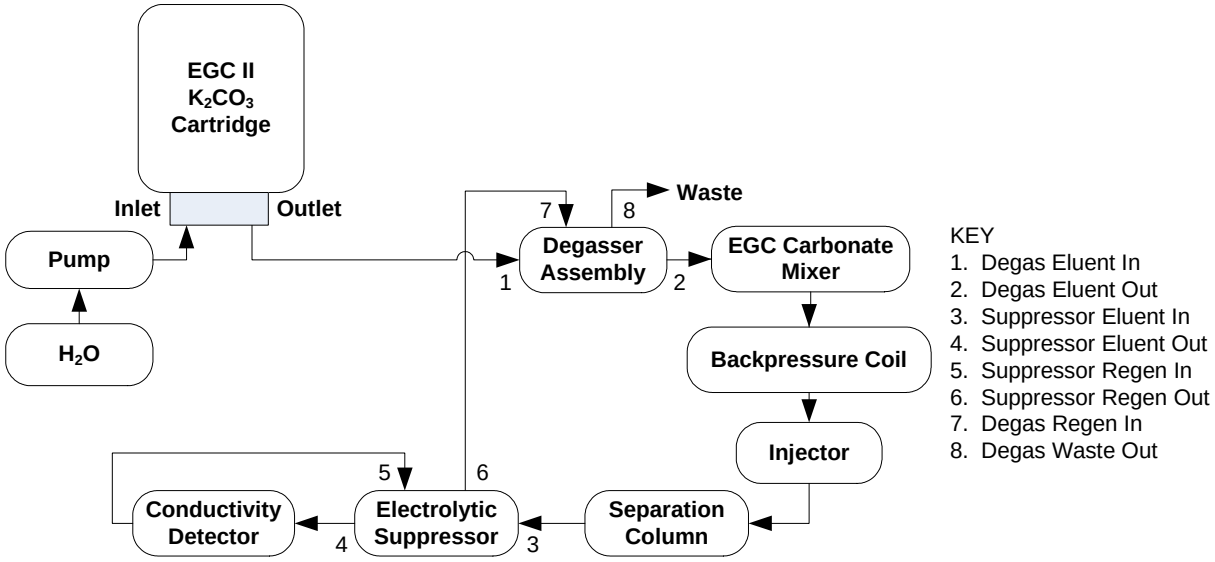


FIGURE 3
Plumbing Schematic for Electrolytic Generation of Carbonate Eluent Only Using an EGC II K_2CO_3 Cartridge in an Ion Chromatography System with Electrolytic Suppressor Operated in Recycle Mode

1.2.2. EGC II K_2CO_3 Cartridge with EPM

To generate eluents of carbonate and bicarbonate, an EPM is installed in the system. The system flow diagram is shown in Figure 4.

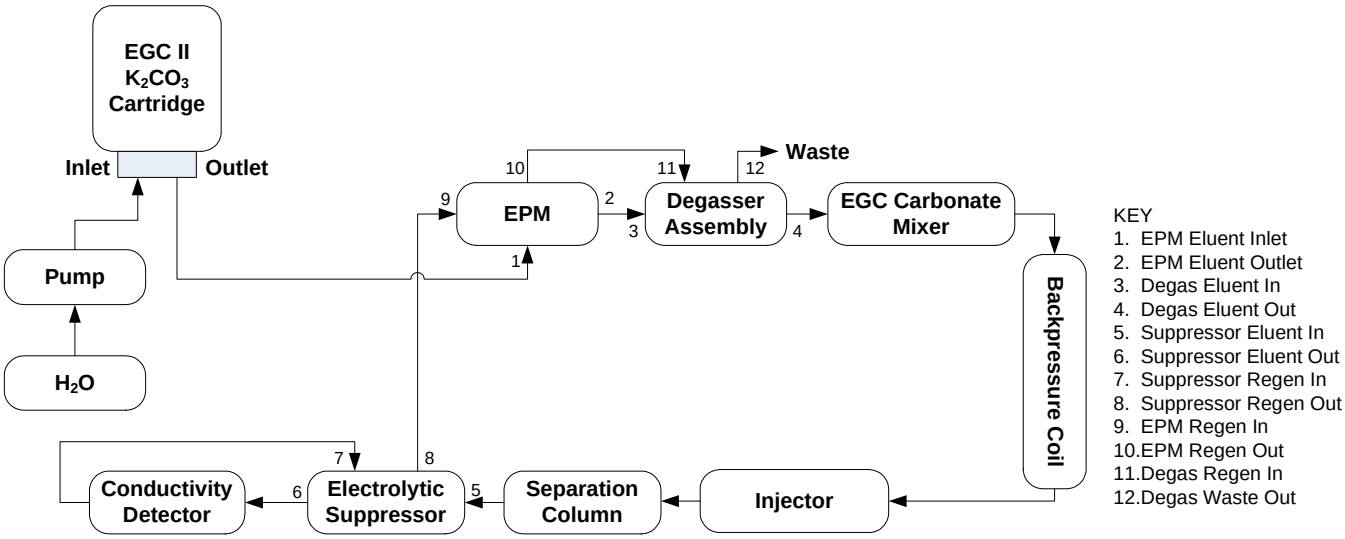


FIGURE 4
Plumbing Schematic for Electrolytic Generation of Carbonate and Bicarbonate Eluents Using an EGC II K_2CO_3 Cartridge and EPM in an Ion Chromatography System with Electrolytic Suppressor Operated in Recycle Mode

2. INSTALLATION

The Potassium Carbonate Eluent Generator Cartridges (EGC II K_2CO_3) and Electrolytic pH Modifiers (EPM) are designed to be used with a Dionex RFIC Reagent-Free™ ICS-3000 System equipped with an EG-3000 module and Chromeleon Chromatography Management System, version 6.7 or higher. For details regarding the operation, please refer to the ICS-3000 operation manual.

NOTE

The EGC-1 of an EG-3000 is assigned to control the EGC II K_2CO_3 cartridge, and the EGC-2 is designed to control the EPM.

2.1. Procedure for EGC II K_2CO_3 Cartridge Installation

This section outlines the procedure for installing an EGC II K_2CO_3 cartridge (P/N 058904) without an EPM. For installation instructions for an EGC II K_2CO_3 cartridge with EPM, see Section 2.2.

2.1.1. Preparation for Installation

1. Remove the EGC II K_2CO_3 cartridge (P/N 058904) from the box. Save the box and the foam for future storage.
2. Configure the EG-3000 module to operate the EGC II K_2CO_3 cartridge by entering the cartridge serial number. Please refer to the EG-3000 and Chromeleon user manuals for detailed procedures for entering the cartridge serial number.
3. Place the EGC II K_2CO_3 cartridge on a flat surface in front of the Eluent Generator (EG-3000 module) with the Electrolysis Chamber and the EGC INLET and OUTLET fittings facing up.
4. Remove the plugs from the EGC INLET and OUTLET fittings.
5. Turn over the EGC II K_2CO_3 cartridge (fittings facing down). Shake the EGC II K_2CO_3 cartridge vigorously, and tap it with the palm of your hand 10 to 15 times to dislodge the air bubbles that may be trapped in the electrolysis chamber.
6. Connect the pump outlet to the EGC INLET port of the EGC II K_2CO_3 cartridge and the OUTLET port of the EGC II K_2CO_3 cartridge to the ELUENT IN port of the RFIC Eluent Degasser Assembly.

NOTE

Be sure to repeat Step 5 each time the EGC electrolysis chamber is turned upward.

7. Orient the EGC II K_2CO_3 cartridge with the cable aligned with the slot in the holder of the EG-3000 enclosure and then slide the EGC II K_2CO_3 down into the holder until secured.
8. Connect the EGC II K_2CO_3 cartridge electrical cable to the EGC-1 port of the EG-3000 enclosure.
9. Connect the ELUENT OUT port of the RFIC Eluent Degasser Assembly to a yellow PEEK™ backpressure restrictor tubing (P/N 053765) with 2,000 psi backpressure at 1.0 mL/min.

2.1.2. Conditioning the EGC II K_2CO_3

1. Fill a 2-L eluent reservoir bottle (P/N 044129) with deionized water. Use ASTM filtered, Type I (18-megohm) deionized water. Connect the reservoir to the eluent inlet line of the pump.
2. Prime the pump as instructed by the ICS-3000 system operation manual. Set the pump flow rate to 1.0 mL/min.
3. Unscrew and remove the plug from the vent opening on the side of the EGC II K_2CO_3 cartridge.
4. Direct the outlet of the yellow PEEK backpressure tubing to a waste container (Figure 5).
5. Turn on the pump. Set EGC II K_2CO_3 concentration at 9 mM from the front control panel of the Chromeleon Chromatography Data System and turn on the EGC-1.
6. Run the EGC under the conditions of 9 mM and 1.0 mL/min for 30 minutes.
7. Turn off the pump.

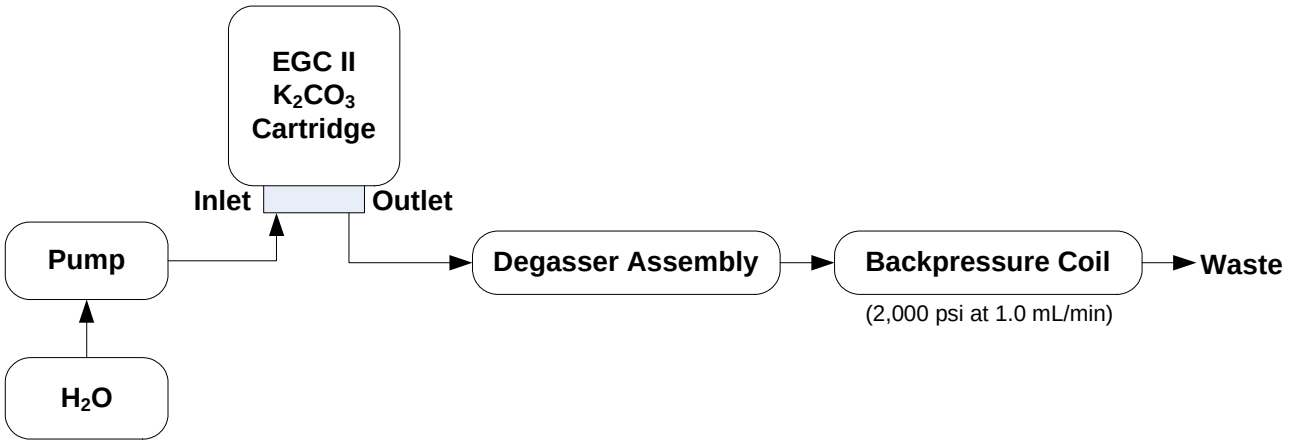


FIGURE 5
Plumbing Diagram for Conditioning the EGC II K_2CO_3 Cartridge

2.1.3. Filling the EGC Carbonate Mixer with K_2CO_3 Eluent of Desired Concentration

1. Connect the outlet of the yellow pressure restrictor tubing (P/N 053765) to the union attached to the INLET port of the EGC Carbonate Mixer (P/N 061686 for 4-mm columns or P/N 063443 for 2-mm columns) as shown in Figure 6.
2. Install the EGC Carbonate Mixer in the EG-3000 enclosure by pushing the mixer onto the mixer holder clip. The OUTLET of the EGC Carbonate Mixer must point upward to ensure sufficient mixing of the eluents generated.
3. Set the pump flow rate at 1.0 mL/min and turn on the pump.
4. Set the desirable K_2CO_3 concentration on EGC-1 (e.g., 9 mM for AS9-HC columns) and turn on EGC-1 current control.
5. Operate EGC II K_2CO_3 cartridge to generate carbonate eluents. The main purpose of this step is to fill the EGC Carbonate Mixer with the electrolytic eluents having the desired carbonate concentration (e.g. 9 mM K_2CO_3 for AS9-HC columns) for your application.
6. The 4-mm EGC Carbonate Mixer has a void volume of about 16 mL. At 1.0 mL/min, it will take about 16 minutes to fill the Mixer with the K_2CO_3 eluents of the set concentration upon initial installation. The 2-mm EGC Carbonate Mixer has a void volume of about 5.0 mL. At 1.0 mL/min, it will take about 5 minutes to fill the mixer with the K_2CO_3 eluents of the set concentration upon initial installation.

NOTE

The system backpressure should be adjusted between 2000 – 2300 psi at a flow rate of 1.0 mL/min. This step is very important to ensure fast system equilibrium and startup.

7. Turn off the EG current, and then turn off the pump flow rate when a consistent flow of eluent, with no air bubbles, is observed flowing from the outlet of the EGC Carbonate Mixer.
8. Replace the yellow backpressure tubing (P/N 053765) with a piece of 0.010-inch ID black PEEK tubing of appropriate length to connect between the ELUENT OUT port of the RFIC Eluent Degasser Assembly and the union attached to the inlet port of the EGC Carbonate Mixer.

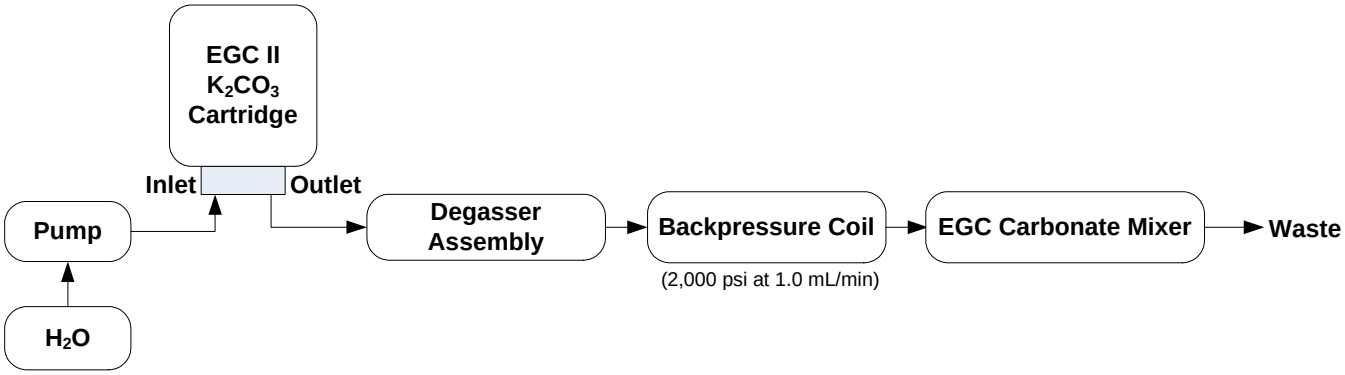


FIGURE 6
Plumbing Diagram for Filling the EGC Carbonate Mixer with the K_2CO_3 Eluents of Desired Concentration

2.1.4. Operation of the Electrolytic K_2CO_3 Eluent Generator for Ion Chromatographic Application

1. Complete the entire system plumbing as shown in Figure 7 for your application.
2. Adjust the length of the backpressure tubing between the INLET of the injection valve and the OUTLET of the EGC Carbonate Mixer if needed to ensure the system backpressure falls between 2000 – 2300 psi at the system operation flow rate.
3. Connect the REGEN OUT port of the suppressor to the REGEN IN port of the RFIC ELUENT Degasser Assembly.
4. Start operating the Electrolytic K_2CO_3 Eluent Generator at desired K_2CO_3 concentrations for your application.

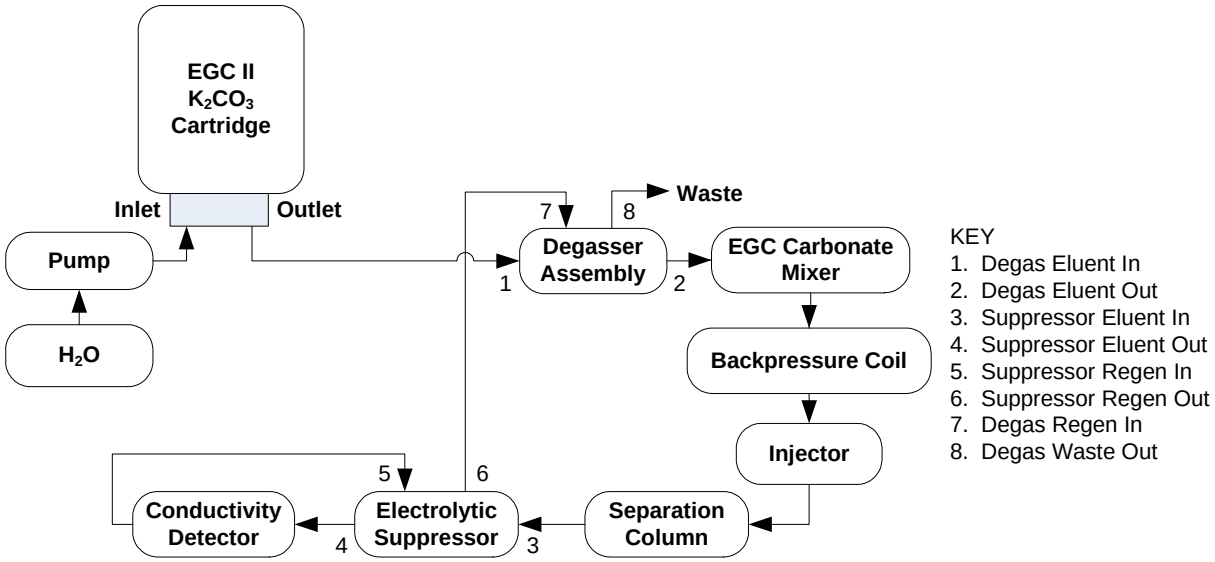


FIGURE 7
Plumbing Diagram for Electrolytic Generation of Carbonate Eluents Using EGC II K_2CO_3 with Electrolytic Suppressor Operating in Recycle Mode

2.2. Procedure for EGC II K_2CO_3 Cartridge and EPM Installation

The section outlines the procedure for installing an EGC II K_2CO_3 cartridge (P/N 058904) and an EPM (P/N 063175).

2.2.1. Preparation for Installation

1. Remove the EGC II K_2CO_3 cartridge (P/N 058904) from the shipping box. Save the box and the foam for future storage.
2. Remove the EPM (P/N 063175) from the shipping box.
3. Configure the EG-3000 module to operate the EGC II K_2CO_3 cartridge and the EPM by entering the serial numbers for the cartridge and EPM. Please refer to the EG-3000 and Chromeleon user manuals for detailed procedures for entering the cartridge and EPM serial numbers.
4. Place the EGC II K_2CO_3 cartridge on a flat surface in front of the Eluent Generator (EG-3000 module) with the Electrolysis Chamber and the EGC INLET and OUTLET fittings facing up.
5. Remove the plugs from the EGC INLET and OUTLET fittings.
6. Remove the plugs from the EPM ELUENT and REGEN liquid fittings.
7. Turn over the EGC II K_2CO_3 cartridge (fittings facing down). Shake the EGC II K_2CO_3 cartridge vigorously, and tap it with the palm of your hand 10 to 15 times to dislodge the air bubbles that may be trapped in the electrolysis chamber.
8. Connect the pump outlet to the EGC INLET port of the EGC II K_2CO_3 cartridge.
9. Connect the OUTLET port of the EGC II K_2CO_3 cartridge to the ELUENT IN port of the EPM.
10. Connect the ELUENT OUTLET port of the EPM to the ELUENT IN port of the RFIC Eluent Degasser Assembly.
11. Connect the ELUENT OUT port of the RFIC Eluent Degasser Assembly to a yellow PEEK backpressure restrictor tubing (P/N 053765).
12. Orient the EGC II K_2CO_3 cartridge with the cable aligned with the slot in the holder of the EG-3000 enclosure and then slide the EGC II K_2CO_3 down into the holder until secured.
13. Connect the EGC II K_2CO_3 cartridge electrical cable to the EGC-1 port of the EG-3000 enclosure.
14. Connect the EPM electrical cable to the EGC-2 port of the EG-3000 enclosure.

2.2.2. Conditioning EGC II K_2CO_3 Cartridge and EPM

1. Fill a 2-L eluent reservoir bottle (P/N 044129) with deionized water. Use ASTM filtered, Type I (18 megohm) deionized water. Connect the reservoir to the eluent inlet line of the pump.
2. Prime the pump as instructed by the ICS-3000 system operation manual. Set the pump flow rate to 1.0 mL/min.
3. Unscrew and remove the plug from the vent opening on the side of the EGC II K_2CO_3 cartridge.
4. Connect the outlet of the yellow PEEK backpressure restrictor tubing (P/N 053765) to the REGEN IN port of the EPM.
5. Connect the REGEN OUT port of the EPM to the REGEN IN port of the RFIC Eluent Degasser Assembly and connect the WASTE OUT port of the RFIC Eluent Degasser Assembly to waste.
6. Complete the system plumbing as shown in Figure 8.

NOTE

The system plumbing shown in Figure 1 is a temporary connection, which is only used during the EGC II K_2CO_3 conditioning step.

7. Set the pump flow rate at 1.0 mL/min.
8. Turn on the pump for 5 min to hydrate EPM.
9. Set 9 mM for EGC-CO_3 (EGC-1) and 1 mM for EPM (EGC-2) from the control panel and turn on the EGC-1 and EGC-2 current controls.
10. Run the EGC and EPM under this condition for 30 min.
11. Turn off the EGC-1 and EGC-2 current controls, and then turn off the pump.

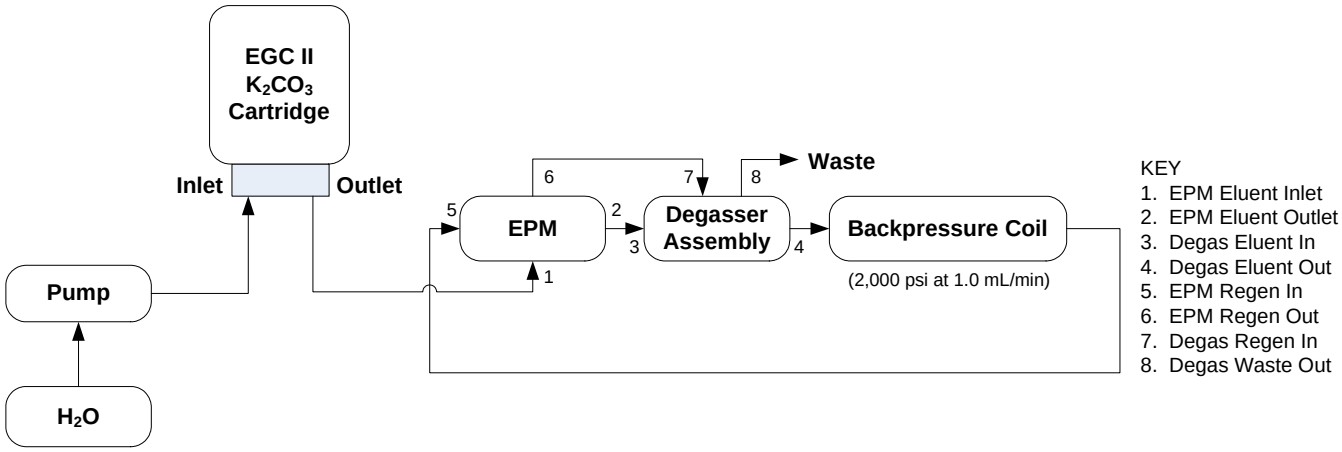


FIGURE 8
Plumbing Diagram for Conditioning EGC II K_2CO_3 Cartridge and EPM

2.2.3. Filling the EGC Carbonate Mixer with the K_2CO_3 / $KHCO_3$ Eluents of Desired Concentration

1. Install the EGC Carbonate Mixer in the EG-3000 enclosure by pushing the mixer onto the Mixer holder clip. The outlet of the EGC Carbonate Mixer must point upward to ensure thorough mixing of the eluent.
2. Disconnect the pump outlet from the INLET of the EGC II K_2CO_3 cartridge.
3. Connect the pump outlet to the inlet of EGC Carbonate Mixer and fill the EGC Carbonate Mixer with deionized water by operating the pump in the ICS-3000 system at 5.0 mL/min. Operate the pump for 5 minutes to fill a 4-mm EGC Carbonate Mixer and 2 minutes to fill a 2-mm EGC Carbonate Mixer or until there is a consistent flow of water coming out the outlet of the Mixer.

WARNING ***Please ensure that both EGC-1 and EGC-2 current controls are turned off in this step.***

4. Disconnect the pump outlet from the inlet of the EGC Carbonate Mixer.
5. Connect the pump outlet to the INLET of the EGC II K_2CO_3 cartridge.
6. Connect the outlet of the yellow PEEK backpressure restrictor tubing (P/N 053765) to the union attached to the inlet of the EGC Carbonate Mixer.
7. Connect the OUTLET of the mixer to the REGEN IN port of the EPM. Connect the REGEN OUT port of the EPM to the REGEN IN port of the RFIC Eluent Degasser Assembly. Divert the WASTE OUT port of the RFIC Degasser Assembly to waste.
8. Complete the system plumbing as shown in Figure 9.

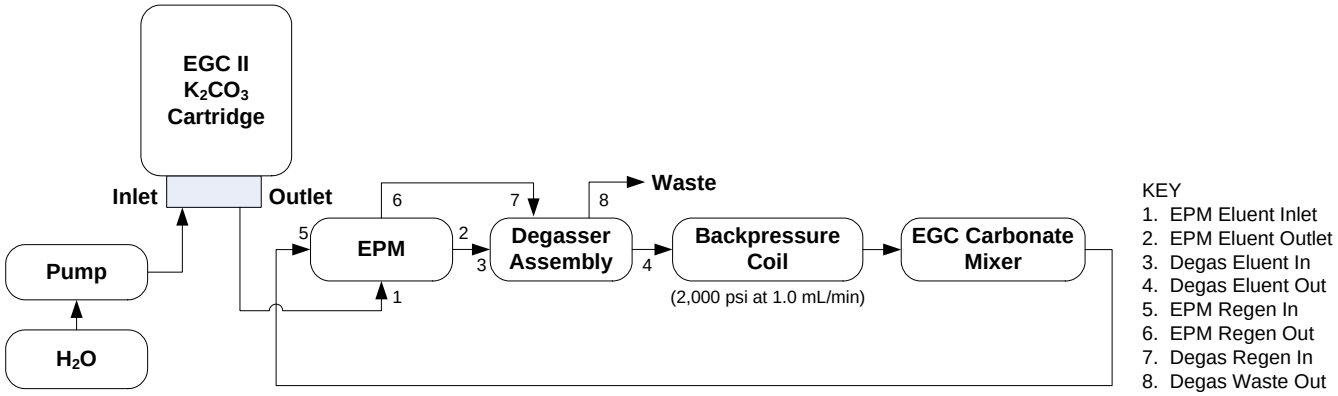


FIGURE 9
Plumbing Diagram for Filling the EGC Carbonate Mixer with the K_2CO_3 / $KHCO_3$ Eluents of Desired Concentrations

9. Operate both the EGC II K_2CO_3 cartridge and EPM under the conditions to generate carbonate and bicarbonate eluent of desired K_2CO_3 /$KHCO_3$ concentration. The main purpose of this step is to fill the EGC Carbonate Mixer with the eluent of the desired concentration (e.g. 3.5 mM K_2CO_3/1.0 mM $KHCO_3$ for AS14 columns) for your application.

10. The 4-mm EGC Carbonate Mixer has a void volume of about 16 mL. At 1.0 mL/min, it will take about 45 minutes to displace the deionized water and fill the mixer with the K_2CO_3 /$KHCO_3$ eluent having the desired concentration upon initial installation. The 2-mm EGC Carbonate Mixer has a void volume of approximately 5.0 mL. At 1.0 mL/min, it will take about 15 minutes to displace the deionized water and fill the Mixer with the K_2CO_3 /$KHCO_3$ eluents of the set concentration upon initial installation.

NOTE

The system backpressure should be adjusted between 2000 – 2300 psi at a flow rate of 1 mL/min. This step is very important to ensure fast system equilibration and startup.

11. Turn off the EG-1 and EG-2 current controls, and then turn off the pump.
12. Replace the yellow backpressure tubing with a piece of 0.010-inch ID black PEEK tubing of appropriate length to connect between the ELUENT OUT port of the RFIC Eluent Degasser Assembly to the union attached to the inlet port of the EGC Carbonate Mixer.

2.2.4. Operation of the Electrolytic K_2CO_3/$KHCO_3$ Eluent Generator for Ion Chromatographic Application

1. Complete the entire system plumbing as shown in Figure 10 for your application.
2. Adjust the length of the backpressure tubing between the INLET of the injection valve and the OUTLET of the EGC Carbonate Mixer if needed to ensure the system backpressure is adjusted between 2000 – 2300 psi at the system operation flow rate.
3. Make sure to connect the REGEN OUT port of the suppressor to the REGEN IN port of the EPM.
4. Turn on the pump at the flow rate recommended for your application.

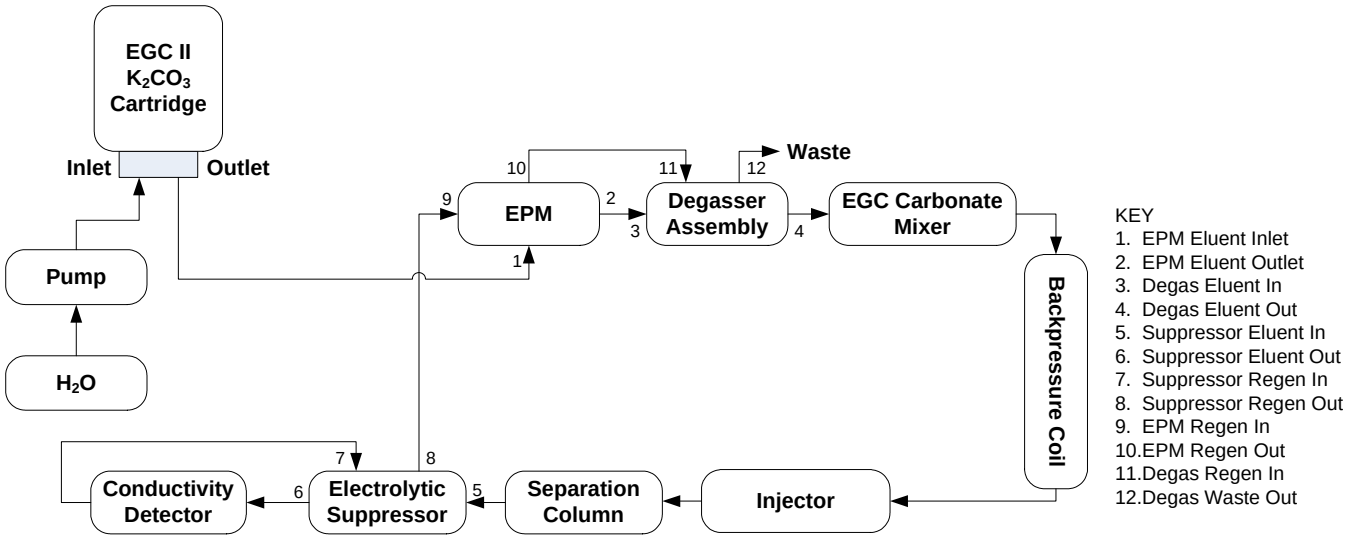


FIGURE 10
Plumbing Diagram for Electrolytic Generation of Carbonate / Bicarbonate Eluents Using K_2CO_3 and Electrolytic pH Modifier with Electrolytic Suppressor Operating in Recycle Mode

2.3. Operation of the EGC II K_2CO_3 Cartridge and EPM with Electrolytic Suppressor Operating in External Water Mode

2.3.1. Operation of the EGC II K_2CO_3 Cartridge with Electrolytic Suppressor Operating in External Water Mode

Figure 11 shows the plumbing diagram of electrolytic generation of carbonate eluents using EGC II K_2CO_3 with an electrolytic suppressor operating the external water mode. See the Suppressor Product Manual for details on setting the operation of the electrolytic suppressor in the external water mode.

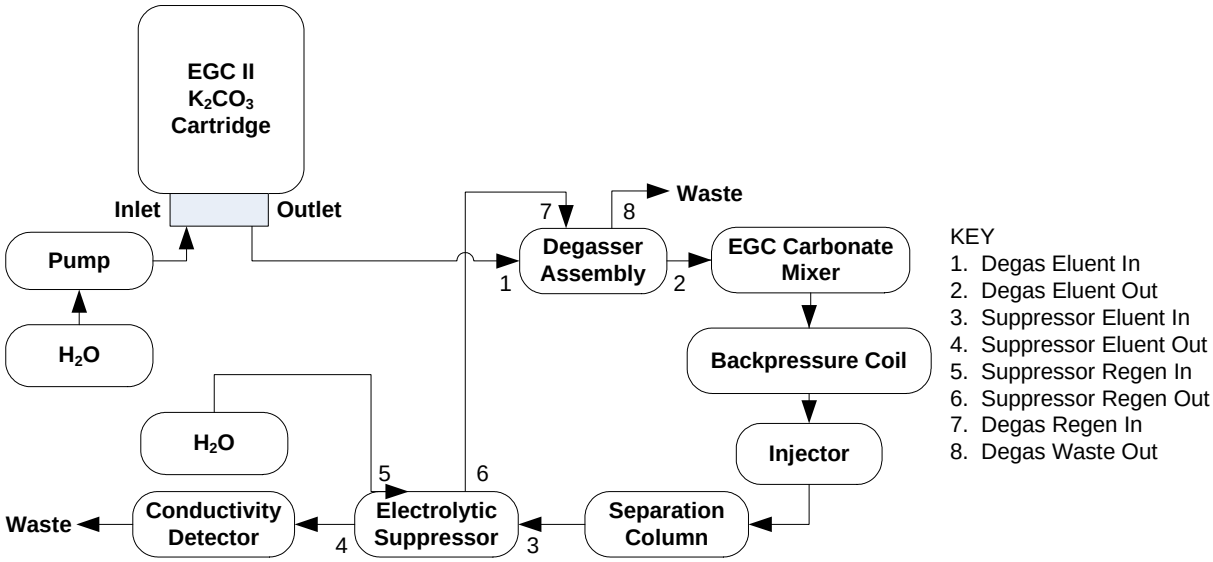


FIGURE 11
Plumbing Diagram for Electrolytic Generation of Carbonate Eluents Using EGC II K_2CO_3 with Electrolytic Suppressor Operating in External Water Mode

2.3.1.1. Operation of the EGC II K_2CO_3 Cartridge and EPM with Electrolytic Suppressor Operating in External Water Mode

Figure 12 shows the plumbing diagram of electrolytic generation of carbonate eluents using EGC II K_2CO_3 and EPM with an electrolytic suppressor operating the external water mode. See the Suppressor Product Manual for details on setting the operation of the electrolytic suppressor in the external water mode.

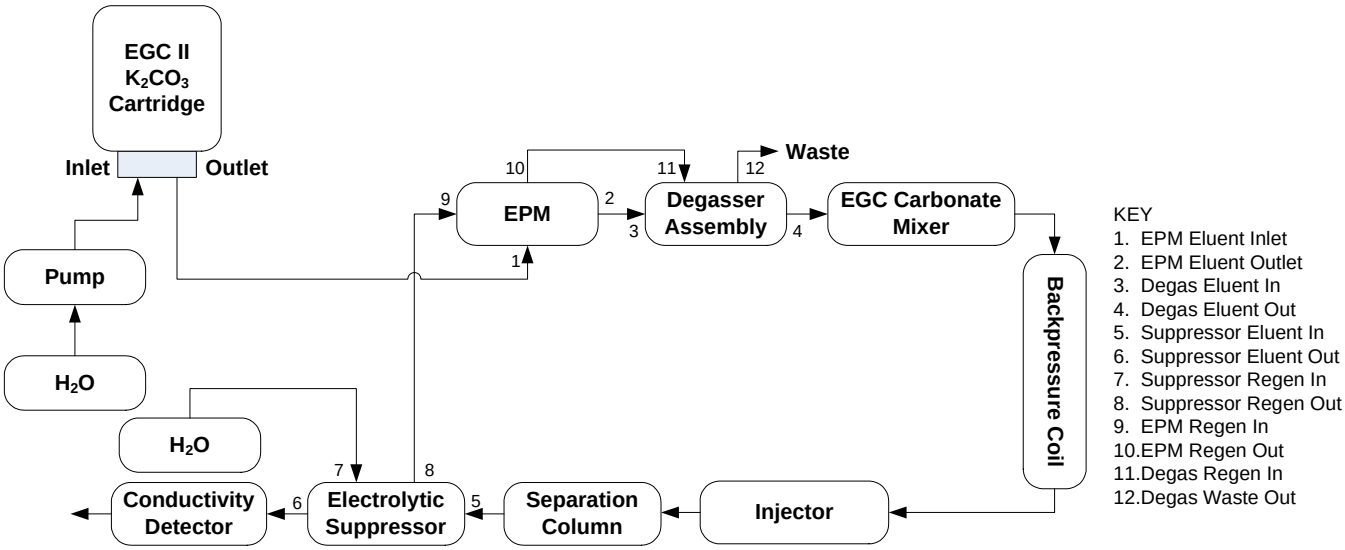


FIGURE 12
Plumbing Diagram for Electrolytic Generation of Carbonate / Bicarbonate Eluents Using K_2CO_3 and Electrolytic pH Modifier with Electrolytic Suppressor Operating in External Water Mode

2.4. Attaching the System Waste Lines

The eluent generator generates eluent by means of electrolysis which results in the production of small amounts of oxygen or hydrogen (up to 2 mL/min at ambient pressure and temperature). Therefore, it is important to operate the eluent generator cartridge in properly ventilated areas. Please refer to the ICS-3000 operation manual for instructions on how to properly set up the system waste lines.

2.5. Optional Pressure Restrictor Tubing

The degas tubing assembly requires at least 2,000 psi (14 MPa) of back pressure for optimal removal of electrolysis gas from the eluent produced by the EGC II. A system backpressure of 2,000 - 2,300 psi is required for operating EGC II K_2CO_3 cartridges. The degas tubing is functional at pressures below 2,000 psi; however, this low system pressure may result in high baseline noise as the eluent concentration increases. If a restrictor is required, the following procedure will assist in determining the correct back pressure restrictor tubing to use as shown in Table 2.

1. Configure the appropriate chromatography system, by configuring Chromeleon for the appropriate EGC II K_2CO_3, EPM, analytical and guard columns, and suppressor.
2. Program Chromeleon to deliver the eluent required in your method.
3. Turn the pump flow on.
4. Confirm the eluent flows at the desired flow rate.
5. Monitor the pump pressure and note the maximum and minimum system pressures for the duration of the method.
6. If the maximum and minimum pressures are between 2,000 and 2,300 psi, the system back pressure is adequate.
7. If the maximum pressure exceeds 2,300 psi, locate the source of the excessive pressure and eliminate it.
8. If the minimum system pressure is below 2,000 psi, a pressure restrictor should be used. Table 2 can be used to determine the appropriate pressure restrictor to adjust the system pressure between 2,000 to 2,300 psi. A system back pressure of 2,100 psi is ideal.
9. The backpressure restrictors listed in Table 2 are supplied in the EG3000 module ship kit.
10. Install the back pressure restrictor between the EGC Carbonate Mixer outlet port and the injection valve.

NOTE

The backpressure restrictor tubing may be installed directly into the injection valve "IN" port.

11. Secure the back pressure restrictor coils to the two coil clips provided on the lower left wall of the EG Module.

Table 2
Optional Back Pressure Restrictors

Part Number	Description	Flow Rate	Approximate Back Pressure Added	Flow Rate	Approximate Back Pressure Added
053763	4-mm Pressure Restrictor	2.0 mL/min	1,000 psi (7 MPa)	1.0 mL/min	500 psi (3.5 MPa)
053762	4-mm Pressure Restrictor	2.0 mL/min	500 psi (3.5 MPa)	1.0 mL/min	250 psi (1.75 MPa)
053765	2-mm Pressure Restrictor	0.5 mL/min	1,000 psi (7 MPa)	0.25 mL/min	500 psi (3.5 MPa)
053764	2-mm Pressure Restrictor	0.5 mL/min	500 psi (3.5 MPa)	0.25 mL/min	250 psi (1.75 MPa)

3. OPERATION

3.1. Routine Operation

The routine operation of EGC II K_2CO_3 and EPM for ion chromatography applications consists of running sample sequences that controls the EG-3000 module. Use Chromeleon control panel to check the EG-3000 operation status. For optimal operation, it is important to adjust the system pressure to the recommended range of 2000 to 2300 psi. See Section 2.4 for detailed instructions on adjusting the system pressure.

For applications using EGC II K_2CO_3 only for generating K_2CO_3 eluents, complete the entire system plumbing as shown in Figure 7. For applications using EGC II K_2CO_3 and EPM for generating K_2CO_3 / $KHCO_3$ eluents, complete the entire system plumbing as shown in Figure 10. Adjust the length of the backpressure tubing between the INLET of the injection valve and the OUTLET of the EGC Carbonate Mixer if needed to ensure the system backpressure falls between 2000 – 2300 psi at the system operation flow rate. Connect the REGEN OUT port of the suppressor to the REGEN IN port of the RFIC ELUENT Degasser Assembly when using EGC II K_2CO_3 only. Be sure to connect the REGEN OUT port of the suppressor to the REGEN IN port of the EPM when using EGC II K_2CO_3 and EPM. Turn on the pump and set the flow to the rate recommended for your application. Start operating the Electrolytic K_2CO_3 /$KHCO_3$ Eluent Generator at the desired K_2CO_3 /$KHCO_3$ concentrations for your application.

3.2. EGC II K_2CO_3 and EPM Application Conditions

The EluGen® Potassium Carbonate Cartridges (EGC II K_2CO_3) and EPM can be used to generate isocratic carbonate and bicarbonate eluents. The EGC II K_2CO_3 can generate up to 15 mM K_2CO_3 at 1.0 mL/min. Eluent concentrations up to 7.5 mM K_2CO_3 can be produced at 2.0 mL/ min. The EPM is capable of converting up to 10 mM K_2CO_3 to $KHCO_3$ at 1.0 mL/min. Eluent concentrations up to 5 mM K_2CO_3 can be converted to $KHCO_3$ at 2.0 mL/min.

The EGC II K_2CO_3 and EPM may be used with the columns and eluent conditions listed below. No solvent should be used with EGC II K_2CO_3 and EPM.

Maximum Flow Rate (4-mm operation):	2.0 mL/min.
Maximum Flow Rate (2-mm operation):	0.25 mL/min.
Maximum System Pressure:	2400 psi (15.4 MPa)
Minimum Recommended System Pressure:	2,000 psi (14 MPa); use optional Pressure Restrictor as required
Concentration Range:	EGC II K_2CO_3: Up to 15 mM K_2CO_3 at 1.0 mL/min; 7.5 mM at 2.0 mL/min. EPM: Up to 10 mM $KHCO_3$ at 1.0mL/min; 5 mM at 2.0 mL/min.
Columns:	AS4A, AS4A-SC, AS9-HC, AS12A, AS14, and AS14A

WARNING ***No solvent should be used with EGC II K_2CO_3 and EPM.***

The predefined lifetime of an EGC II K_2CO_3 is 1500 hours if it is used to generate 9 mM at K_2CO_3 1.0 mL/min. The actual lifetime of K_2CO_3 depends on the operating conditions (i.e. flow rate and eluent concentration). EPM does not have a predetermined lifetime.

3.3. Verifying the System Configuration

After configuring the system, run the standard chromatogram for your column. Be sure to run the analysis at the temperature given for the chromatogram, if one is listed. If a temperature is not listed, the chromatogram should be run at room temperature. If the chromatogram obtained matches the test chromatogram included with the column, the system is operating correctly for that set of system operating parameters. If the chromatogram obtained does not match the sample chromatogram, see Section 6 for troubleshooting information.

3.4. Operating Precautions

1. The Dionex Eluent Generator generates eluents by means of electrolysis which results in the production of small amounts of oxygen or hydrogen gas. Ensure that the Gas Separator Waste Tube, provided with your conductivity detector, is installed.
2. Operate the EG in properly ventilated areas only.

SAFETY

Do not cap the waste reservoir!

3. The small amount of gas generated by the EG and the Self-Regenerating Suppressor (SRS) is not dangerous unless the gas is trapped in a closed container and allowed to concentrate. The Gas Separator Waste Tube must be open to the atmosphere in order to operate properly.
4. Do not operate a chromatography system where the Eluent Generator (EG) is plumbed into the system, but not software controlled. The excessive backpressures that are allowed in systems can damage components.
5. The pressure limits protect degas tubing assembly from mechanical failure. Excessive backpressure may cause the degas tubing assembly to rupture. The recommended operating pressure range for EGC II K_2CO_3 cartridge and EPM is 2000 – 2300 psi. However, a system pressure of 2,100 psi is optimal for EGC II K_2CO_3 or a combination of EGC II K_2CO_3 and EPM.
6. To prevent the buildup of hydrogen and oxygen gases, install the EG Module in a well-ventilated site.
7. Be sure the SRS Gas Separator Waste Tube (P/N 045460) is correctly installed. The tube is used to dissipate the small amounts of hydrogen and oxygen gases that are generated during EG and SRS operation.
8. Do not allow the system backpressure to drop below 2,000 psi (14 MPa). The degas assembly will not properly degas the eluent if the system pressure is below 2,000 psi and gases will build up on the analytical column.

WARNING

If you enter a lower flow rate, note the following: The EG continues to generate eluent at the concentration set in the last step of the last method. If the low flow rate method does not include the EG system, the EG will continue to generate eluent at the rate required for the higher flow rate set in the last method. If this occurs, the eluent concentration will increase in proportion to the decrease in the flow rate. In extreme cases, excessive heat buildup can occur, causing damage to the EGC II.

3.5. System Shutdown

3.5.1. Short Term Shutdown

Dionex recommends continuous operation of your IC system for the most trouble-free operation. A microbore system will provide the most economical operation.

The EluGen Potassium Carbonate Cartridge (EGC II K_2CO_3) and EPM may be left in the EG-3000 Module for short-term storage for up to three months. The system should be shutdown using the method below. Restart instructions follow.

1. Turn system OFF completely.
   i. Turn the pump, EG, EPM, and SRS off.
   ii. Check that the currents to the EGC-1, EGC-2, and ASRS Ultra II or AAES are off.

2. To restart the system.
   i. Apply the required system settings. Please be sure to turn on the pump before powering the electrolytic devices.
   ii. Allow the system to equilibrate for 45 minutes prior to collecting data.
   iii. If the system has been shut down for more than 3-4 days, the suppressor should be hydrated. See the appropriate SRS manual or AAES manual for start-up details.

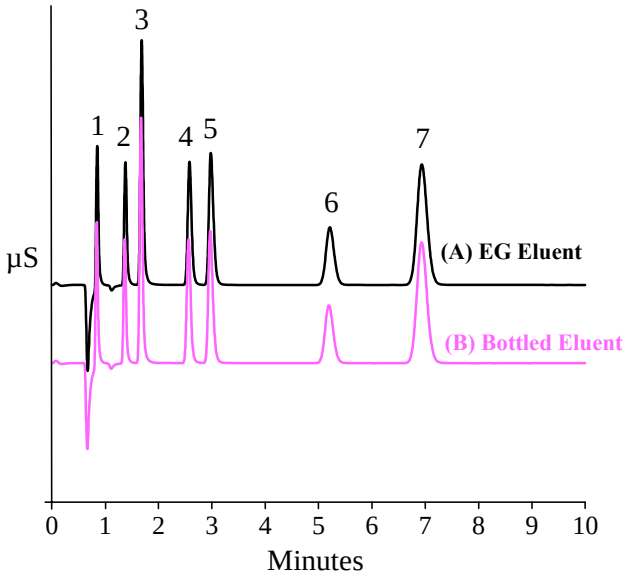
3.5.2. Long Term Shutdown

For long-term storage, the EGC II K_2CO_3 cartridge and EPM may be left in the EG-3000 module. If you need to remove the cartridge and store it, follow the directions in Section 5. Cap all vents and liquid connections.

4. EGC II K_2CO_3 AND EPM APPLICATIONS

This section contains examples of common anions on various anion exchange columns using eluents that are either prepared by a conventional method (bottled eluent) or generated on-line using the Dionex Electrolyte Eluent Generator equipped with the EGC II K_2CO_3 cartridge and EPM.

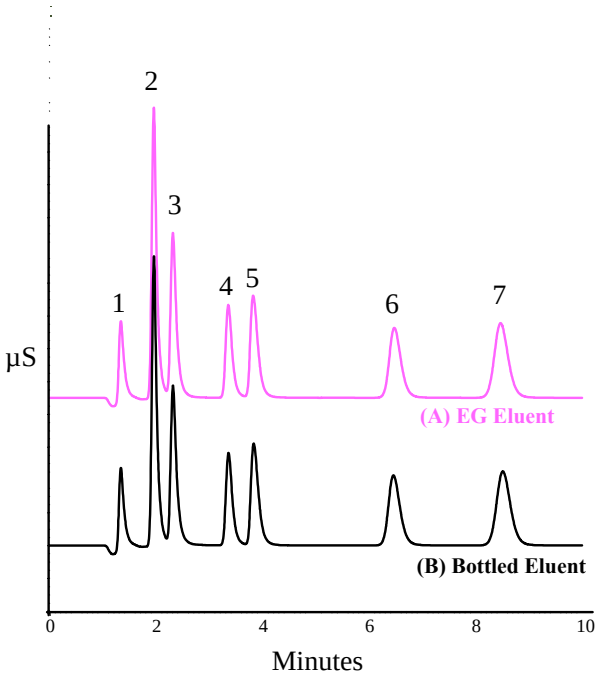
4.1.1. Separation of Seven Anions on a 4-mm IonPac AS4A-SC Column Using a K_2CO_3 / $KHCO_3$ Eluent Generator



Column:	IonPac AG4A-SC, 4 x 50 mm IonPac AS4A SC, 4 x 250 mm
Eluent Source:	EG or premixed
Eluent:	(A) 1.8 mM K_2CO_3/1.7 mM $KHCO_3$ (B) 1.8 mM Na_2CO_3/1.7 mM $NaHCO_3$
Flow Rate:	2.0 mL/ min
Temperature:	30 °C
Inj Volume:	10 µL
Suppressor:	AAES

Peaks:		
	1. Fluoride	2 mg/L
	2. Chloride	3
	3. Nitrite	5
	4. Bromide	10
	5. Nitrate	10
	6. Phosphate	15
	7. Sulfate	15

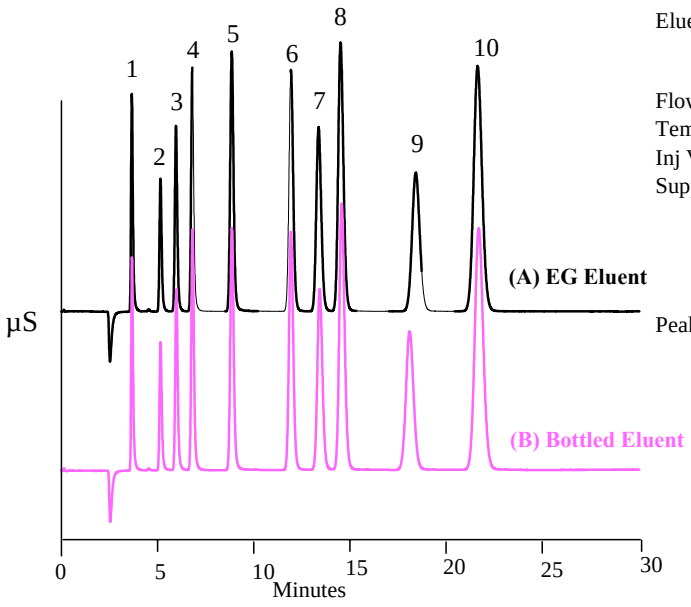
4.1.2. Separation of Seven Anions on a 2-mm IonPac AS4A-SC Column Using a K_2CO_3 / $KHCO_3$ Eluent Generator



Column:	IonPac AG4A-SC, 2 x 50 mm IonPac AS4A-SC 2 x 250 mm
Eluent Source:	EG or premixed
Eluent:	(A) 1.8 mM K_2CO_3/1.7 mM $KHCO_3$ (B) 1.8 mM Na_2CO_3/1.7 mM $NaHCO_3$
Flow Rate:	0.5 mL/ min
Temperature:	30 °C
Inj Volume:	5 µL
Suppressor:	AAES

Peaks:		
	1. Fluoride	2 mg/L
	2. Chloride	10
	3. Nitrite	10
	4. Bromide	10
	5. Nitrate	10
	6. Phosphate	20
	7. Sulfate	10

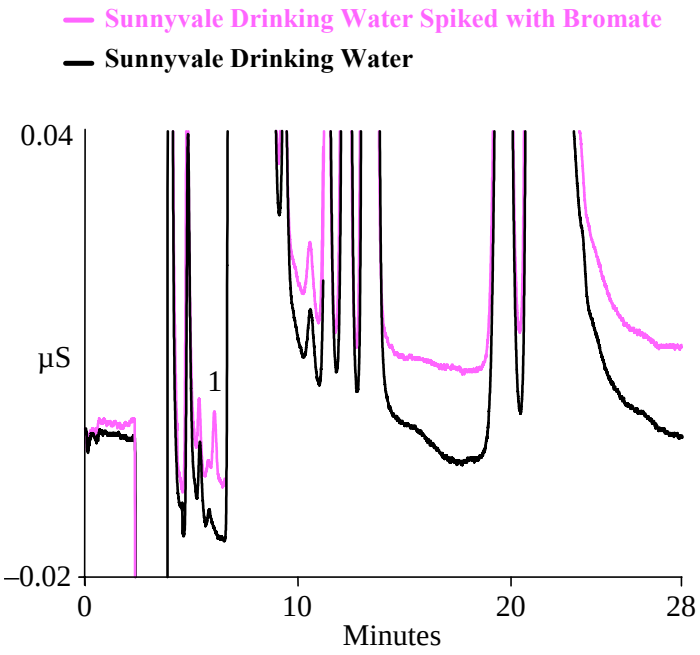
4.1.3. Separation of Ten Anions on a 4-mm IonPac AS9-HC Column Using a K_2CO_3 Eluent Generator



Columns:	IonPac AG9-HC, 4 x 50 mm IonPac AS9-HC, 4 x 250 mm
Eluent Source:	EG or premixed
Eluent:	(A) 9.0 mM K_2CO_3 (B) 9.0 mM Na_2CO_3
Flow Rate:	1.0 mL/ min
Temperature:	30 °C
Inj Volume:	25 µL
Suppressor:	AAES

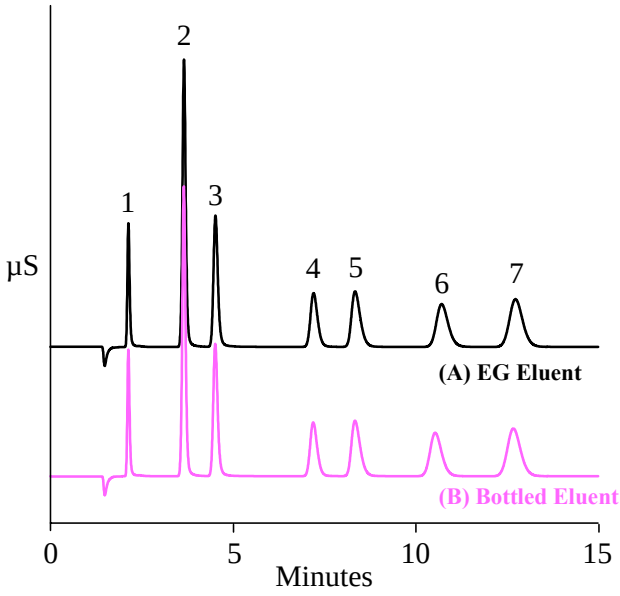
Peaks:		
	1. Fluoride	3 mg/L
	2. Chlorite	10
	3. Bromate	20
	4. Chloride	6
	5. Nitrite	15
	6. Bromide	25
	7. Chlorate	25
	8. Nitrate	25
	9. Phosphate	40
	10. Sulfate	30

4.1.4. Determination of Trace Bromate in Drinking Water Using a 4-mm IonPac AS9-HC Column and a K_2CO_3 Eluent Generator



Column:	IonPac AG9-HC, 4 x 50 mm IonPac AS9-HC, 4 x 250 mm
Eluent:	9.0 mM K_2CO_3
Eluent Source:	EGC II K_2CO_3 cartridge
Flow Rate:	1.0 mL/min
Inj. Volume:	225 µL
Detection:	Suppressed conductivity
Analyte	Spike level (µg/L)
Peak:	1. Bromate 5 mg/L

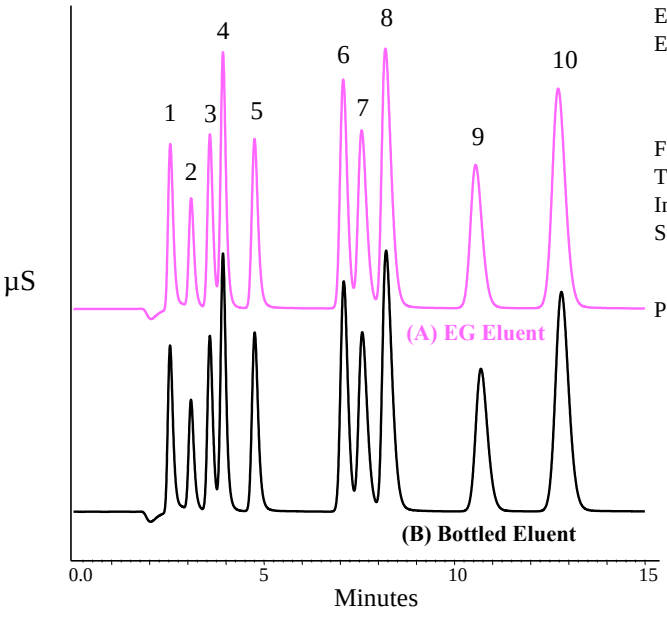
4.1.5. Separation of Seven Anions on a 4-mm IonPac AS12A Column Using a K_2CO_3 / $KHCO_3$ Eluent Generator



Column:	IonPac AG12A, 4 x 50 mm IonPac AS12A, 4 x 200 mm
Eluent Source:	EG or premixed
Eluent:	(A) 2.7 mM K_2CO_3/0.3 mM $KHCO_3$ (B) 2.7 mM Na_2CO_3/0.3 mM $NaHCO_3$
Flow Rate:	1.5 mL/ min
Temperature:	35 °C
Inj. Volume:	25 µL
Suppressor:	AAES, 30 mA

Peaks:		
1. Fluoride	2	mg/L
2. Chloride	10	
3. Nitrite	10	
4. Bromide	10	
5. Nitrate	10	
6. Phosphate	20	
7. Sulfate	10	

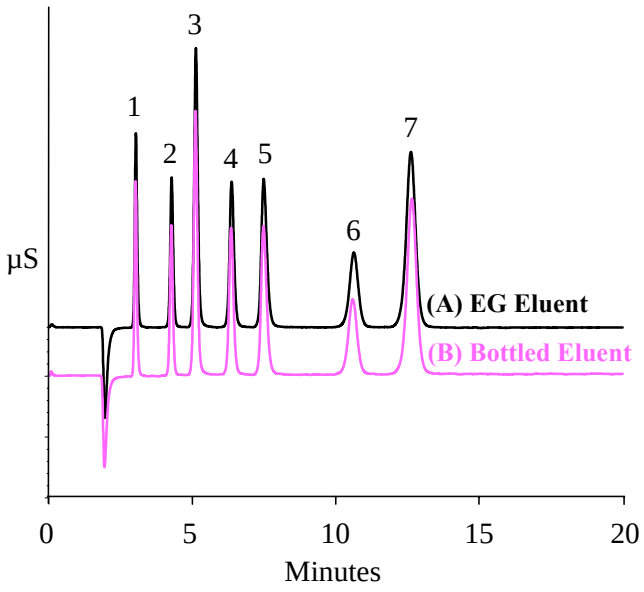
4.1.6. Separation of Ten Anions on a 2-mm IonPac AS12A Column Using a K_2CO_3 / $KHCO_3$ Eluent Generator



Columns:	IonPac AG12A, 2 x 50 mm IonPac AS12A, 2 x 200 mm
Eluent Source:	EG or premixed
Eluent:	(A) 2.7 mM K_2CO_3/0.3 mM $KHCO_3$ (B) 2.7 mM Na_2CO_3/0.3 mM $NaHCO_3$
Flow Rate:	0.38 mL/ min
Temperature:	30 °C
Inj Volume:	5 µL
Suppressor:	AAES

Peaks:		
1. Fluoride	3	mg/L
2. Chlorite	10	
3. Bromate	20	
4. Chloride	6	
5. Nitrite	10	
6. Bromide	20	
7. Chlorate	20	
8. Nitrate	20	
9. Phosphate	30	
10. Sulfate	20	

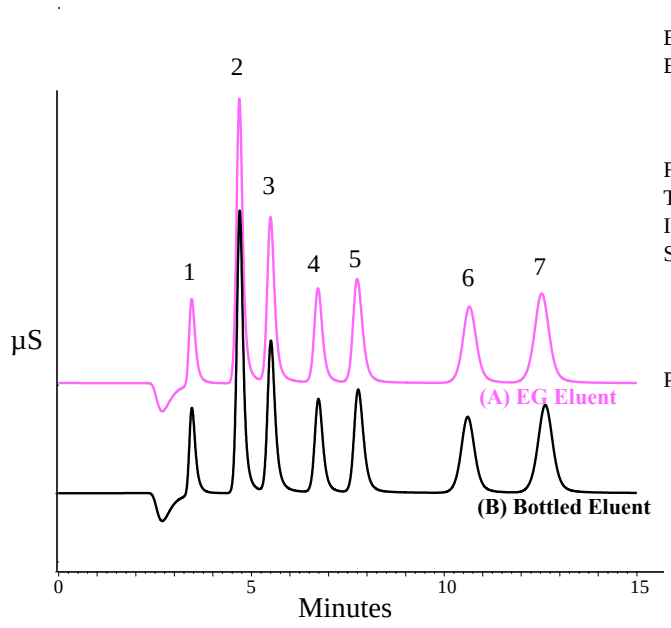
4.1.7. Separation of Seven Anions on a 4-mm IonPac AS14 Column Using a K_2CO_3 / $KHCO_3$ Eluent Generator



Column:	IonPac AG14, 4 x 50 mm IonPac AS14, 4 x 250 mm
Eluent Source:	EG or premixed
Eluent:	(A) 3.5 mM K_2CO_3/1.0 mM $KHCO_3$ (B) 3.5 mM Na_2CO_3/1.0 mM $NaHCO_3$
Flow Rate:	1.2 mL/ min
Temperature:	30 °C
Inj. Volume:	10 µL
Suppressor:	AAES

Peaks:		
	1. Fluoride	3 mg/L
	2. Chloride	6
	3. Nitrite	15
	4. Bromide	25
	5. Nitrate	25
	6. Phosphate	40
	7. Sulfate	30

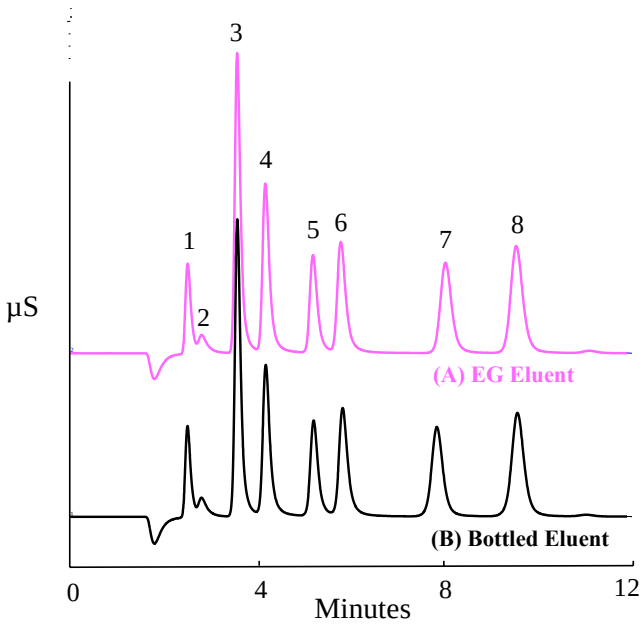
4.1.8. Separation of Seven Anions on a 2-mm IonPac AS14 Column Using a K_2CO_3 / $KHCO_3$ Eluent Generator



Columns:	IonPac AG14, 2 x 50 mm IonPac AS14, 2 x 250 mm
Eluent Source:	EG or premixed
Eluent:	(A) 3.5 mM K_2CO_3/1.0 mM $KHCO_3$ (B) 3.5 mM Na_2CO_3/1.0 mM $NaHCO_3$
Flow Rate:	0.3 mL/ min
Temperature:	30 °C
Inj Volume:	10 µL
Suppressor:	AAES

Peaks:		
	1. Fluoride	1 mg/L
	2. Chloride	5
	3. Nitrite	5
	4. Bromide	5
	5. Nitrate	5
	6. Phosphate	10
	7. Sulfate	5

4.1.9. Separation of Eight Anions on a 3-mm IonPac AS14A Column Using a K_2CO_3 / $KHCO_3$ Eluent Generator



Column:	IonPac AG14A, 3 x 30 mm IonPac AS14A, 3 x 150 mm
Eluent Source:	EG or premixed
Eluent:	(A) 8.0 mM K_2CO_3/1.0 mM $KHCO_3$ (B) 8.0 mM Na_2CO_3/1.0 mM $NaHCO_3$
Flow Rate:	0.5 mL/ min
Temperature:	30 °C
Inj Volume:	5 µL
Suppressor:	AAES

Peaks:		
1. Fluoride	2	mg/L
2. Acetate	10	
3. Chloride	10	
4. Nitrite	10	
5. Bromide	10	
6. Nitrate	10	
7. Phosphate	20	
8. Sulfate	10	

5. MAINTENANCE

5.1. Isolating a Restriction in the Liquid Lines

A restriction in the liquid plumbing will cause excessive system backpressure.

1. Begin pumping eluent through the system (including the columns) at the flow rate normally used.
2. Work backward through the system, beginning at the flow cell exit. One at a time, loosen each fitting and observe the pressure. The connection at which the pressure drops abnormally indicates the point of restriction. If the EluGen cartridge is the source of the high backpressure, replace the outlet frit as instructed in Section 5.2.3.
3. If the restriction has caused such high pressure that the system cannot be operated, you must work forward through the system, adding parts one at a time, until an abnormal pressure increase (and hence, the restriction) is found.

5.2. Replacing the EluGen Cartridge

Replace the EluGen Cartridge (EGC II) when the cartridge is expended or when it leaks. The EGC II cartridge replacement procedure consists of several steps:

- Removal of the Used EluGen Cartridge
- Disposal of the Used EluGen Cartridge
- Installation of the New EluGen Cartridge
- Conditioning of the New EluGen Cartridge

5.2.1. Removing the Used EluGen Cartridge

1. Turn off the pump flow on the Control panel in Chromeleon Xpress or Chromeleon. (This automatically turns off the power to the EluGen Cartridge and the suppressor.)
2. Open the front door of the EG. Push down on the slide release latch and pull the tray forward until it reaches the stop.
3. The EluGen Cartridge electrical cable is connected to the EGC 1 (or EGC 2) bulkhead connector on the rear wall of the EG. Twist the ring on the cable counterclockwise to loosen it, and then pull the cable straight out of the connector.
4. Unscrew the Luer lock from the Luer adapter at the top corner of the cartridge and detach the VENT line. Tip: If necessary, use a wrench to hold the Luer adapter in place while unscrewing the vent line.
5. Locate the Luer cap stored in the EG drip tray during initial installation (see note below). Install the Luer cap onto the Luer adapter; this will prevent leakage from the vent opening when you turn over the cartridge in Step 7. NOTE During initial installation of an EluGen Cartridge, the Luer cap (P/N 053981) is removed from the cartridge and placed in the drip tray for storage until required for disposal or storage of the cartridge.
6. Lift the EluGen Cartridge straight up and off the cartridge holder.
7. Turn the cartridge upside down and place it on the drip tray; this is the service position.
8. Disconnect the EGC IN and EGC OUT lines from the INLET and OUTLET fittings on the EluGen Cartridge.

5.2.2. Disposal of the Used EluGen Cartridge

If the EluGen Cartridge is expended, dispose of it as follows:

1. Hold the cartridge with the electrolysis chamber upward. Unscrew the eluent generation chamber from the electrolyte reservoir and pour the remaining electrolyte solution into an appropriate hazardous waste container. Refer to the Material Safety Data Sheet (MSDS) shipped with the EluGen Cartridge for the chemical description.
2. Rinse the electrolyte reservoir and electrolysis chamber with ASTM filtered, Type I (18-megohm) deionized water three times. Rinsing should render the reservoir and the electrolysis chamber non-hazardous; however, check your local, state, and federal regulatory agency regulations for proper disposal.

SAFETY

Refer to the Material Safety Data Sheet (MSDS) shipped with the EGC II for the chemical description.

SAFETY

Rinsing should render the reservoir and the electrolysis chamber non-hazardous; however, check with local, state, and federal regulatory agency regulations for proper disposal.

If the EluGen Cartridge is not expended, it can be stored for up to two years. Prepare the cartridge as follows:

1. Plug all fittings. Cap the vent port. (This will prevent the evaporation of water in the electrolyte reservoir.)
2. Store the cartridge in an upright position (with the electrolyte reservoir at top) at 4 to 40 °C (39 to 104 °F) until its next use. The original shipping container is ideal for storage. Before resuming operation, condition the cartridge.
3. To install a new or partially consumed cartridge, follow the procedure in Section 2.

5.2.3. Replacing the EluGen Cartridge II Outlet Frit

If the source of the system high backpressure is isolated to the EGC II, the outlet frit should be replaced. The EGC II should add <100 psi of backpressure.

1. Unscrew the Luer lock from the Luer adaptor at the top corner of the EGC II electrolyte reservoir and detach the gas vent line.
2. Install the plastic plug in the gas vent port. Use the plug removed from the port during initial installation of the EG. The plug should be in the drip tray.
3. Turn off the pump flow.
4. With the eluent lines and electrical connects still attached, lift the EGC II from the cartridge shelf, and turn it so the eluent generation chamber and liquid line fittings are upward.
5. Unscrew the cartridge outlet line from the outlet fitting on the EGC II.

NOTE

The outlet frit is located in the electrolysis chamber at the base of this fitting.

6. Using a sharp or pointed tool, such as the mini screwdriver (P/N 46985), carefully puncture and remove the frit body and seal ring.
7. Replace with a new frit assembly (P/N 42310) provided with the EGC II.
8. Reattach the outlet line.

NOTE

Invert the EGC II with the Eluent Generation (EG) Chamber downward. Shake the EGC II vigorously, and tap the eluent generation chamber with the palm of your hand 10 to 15 times. Watch to be sure all bubbles trapped in the electrolysis chamber are dislodged. Repeat this process each time the EGC II is turned with the eluent generation chamber upward.

a. Position the EGC II in the eluent generator controller Module, such as the EG module, with the eluent generation electrolysis chamber downward by positioning the EG chamber just below the shelf and sliding the cartridge through the opening in the shelf.

6. TROUBLESHOOTING GUIDE

The purpose of the Troubleshooting Guide is to help solve operating problems that may arise while using the Eluent Generator (EG). For more information on problems that originate with the Ion Chromatograph (IC), column, or suppressor, refer to the Troubleshooting Guide in the appropriate operator's manual. If you cannot solve the problem on your own, contact the Dionex North America Technical Call Center at 1-800-DIONEX-0 (1-800-346-6390) or the nearest Dionex Office (see "Dionex Worldwide Offices" on the Reference Library CD-ROM).

6.1. EG-3000 Error Messages and Troubleshooting

6.1.1. EG1 Cartridge Disconnected and EG2 Cartridge Disconnected

This error occurs if Chromeleon or Chromeleon Xpress sends a command to set an EG parameter when the EluGen cartridge is disconnected. To troubleshoot: (1) Connect the EluGen cartridge and (2) If the error message appears again, contact Dionex for assistance. The EluGen cartridge control electronics may have malfunctioned. NOTE: The ICS-3000 Ion Chromatography System electronics components cannot be serviced by the user.

6.1.2. EG1 Invalid Concentration and EG2 Invalid Concentration

This error occurs if the eluent concentration is outside the concentration range allowed for the type of EluGen cartridge used. This may be a user setting error. This may also indicate corrupted memory or a problem in the EG Moduleware (the instrument control firmware installed in the EG). To troubleshoot: set the correct EG concentration. If failed with correct concentration settings, contact Dionex for assistance. NOTE: The ICS-3000 Ion Chromatography System electronics components and Moduleware cannot be serviced by the user.

This error may also occur due to the incorrect linking of the EG to the correct pump in the Chromeleon server configuration. To troubleshoot, re-link the EG to the correct pump using the Chromeleon server configuration.

6.1.3. EG1 Invalid Flow and EG2 Invalid Flow

This error occurs if the flow rate is set to a value not supported by the EG. The DP/SP flow rate range is 0.001 to 10.0 mL/min; however, when an EG is installed, the allowed range is 0.01 to 3.00 mL/min. The recommended operating range is 0.25 to 2.00 mL/min. To troubleshoot: set the flow rate to a value within the allowed range.

This error may also occur due to the incorrect linking of the EG to the correct pump in the Chromeleon server configuration. To troubleshoot, re-link the EG to the correct pump using the Chromeleon server configuration.

6.1.4. EG1 Invalid Flow Rate-Concentration and EG2 Invalid Flow Rate-Concentration

This error occurs if the selected concentration is too high for the set flow rate. To troubleshoot: set the flow rate to a value within the allowed range. The allowable eluent concentration for a particular application depends on several factors: the flow rate, suppressor type, EluGen cartridge type, and cartridge configuration.

This error may also occur due to the incorrect linking of the EG to the correct pump in the Chromeleon server configuration. To troubleshoot, re-link the EG to the correct pump using the Chromeleon server configuration.

6.1.5. EG1 over Current, EG2 over Current, EG1 over Power, and EG2 over Power

This error occurs when the current applied to the EluGen cartridge exceeds the maximum current allowed. (The EluGen current is automatically turned off to prevent damage to the cartridge.). If the error message appears, contact Dionex for assistance. The cartridge control electronics may have malfunctioned. NOTE: The ICS-3000 Ion Chromatography System electronics components cannot be serviced by the user.

6.1.6. EG1 over Voltage and EG2 over Voltage

This error occurs when the Elugen cartridge is not connected properly to the EG1 and EG2 current source. To troubleshoot: check the EluGen cartridge cable connection to the electrical bulkhead. If the error message appears again, contact Dionex for assistance. The EluGen cartridge or EG-3000 control electronics may have malfunctioned. NOTE The ICS-3000 Ion Chromatography System electronics components cannot be serviced by the user.

6.2. EG Alarm Light is Lighted

CAUSE: Leaking fitting.
ACTION: Locate the source of the leak. Tighten or replace liquid line connections as needed.

CAUSE: Blocked or improperly installed waste line.
ACTION: Check the EG waste lines to be sure they are not crimped or otherwise blocked. Ensure the lines are not elevated at any point after they exit the EG.

CAUSE: EluGen cartridge leaks.
ACTION: Replace the EluGen cartridge.

CAUSE: RFIC Eluent Degasser leaks.
ACTION: Replace the RFIC Eluent Degasser.

CAUSE: EluGen cartridge electrical connection is open.
ACTION: Tug gently on the EluGen cartridge electrical cable; the locking connector should hold the cable in place. If the cable is fully seated and the problem persists, the cartridge is defective and must be replaced.

CAUSE: EluGen cartridge input electrical connection has shorted out.
ACTION: Replace the EluGen cartridge.

CAUSE: EluGen cartridge input electrical connection has shorted out.
ACTION: Replace the EluGen cartridge.

CAUSE: Electrical error. The EG current and/or voltage may have become unstable.
ACTION: Contact Dionex for assistance. NOTE: The ICS-3000 Ion Chromatography System electronics components cannot be serviced by the user.

6.3. EG POWER LED Fails to Light

CAUSE: No power
ACTION: Check that the POWER button on the front of the EG is turned on. Check that the EG main power switch (on the rear panel) is turned on. Check that the main power cord is plugged into both the EG rear panel connector and the power source. Check that the wall outlet has power. If the POWER LED still fails to light, contact Dionex for assistance.

6.4. Liquid Leaks in the EG

CAUSE: Leaking fitting
ACTION: Locate the source of the leak. Tighten or replace liquid line connections as needed.

CAUSE: Blocked or improperly installed waste line.
ACTION: Check the EG waste lines to be sure they are not crimped or otherwise blocked. Make sure the lines are not elevated at any point after they exit the EG.

CAUSE: EluGen Cartridge leaks.
ACTION: Replace the EluGen Cartridge.

CAUSE: RFIC Eluent Degasser leaks.
ACTION: Replace the RFIC Eluent Degasser.

6.5. No Flow

CAUSE: DP/SP power is off. Turning off the DP/SP automatically turns off the EG and the suppressor.
ACTION: Check that the power to the DP/SP is turned on. Prime the pump and then resume operation.

CAUSE: DP/SP pressure limit tripped. When a system includes an EG, the high pressure limit for the DP/SP is 21 MPa (3000 psi) and the low pressure limit is 1.4 MPa (200 psi).

ACTION: Check that the Current Pressure (under Pressure Display on the pump Control panel) is within this range. NOTE: The EluGen cartridge requires at least 14 MPa (2000 psi) of backpressure for optimal removal of electrolysis gas from the eluent produced by the cartridge. A system backpressure of 16 MPa (2300 psi) is ideal.

CAUSE: RFIC Eluent Degasser tubing is ruptured. If flow from the EG waste line is normal, but there is no flow through the columns, the tubing assembly inside the RFIC Eluent Degasser has ruptured.
ACTION: Replace the degasser.

6.6. EG Stops Operation

CAUSE: DP/SP power is off. Turning off the DP/SP automatically turns off the EG and the suppressor.
ACTION: Check that the power to the DP/SP is turned on. Prime the pump and then resume operation.

CAUSE: DP/SP pressure limit tripped. When a system includes an EG, the high pressure limit for the DP/SP is 21 MPa (3000 psi) and the low pressure limit is 1.4 MPa (200 psi).

CAUSE: DP/SP flow rate is too low or too high.
ACTION: Select a flow rate between 0.1 and 3.0 mL/min.

CAUSE: Electrical error detected (Alarm LED is lighted). To prevent damage to the EluGen Cartridges, the DP/SP automatically turns off electrical power to the cartridge when excessive current or voltage is detected.
ACTION: Ensure the Elugen Cartridge electrical cable is properly connected to the EG 3000 module. If failure persists, contact Dionex for assistance. NOTE: The ICS-3000 Ion Chromatography System electronics components cannot be serviced by the user.

CAUSE: EluGen Cartridge is expended.
ACTION: Replace the cartridge.

CAUSE: No communication with Chromeleon or Chromeleon Xpress.
ACTION:

1. Check that the POWER button on the front of the EG is turned on.
2. Check that the EG main power switch (on the rear panel) is turned on.
3. Check that the main power cord is plugged into both the EG rear panel connector and the power source.
4. Check that the wall outlet has power.
5. Check the USB connections. The EG should be connected to the DP/SP (or other ICS-3000 module) via a USB cable (P/N 960777). In addition, one module in the system must be connected to the PC on which Chromeleon or Chromeleon Xpress is installed.
6. Check that the EG is configured in the software and assigned to a timebase.

6.7. Excessive System Backpressure

CAUSE: Restriction in the liquid line plumbing.
ACTION:

1. Begin pumping eluent through the system (including the columns) at the flow rate normally used.
2. Work backward through the system, beginning at the cell exit. One at a time, loosen each fitting and observe the pressure. The connection at which the pressure drops abnormally indicates the point of restriction.
3. If the EGC II Cartridge is identified as the source of the high backpressure, the outlet frit should be replaced. A restriction often causes such high pressure that the entire system cannot be operated. In that case, work forward through the system starting at the EGC II, adding parts one at a time until an abnormal pressure increase (and hence, the restriction) is found.

6.8. No Peaks

CAUSE: EGC II current may not be on. The Chromeleon program may not be started.
ACTION: Make sure EG current is applied. Configure EGC II correctly using Chromeleon software.

6.9. Peak Retention Times are Too Short

CAUSE: Concentration settings are too high. Pump flow rate is low.
ACTION: Check the Chromeleon program for correct concentration and flow rate combinations. Check the pump flow rate.

6.10. Peak Retention Times are Too Long

CAUSE: Concentration settings are too low. Pump flow rate is high. The OFFSET VOLUME in the EG II program is too large.
ACTION: Check the Chromeleon program for correct concentration and flow rate combinations. Check the pump flow rate.

6.11. Low System Backpressure

CAUSE: Loose fitting. High pressure degas tubing assembly ruptured. Internal EGC II leak in the membrane barrier. (This leak will not be detected immediately by the EG II leak sensor since the liquid leak will pass out through the vent line).
ACTION: Check all system fittings. If there is no flow through the columns, although flow from the waste line remains normal, the degas tubing assembly has ruptured and must be replaced. This type of leak may trip the pump pressure limit and the pump will shut off. The cartridge must be replaced.

EluGen® Cartridge
Potassium Carbonate
Product No. 058904

Date: 03-Jun-05 12:32
Serial No. : 050610699031

Quality Assurance Report

To assure quality, Dionex tests each EluGen Cartridge using a prescribed set of quality assurance tests for backpressure and current delivery over the product concentration range. This Quality Assurance Report covers the tests that are done with this product.

Performance Test Results

Parameter	Specification	Result
Maximum Concentration	Pass/Fail	Passed
Maximum Operating Voltage	Pass/Fail	Passed
Maximum Cartridge Back Pressure	Pass/Fail	Passed

RFIC Eluent Generation Theory

The eluent concentration generated by an RFIC Eluent Generation System is dependent on two main factors:

- the eluent flow rate delivered to the EG Cartridge from the pumping system
- the applied current delivered to the EG Cartridge from the Eluent Generator module.

Dionex's patented Eluent Generation technology follows Faraday's Law and the eluent concentration is therefore directly proportional to the applied current and inversely proportional to the eluent flow rate.

$$[\text{Eluent (mM)}] \quad \alpha \quad \frac{\text{Applied Current (mA)}}{\text{Eluent Flow Rate (mL/min)}}$$

This physical law ensures the accuracy of each EluGen Cartridge provided the applied current and eluent flow rate are accurately calibrated. It is critical that the pump flow rate is calibrated and the Eluent Generator module is verified to supply the correct current. Dionex offers a series of Operational Qualification and Performance Qualification (OQ/PQ) procedures for pump and eluent generator module calibration. These are available for Dionex Chromeleon version 6.70 or later.

Production Reference:

Datasource: EGC_local
Sequence: EGC_K2CO3_VALIDATION
Sample No.: 46

Electrolytic pH Modifier (EPM)
Product No. 063175

Date: 31-May-05 07:20
Serial No. : 050610621061

Quality Assurance Report

To assure quality, Dionex tests each Electrolytic pH Modifier (EPM) using a prescribed set of quality assurance tests for backpressure and current delivery over the product concentration range.
This Quality Assurance Report covers the tests that are done with this product.

Performance Test Results

Parameter	Specification	Result
Maximum Concentration	Pass/Fail	Passed
Maximum Operating Voltage	Pass/Fail	Passed
Maximum Cartridge Back Pressure	Pass/Fail	Passed

RFIC Eluent Generation Theory

The eluent concentration generated by an RFIC Eluent Generation System using an EG Cartridge and EPM is dependent on two main factors:

- the eluent flow rate delivered to the EG Cartridge and EPM from the pumping system,
- the applied current delivered to the EG Cartridge and EPM from the Eluent Generator module.

Dionex's patented Eluent Generation technology follows Faraday's Law and the eluent concentration is therefore directly proportional to the applied current and inversely proportional to the eluent flow rate.

$$[\text{Eluent (mM)}] \quad \alpha \quad \frac{\text{Applied Current (mA)}}{\text{Eluent Flow Rate (mL/min)}}$$

This physical law ensures the accuracy of each EPM provided the applied current and eluent flow rate are accurately calibrated. It is critical that the pump flow rate is calibrated and the Eluent Generator module is verified to supply the correct current. Dionex offers a series of Operational Qualification and Performance Qualification (OQ/PQ) procedures for pump and eluent generator module calibration. These are available for Dionex Chromeleon version 6.70 or later.

Production Reference:
Datasource: EGC_local
Sequence: EPM_Validation
Sample No.: 26