Product Manual

for

Dionex Eluent Generator Cartridges
(Dionex EGC)

Dionex EGC III KOH
(Potassium Hydroxide Cartridge, P/N 074532)

Dionex EGC 500 KOH
(Potassium Hydroxide Cartridge, P/N 075778)

Dionex EGC-KOH (Capillary)
(Capillary Potassium Hydroxide Cartridge, P/N 072076)

Dionex EGC III NaOH
(Sodium Hydroxide Cartridge, P/N 074533)

Dionex EGC III LiOH
(Lithium Hydroxide Cartridge, P/N 074534)

Dionex EGC 500 K₂CO₃
(Potassium Carbonate Cartridge, P/N 088453)

Dionex EPM 500
(Electrolytic pH Modifier, P/N 088471)

Dionex EGC 500 Carbonate Mixer
(4 mm, P/N 088468; 2 mm, P/N 088467)

Dionex EGC III MSA
(Methanesulfonic Acid Cartridge, P/N 074535)

Dionex EGC 500 MSA
(Methanesulfonic Acid Cartridge, P/N 075779)

Dionex EGC-MSA (Capillary)
(Capillary Methanesulfonic Acid Cartridge, P/N 072077)
Safety and Special Notices

Make sure you follow the precautionary statements presented in this guide. The safety and other special notices appear in boxes. Safety and special notices include the following:

**SAFETY**

Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

**WARNING**

Indicates a potentially hazardous situation which, if not avoided, could result in damage to equipment.

**CAUTION**

Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury. Also used to identify a situation or practice that may seriously damage the instrument, but will not cause injury.

**NOTE**

Indicates information of general interest.

**IMPORTANT**

Highlights information necessary to prevent damage to software, loss of data, or invalid test results; or might contain information that is critical for optimal performance of the system.

**Tip**

Highlights helpful information that can make a task easier.
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1. Introduction

A Reagent-Free™ Ion Chromatography system with Eluent Generation (RFIC™-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. RFIC-EG systems produce high purity, contaminant free eluents online. The use of these high purity eluents can significantly improve the performance of IC methods.

An important advantage of EG is that gradient separations can be performed using electrical current to generate gradients with minimal delay. In addition, the use of EG can reduce the maintenance costs of a pumping system since the pump only comes in contact with DI water instead of corrosive acids or bases.

Thermo Scientific offers 10 Thermo Scientific™ Dionex™ Eluent Generator Cartridges (Dionex EGC). Five are high purity hydroxide eluent cartridges used for anion separations with hydroxide selective columns:

1. Thermo Scientific™ Dionex™ EGC III KOH cartridge for the generation of potassium hydroxide (KOH).
2. Thermo Scientific™ Dionex™ EGC III NaOH cartridge for the generation of sodium hydroxide (NaOH).
3. Thermo Scientific™ Dionex™ EGC III LiOH cartridge for the generation of lithium hydroxide (LiOH).
4. Thermo Scientific™ Dionex™ EGC-KOH (Capillary) cartridge for the generation of potassium hydroxide (KOH) at capillary flow rates (0.001 – 0.030 mL/min).
5. Thermo Scientific™ Dionex™ EGC 500 KOH cartridge for the generation of potassium hydroxide (KOH) in high pressure IC systems at pressures up to 5,000 psi.

In addition, Thermo Scientific offers a high purity carbonate eluent cartridge and an Electrolytic pH Modifier for use with anion separations with carbonate eluent based columns:

1. Thermo Scientific™ Dionex™ EGC 500 K₂CO₃ cartridge for the generation of potassium carbonate (K₂CO₃) in traditional RFIC-EG systems up to 3,000 psi as well as high pressure IC (HPIC) systems at pressures up to 5,000 psi.
2. Thermo Scientific™ Dionex™ EPM 500 eluent pH modifier for the in-line titration of potassium carbonate to potassium bicarbonate (KHCO₃) in traditional RFIC-EG systems up to 3,000 psi as well as high pressure IC (HPIC) systems at pressures up to 5,000 psi.
3. Thermo Scientific™ Dionex™ EGC 500 Carbonate Mixer for the mixing of carbonate or carbonate / bicarbonate eluents to ensure a homogenous delivery of eluent.

Finally, Thermo Scientific offers three high purity methanesulfonic acid cartridges for use with cation separations:

1. Thermo Scientific™ Dionex™ EGC III MSA cartridge for the generation of methanesulfonic acid (CH₃ SO₃H).
2. Thermo Scientific™ Dionex™ EGC-MSA (Capillary) cartridge for the generation of methanesulfonic acid (CH₃ SO₃H) at capillary flow rates (0.001 – 0.030 mL/min).
3. Thermo Scientific™ Dionex™ EGC 500 MSA cartridge for the generation of methanesulfonic acid (CH₃SO₃H) in high pressure IC systems at pressures up to 5,000 psi.

Thermo Scientific also offers a Thermo Scientific™ Dionex™ Continuously Regenerated Trap Column (Dionex CR-TC 500). A Dionex CR-TC 500 removes any extraneous contaminants.
from the DI water source. The Dionex CR-TC 500 is electrolytically regenerated, thus eliminating the need for offline chemical regeneration. A Thermo Scientific™ Dionex™ CR-ATC 500 Trap Column is used for anion exchange applications while a Thermo Scientific™ Dionex™ CR-CTC 500 Trap Column is used for cation exchange applications. A Dionex CR-TC 500 can be used at pressures up to 5,000 psi, and is compatible with both standard and high pressure IC systems.

1.1 Dionex EGC 500 KOH, Dionex EGC III KOH, NaOH and LiOH, and Dionex EGC-KOH (Capillary) Principle of Operation

Figure 1 Dionex EGC 500 KOH, Dionex EGC III KOH, NaOH, LiOH or Dionex EGC-KOH (Capillary) Cartridge for generation of KOH, NaOH or LiOH eluent.

Figure 1 illustrates the operation principle of a Dionex EGC 500 KOH, Dionex EGC III KOH, NaOH, LiOH or Dionex EGC-KOH (Capillary). The cartridge consists of a high pressure eluent generation chamber and a low pressure K⁺, Na⁺ or Li⁺ ion electrolyte reservoir. The eluent generation chamber contains a perforated platinum (Pt) cathode where hydroxide ions are formed. The K⁺, Na⁺ or Li⁺ ion electrolyte reservoir contains a Pt anode and an electrolyte solution of K⁺, Na⁺ or Li⁺ ions. The eluent generation chamber is connected to the electrolyte reservoir by means of a cation exchange connector which permits the passage of ions from the electrolyte reservoir into the high pressure generation chamber, while preventing the passage of anions from the electrolyte reservoir into the generation chamber. The cation exchange connector also serves the critical role of a high pressure physical barrier between the low pressure electrolyte reservoir and the high pressure generation chamber.

To generate a KOH, NaOH or LiOH eluent, deionized water is pumped through the eluent generation chamber and a DC current is applied between the anode and cathode of the Dionex EGC. Under the applied field, the electrolysis of water occurs at both the anode and cathode of the device. As shown below, water is oxidized to form H⁺ ions and oxygen gas at the anode in the K⁺, Na⁺ or Li⁺ electrolyte reservoir.
H₂O + 2e⁻ → 2 H⁺ + 1/2 O₂↑ (at anode)

Water is reduced to form OH⁻ ions and hydrogen gas at the cathode in the KOH, NaOH or LiOH generation chamber.

2 H₂O + 2e⁻ → 2 OH⁻ + H₂↑ (at cathode)

As H⁺ ions, generated at the anode, displace K⁺, Na⁺ or Li⁺ ions in the electrolyte reservoir, the displaced ions migrate across the cation exchange connector into the eluent generation chamber. These ions combine with OH⁻ ions generated at the cathode to produce the KOH, NaOH or LiOH solution, which is used as the eluent for anion exchange chromatography. The concentration of generated KOH, NaOH or LiOH is determined by the current applied to the generator and the carrier water flow rate through the generation chamber. Therefore, given the carrier flow rate, the EG module will precisely control the applied current to accurately and reproducibly generate KOH, NaOH or LiOH at the desired concentration.

1.2 Dionex EGC 500 MSA, Dionex EGC III MSA, and Dionex EGC-MSA (Capillary) Principle of Operation

![Diagram of Dionex EGC 500 MSA, Dionex EGC III MSA or Dionex EGC-MSA (Capillary) Cartridge for generation of MSA eluent.](image-url)

- **Pt Cathode**
  - (2H₂O + 2e⁻ → 2OH⁻ + H₂)
- **Pt Anode**
  - (H₂O → 2H⁺ + 1/2O₂ + 2e⁻)
- **H₂O**
- **Pump**
- **Eluent Generation Chamber**
- **MSA Electrolyte Reservoir**
- **Anion-Exchange Connector**
- **Degas Module**
- **H₂**
- **MSA + H₂**
- **MSA**
- **CR-CTC**
- **Vent**
The concept described for the generation of hydroxide can be applied to the generation of acid. Figure 2 illustrates the operation principle of a Dionex EGC 500 MSA, Dionex EGC III MSA or Dionex EGC-MSA (Capillary) cartridge. The cartridge consists of a high pressure eluent generation chamber and a low pressure methanesulfonate (MSA\(^-)\) ion electrolyte reservoir. The eluent generation chamber contains a perforated platinum (Pt) anode. The electrolyte reservoir contains a Pt cathode and an electrolyte solution of MSA\(^-)\) ions. The eluent generation chamber is connected to the MSA\(^-)\) ion electrolyte reservoir using an anion exchange connector which permits the passage of MSA\(^-)\) ions from the electrolyte reservoir into the high pressure generation chamber, while preventing the passage of cations.

The anion exchange connector also serves the critical role of a high pressure physical barrier between the low pressure electrolyte reservoir and the high pressure eluent generation chamber.

To generate a MSA eluent, deionized water is pumped through the MSA generation chamber and a DC current is applied between the anode and cathode of the eluent generator cartridge. Under the applied field, the electrolysis of water occurs at the anode and cathode of the device. Water is oxidized to form H\(^+\) ions and oxygen gas at the anode in the MSA generation chamber as shown below.

\[
\text{H}_2\text{O} + 2e^- \rightarrow 2\text{H}^+ + \frac{1}{2}\text{O}_2 \uparrow \text{ (at anode)}
\]

Water is reduced to form OH\(^-\) ions and hydrogen gas at the cathode in the MSA\(^-)\) electrolyte reservoir.

\[
2\text{H}_2\text{O} + 2e^- \rightarrow 2\text{OH}^- + \text{H}_2 \uparrow \text{ (at cathode)}
\]

As the OH\(^-\) ions, generated at the cathode, displace MSA\(^-)\) ions in the electrolyte reservoir, MSA\(^-)\) ions migrate across the anion exchange connector into the MSA electrolysis chamber. The MSA\(^-)\) ions combine with H\(^+\) ions generated at the anode to produce a methanesulfonic acid (MSA) solution, which is used as the eluent for cation exchange chromatography. The concentration of MSA generated is determined by the current applied to the MSA generator and the carrier flow rate through the MSA generation chamber. Therefore, given the carrier flow rate, the EG module will control the applied current in order to accurately and reproducibly generate MSA at the desired concentration.
1.3 Dionex EGC 500 $\text{K}_2\text{CO}_3$ Principle of Operation

The Potassium Carbonate Eluent Generator Cartridge (Dionex EGC 500 $\text{K}_2\text{CO}_3$) is the heart of the electrolytic carbonate eluent generation process. Figure 3 shows the principle of electrolytic generation of carbonate eluents. Carbonate eluents are generated by using a Dionex EGC 500 $\text{K}_2\text{CO}_3$ cartridge. The Dionex EGC 500 $\text{K}_2\text{CO}_3$ cartridge consists of an electrolyte reservoir and two high-pressure eluent generation chambers, which are connected in series. The ion exchange connector sections in these two chambers are cation exchange section and anion exchange section, respectively.
In the first generation chamber, the cation exchange section is located directly above the cathode and the anion exchange section is located directly above the anode in the second 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.

$$2 \text{H}_2\text{O} + 2\text{e}^- \rightarrow 2\text{OH}^- + \text{H}_2\uparrow \text{ (at cathode)}$$

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

$$\text{H}_2\text{O} - 2\text{e}^- \rightarrow 2\text{H}^+ + \frac{1}{2}\text{O}_2\uparrow \text{ (at anode)}$$

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 potassium carbonate (K$_2$CO$_3$) solution, which can be used as the eluent in ion chromatography. The concentration of K$_2$CO$_3$ 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.
1.4 Dionex EPM 500 Principle of Operation

When the Dionex EGC 500 K₂CO₃ cartridge is combined with an Electrolytic pH Modifier (Dionex EPM 500), eluents of carbonate and bicarbonate can be generated electrolytically. The Dionex EPM 500 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 Dionex EPM 500 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 4. 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.

$$2 \text{K}_2\text{CO}_3 + \text{H}^+ \rightarrow \text{K}_2\text{CO}_3 + \text{KHCO}_3$$
1.5 Differences between Dionex EGC II and Dionex EGC III

The Dionex EGC III is a direct replacement for the Thermo Scientific™ Dionex™ EGC II. The following table outlines the discontinued products and their direct replacements:

<table>
<thead>
<tr>
<th>Old P/N</th>
<th>Old Description</th>
<th>New P/N</th>
<th>New Description</th>
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<tr>
<td>058900</td>
<td>Dionex EGC II KOH</td>
<td>074532</td>
<td>Dionex EGC III KOH</td>
</tr>
<tr>
<td>058908</td>
<td>Dionex EGC II NaOH</td>
<td>074533</td>
<td>Dionex EGC III NaOH</td>
</tr>
<tr>
<td>058906</td>
<td>Dionex EGC II LiOH</td>
<td>074534</td>
<td>Dionex EGC III LiOH</td>
</tr>
<tr>
<td>058902</td>
<td>Dionex EGC II MSA</td>
<td>074535</td>
<td>Dionex EGC III MSA</td>
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A chip has been added to the cable of the Dionex EGC III devices. This chip will be ignored by instruments that do not include a chip reader, such as the Thermo Scientific™ Dionex™ EG40, Thermo Scientific™ Dionex™ EG50, Thermo Scientific™ Dionex™ ICS-2000, Thermo Scientific™ Dionex™ ICS-2100, Thermo Scientific™ Dionex™ ICS-3000 EG and Thermo Scientific™ Dionex™ RFC-30. Newer instruments such as the Thermo Scientific™ Dionex™ ICS-5000 EG module and Thermo Scientific™ Dionex™ ICS-5000 EG module do include a chip reader to make use of this new feature.

**The Dionex ICS-5000 EG and Dionex ICS-5000+ EG require a Dionex EGC III, Dionex EGC (Capillary), Dionex EGC 500 or Dionex EPM 500 to function. The Dionex ICS-5000 EG and Dionex ICS-5000+ EG will not function with a Dionex EGC II or Dionex EPM.**

The Dionex EGC III reservoir, membranes, screens and electrodes use the same materials and undergo the same testing as the Dionex EGC II cartridges they replace. The EGC III can be used in place of the EGC II without any change in form, fit or function. The EPM 500 can be used in place of the Thermo Scientific™ Dionex™ EPM without any change in form, fit or function.
1.6 Differences between Dionex EGC III and Dionex EPM III, and Dionex EGC 500 and Dionex EPM 500

With the exception of the Dionex EGC K$_2$CO$_3$, the Dionex EGC 500 is not a direct replacement for the Dionex EGC III. The Dionex EGC 500 is designed to enable high pressure operation in High Pressure RFIC-EG systems such as the Dionex ICS-5000. In order to operate above 3,000 psi, a High Pressure RFIC system must be fitted with a Dionex EGC 500.

The Dionex EGC 500 K$_2$CO$_3$ is a direct replacement for the Dionex EGC III K$_2$CO$_3$ and the Dionex EPM 500 is a direct replacement for the Dionex EPM III. The Dionex EGC 500 K$_2$CO$_3$ and Dionex EPM 500 are designed to enable high pressure operation in High Pressure RFIC-EG systems (HPIC systems) such as the Dionex ICS-5000. The Dionex EGC 500 K$_2$CO$_3$ and Dionex EPM 500 are compatible with non-HPIC RFIC-EG systems such as the Dionex ICS-2100, but the backpressure will be restricted to 3,000 psi in these systems.

The following table outlines the equivalent Dionex EGC III and Dionex EGC 500 products:

<table>
<thead>
<tr>
<th>Dionex EGC III Products</th>
<th>Dionex EGC 500 Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>P/N</td>
<td>Description</td>
</tr>
<tr>
<td>074532</td>
<td>Dionex EGC III KOH</td>
</tr>
<tr>
<td>074535</td>
<td>Dionex EGC III MSA</td>
</tr>
<tr>
<td>074536</td>
<td>Dionex EGC III K$_2$CO$_3$</td>
</tr>
<tr>
<td>080135</td>
<td>Dionex EPM III</td>
</tr>
</tbody>
</table>

NOTE

With the exception of the Dionex EGC K$_2$CO$_3$, the Dionex EGC 500 is not compatible with non-High Pressure RFIC systems and modules such as the Dionex ICS-5000, Dionex ICS-2100 or Dionex RFC-30. If a Dionex EGC 500 KOH or Dionex EGC 500 MSA is installed into a non-High Pressure RFIC system the cartridge will not be recognized.
1.7 System Flow Diagram

1.7.1 Eluent Generator module with hydroxide or MSA eluent and Dionex CR-TC Trap Column

Figure 5 shows the configuration of a typical RFIC-EG system. The EG Module is placed between the outlet of the pump and the inlet of the sample injector. Deionized water is used as the carrier for the EG. For anion analysis, a Dionex Continuously Regenerated Trap Column (Dionex CR-TC 500) for Anions (Dionex CR-ATC 500, P/N 075550), should be placed at the Dionex Eluent Generator Cartridge (Dionex EGC) outlet to remove dissolved carbon dioxide and other anionic contaminants from the deionized water. For cation analysis, a Dionex Continuously Regenerated Cation Trap Column (Dionex CR-CTC 500, P/N 075551) should be placed at the Dionex EGC outlet to remove cationic contaminants such as ammonium from the acidic eluent.

The high pressure degas tubing assembly is located between the outlet of the Dionex CR-TC 500 and the inlet of the sample injector to remove electrolysis gases generated during the eluent generation process. After exiting the degas tubing assembly, the high purity eluent passes through the injector, column, suppressor, and finally to the detector. Depending on the pressure drop across the guard and analytical column, an optional pressure restrictor can be installed between the outlet of the high pressure degas tubing assembly and the inlet of the sample injector for optimal system performance. A total backpressure of 2,300 psi is ideal. When using suppressed conductivity detection, the suppressor regenerant effluent is directed to flow through the degas tubing assembly to remove any released hydrogen or oxygen gas as shown in Figure 6.
Figure 5  Standard Pressure System Flow Diagram for a typical RFIC-EG application using hydroxide or MSA eluent.

KEY
1. CR-TC Eluent Inlet
2. CR-TC Eluent Outlet
3. Degas Eluent In
4. Degas Eluent Out
5. Suppressor Eluent In
6. Suppressor Eluent Out
7. Suppressor Regen In
8. Suppressor Regen Out
9. CR-TC Regen In
10. CR-TC Regen Out
11. Degas Regen In
12. Degas Regen Out

* Use with CR-TC.
** Remove for CR-TC use.
Figure 6  High Pressure System Flow Diagram for a Typical RFIC-EG Application Using Hydroxide or MSA Eluent.

**Eluent Generator (EG) Module**

**KEY**
1. CR-TC Eluent Inlet
2. CR-TC Eluent Outlet
3. Degas Eluent In
4. Degas Eluent Out
5. Suppressor Eluent In
6. Suppressor Eluent Out
7. Suppressor Regen In
8. Suppressor Regen Out
9. CR-TC Regen In
10. CR-TC Regen Out

* Use with CR-TC.
** Remove for CR-TC use.
1.7.2 Eluent Generator module with hydroxide or MSA eluent and Dionex ATC-HC or Dionex CTC-1.

As an alternative to the Dionex CR-ATC 500, the Thermo Scientific™ Dionex™ IonPac™ ATC-HC Trap Column (P/N 059604) or Thermo Scientific™ Dionex™ IonPac™ ATC-HC 500 (P/N 075978) can be used for anion exchange applications. The Thermo Scientific™ Dionex™ IonPac™ CTC-1 Trap Column (P/N 040192) or Thermo Scientific™ Dionex™ IonPac™ CTC 500 (P/N 075977) can be used as an alternate to the Dionex CR-CTC 500 Trap Column for cation applications. See Appendix A.

1.7.3 Eluent Generator module with hydroxide or MSA eluent and UltraViolet (UV) Detection.

When using UV detection, the detector effluent is directed to flow through the degas tubing assembly to remove any released hydrogen gas, as shown in Figure 7.

Figure 7 High Pressure System Flow Diagram for a Typical RFIC-EG Application Using Hydroxide or MSA Eluent and UV Detection.

**KEY**
1. CR-TC Eluent Inlet
2. CR-TC Eluent Outlet
3. Degas Eluent In
4. Degas Eluent Out
5. CR-TC Regen In
6. CR-TC Regen Out

* Use with CR-TC.
** Remove for CR-TC use.
1.7.4 Eluent Generator module with hydroxide or MSA eluent and Amperometric Detection.

Because the hydrogen and oxygen gasses generated by the electrolytic reactions in the Dionex EGC cartridges are electroactive, they must be removed with greater efficiency for Amperometric Detection compared to other detection methods such as suppressed conductivity. To achieve this it is necessary to pull a vacuum on the Dionex EG Degas module.

To increase the gas removal efficiency, the cell effluent is directed to the Dionex CR-ATC REGEN IN and then diverted to waste. A Dionex VP Vacuum Pump Kit (P/N 066463) or the Dionex EG/DP/SP Vacuum Degas Conversion Kit (P/N 063353) is installed to vacuum degas the EG eluent prior to operation.

The Dionex VP Vacuum Pump Kit contains a stand-alone vacuum pump with all the components required to connect the pump and to remove H₂ gas from the Dionex EG Degas module.

The EG/DP/SP Vacuum Degas Conversion Kit contains all components required to convert the Dionex ICS-3000/5000/5000+ DP or SP vacuum degas pump to remove H₂ gas from EG Degas module. A Dionex ICS-3000/5000/5000+ DP or SP with vacuum degas option is required.

Figure 8 High Pressure System Flow Diagram for Carbohydrate Applications Using an Eluent Generator Module.

1.7.5 Eluent Generator Module with Carbonate Eluent

Figure 9 shows the plumbing schematic for electrolytic generation of carbonate only eluent using a Dionex EGC 500 K₂CO₃ cartridge in a Dionex RFIC-EG system. The Dionex EGC 500 K₂CO₃ Cartridge and EGC 500 Carbonate Mixer are shipped in separate boxes. The EGC 500 Carbonate Mixer is used to provide sufficient mixing of the KOH and H₂CO₃ formed from the cation pod and anion pod of the Dionex EGC 500 K₂CO₃ cartridge, respectively. The Dionex EGC degas assembly is installed inside the EG module at the factory.
1.7.6 Eluent Generator Module with Carbonate/Bicarbonate Eluent

To generate eluents of carbonate and bicarbonate, a Dionex EPM 500 is installed in the system. The system flow diagram is shown in Figure 10.

**Figure 10** Plumbing Schematic for Electrolytic Generation of Carbonate and Bicarbonate Mixed Eluents Using a Dionex EGC 500 K$_2$CO$_3$ Cartridge and Dionex EPM 500 in an RFIC-EG System.

**KEY**
1. EPM Eluent In
2. EPM Eluent Outlet
3. Degas Eluent In
4. Degas Eluent Out
5. Suppressor Eluent In
6. Suppressor Eluent Out
7. Suppressor Regen In
8. Suppressor Regen Out
9. EPM Regen In
10. EPM Regen Out
1.8 Dionex EGC 500, Dionex EGC III, and Dionex EGC (Capillary) Operational Lifetime

The life expectancy of an analytical Dionex EGC cartridge is a function of a number of user-selectable parameters. Based on eluent concentration and flow rate, the number of expected operating hours for the cartridge can be determined. The Dionex EGC 500 has identical operational lifetime than the Dionex EGC III. But with higher flow rates, HPIC systems typically can run more samples in the same period of time. This gives the Dionex EGC 500 cartridge a cost of ownership advantage over the Dionex EGC III.

Under most conditions, the Dionex EGC (Capillary) will last 18 months regardless of use, allowing Always on operation without concern for accelerated consumption of the Dionex EGC cartridge.

1.8.1 Dionex EGC 500 and Dionex EGC III KOH and NaOH

The KOH and NaOH versions of the Dionex EGC 500 and Dionex EGC III have a lifetime of 2,500 hours at 1.0 mL/min and 20 mM. Increasing the flow rate or eluent concentration will accelerate the consumption of the Dionex EGC III or Dionex EGC 500 proportionately. Decreasing the flow rate or eluent concentration will decelerate the consumption of the Dionex EGC III or Dionex EGC 500 proportionately.

\[
\text{lifetime} = \frac{50,000}{\text{flowrate} \times \text{concentration}} \text{ hours}
\]

The Dionex EGC 500 and EGC III are not consumed while they are turned off. However there is a 2 year best if used by date. The cartridge can be used beyond this date, but the generated eluent concentration should be re-validated.

1.8.2 Dionex EGC III LiOH

The LiOH version of the Dionex EGC III has a lifetime of 2,000 hours at 1.0 mL/min and 20 mM. Increasing the flow rate or eluent concentration will accelerate the consumption of the Dionex EGC III proportionately. Decreasing the flow rate or eluent concentration will decelerate the consumption of the Dionex EGC III proportionately.

\[
\text{lifetime} = \frac{40,000}{\text{flowrate} \times \text{concentration}} \text{ hours}
\]

The Dionex EGC III is not consumed while it is turned off. However there is a 2 year best if used by date. The cartridge can be used beyond this date, but the generated eluent concentration should be re-validated.
1.8.3 **Dionex EGC 500 and Dionex EGC III MSA**

The MSA versions of the Dionex EGC 500 and Dionex EGC III have a lifetime of 1,250 hours at 1.0 mL/min and 20 mM. Increasing the flow rate or eluent concentration will accelerate the consumption of the Dionex EGC III or Dionex EGC 500 proportionately. Decreasing the flow rate or eluent concentration will decelerate the consumption of the Dionex EGC III or Dionex EGC 500 proportionately.

\[
\text{lifetime} = \frac{25,000}{\text{flowrate} \times \text{concentration}} \text{ hours}
\]

The Dionex EGC 500 and EGC III are not consumed while they are turned off. However there is a 2 year best if used by date. The cartridge can be used beyond this date, but the generated eluent concentration should be re-validated.

1.8.4 **Dionex EGC 500 K₂CO₃ and Dionex EPM 500**

The K₂CO₃ version of the EGC 500 has a lifetime of 1,500 hours at 1.0 mL/min and 9.0 mM. Increasing the flow rate or eluent concentration will accelerate the consumption of the Dionex EGC III or Dionex EGC 500 proportionately. Decreasing the flow rate or eluent concentration will decelerate the consumption of the Dionex EGC III or Dionex EGC 500 proportionately.

\[
\text{lifetime} = \frac{13,500}{\text{flowrate} \times \text{concentration}} \text{ hours}
\]

The Dionex EGC 500 is not consumed while it is turned off. However there is a 2 year best if used by date. The cartridge can be used beyond this date, but the generated eluent concentration should be re-validated.

The Dionex EPM 500 has no expiration lifetime built in. It is recommended to replace the Dionex EPM 500 with every third Dionex EGC 500 K₂CO₃.

1.8.5 **Dionex EGC-KOH (Capillary) and Dionex EGC-MSA (Capillary)**

Both the KOH and MSA versions of the Dionex EGC (Capillary) have an 18 month lifetime from the day they are first turned on. The Dionex EGC (Capillary) is consumed while it is turned off once it has been placed into a system and turned on. The counter is inactive when the Dionex EGC (Capillary) is shipped; the cartridge can be stored indefinitely without activating the 18 month counter. As soon as the Dionex EGC (Capillary) is installed in a system and turned on, the 18 month counter begins regardless of use.

There is also a 2 year best if used by date. The cartridge can be used beyond this date, but the generated eluent concentration should be re-validated.
2. Installation

The Dionex Eluent Generator Cartridges (Dionex EGC) are designed to be used with Dionex EG modules including Dionex EG40, Dionex EG50, Dionex RFC-30, Dionex ICS-2000, Dionex ICS-2100, Dionex ICS-3000 EG, Dionex ICS-5000 EG and Dionex ICS-5000+ EG modules. For details regarding the operation of these modules please refer to their respective operating manuals.

The Dionex Potassium Carbonate Eluent Generator Cartridges (Dionex EGC 500 K₂CO₃) and Dionex Electrolytic pH Modifier (Dionex EPM 500) are not compatible with the Dionex EG40, Dionex EG50 or Dionex RFC-30 modules and require Thermo Scientific™ Dionex™ Chromeleon™ Chromatography Management System, version 6.7 or higher. For details regarding the operation, please refer to the EG module operation manual.

The Dionex EGC-KOH (Capillary) and Dionex EGC-MSA (Capillary) Cartridges are designed to be used with a Dionex Capillary Ion Chromatography system such as the Dionex ICS-4000, Dionex ICS-5000 or Dionex ICS-5000+ with IC Cube and Capillary pump heads. These cartridges are not compatible with analytical scale instruments.

2.1 Procedure for Dionex EGC Installation

2.1.1 Preparation for Installation

A. Remove the Dionex EGC from the box. Save the box and foam for future storage.
B. If required, configure the EG module to operate the cartridge by entering the cartridge serial number. Please refer to the EG Module and Chromeleon user manuals for detailed procedures for entering the cartridge serial number.

- The ICS-5000+ EG, ICS-5000 EG and ICS-4000 modules will automatically detect the cartridge type and do not require the serial number to be entered manually.
- The ICS-5000+ and ICS-5000 EG modules require a Dionex EGC 500 (Dionex ICS-5000+ only), Dionex EGC III, Dionex EPM 500 or Dionex EGC (Capillary) cartridge. Dionex EGC II and Dionex EPM cartridges will not be recognized by these systems and will not function.

C. Place the Dionex EGC on a flat surface in front of the EG module with the Eluent Generation Chamber and INLET and OUTLET fittings facing up.
D. Remove the plugs from the Dionex EGC INLET and OUTLET fittings.
E. Turn over the Dionex EGC cartridge (fittings facing down). Shake the Dionex EGC 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.
F. Connect the pump outlet to the Dionex EGC INLET port of the cartridge and the OUTLET port of the cartridge to the ELUENT IN port of the RFIC Eluent Degasser Assembly.

G. Orient the cartridge with the cable aligned with the slot in the holder of the EG enclosure and then slide the cartridge down into the holder until secured.

H. Connect the cartridge electrical cable to the EGC-1 port of the EG module.

I. 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 Dionex EGC

A. Fill a 2-L eluent reservoir bottle with ASTM filtered, Type I (18-megohm) deionized water. Connect the reservoir to the eluent inlet line of the pump.

B. Prime the pump as instructed by the system operation manual.

C. Set the pump flow rate to 1.0 mL/min.

D. Unscrew and remove the plug from the vent opening on the side of the cartridge (Dionex EGC III) or loosen the plug on the top of the cartridge (Dionex EGC 500).

E. Direct the outlet of the yellow PEEK backpressure tubing to a waste container.

F. Turn on the pump and pump DI water through the cartridge for 10 minutes.

G. Set the concentration to the value listed in Table 1 from the front control panel of the Chromeleon Chromatography Data System and turn on the Dionex EGC.

H. Run the Dionex EGC for the duration listed in Table 1.

I. Turn off the pump.

<table>
<thead>
<tr>
<th>Dionex EGC Type</th>
<th>Eluent Flow Rate</th>
<th>Eluent Concentration</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dionex EGC 500 K$_2$CO$_3$, Dionex EGC III KOH, Dionex EGC III NaOH, Dionex EGC III LiOH, Dionex EGC 500 MSA, Dionex EGC III MSA</td>
<td>1.0 mL/min</td>
<td>9 mM</td>
<td>30 minutes</td>
</tr>
<tr>
<td>Dionex EGC 500 KOH, Dionex EGC III KOH</td>
<td>1.0 mL/min</td>
<td>50 mM</td>
<td>30 minutes</td>
</tr>
</tbody>
</table>

A. Disconnect the backpressure restrictor tubing from the Dionex EGC outlet tubing.

If installing a Dionex EGC 500 K$_2$CO$_3$, proceed to Section 0. If installing a new Dionex Continuously Regenerated Trap Column (Dionex CR-TC 500) proceed to Section 2.2.1. If the Dionex CR-TC is already installed, proceed to Section 2.2.2.
2.2 Conditioning the Capillary Dionex EGC Cartridges

A. Fill a 2 L eluent reservoir bottle with ASTM filtered, Type I (18 megohm) deionized water. Connect the reservoir to the eluent inlet line of the pump.
B. Prime the pump as instructed by the system operation manual.
C. Pump DI water through the Dionex EGC (Capillary) cartridge at 0.1 mL/min for 30 minutes (use the capillary pump in the prime mode to perform this step).
D. Connect the outlet port of the Dionex EGC (Capillary) cartridge to a PEEK backpressure tubing that generate 2000 psi at 30 uL/min
E. Set the pump flow rate to 30 ul/min and the EGC concentration to 50 mM and condition the cartridge for 30 minutes.
F. Direct the EGC effluent to a waste container.
G. Turn off the pump.
H. Disconnect the backpressure restrictor tubing from the EGC outlet tubing.

2.2.1 Installing the Dionex Continuously Regenerated Trap Column (Dionex CR-TC)

- For analytical scale anion exchange applications use Dionex CR-ATC 500 P/N 075550. For capillary scale anion exchange applications use Dionex CR-ATC (Capillary) P/N 072078. For analytical scale cation exchange applications use Dionex CR-CTC 500 P/N 075551. For capillary scale cation exchange applications use Dionex CR-CTC (Capillary) P/N 072079.
- When making final plumbing connections all fittings should be finger tight plus ¼ turn.
- The Dionex CR-ATC 500 is not compatible with a Dionex EGC 500 K₂CO₃.
- The guidelines here are intended to supplement, not to replace the information in the Dionex CR-TC manual.

A. Turn off power to the pump, Dionex EGC, Dionex CR-TC, and the suppressor (Dionex ERS/AES/CES).
B. Disconnect the following:
   i. Continuously regenerated trap columns (Dionex CR-ATC 500 or Dionex CR-CTC 500) installed between the EG and the Degas Assembly.
   ii. Trap columns (Dionex IonPac ATC or Dionex IonPac CTC) installed between the pump and the EG module.
C. Remove the plugs on the Dionex CR-TC ports.
D. Find the tubing with the red label on one end and a white label on the other end (supplied with the EG module).
E. Connect the end with the white label to the Eluent Out port of the Dionex EGC.
F. Connect the end with the red label to the Eluent In port of the Dionex CR-TC.
G. Connect the tubing with the orange label to the Regen In port of the Dionex CR-TC.
H. Connect the tubing with the blue label to the blue Regen Out port of the Dionex CR-TC.
I. Connect the tubing with the yellow label to the yellow Eluent Out port of the Dionex CR-TC.
The Dionex CR-TC should be hydrated after first installation before operation, or after long-term storage. The process ensures the Dionex CR-TC resin and membranes are fully hydrated and ready for operation.

J. Disconnect the ELUENT OUT line protruding from the Degas Assembly at the end labeled TO INJECTION VALVE IN-P.
K. If hydrating a Dionex CR-TC 500 connect this end to a 10-32 to 1/4-28 coupler (P/N 042806).
L. If hydrating a Dionex CR-TC 500:
   i. Connect the free end of the tubing, labeled TO ERS/AES REGEN OUT, to the 1/4-28 end of the coupler.
M. If hydrating a Dionex CR-TC (Capillary):
   i. Connect 2.1 m (7 ft) of 1-58 mm (0.062 in) ID clear Tefzel tubing to the REGEN OUT port of the Dionex CR-TC (Capillary). Direct the other end of the tubing to waste.
N. Ensure that the current to the Dionex EGC cartridge and suppressor are turned off.
O. If hydrating a Dionex CR-TC 500:
   i. From the pump front panel, turn on the pump flow rate to hydrate the Dionex CR-TC by pumping DI water at the flow rate of your application for at least 10 minutes.
   ii. Turn off the pump flow.
   iii. Disconnect the coupler.
P. If hydrating a Dionex CR-TC (Capillary):
   i. Set the pump flow rate to 0.1 mL/min and flush the Dionex CR-TC for 3 minutes.
   ii. Change the pump flow rate to 0.03 mL/min.
   iii. Set the EGC concentration to 50 mM and turn on the Dionex EGC and Dionex CR-TC power for 30 minutes.
   iv. Turn off the Dionex EGC and Dionex CR-TC power.
   v. Turn off the pump flow.

Figure 11 Dionex CR-TC 500 Plumbing Diagram for Hydration.
A. Verify the tubing labeled “TO INJECTION VALVE IN-P” is connected to the injection valve.

B. Verify that the tubing with the Red label (TO CR-TC ELUENT IN) is connected to the Eluent In port of the CR-TC.

C. Verify that the other end of this tubing with the White label (EGC OUT) is connected to the OUTLET port of the EGC.

D. Verify that the tubing with the Yellow label (TO CR-TC ELUENT OUT) is connected to the CR-TC Eluent Out port.

E. Verify that the tubing with the Orange label (TO CR-TC REGEN-IN) is connected to the CR-TC Regen In port.

F. Connect the other end of this tubing with the White label (TO ERS/AES, REGEN OUT) to the suppressor REGEN OUT port.

G. Verify that the tubing with the Blue label (TO CR-TC REGEN-OUT) is connected to the Dionex CR-TC Regen Out port.

H. Mount the Dionex CR-TC.

The Dionex CR-TC is mounted onto the mounting plate or underneath the Dionex EGC Cartridge Holder by aligning the hole on the Dionex CR-TC back plate with the ball stud on the mounting plate and pushing the Dionex CR-TC firmly onto the mounting ball stud. The Dionex CR-TC will click into place when properly installed.
Figure 13  Plumbing schematic for the Dionex EGC III with Dionex CR-TC on a 3000 psi System.
Figure 14   Plumbing schematic for the Dionex EGC (Capillary) with Dionex CR-TC (Capillary).
Figure 15  Plumbing schematic for the Dionex EGC 500 with Dionex CR-TC 500 on a 5000 psi System.
2.2.2 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 Dionex EGC III or Dionex EGC 500. A system backpressure of 2,300 psi is ideal. The degas tubing is functional at pressures below 2,000 psi (14 MPa); however, this low system pressure may result in high baseline noise as the eluent concentration increases in the gradient. If a restrictor is required, the following procedure will assist in determining the correct back pressure restrictor tubing to use.

**The capillary degas tubing assembly requires only 1,000 psi (7 MPa) of backpressure for optimal removal of electrolysis gas. Pressure restrictor tubing is thus not required for systems using a Dionex EGC (Capillary) with a capillary degas module. The minimum backpressure value applies during normal operation and during stand-by. Do not operate the EGC for an extended period of time below the minimum backpressure value, even when the system is not being used.**

A. Turn the pump flow on.
B. Confirm the eluent flows at the desired flow rate.

**If the method is a gradient method, it should be run to completion.**

C. Monitor the pump pressure and note the maximum and minimum system pressures for the duration of the method.
D. If the maximum and minimum pressures are between 2,000 and 3,000 psi (Dionex EGC III) or between 2,000 and 5,000 psi (Dionex EGC 500), the system back pressure is adequate.
E. If the maximum pressure exceeds 3,000 psi (Dionex EGC III) or 5,000 psi (Dionex EGC 500), the method will terminate prematurely.
   i. Locate the source of the excessive pressure and eliminate it.

**Several analytical and guard columns generate system pressures above 3,000 psi, especially when solvents are used in the eluent or the column uses 4µm particles. A Dionex EGC III cannot be used with these columns unless the flow rate is reduced so that the maximum system pressure is between 2,000 and 3,000 psi.**

F. If the minimum system pressure is below 2,000 psi, a pressure restrictor should be used (except capillary systems). Table 2 can be used to determine the appropriate pressure restrictor to adjust the system pressure between 2,000 to 3,000 psi (14-21 MPa) or 2,000 to 5,000 psi (14 - 34.5 MPa). A system back pressure of 2,300 psi is ideal.
G. The backpressure restrictors listed in Table 2 are supplied in the EG Module ship kit. If necessary, trim a back pressure coil to the desired length to provide adequate backpressure restriction.
   i. Install the back pressure restrictor between the degas assembly "ELUENT OUT" port and the injection valve.
The back pressure restrictor tubing may be installed directly into the injection valve "IN" port.

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

Table 2  Optional Back Pressure Restrictors.

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Description</th>
<th>Flow Rate</th>
<th>Approx. Back Pressure Added</th>
<th>Flow Rate</th>
<th>Approx. Back Pressure Added</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAA-053763</td>
<td>4 mm Pressure Restrictor</td>
<td>2.0 mL/min</td>
<td>1,000 psi (7 MPa)</td>
<td>1.0 mL/min</td>
<td>500 psi (3.5 MPa)</td>
</tr>
<tr>
<td>AAA-053762</td>
<td>4 mm Pressure Restrictor</td>
<td>2.0 mL/min</td>
<td>500 psi (3.5 MPa)</td>
<td>1.0 mL/min</td>
<td>250 psi (1.75 MPa)</td>
</tr>
<tr>
<td>053765</td>
<td>2 mm Pressure Restrictor</td>
<td>0.5 mL/min</td>
<td>1,000 psi (7 MPa)</td>
<td>0.25 mL/min</td>
<td>500 psi (3.5 MPa)</td>
</tr>
<tr>
<td>053764</td>
<td>2 mm Pressure Restrictor</td>
<td>0.5 mL/min</td>
<td>500 psi (3.5 MPa)</td>
<td>0.25 mL/min</td>
<td>250 psi (1.75 MPa)</td>
</tr>
</tbody>
</table>
2.3 Preparation for Installation of EGC 500 K₂CO₃ Cartridge

If installing an EGC 500 and EPM 500 proceed to section 5.

A. Remove the EGC from the box. Save the box and foam for future storage.

B. Configure the EG module to operate the cartridge by entering the cartridge serial number. Please refer to the EG Module and Chromeleon user manuals for detailed procedures for entering the cartridge serial number.

C. Place the EGC on a flat surface in front of the EG module with the Eluent Generation Chamber and INLET and OUTLET fittings facing up.

D. Remove the plugs from the EGC INLET and OUTLET fittings.

E. Turn over the EGC cartridge (fittings facing down). Shake the EGC 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.

F. Connect the pump outlet to the EGC INLET port of the cartridge and the OUTLET port of the cartridge to the ELUENT IN port of the RFIC Eluent Degasser Assembly.

G. Orient the cartridge with the cable aligned with the slot in the holder of the EG enclosure and then slide the cartridge down into the holder until secured.

H. Connect the cartridge electrical cable to the EGC-1 port of the EG module.

I. 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.

2.4 Conditioning the EGC 500 K₂CO₃

A. Fill a 2-L eluent reservoir bottle with ASTM filtered, Type I (18-megohm) deionized water. Connect the reservoir to the eluent inlet line of the pump.

B. Prime the pump as instructed by the system operation manual. Set the pump flow rate to 1.0 mL/min.

C. Unscrew and remove the plug from the vent opening on top of the cartridge.

D. Direct the outlet of the yellow PEEK backpressure tubing to a waste container.

E. Turn on the pump. Set the concentration 9 mM from the front control panel of the Chromeleon Chromatography Data System and turn on the EGC.

F. Run the EGC for 30 minutes.

G. Turn off the pump.

H. Disconnect the backpressure restrictor tubing from the EGC outlet tubing.
2.5 Filling the EGC 500 Carbonate Mixer with K$_2$CO$_3$ Eluent of Desired Concentration

A. Connect the outlet of the yellow pressure restrictor tubing (P/N 053765) to the union attached to the INLET port of the EGC 500 Carbonate Mixer (P/N 088468 for 4-mm columns or P/N 088467 for 2-mm columns) as shown in Figure 17.

B. Install the EGC Carbonate Mixer in the system 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.

C. Set the pump flow rate at 1.0 mL/min and turn on the pump.

D. Set the desirable K$_2$CO$_3$ concentration on EGC-1 (e.g., 9 mM for AS9-HC columns) and turn on EGC-1 current control.

E. Operate EGC 500 K$_2$CO$_3$ cartridge to generate carbonate eluents. The main purpose of this step is to fill the EGC 500 Carbonate Mixer with the electrolytic eluents having the desired carbonate concentration (e.g. 9 mM K$_2$CO$_3$ for AS9-HC columns) for your application.

F. The 4 mm EGC 500 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$_2$CO$_3$ eluent of the set concentration upon initial installation. The 2 mm EGC 500 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$_2$CO$_3$ eluent of the set concentration upon initial installation.
2.6 Operation of the High Pressure Electrolytic K₂CO₃ Eluent Generator for Ion Chromatographic Application

A. Complete the entire system plumbing as shown in Figure 18 for your application.
B. Adjust the length of the backpressure tubing between the INLET of the injection valve and the OUTLET of the EGC 500 Carbonate Mixer if needed to ensure the system backpressure is adjusted between 2000 – 2300 psi at the system operation flow rate.
C. Make sure to connect the REGEN OUT port of the suppressor to the REGEN IN port of the EPM 500.
D. Turn on the pump at the flow rate recommended for your application.

Figure 18 Plumbing Diagram for Electrolytic Generation of Carbonate Eluents Using EGC 500 K₂CO₃ with Electrolytic Suppressor Operated in Recycle Mod

Key
1. Degas Eluent In
2. Degas Eluent Out
3. Suppressor Eluent In
4. Suppressor Eluent Out
5. Suppressor Regen In
6. Suppressor Regen Out
2.7 Preparation for Installation of EGC 500 K₂CO₃ Cartridge and EPM 500

A. Remove the EGC 500 K₂CO₃ cartridge (P/N 088453) from the shipping box. Save the box and the foam for future storage.
B. Remove the EPM 500 (P/N 088471) from the shipping box.
C. Configure the EG module to operate the EGC 500 K₂CO₃ cartridge and the EPM 500 by entering the serial numbers for the cartridge and the EPM. Please refer to the EG or System and Chromeleon user manuals for detailed procedures for entering the cartridge and EPM serial numbers.

- **NOTE**
  - *The ICS-5000 EG module will automatically detect the cartridge type and does not require the serial number to be entered manually.*
  - *The ICS-5000 EG module requires an EGC 500 cartridge and EPM 500. EGC III cartridge and EPM III will not be recognized by the ICS-5000 and will not function.*

D. Place the EGC 500 K₂CO₃ cartridge on a flat surface in front of the EG module with the Eluent Generator Chamber and the EGC INLET and OUTLET fittings facing up.
E. Remove the plugs from the EGC INLET and OUTLET fittings.
F. Remove the plugs from the EPM ELUENT and REGEN liquid fittings.
G. Turn over the EGC 500 K₂CO₃ cartridge (fittings facing down). Shake the EGC 500 K₂CO₃ cartridge vigorously, and tap it with the palm of your hand 10 to 15 times to dislodge any air bubbles that may be trapped in the electrolysis chamber.
H. Connect the pump outlet to the EGC INLET port of the EGC 500 K₂CO₃ cartridge.
I. Connect the OUTLET port of the EGC 500 K₂CO₃ cartridge to the ELUENT IN port of the EPM 500.
J. Connect the ELUENT OUTLET port of the EPM 500 to the ELUENT IN port of the RFIC Eluent Degasser Assembly.
K. Connect the ELUENT OUT port of the RFIC Eluent Degasser Assembly to a yellow PEEK backpressure restrictor tubing (P/N 053765).
L. Orient the EGC 500 K₂CO₃ cartridge with the cable aligned with the slot in the holder of the EG enclosure or ICS system and then slide the EGC 500 K₂CO₃ down into the holder until secured.
M. Connect the EGC 500 K₂CO₃ cartridge electrical cable to the EGC-1 port of the EG enclosure or ICS system.
N. Connect the EPM 500 electrical cable to the EGC-2 port of the EG enclosure or ICS system.

2.8 Conditioning the EGC 500 K₂CO₃ Cartridge and EPM 500

A. 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.
B. Prime the pump as instructed by the system operation manual. Set the pump flow rate to 1.0 mL/min.
C. Unscrew and remove the plug from the vent opening on the side of the EGC 500 K₂CO₃ cartridge.
D. Connect the outlet of the yellow PEEK backpressure restrictor tubing (P/N 053765) to the REGEN IN port of the EPM 500.
E. Connect the REGEN OUT port of the EPM 500 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.
F. Complete the system plumbing as shown in Figure 19.
The system plumbing shown in Figure 4 is a temporary connection which is only used during the EGC 500 K₂CO₃ and EPM 500 conditioning step.

G. Set the pump flow rate at 1.0 mL/min.
H. Turn on the pump for 5 min to hydrate the EPM 500.
I. Set 9 mM for EGC 500 K₂CO₃ (EGC-1) and 1 mM for EPM 500 (EGC-2) from the control panel and turn on the EGC-1 and EGC-2 current controls.
J. Run the EGC 500 K₂CO₃ and EPM 500 under these conditions for 30 min.
K. Turn off the EGC-1 and EGC-2 current controls, and then turn off the pump.

Figure 19  Plumbing Diagram for Conditioning the EGC 500 K₂CO₃ Cartridge and EPM 500.

Key
1. EPM Eluent Inlet
2. EPM Eluent Outlet
3. Degas Eluent In
4. Degas Eluent Out
5. EPM Regen In
6. EPM Regen Out
2.9 Filling the EGC 500 Carbonate Mixer with the $K_2CO_3$ / $KHCO_3$ Eluents of Desired Concentration

A. Install the EGC 500 Carbonate Mixer in the EG enclosure or the side of the EGC cartridge holder by pushing the mixer onto the Mixer holder clip. The outlet of the EGC 500 Carbonate Mixer must point upward to ensure thorough mixing of the eluent.

B. Disconnect the pump outlet from the INLET of the EGC 500 $K_2CO_3$ cartridge.

C. Connect the pump outlet to the inlet of EGC 500 Carbonate Mixer and fill the EGC 500 Carbonate Mixer with deionized water by operating the pump at 5.0 mL/min. Operate the pump for 5 minutes to fill a 4 mm EGC 500 Carbonate Mixer and 2 minutes to fill a 2 mm EGC 500 Carbonate Mixer or until there is a consistent flow of water coming out the outlet of the Mixer.

D. Disconnect the pump outlet from the inlet of the EGC 500 Carbonate Mixer.

E. Connect the pump outlet to the INLET of the EGC 500 $K_2CO_3$ cartridge.

F. Connect the outlet of the yellow PEEK backpressure restrictor tubing (P/N 053765) to the union attached to the inlet of the EGC 500 Carbonate Mixer.

G. Connect the OUTLET of the mixer to the REGEN IN port of the EPM 500. Divert the REGEN OUT port of the EPM 500 to waste.

H. Complete the system plumbing as shown in Figure 20.

I. Operate both the EGC 500 $K_2CO_3$ cartridge and EPM 500 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. 4.5 mM $K_2CO_3$/1.4 mM $KHCO_3$ for AS22 columns) for your application.

J. The 4 mm EGC 500 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.

**WARNING**

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

**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.

K. Turn off the EG-1 and EG-2 current controls, and then turn off the pump.

L. 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 500 Carbonate Mixer.
2.10 Operation of the Electrolytic K$_2$CO$_3$/KHCO$_3$ Eluent Generator for Ion Chromatographic Application

A. Complete the entire system plumbing as shown in Figure 21 for your application.
B. Adjust the length of the backpressure tubing between the INLET of the injection valve and the OUTLET of the EGC 500 Carbonate Mixer if needed to ensure the system backpressure is adjusted between 2000 – 2300 psi at the system operation flow rate.
C. Make sure to connect the REGEN OUT port of the suppressor to the REGEN IN port of the EPM 500.
D. Turn on the pump at the flow rate recommended for your application.
Figure 21  Plumbing Diagram for Electrolytic Generation of Carbonate / Bicarbonate Eluents Using an EGC 500 K₂CO₃ and an EPM 500 with Electrolytic Suppressor Operated in Recycle Mode.

Key
1. EPM Eluent Inlet
2. EPM Eluent Outlet
3. Degas Eluent In
4. Degas Eluent Out
5. Suppressor Eluent In
6. Suppressor Eluent Out
7. Suppressor Regen In
8. Suppressor Regen Out
9. EPM Regen In
10. EPM Regen Out
3. **Operation**

3.1 **Routine Operation for Analytical Scale Systems**

For analytical scale operation (≥ 1 mm), the recommended system backpressure is 2,000 – 3,000 psi (14 - 21 MPa) for the Dionex EGC III, or 2,000 - 5,000 psi (14 - 34.5 MPa) for the Dionex EGC 500; a system back pressure of 2,300 psi is ideal. If necessary, add a backpressure restrictor to increase the pressure. The pressure restrictor tubing is located in the Eluent Generator Module or System ship kit. See Section 2.1 for instructions.

3.2 **Routine Operation for Capillary Scale Systems**

For capillary scale operation (< 1 mm), the recommended system backpressure is 1,000 – 5,000 psi (7 - 35 MPa); a system back pressure of 2,000 psi is ideal. Backpressure restrictor tubing is not recommended for capillary systems.

3.3 **Operating Precautions**

A. The EG Module generates eluent 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.

B. Operate the EG in properly ventilated areas only.

C. Ensure a vent line is attached to the Dionex EGC vent port. The end of the vent line should be placed in a waste container in case of electrolyte overflow.

NOTE

Under certain conditions it is normal for the Dionex EGC electrolyte level to increase or decrease over time.

D. DO NOT CAP THE WASTE RESERVOIR! The small amount of gas generated by the EG and the Electrolytic Suppressor (Dionex ERS, Dionex AES or Dionex CES) is not dangerous unless the gas is trapped in a closed container and allowed to accumulate. The Gas Separator Waste Tube must be open to the atmosphere in order to operate properly.

E. Do not operate a chromatography system where the Eluent Generator (EG) is plumbed into the system, but not software controlled. The excessive pressures that are allowed in systems without an EG can damage components.

F. The pressure limits protect the degas tubing assembly from mechanical failure. Excessive backpressure may cause the degas tubing assembly to rupture.

i. For analytical scale operation (≥ 1 mm), the recommended maximum operating pressure for the EG Module is 3,000 psi (21 MPa) (Dionex EGC III) or 5,000 psi (34.5 MPa) (Dionex EGC 500), however 2,300 psi is ideal.

ii. For capillary scale operation (< 1 mm), the recommended maximum operating pressure for the EG Module is 5,000 psi (34.5 MPa).

G. Due to the high backpressure, exercise care when using solvents with the following columns: Thermo Scientific™ Dionex™ IonPac™ AS11-HC or Thermo Scientific™ Dionex™ CarboPac™ PA10.
For analytical scale operation (≥ 1 mm), solvents may be used if the flow rate is reduced sufficiently to reduce the system pressure to less than 3,000 psi (21 MPa) (Dionex EGC III) or 5,000 psi (34.5 MPa) (Dionex EGC 500).

H. Due to the high backpressure, do not operate the EG with the following columns: the Thermo Scientific™ Dionex™ IonPac™ AS5A, Thermo Scientific™ Dionex™ IonPac™ AS10, Thermo Scientific™ Dionex™ OmniPac™ PAX-100, or Thermo Scientific™ Dionex™ OmniPac™ PAX-500 unless the flow rate has been reduced to lower the system pressure to less than 3,000 psi (21 MPa) or an EGC 500 is used in a high pressure IC system such as the ICS-5000+. Excessive backpressure may cause the degas tubing assembly to rupture.

I. Do not operate the Dionex EGC 500 KOH, Dionex EGC III KOH, Dionex EGC III NaOH, Dionex EGC III LiOH or Dionex EGC-KOH (Capillary) with solvents other than methanol (maximum 25%) for anion separations.

J. Do not operate the Dionex EGC 500 K₂CO₃, Dionex EGC 500 MSA, Dionex EGC III MSA, Dionex EGC-MSA (Capillary) or Dionex EPM 500 with any solvent content.

K. To prevent the buildup of hydrogen and oxygen gases, install the EG Module in a well-ventilated site.

L. Make sure the Suppressor 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 Suppressor operation.

M. Do not allow the flow rate of the Dionex EGC III or Dionex EGC 500 to drop to a level where the backpressure can fall 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 gas will build up on the analytical column.

N. For anion exchange separations, carbonate may accumulate on the columns at low hydroxide concentrations. This accumulated carbonate will elute from the column when the hydroxide concentration is increased.

3.4 System Shutdown

3.4.1 Short-Term Shutdown

Thermo Scientific recommends continuous operation of your IC system for the most trouble-free operation. For analytical scale operation (≥ 1 mm), a microbore system will provide the most economical operation. Capillary scale systems (< 1 mm) are designed to be operated non-stop for months at a time and provide the ultimate in economical operation.

The Dionex EGC 500, Dionex EGC III, Dionex EGC (Capillary) or Dionex EPM III may be left in the EG Module for short-term storage up to three months. The system should be shutdown using the following methods:

A. Turn System OFF Completely:
   i. Turn the pump, EGC, CR-TC, and Suppressor off.
   ii. Check that the current to the EGC, CR-TC and Suppressor are off.

The suppressor should only be stored for up to 1 week with eluent in the chambers. See the suppressor user's guide for further instructions.
3 – Operation

B. To restart the system:
   i. Apply the required system settings.
   ii. Allow the system to equilibrate for 30-45 minutes prior to collecting data.

**NOTE**

*If the system has been shut down for more than 3-4 days, the Suppressor should be rehydrated prior to starting pump flow.*

See the appropriate Suppressor manual for Suppressor start-up details.

### 3.4.2 Long-Term Shutdown

For long-term storage, the Dionex EGC III may be left in the EG module, but the EGC cable should be disconnected. If you need to remove the cartridge and store it, follow the directions in Section 5.1 (a-f). Cap all vents and liquid connections. The pump may be used for conventional delivery of eluents by connecting the outlet of the pump pressure transducer to the INJ IN port on the Rheodyne injection valve.
4. Example Applications

4.1 Principles of Operation

4.1.1 Hydroxide based Applications

The Eluent Generator Cartridges – Dionex EGC 500 KOH, Dionex EGC III KOH, Dionex EGC III NaOH, Dionex EGC III LiOH and Dionex EGC-KOH (Capillary) – may be used to generate isocratic or gradient eluents. The Dionex EGC 500 KOH, Dionex EGC III KOH and Dionex EGC III NaOH can generate up to 100 mM KOH or NaOH at 1.0 mL/min. The Dionex EGC III LiOH can generate up to 80 mM LiOH at 1.0 mL/min. The Dionex EGC-KOH (Capillary) cartridge may be used to generate up to 200 mM KOH at 0.010 mL/min.

Eluent concentrations up to 50 mM KOH or NaOH can be produced at 2.0 mL/min. Eluent concentrations up to 40 mM LiOH can be produced at 2.0 mL/min. Eluent concentrations up to 100 mM KOH can be produced at 0.020 mL/min.

Up to 25% methanol may be used in the eluent with a Dionex EGC 500 KOH, Dionex EGC III KOH, Dionex EGC III NaOH or Dionex EGC III LiOH.

4.1.2 Carbonate based Applications

The Eluent Generator Cartridges – Dionex EGC 500 K$_2$CO$_3$ and Dionex EPM 500 – may be used to generate isocratic eluents; gradient eluents are not recommended. The Dionex EGC 500 K$_2$CO$_3$ can generate up to 15 mM K$_2$CO$_3$ at 1.0 mL/min. The Dionex EPM 500 can convert up to 10 mM K$_2$CO$_3$ to KHCO$_3$ at 1.0 mL/min.

Eluent concentrations up to 7.5 mM K$_2$CO$_3$ can be produced at 2.0 mL/min. Up to 5.0 M K$_2$CO$_3$ can be converted to KHCO$_3$ at 2.0 mL/min.

No solvents can be used in the eluent with an Dionex EGC 500 K$_2$CO$_3$ or Dionex EPM 500.

4.1.3 Methanesulfonic acid based Applications

The Eluent Generator Cartridges – Dionex EGC 500 MSA, Dionex EGC III MSA and Dionex EGC-MSA (Capillary) – may be used to generate isocratic or gradient eluents. The Dionex EGC 500 MSA and Dionex EGC III MSA can generate up to 100 mM MSA at 1.0 mL/min. The Dionex EGC-MSA (Capillary) cartridge may be used to generate up to 200 mM MSA at 0.010 mL/min.

Eluent concentrations up to 50 mM MSA can be produced at 2.0 mL/min. Eluent concentrations up to 100 mM MSA can be produced at 0.020 mL/min.

No solvents can be used in the eluent with a Dionex EGC 500 MSA, Dionex EGC III MSA or Dionex EGC-MSA (Capillary).
4.1.4 Dionex EGC and Dionex EPM Operating Conditions

The Dionex EGC and Dionex EPM products may be used with the columns and eluent conditions listed below. Verify the performance of the entire system by duplicating the column test chromatogram.

A. EGC General Operating Conditions:

<table>
<thead>
<tr>
<th>Condition</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Flow Rate (4 mm operation)</td>
<td>3.0 mL/min.</td>
</tr>
<tr>
<td>Maximum Flow Rate (2 mm operation)</td>
<td>0.75 mL/min.</td>
</tr>
<tr>
<td>Maximum Flow Rate (Capillary operation)</td>
<td>0.030 mL/min.</td>
</tr>
<tr>
<td>Maximum System Pressure (Dionex EGC III)</td>
<td>3,000 psi (21 MPa).</td>
</tr>
<tr>
<td>Maximum System Pressure (Dionex EGC 500 and Dionex EGC (Capillary))</td>
<td>5,000 psi (35 MPa).</td>
</tr>
<tr>
<td>Minimum Recommended System Pressure (Dionex EGC 500 and Dionex EGC III)</td>
<td>2,000 psi (14 MPa); use optional Pressure Restrictor as required.</td>
</tr>
<tr>
<td>Minimum Recommended System Pressure Dionex EGC (Capillary)</td>
<td>1,000 psi (7 MPa); Pressure Restrictor is not recommended.</td>
</tr>
</tbody>
</table>

B. Anion Exchange Dionex EGC 500 KOH, Dionex EGC III KOH, Dionex EGC III NaOH and Dionex EGC-KOH (Capillary):

<table>
<thead>
<tr>
<th>Condition</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concentration Range for 4 mm operation</td>
<td>Up to 100 mM KOH or NaOH at 1.0 mL/min; 50 mM at 2.0 mL/min.</td>
</tr>
<tr>
<td>Concentration Range for 2 mm operation</td>
<td>Up to 100 mM KOH or NaOH at 0.25 mL/min.</td>
</tr>
<tr>
<td>Concentration Range for capillary operation</td>
<td>Up to 200 mM KOH at 0.010 mL/min; 100 mM at 0.020 mL/min.</td>
</tr>
<tr>
<td>Solvent Concentration Range</td>
<td>Up to 25% Methanol.</td>
</tr>
<tr>
<td>Columns</td>
<td>All hydroxide selective columns.</td>
</tr>
</tbody>
</table>

C. Anion Exchange Dionex EGC III LiOH:

<table>
<thead>
<tr>
<th>Condition</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concentration Range for 4 mm operation</td>
<td>Up to 80 mM LiOH at 1.0 mL/min; 40 mM at 2.0 mL/min.</td>
</tr>
<tr>
<td>Concentration Range for 2 mm operation</td>
<td>Up to 80 mM LiOH at 0.25 mL/min.</td>
</tr>
<tr>
<td>Solvent Concentration Range</td>
<td>Up to 25% Methanol.</td>
</tr>
<tr>
<td>Columns</td>
<td>All hydroxide selective columns.</td>
</tr>
</tbody>
</table>

D. Anion Exchange Dionex EGC 500 K₂CO₃:

<table>
<thead>
<tr>
<th>Condition</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concentration Range for 4 mm operation</td>
<td>Up to 15 mM K₂CO₃ at 1.0 mL/min; 7.5 mM at 2.0 mL/min.</td>
</tr>
<tr>
<td>Concentration Range for 2 mm operation</td>
<td>Up to 15 mM K₂CO₃ at 0.25 mL/min.</td>
</tr>
<tr>
<td>Solvent Concentration Range</td>
<td>Not compatible with any solvents.</td>
</tr>
<tr>
<td>Columns</td>
<td>All carbonate based anion exchange columns.</td>
</tr>
</tbody>
</table>

**NOTE**: In most cases the Dionex EGC III NaOH can be used with equivalent results to the Dionex EGC III KOH.
### E. Anion Exchange Dionex EPM 500:

<table>
<thead>
<tr>
<th>Concentration Range for 4 mm operation</th>
<th>Convert up to 10 mM K$_2$CO$_3$ to KHCO$_3$ at 1.0 mL/min; 5.0 mM at 2.0 mL/min.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concentration Range for 2 mm operation</td>
<td>Convert up to 10 mM K$_2$CO$_3$ to KHCO$_3$ at 0.25 mL/min.</td>
</tr>
<tr>
<td>Solvent Concentration Range</td>
<td>Not compatible with any solvents.</td>
</tr>
<tr>
<td>Columns</td>
<td>All carbonate based anion exchange columns.</td>
</tr>
</tbody>
</table>

### F. Cation Exchange Dionex EGC 500 MSA, Dionex EGC III MSA and Dionex EGC-MSA (Capillary)

<table>
<thead>
<tr>
<th>Concentration Range for 4 mm operation</th>
<th>Up to 100 mM MSA at 1.0 mL/min; 50 mM at 2.0 mL/min.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concentration Range for 2 mm operation</td>
<td>Up to 100 mM MSA at 0.25 mL/min.</td>
</tr>
<tr>
<td>Concentration Range for capillary operation</td>
<td>Up to 200 mM MSA at 0.010 mL/min; 100 mM at 0.020 mL/min.</td>
</tr>
<tr>
<td>Solvent Concentration Range</td>
<td>Not compatible with any solvents.</td>
</tr>
<tr>
<td>Columns</td>
<td>All cation exchange columns compatible with MSA eluents.</td>
</tr>
</tbody>
</table>
4.1.5 Duplication of Conventional Gradient Methods Using the Offset Volume

If the Eluent Generator system is connected to a gradient pump, gradients can be generated from both the pump and from the Eluent Generator system. Because the Eluent Generator system is downstream from the pump, gradients generated by the Eluent Generator system reach the column faster than gradients generated at the pump. Thermo Scientific™ Dionex™ PeakNet™ or Dionex Chromeleon software can automatically compensate for this timing difference by using an offset volume value. The offset volume is the fluid volume between the pump gradient mixing chamber outlet and the Eluent Generator outlet. Once this value is determined and entered the system software will synchronize the pump and Eluent Generator system operation, allowing gradients from both the pump and the Eluent Generator system to reach the column at the same time.

We recommend an offset volume of 0 μL for most applications. However, an offset volume of 0 - 2000 μL may be specified in the Eluent Generator system software. The default value is 0 μL. The actual offset volume may be different depending on the system configuration (tubing lengths, and whether the system is 2 mm or 4 mm). To determine the volume, follow the instructions below.

The offset volume has no effect when using isocratic eluent generation but does delay the Eluent Generator system timed events. For isocratic Methods the offset volume value should be set to 0 μL.

Determining the Offset Volume Value:

Before starting this procedure, set up the system for normal operation.

A. Fill pump reservoir A with 100% deionized water.
B. Fill a reservoir with 10 mM KOH or MSA (whichever eluent the Eluent Generator system will be generating) and connect the reservoir to the pump as reservoir B.
C. In the Dionex PeakNet or Dionex Chromeleon pump/Eluent Generator system Method Setup dialog box, enter an Offset Volume of 0 μL.
D. In the Method Editor dialog box, set the same concentration step change for both the pump and the Eluent Generator system to start at the same timed event. The step change should be large enough to affect the detector output readings, but not so large that the output goes off scale.

For example:
At time INIT, select 100% from reservoir A (deionized water) for the pump eluent and 0 mM for the Eluent Generator system generated eluent.
At time 0.0, select 10% from reservoir B (a 1.0 mM solution of eluent) and select 1.0 mM for the Eluent Generator system eluent concentration.
E. Connect the pump outlet directly to a length of 0.005" ID tubing which generates a system back pressure of about 2,000 psi (14 MPa) at the chosen flow rate (e.g. 1.0 mL/min) Connect to the inlet of the conductivity cell.
F. Monitor the conductivity detector response.
   i. The first increase in detector response is the new eluent concentration arriving from the Eluent Generator system. Note the time this occurs.
   ii. The second increase in detector response is the new eluent concentration arriving from the pump. Note the time this occurs.
   iii. Calculate the time difference between the first and second increases in detector response.
   iv. Multiply the time difference (in minutes) by the flow rate (in mL/min x 1,000) to get the offset volume value (in μL).
G. After calculating the offset volume, enter its value into the pump/Eluent Generator software control.
4 – Example Applications

4.2 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 no temperature is 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.

4.3 Using the Dionex EGC 500 KOH or Dionex EGC III KOH Cartridge for Dionex IonPac AS11 Hydroxide Gradients

This application demonstrates the comparison of a Thermo Scientific™ Dionex™ IonPac™ AS11 gradient separation using conventional gradient pump delivery with the gradient separation using Dionex EGC gradient delivery. Figure, “Conventional Hydroxide Gradient on the Dionex IonPac AS11,” illustrates the use of a conventional pump method. Since the Dionex EGC is located close to the injection valve, the gradient reaches the head of the column more quickly resulting in a shift in the gradient as shown in Figure, “Dionex EGC KOH Gradient on the Dionex IonPac AS11.” Figure illustrates the use of a Dionex EGC with an identical gradient program using the default OFFSET VOLUME of 0 µL. In Figure, “Dionex EGC KOH Gradient on the Dionex IonPac AS11 (OFFSET VOLUME = 400 µL),” the value for the OFFSET VOLUME is set to 400 µL. Dionex Chromeleon uses this value to delay the Dionex EGC gradient program by 0.2 minutes (0.400 mL / 2 mL per minute).

Note that the baseline shift using the gradient pump is approximately 1.5 µS. Using the Dionex EGC to generate carbonate-free hydroxide reduces the baseline shift to approximately 50 nS.

Trap Column: Dionex IonPac ATC-3, (Located between pump and injection valve);

! IMPORTANT

The Dionex IonPac ATC-3 Trap Column may be replaced with a Dionex IonPac ATC-HC Trap Column after the pump.

For systems other than the Dionex EG40, use the Dionex CR-ATC 500 continuously Generated Trap Column instead of the Dionex IonPac ATC-3 or Dionex IonPac ATC-HC Trap Columns. The Dionex IonPac CR-ATC 500 is located after the Dionex EGC KOH cartridge.
Sample Volume: 10 µL
Column: Dionex IonPac AS11 Analytical Column and Dionex IonPac AG11 Guard (4 mm)
Eluent: See table of conditions
Eluent Flow Rate: 2.0 mL/min
Suppressor: Thermo Scientific™ Dionex™ ASRS 300 (4 mm)
AutoSuppression® Recycle Mode

Expected Background Conductivity:
(Dionex GP40 or Dionex GP50)
(Dionex EGC)
0.5 mM NaOH: 1 µS 35 mM NaOH: 2.5 µS
0.5 mM NaOH: 0.7 µS 35 mM NaOH: 0.75 µS

Typical Operating Back Pressure:
(Dionex GP40 or Dionex GP50)
(Dionex EGC)
Pressure Restrictor, (P/N 53762) was used with the Dionex EGC

<table>
<thead>
<tr>
<th>Analyte</th>
<th>mg/L (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Quinate</td>
<td>5</td>
</tr>
<tr>
<td>2. Fluoride</td>
<td>1</td>
</tr>
<tr>
<td>3. Acetate</td>
<td>5</td>
</tr>
<tr>
<td>4. Propionate</td>
<td>5</td>
</tr>
<tr>
<td>5. Formate</td>
<td>5</td>
</tr>
<tr>
<td>6. Methylsulfonate</td>
<td>5</td>
</tr>
<tr>
<td>7. Pyruvate</td>
<td>5</td>
</tr>
<tr>
<td>8. Valerate</td>
<td>5</td>
</tr>
<tr>
<td>9. Monochloroacetate</td>
<td>5</td>
</tr>
<tr>
<td>10. Bromate</td>
<td>5</td>
</tr>
<tr>
<td>11. Chloride</td>
<td>2</td>
</tr>
<tr>
<td>12. Nitrite</td>
<td>5</td>
</tr>
<tr>
<td>13. Trifluoroacetate</td>
<td>5</td>
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<tr>
<td>14. Bromide</td>
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</tr>
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<td>3</td>
</tr>
<tr>
<td>16. Chlorate</td>
<td>3</td>
</tr>
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<td>17. Selenite</td>
<td>5</td>
</tr>
<tr>
<td>18. Carbonate</td>
<td>trace</td>
</tr>
<tr>
<td>19. Malonate</td>
<td>5</td>
</tr>
<tr>
<td>20. Maleate</td>
<td>5</td>
</tr>
<tr>
<td>21. Sulfate</td>
<td>5</td>
</tr>
<tr>
<td>22. Oxalate</td>
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</tr>
<tr>
<td>23. Tungstate</td>
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<td>25. Phosphate</td>
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</tr>
<tr>
<td>26. Chromate</td>
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</tr>
<tr>
<td>27. Citrate</td>
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</tr>
<tr>
<td>28. Tricarballylate</td>
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</tr>
<tr>
<td>29. Isocitrate</td>
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<tr>
<td>30. cis-Aconitate</td>
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</tr>
<tr>
<td>31. trans-Aconitate</td>
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</tr>
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</table>

**Dionex GP40 / Dionex GP50 Conditions**

<table>
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<tr>
<th>Eluent: Deionized water</th>
<th>%E1</th>
<th>%E2</th>
<th>%E3</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Equilibration</strong></td>
<td>0</td>
<td>90</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>7.0</td>
<td>90</td>
<td>10</td>
<td>0.5 mM NaOH for 7 min</td>
</tr>
<tr>
<td><strong>Analysis</strong></td>
<td>0.0</td>
<td>90</td>
<td>10</td>
<td>0.5 mM NaOH, Inject</td>
</tr>
<tr>
<td></td>
<td>0.2</td>
<td>90</td>
<td>10</td>
<td>Inject Valve to Load Position</td>
</tr>
<tr>
<td></td>
<td>2.5</td>
<td>90</td>
<td>10</td>
<td>0.5-5.0 mM NaOH in 3.5 min</td>
</tr>
<tr>
<td></td>
<td>6.0</td>
<td>0</td>
<td>100</td>
<td>5.0-38.25 mM NaOH in 12 min</td>
</tr>
<tr>
<td></td>
<td>18.0</td>
<td>0</td>
<td>65</td>
<td>35</td>
</tr>
</tbody>
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**Dionex EGC Conditions**

<table>
<thead>
<tr>
<th>Eluent: Deionized water</th>
<th>Time (min)</th>
<th>Eluent Conc. (mM)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Equilibration</strong></td>
<td>0</td>
<td>0.5</td>
<td>0.5 mM KOH for 7 min</td>
</tr>
<tr>
<td></td>
<td>7.0</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td><strong>Analysis</strong></td>
<td>0.0</td>
<td>0.5</td>
<td>0.5 mM KOH, Inject</td>
</tr>
<tr>
<td></td>
<td>0.2</td>
<td>0.5</td>
<td>Inject Valve to Load Position</td>
</tr>
<tr>
<td></td>
<td>2.5</td>
<td>0.5</td>
<td>0.5-5.0 mM KOH in 3.5 min</td>
</tr>
<tr>
<td></td>
<td>6.0</td>
<td>5.0</td>
<td>5.0-38.3 mM KOH in 12 min</td>
</tr>
<tr>
<td></td>
<td>18.0</td>
<td>38.3</td>
<td></td>
</tr>
</tbody>
</table>
Figure 22  Conventional Hydroxide Gradient on the Dionex IonPac AS11

Figure 23  Dionex EGC KOH Gradient on the Dionex IonPac AS11 (OFFSET VOLUME = 0 µL)

Figure 24  Dionex EGC KOH Gradient on the Dionex IonPac AS11 (OFFSET VOLUME = 400 µL)
4.4 Comparison of Eluent Generation with Dionex IonPac ATC-HC and Dionex CR-ATC for Dionex IonPac AS11 Gradient

This set of chromatograms demonstrates the decrease in baseline shift during a gradient when the Dionex IonPac ATC-HC or Dionex CR-ATC is used. The Dionex CR-ATC does not require off-line chemical regeneration.

Column: Dionex IonPac AS11 Analytical (4 mm)
Eluent: Dionex EGC generated KOH
Flow Rate: 2.0 mL/min
Inj. Volume: 10 µL
Detection: Suppressed Conductivity
Temperature: 30°C
Suppressor: Dionex ASRS 300 (4-mm), Recycle Mode

**Gradient Program**

<table>
<thead>
<tr>
<th>Time (min)</th>
<th>Concentration (mN)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.5</td>
</tr>
<tr>
<td>2.5</td>
<td>0.5</td>
</tr>
<tr>
<td>6.0</td>
<td>5.0</td>
</tr>
<tr>
<td>18.0</td>
<td>38.3</td>
</tr>
<tr>
<td>23.0</td>
<td>38.3</td>
</tr>
</tbody>
</table>

**Analyte**

1. Fluoride  0.2  
2. Chloride  0.3  
3. Nitrate   1.0  
4. Carbonate NA  
5. Sulfate   1.5  
6. Phosphate 1.5

**Background (µS/cm)**

<table>
<thead>
<tr>
<th>Eluent Type</th>
<th>Start</th>
<th>End</th>
<th>Drift</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dionex EGC</td>
<td>0.33</td>
<td>0.56</td>
<td>0.23</td>
</tr>
<tr>
<td>Dionex IonPac ATC-HC</td>
<td>0.32</td>
<td>0.36</td>
<td>0.04</td>
</tr>
<tr>
<td>Dionex CR-ATC</td>
<td>0.32</td>
<td>0.36</td>
<td>0.04</td>
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</table>
4.5 Using the Dionex EGC III KOH or Dionex EGC 500 KOH Cartridge for Dionex IonPac AS15 Isocratic Elution

This application demonstrates the comparison of a Thermo Scientific™ Dionex™ IonPac™ AS15 isocratic separation using conventional pump delivery to Dionex EGC eluent delivery. Figure 26, “Conventional Hydroxide Eluent on the Dionex IonPac AS15,” illustrates use of a conventional method. Figure 27, “Dionex EGC KOH Eluent on the Dionex IonPac AS15,” illustrates the use of the Dionex EGC with an identical isocratic program using an OFFSET VOLUME of 400 µL. The offset volume has no effect on isocratic Dionex EGC eluent delivery. In Figure 26, the chromatogram generated using the Dionex GP50 with conventional delivery of KOH was contaminated from carbonate in the DI reagent water used to make the KOH eluent. This contamination decreases the pH of the eluent and causes phosphate to coelute with nitrate. Use of the Dionex EGC eliminates the eluent contamination problem, resulting in baseline resolution of nitrate and phosphate.

Sample Volume: 25 µL
Column: Dionex IonPac AS15 analytical (4 mm) and Thermo Scientific™ Dionex™ IonPac™ AG15 guard (4 mm)
Eluent: 40 mM KOH
Eluent Flow Rate: 2.0 mL/min
Suppressor: Dionex ASRS 300 (4 mm)
AutoSuppression Recycle Mode
Temperatures: 30°C
Expected Background Conductivity: 0.8-1.2 µS (Dionex EGC) 2-3 µS (Dionex GP40, Dionex GP50, or Dionex GS50)
Typical Operating Back Pressure: 2100 psi (Dionex EGC) 1700 psi (Dionex GP40, Dionex GP50, or Dionex GS50)
Back pressure restrictor was not used with the Dionex EGC

<table>
<thead>
<tr>
<th>Analyte</th>
<th>mg/L (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Fluoride</td>
<td>2.0</td>
</tr>
<tr>
<td>2. Acetate</td>
<td>2.0</td>
</tr>
<tr>
<td>3. Chloride</td>
<td>5.0</td>
</tr>
<tr>
<td>4. Carbonate</td>
<td>10.0</td>
</tr>
<tr>
<td>5. Nitrate</td>
<td>10.0</td>
</tr>
<tr>
<td>6. Sulfate</td>
<td>10.0</td>
</tr>
<tr>
<td>7. Bromide</td>
<td>20.0</td>
</tr>
<tr>
<td>8. Nitrate</td>
<td>20.0</td>
</tr>
<tr>
<td>9. Phosphate</td>
<td>30.0</td>
</tr>
</tbody>
</table>

Figure 26 Conventional Hydroxide Eluent on the Dionex IonPac AS15
Figure 27  Dionex EGC KOH Eluent on the Dionex IonPac AS15
4.6 Comparison of Conventional Eluent System and RFIC-EG System

The following example illustrates a comparison of a gradient delivered using conventional pump delivery and using a Dionex EGC. When using the conventional gradient delivery, dissolved carbonate causes a baseline shift of approximately 1 µS. The carbonate-free potassium hydroxide gradient produced by the Dionex EGC results in a very low baseline shift (< 0.1 µS). This low baseline shift allows easy integration of trace components.

Sample Loop Volume: 2 mL
Trap Columns: Thermo Scientific™ Dionex™ IonPac™ ATC-1 (2), 1 after pump; 1 between Dionex EGC degas assembly and injector. NOTE: The Dionex IonPac ATC-1 Trap Columns should be replaced with one Dionex IonPac ATC-HC Trap Column after the pump. NOTE: For systems other than the Dionex EG40, use the Dionex CR-ATC continuously Generated Trap Column instead of the Dionex IonPac ATC-1 or Dionex IonPac ATC-HC Trap Columns. The Dionex CR-ATC is located after the Dionex EGC KOH cartridge.

Column: Dionex IonPac AS15 + Dionex IonPac AG15 (4 mm)
Eluent: See Chromatogram
Eluent Source: See chromatogram
Eluent Flow Rate: 1.6 mL/min.
Temperature: 30° C
ERS Suppressor: Thermo Scientific™ Dionex™ AERS 500
AutoSuppression Recycle Mode
CRS Suppressor: Thermo Scientific™ Dionex™ ACRS 500
CRS Regenerant: 50 mN H2SO4
Expected Background Conductivity: Dionex EGC eluent: 0.8-1.2 µS
Bottle eluent: 2-3 µS

Figure 28 Comparison of RFIC-EG System with Conventional Eluent System

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Example A µg/L (ppb)</th>
<th>Example B µg/L (ppb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Fluoride</td>
<td>1.08</td>
<td>2.0</td>
</tr>
<tr>
<td>2. Glycolate</td>
<td>3.35</td>
<td>4.0</td>
</tr>
<tr>
<td>3. Acetate</td>
<td>3.86</td>
<td>4.0</td>
</tr>
<tr>
<td>4. Formate</td>
<td>3.63</td>
<td>2.0</td>
</tr>
<tr>
<td>5. Chloride</td>
<td>1.03</td>
<td>2.0</td>
</tr>
<tr>
<td>6. Carbonate</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>7. Nitrite</td>
<td>1.17</td>
<td>2.0</td>
</tr>
<tr>
<td>8. Sulfate</td>
<td>0.91</td>
<td>2.0</td>
</tr>
<tr>
<td>9. Oxalate</td>
<td>0.97</td>
<td>2.0</td>
</tr>
<tr>
<td>10. Bromide</td>
<td>2.87</td>
<td>4.0</td>
</tr>
<tr>
<td>11. Nitrate</td>
<td>0.89</td>
<td>4.0</td>
</tr>
<tr>
<td>12. Phosphate</td>
<td>3.07</td>
<td>6.0</td>
</tr>
</tbody>
</table>
4.7 Large Loop Injection for µg/L (ppb) Level Analysis on a 2 mm Dionex IonPac AS15

High capacity of the Dionex IonPac AS15 column allows for the determination of trace inorganic anions and low molecular weight organic acids in high purity water matrices using a large loop injection. This chromatogram illustrates the separation of inorganic anions and low molecular weight organic acids in a high purity water sample using a large loop injection with a hydroxide linear gradient coupled with suppressed conductivity detection. Low ppb levels of these analytes can easily be determined using a 1 mL injection loop on a 2 mm Dionex IonPac AS15 column. Notice the much lower baseline shift produced when using the Dionex EGC as the eluent source. To ensure reproducible retention times, the Dionex IonPac AS15 column must be operated at an elevated temperature (30°C).

Sample Loop Volume: 1 mL
Trap Columns: Dionex IonPac ATC-1 (2), 1 after pump; 1 between Dionex EGC degas assembly and injector. NOTE: The Dionex IonPac ATC-1 Trap should be replaced with one Dionex IonPac ATC-HC Trap Column after the pump. NOTE: For systems other than the Dionex EG40, use the CR-ATC continuously Generated Trap Column instead of the Dionex IonPac ATC-1 or Trap Columns. The Dionex CR-ATC is located after the Dionex EGC KOH cartridge.
Column: Dionex IonPac AS15 + Dionex IonPac AG15 (2 mm).
Eluent Source: Dionex EGC KOH
Eluent: 8 mM KOH (0-6 min.)
8-60 mM KOH (6-16 min.)
Eluent Flow Rate: 0.5 mL/min.
Temperature: 30°C
ERS Suppressor: Dionex AERS 500 suppressor
or CRS Suppressor: Dionex ACRS 500 suppressor
CRS Regenerant: 50 mN H2SO4
Expected Background Conductivity: 0.8-1.2 µS

Figure 29 Large Loop Injection for µg/L (ppb) analysis on 2 mm Dionex IonPac AS15

<table>
<thead>
<tr>
<th>Analyte</th>
<th>µg/L (ppb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Fluoride</td>
<td>1.08</td>
</tr>
<tr>
<td>2. Glycolate</td>
<td>3.35</td>
</tr>
<tr>
<td>3. Acetate</td>
<td>3.86</td>
</tr>
<tr>
<td>4. Formate</td>
<td>3.63</td>
</tr>
<tr>
<td>5. Chloride</td>
<td>1.03</td>
</tr>
<tr>
<td>6. Nitrite</td>
<td>1.17</td>
</tr>
<tr>
<td>7. Carbonate</td>
<td>-</td>
</tr>
<tr>
<td>8. Sulfate</td>
<td>0.91</td>
</tr>
<tr>
<td>9. Oxalate</td>
<td>0.97</td>
</tr>
<tr>
<td>10. Bromide</td>
<td>2.87</td>
</tr>
<tr>
<td>11. Nitrate</td>
<td>0.89</td>
</tr>
<tr>
<td>12. Phosphate</td>
<td>3.07</td>
</tr>
</tbody>
</table>
4.8 Comparison of Conventional Eluent System and RFIC-EG System for Gradient Elution on the Dionex IonPac AS16

Figure 30, “Separation of Polarizable Anions and Inorganic Anions using Gradient Elution,” illustrates the separation of a wide variety of inorganic anions including polarizable anions. Weakly retained anions such as acetate, propionate, and formate are resolved using an isocratic hydroxide eluent and the highly retained anions such as thiosulfate, thiocyanate, and perchlorate are eluted with a hydroxide gradient. Peak shape and efficiency are greatly improved for the polarizable anions on the Thermo Scientific™ Dionex™ IonPac™ AS16 column.

The following example also illustrates a comparison of a gradient delivered using a bottle eluent system and using an RFIC-EG system. When using the conventional bottle eluent delivery, dissolved carbonate causes a baseline shift of approximately 1 µS. The carbonate free potassium hydroxide gradient produced by the Dionex EGC results in a very low baseline shift (<0.3 µS). This low baseline shift allows easy integration of trace components.

| Trap Column: | Bottle Eluent System, Dionex IonPac ATC-1 located after pump. NOTE: The Dionex IonPac ATC-1 Trap Column should be replaced with a Dionex IonPac ATC-3 (4 mm) Trap Column (P/N 059660). EG50 system, Dionex IonPac ATC-1 (2), 1 located after pump; 1 located between Dionex EGC degas assembly and injector. NOTE: The Dionex IonPac ATC-1 Trap Columns should be replaced with one Dionex IonPac ATC-HC Trap Column after the pump. NOTE: For systems other than the Dionex EG40, use the Dionex CR-ATC continuously GeneratedTrap Column instead of the Dionex IonPac ATC-1 or Dionex IonPac ATC-HC Trap Columns. The Dionex CR-ATC is located after the Dionex EGC KOH cartridge. |
| Sample Volume: | 10 µL |
| Column: | Dionex IonPac AS16 (4 mm) analytical and Thermo Scientific™ Dionex™ IonPac™ AG16 (4 mm) guard |
| Eluent: | E1: 5.0 mM NaOH E2: Deionized water E3: 100 mM NaOH |
| Eluent Flow Rate: | 1.5 mL/min |
| Operating Temperature: | 30°C |
| ERS Suppressor: | Dionex AERS 500 (4 mm) suppressor AutoSuppression Recycle Mode |
| or CRS Suppressor: | Dionex ACRS 500 (4 mm) suppressor |
| CRS Regenerant: | 50 mN H₂SO₄ |
| Expected Background Conductivity: | 1.5 mM NaOH: 1 µS 55 mM NaOH: 2.5 - 3.5 µS |
| Typical Operating Back Pressure: | 2,300 psi (15 MPa) |
| Analyte | mg/L (ppm) |
| 1. Fluoride | 2.0 |
| 2. Acetate | 10.0 |
| 3. Propionate | 10.0 |
| 4. Formate | 10.0 |
| 5. Chlorite | 10.0 |
| 6. Bromate | 10.0 |
| 7. Chloride | 5.0 |
| 8. Nitrite | 10.0 |
| 9. Nitrate | 10.0 |
| 10. Selenite | 10.0 |
| 11. Carbonate | 20.0 |
| 12. Sulfate | 10.0 |
| 13. Selenate | 10.0 |
| 14. Iodide | 20.0 |
| 15. Thiosulfate | 10.0 |
| 16. Chromate | 20.0 |
| 17. Phosphate | 20.0 |
| 18. Arsenate | 20.0 |
| 19. Thiocyanate | 20.0 |
| 20. Perchlorate | 30.0 |

<table>
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<tr>
<th>Time (min)</th>
<th>%E1</th>
<th>%E2</th>
<th>%E3</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>30</td>
<td>70</td>
<td>0</td>
<td>1.5 mM NaOH for 7 min.</td>
</tr>
<tr>
<td>7.0</td>
<td>30</td>
<td>70</td>
<td>0</td>
<td></td>
</tr>
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<td>Analysis</td>
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<td>30</td>
<td>70</td>
<td>0</td>
</tr>
<tr>
<td>7.5</td>
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<td>70</td>
<td>0</td>
<td>Inject Valve to Load Position</td>
</tr>
<tr>
<td>14.0</td>
<td>30</td>
<td>70</td>
<td>0</td>
<td>End Isocratic analysis, Begin Gradient analysis</td>
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<td></td>
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<tr>
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<td>0</td>
<td>45</td>
<td>55</td>
<td></td>
</tr>
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</table>
### Dionex EGC Conditions

Eluent: Deionized water  
Offset volume = 0.0 µL

<table>
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<tr>
<th>Time (min)</th>
<th>Concentration (mM)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equilibration</td>
<td>1.5</td>
<td>1.5 mM KOH for 7 min</td>
</tr>
<tr>
<td>7.0</td>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td>Analysis</td>
<td>7.1</td>
<td>1.5</td>
</tr>
<tr>
<td>7.5</td>
<td>1.5</td>
<td>Inject Valve to Load Position</td>
</tr>
<tr>
<td>15.3</td>
<td>1.5</td>
<td>End Isocratic analysis, Begin Gradient analysis</td>
</tr>
<tr>
<td>21.3</td>
<td>10.0</td>
<td></td>
</tr>
<tr>
<td>31.3</td>
<td>55.0</td>
<td></td>
</tr>
</tbody>
</table>

#### Example A
**Gradient Analysis Using Bottle Eluent System**

#### Example B
**Gradient Analysis Using RFIC-EG System**

---

**Figure 30** Separation of Polarizable Anions and Inorganic Anions Using Gradient Elution

---
4.9 Using an RFIC-EG System for KOH Elution of Inorganic Anions, Oxyhalides, and Organic Acids on the Dionex IonPac AS17

The following chromatograms compare the Dionex EGC eluent delivery system with the bottle eluent delivery system at room temperature (22°C) for the determination of inorganic anions, oxyhalides, and organic acids on the Thermo Scientific™ Dionex™ IonPac™ AS17 column. Notice, due to the large system void volume with the bottle eluent system, a longer equilibration time is required before injection.

| Trap Column: Bottle Eluent System, Dionex IonPac ATC-1 located after pump. NOTE: The Dionex IonPac ATC-1 Trap Column should be replaced with a Dionex IonPac ATC-3 (4 mm) Trap Column (P/N 059660). RFIC-EG System, Dionex ATC-1 (2), 1 located after pump; 1 located at eluent outlet of Dionex EGC degas assembly and before injector. NOTE: For systems other than the Dionex EG40 use the Dionex CR-ATC 500 continuously Generated Trap Column instead of the Dionex IonPac ATC-1 or Dionex IonPac ATC-HC Trap Columns. The Dionex CR-ATC 500 is located after the Dionex EGC KOH cartridge. |
| Sample Volume: 4 mm: 10 µL Loop + 0.8 µL Injection valve dead volume |
| Column: Dionex IonPac AS17, Thermo Scientific™ Dionex™ IonPac™ AG17 4 mm |
| Eluent Source: See table |
| Eluent: See table |
| Eluent Flow Rate: 1.5 mL/min (4 mm) |
| Temperature: Room temperature (22°C) |
| ERS Suppressor: Dionex AERS 500 (4 mm) suppressor |
| CRS Suppressor: Dionex ACRS 500 (4 mm) suppressor |
| CRS Regenerant: 50 mN H2SO4 |
| Expected Background: Conductivity: 0.5-1.0 µS |
| Storage Solution: Eluent |

<table>
<thead>
<tr>
<th>Analyte</th>
<th>mg/L (ppm)</th>
<th>Time (min)</th>
<th>Eluent Conc. (mM)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Fluoride</td>
<td>2.0</td>
<td>Equilibration</td>
<td>1.0</td>
<td>1.0 mM KOH for 4 min</td>
</tr>
<tr>
<td>2. Acetate</td>
<td>5.0</td>
<td></td>
<td>0</td>
<td>1.0</td>
</tr>
<tr>
<td>3. Propionate</td>
<td>5.0</td>
<td>Analysis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Formate</td>
<td>5.0</td>
<td></td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>5. Chloride</td>
<td>5.0</td>
<td></td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>6. Bromate</td>
<td>5.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Chloride</td>
<td>3.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Nitrite</td>
<td>5.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Bromide</td>
<td>10.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Nitrate</td>
<td>10.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Chlorate</td>
<td>10.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Carbonate</td>
<td>20.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. Sulfate</td>
<td>5.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. Oxalate</td>
<td>5.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. Phosphate</td>
<td>10.0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Eluent: Deionized water |
| Offset volume = 0.0 µL |

<p>| Gradient Conditions: E1: 5 mM NaOH E2: DI water E3: 100 mM NaOH |</p>
<table>
<thead>
<tr>
<th>Time (min)</th>
<th>%E1</th>
<th>%E2</th>
<th>%E3</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equilibration</td>
<td>-5.0</td>
<td>20</td>
<td>80</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>20</td>
<td>80</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Analysis</td>
<td>0</td>
<td>20</td>
<td>80</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>20</td>
<td>80</td>
<td>0</td>
<td>Inject valve to load position</td>
</tr>
<tr>
<td>0</td>
<td>20</td>
<td>80</td>
<td>0</td>
<td>Begin gradient analysis</td>
</tr>
<tr>
<td>7.0</td>
<td>0</td>
<td>90</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>11.0</td>
<td>0</td>
<td>65</td>
<td>35</td>
<td>End gradient</td>
</tr>
</tbody>
</table>
Figure 31  Determination of Inorganic Anions, Oxyhalides, and Organic Acids at Room Temperature

RFIC-EG system

Bottle eluent delivery system
4.10 Using the Dionex EGC 500 MSA or Dionex EGC III MSA Cartridge for Isocratic MSA Elution on the Dionex IonPac CS12A

This application demonstrates the comparison of a Thermo Scientific™ Dionex™ IonPac™ CS12A isocratic separation using conventional isocratic pump delivery with Dionex EGC isocratic delivery. Figure 32, “Conventional MSA Isocratic Elution on the Dionex IonPac CS12A,” illustrates the use of a conventional pump method. Figure 33, “Dionex EGC MSA Isocratic Elution on the Dionex IonPac CS12A,” illustrates the use of a Dionex EGC with an identical isocratic program using an OFFSET VOLUME of 0.0 µL.

Sample Volume: 25 µL
Column: Dionex IonPac CS12A analytical (4 mm) and Thermo Scientific™ Dionex™ IonPac™ CG12A guard (4 mm)
Eluent: 18 mM MSA
Eluent Flow Rate: 1.0 mL/min
Oven Temperature: 30° C
Cell Temperature: 35°C
Suppressor: Thermo Scientific™ Dionex™ CSRS 300 (4 mm)
AutoSuppression Recycle Mode
Expected Background Conductivity: 0.3 µS (Dionex EGC) 0.4 µS (Conventional Gradient)
Typical Operating Back Pressure: 1980 psi (Dionex EGC) 970 psi (Conventional Gradient)
Back pressure restrictor (P/N 53763) was used with the Dionex EGC

Figure 32 Conventional MSA Isocratic Elution on the Dionex IonPac CS12A.

Figure 33 Dionex EGC MSA Isocratic Elution on the Dionex IonPac CS12A.
4.11 Using the Dionex EGC 500 MSA or Dionex EGC III MSA Cartridge for Dionex IonPac CS12A MSA Gradient

This application demonstrates the comparison of a Dionex IonPac CS12A gradient separation using conventional gradient pump delivery to the gradient separation using Dionex EGC gradient delivery. Figure 34, “Conventional MSA Linear Gradient on the Dionex IonPac CS12A,” illustrates the use of a conventional pump method. Figure 35, “Dionex EGC MSA Linear Gradient on the Dionex IonPac CS12A,” illustrates the use of a Dionex EGC with an identical gradient program using the OFFSET VOLUME of 0 µL. Note the smaller baseline shift during the gradient when using the Dionex EGC. Since the Dionex EGC delivers the gradient with a much smaller delay volume, the peaks elute more quickly. By increasing the OFFSET VOLUME from 0 µL to 400 µL, the start of the gradient will be delayed 0.2 minutes and the retention times of the peaks eluted by the gradient will increase.

**NOTE: Solvents should not be used with a Dionex EGC MSA cartridge.**

Sample Volume: 25 µL  
Column: Dionex IonPac CS12A analytical and Thermo Scientific™ Dionex™ IonPac CG12A guard (4 mm)  
Eluent: See table of conditions  
Eluent Flow Rate: 1.0 mL/min  
Cell Temperature: 35°C  
Oven Temperature: 30°C  
Suppressor: Dionex CSRS 300 (4 mm)  
AutoSuppression Recycle Mode  
Expected Background Conductivity:  
- **(Conventional Gradient)** 11 mM MSA: 0.4 µS, 57 mM MSA: 0.8 µS  
- **(Dionex EGC)** 11 mM MSA: 0.4 µS, 57 mM MSA: 0.44 µS  
Typical Operating Back Pressure:  
- **(Conventional Gradient)** 960 psi (6.6 MPa)  
- **(Dionex EGC)** 1880 psi (13 MPa)  
Pressure Restrictor, (P/N 53763) was used with the Dionex EGC  
Offset Volume: 0.0 µL

### Conventional Gradient Conditions

<table>
<thead>
<tr>
<th>Time (min)</th>
<th>%E1</th>
<th>%E2</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Equilibration</strong></td>
<td>-7.0</td>
<td>89</td>
<td>11</td>
</tr>
<tr>
<td>0</td>
<td>89</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td><strong>Analysis</strong></td>
<td>0.0</td>
<td>89</td>
<td>11</td>
</tr>
<tr>
<td>0.0</td>
<td>89</td>
<td>11</td>
<td>Inject Valve to Load Position</td>
</tr>
<tr>
<td>9.0</td>
<td>55</td>
<td>45</td>
<td>Step change to 45 mM MSA</td>
</tr>
<tr>
<td>14.0</td>
<td>55</td>
<td>45</td>
<td>45-57 mM MSA in 3.0 min.</td>
</tr>
<tr>
<td>17.0</td>
<td>43</td>
<td>57</td>
<td>57 mM MSA</td>
</tr>
<tr>
<td>20.0</td>
<td>43</td>
<td>57</td>
<td>57 mM MSA (end)</td>
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</table>

### Dionex EGC Conditions

<table>
<thead>
<tr>
<th>Time (min)</th>
<th>Eluent conc. (mM)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Equilibration</strong></td>
<td>-7.0</td>
<td>11</td>
</tr>
<tr>
<td>0</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td><strong>Analysis</strong></td>
<td>0.0</td>
<td>11</td>
</tr>
<tr>
<td>0.0</td>
<td>11</td>
<td>Inject Valve to Load Position</td>
</tr>
<tr>
<td>9.0</td>
<td>45</td>
<td>Step change to 45 mM MSA</td>
</tr>
<tr>
<td>14.0</td>
<td>45</td>
<td>45-57 mM MSA in 3.0 min.</td>
</tr>
<tr>
<td>17.0</td>
<td>57</td>
<td>57 mM MSA</td>
</tr>
<tr>
<td>20.0</td>
<td>57</td>
<td>57 mM MSA (end)</td>
</tr>
</tbody>
</table>

### Analytes (mg/L (ppm))

1. Lithium 0.5  
2. Sodium 2.0  
3. Ammonium 5.0  
4. Potassium 5.0  
5. 5-Amino-1-pentanol 20.0  
6. Morpholine 15.0  
7. Magnesium 2.5  
8. Calcium 5.0  
9. 3-Dimethylamino-propylamine 10.0
Figure 34  Conventional MSA Linear Gradient on the Dionex IonPac CS12A.

Figure 35  Dionex EGC MSA Linear Gradient on the Dionex IonPac CS12A.
4.12 Comparison of Eluent Generation using a Dionex IonPac CTC-1 and a Dionex CR-CTC 500 for Dionex IonPac CS12A Gradient

The set of chromatograms in Figure 36 demonstrates the decrease in baseline shift during a gradient when the Thermo Scientific™ Dionex™ IonPac™ CTC-1 or Dionex CR-CTC 500 is used. The Dionex CR-CTC 500 does not require off-line chemical regeneration.

Column: Dionex IonPac CS12A (4 mm)
Eluent: Dionex EGC generated MSA
Flow Rate: 1.0 mL/min
Inj. Volume: 10 µL
Detection: Suppressed Conductivity
Temperature: 30°C
Suppressor: Dionex CSRS 300 (4 mm), Recycle Mode

![Figure 36: Comparison of the Dionex EGC Using a Dionex IonPac CTC and a Dionex CR-CTC Trap Column with Dionex IonPac CS12A Gradient](image)

<table>
<thead>
<tr>
<th>Analytes</th>
<th>mg/L</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Lithium</td>
<td>0.5</td>
</tr>
<tr>
<td>2. Sodium</td>
<td>0.5</td>
</tr>
<tr>
<td>3. Ammonium</td>
<td>0.5</td>
</tr>
<tr>
<td>4. Potassium</td>
<td>0.5</td>
</tr>
<tr>
<td>5. Magnesium</td>
<td>0.5</td>
</tr>
<tr>
<td>6. Calcium</td>
<td>0.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gradient Program</th>
<th>Concentration (mM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time (min)</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>25.0</td>
<td>50</td>
</tr>
<tr>
<td>30</td>
<td>50</td>
</tr>
<tr>
<td>30.1</td>
<td>1.0</td>
</tr>
<tr>
<td>40</td>
<td>1.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Baseline Drift</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Dionex EGC</td>
<td>70 nS/cm</td>
</tr>
<tr>
<td>Dionex EGC +</td>
<td></td>
</tr>
<tr>
<td>Dionex IonPac CTC-3</td>
<td>57 nS/cm</td>
</tr>
<tr>
<td>Dionex CR-CTC</td>
<td>42 nS/cm</td>
</tr>
</tbody>
</table>

065018-05
4.13 Glycoconjugate Monosaccharide Analysis with the Dionex EGC 500 KOH or Dionex EGC III KOH Cartridge

This application demonstrates the use of the Dionex EGC KOH generator for resolving glycoconjugate-derived monosaccharides in the Biotechnology and Pharmaceutical industries. The conventional method, using manual or pump-generated eluent, requires a step to 200 mM NaOH for 10 minutes to remove carbonate from the column, followed by a 15 minute re-equilibration to force a 50 minute cycle time. The Dionex EGC KOH method, (see Figure 37, “Analysis of Monosaccharide Standards Showing a Fast Cycle Time with Dionex EGC-Generated Carbonate-Free Eluent”) employs a 5 minute step at 80 mM to remove amino acids or late eluting components, and a short re-equilibration to support a 30 minute cycle time. This demonstrates that control of carbonate anion results in a 40% gain in throughput for this application.

Sample: 10 µL, 20 µM standards  
Eluent: Deionized Water  
Column: Thermo Scientific™ Dionex™ CarboPac™ PA10 (Analytical) and Thermo Scientific™ Dionex™ AminoTrap™  
Flow: 1.0 mL/min  
Pressure: 2,800 psi

**Figure 37  Analysis of Monosaccharide Standards Showing a Fast Cycle Time with Dionex EGC-Generated Carbonate-Free Eluent**

Analyze  
1. Fucose  
2. Deoxy-Glucose  
3. Galactosamine  
4. Glucosamine  
5. Galactose  
6. Glucose  
7. Mannose
4.14 Analysis of Mono- and Disaccharides Found in Foods and Beverages Using Dionex EGC Generated KOH as Eluent

This application demonstrates the use of the Dionex EGC KOH cartridge for resolving carbohydrates found in foods and beverages (Figure 38, “Analysis of Monosaccharides in Foods and Beverages with the Dionex EGC Generated Carbonate-Free Eluent”). Resolution of galactose, glucose, mannose and xylose, as well as other carbohydrates is impacted by carbonate ion. This divalent anion is present to varying degrees in hydroxide-containing eluents due to dissolution of carbon dioxide in the basic eluent. Use of KOH, generated electrolytically at the time of use, prevents the accumulation of carbonate on the column. When hydroxide-containing eluents in system reservoirs are used, separation of these carbohydrates can only be accomplished following the completion of the following steps: (1) 15 min wash with 300 mM NaOH to remove carbonate from the column, (2) 15 min rinse with DI water. The sample can then be injected.

When 2.3 mM KOH is generated by the Dionex EGC KOH cartridge, these carbohydrates are well resolved by a system that requires neither post-column base addition, nor preparation of caustic eluents. A 5 min step to 100 mM KOH at the end of the carbohydrate elution window is employed to remove organic acids and other late eluting compounds. With the step and time for equilibration, cycle time is reduced from 80 min to 60 min, demonstrating that control of carbonate results in a 33% gain in throughput.

Sample: 10 µL, 20 µM standards
Eluent: Deionized Water
Column: Dionex CarboPac PA10 (4 mm) + Dionex AminoTrap (4-mm)
Flow: 1.0 mL/min
Pressure: 2,800 psi

---

**Figure 38** Analysis of Monosaccharides in Foods and Beverages with Dionex EGC Generated Carbonate-Free Eluent

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Gradient Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time (min)</td>
<td>KOH mM</td>
</tr>
<tr>
<td>0.0</td>
<td>2.3</td>
</tr>
<tr>
<td>39.5</td>
<td>2.3</td>
</tr>
<tr>
<td>40.0</td>
<td>100</td>
</tr>
<tr>
<td>45.0</td>
<td>100</td>
</tr>
<tr>
<td>45.5</td>
<td>2.3</td>
</tr>
</tbody>
</table>

1. Mannitol
2. Fucose
3. Arabinose
4. Rhamnose
5. Galactose
6. Glucose
7. Sucrose
8. Xylose
9. Mannose
10. Fructose
11. Ribose
4.15 Analysis of Carbohydrates using both EGC Generated KOH and Manually Prepared NaOH or KOH as Eluent

This application demonstrates the use of the Dionex EGC KOH generator with manually prepared 200 mM NaOH eluent for resolving carbohydrates found in foods, beverages, lignocellulosic hydrolysates where determination of more strongly retained carbohydrates or more effective column washing is desired. Figure 39, "Analysis of carbohydrates in corn stover hydrolysate with Dionex EGC Generated Carbonate-Free and Manually Prepared Eluent" shows the resolution of arabinose, galactose, glucose, xylose, mannose, fructose using Dionex EGC generated 0.5 mM KOH, and the rapid elution of cellobiose and other more strongly retained carbohydrates using manually prepared 200 mM NaOH eluents. Carbohydrate applications that require greater than 100 mM (the upper concentration limit for the Dionex EGC), but less than 200 mM KOH or NaOH eluent concentration may use manually prepared eluent to supplement the hydroxide produced by the Dionex EGC. For example, the Dionex EGC can be used to produce 0.5 to 20 mM concentrations of hydroxide eluent, used to separate weakly retained carbohydrates or alter their selectivity, and then change the proportioning valve on the pump to use another eluent channel (other than water) that contains manually prepared 200 mM KOH or NaOH to elute the more highly retained carbohydrates or other substances. The combined use of Dionex EGC and manually prepared eluent enable many of the benefits of eluent generation, and also provide the ability to rapidly elute highly retained compounds and more effectively clean the column. When manually prepared eluent is allowed to pass through the Dionex EGC cartridge and the Dionex CR-ATC 500, the Dionex EGC must be left on at low eluent concentration (e.g., 0.5 mM) to ensure polarization of the Dionex EGC cartridge membranes and ensure longevity of the device. The use of combined Dionex EGC and manually prepared eluent does not require any additional plumbing or system configuration, but does require a gradient pump with two or more eluent channels and a proportioning valve. The manually prepared eluents should be prepared follow the procedures described in Thermo Scientific™ Dionex™ Technical Note 71.

Sample: 1) Carbohydrate standards, 0.2 µL  
       2) Undiluted corn stover acid hydrolysate, 0.2 µL

Eluent:  
       A: Water  
       B: 200 mM NaOH

Column: Thermo Scientific™ Dionex™ CarboPac™ PA1 (4 mm)

Flow: 1.0 mL/min

Pressure: 1400 psi

Gradient Program:

<table>
<thead>
<tr>
<th>Time</th>
<th>%A</th>
<th>%B</th>
<th>mM KOH (EG)</th>
<th>mM NaOH*</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>100</td>
<td>0</td>
<td>0.50</td>
<td>0</td>
</tr>
<tr>
<td>35.0</td>
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<td>0</td>
<td>0.50</td>
<td>0</td>
</tr>
<tr>
<td>35.1</td>
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<td>100</td>
<td>0.50</td>
<td>200</td>
</tr>
<tr>
<td>50.0</td>
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<td>100</td>
<td>0.50</td>
<td>200</td>
</tr>
<tr>
<td>50.1</td>
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<td>0.00</td>
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<td>55.0</td>
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</tr>
<tr>
<td>55.1</td>
<td>100</td>
<td>0</td>
<td>0.50</td>
<td>0</td>
</tr>
</tbody>
</table>

Analyte:  
1. Arabinose  
2. Galactose  
3. Glucose  
4. Xylose  
5. Mannose  
6. Fructose  
7. Cellobiose

* Manually prepared eluent
Figure 39  Analysis of Carbohydrates in Corn Stover Hydrolysate with Dionex EGC Generated Carbonate-Free and Manually Prepared Eluent
4.16 Determination of Trace Perchlorate Using the Dionex IonPac Cryptand C1 Concentrator Column

Figure 40 illustrates the basic system configuration for the determination of trace perchlorate using a Dionex IonPac Cryptand C1 concentrator column, 2 mm Dionex IonPac AS16 separation column, and a Dionex EGC III NaOH. In this system, the deionized water is pumped into the Dionex EGC III NaOH cartridge where a high-purity NaOH eluent is generated electrolytically. The Dionex CR-ATC 500 and the degas unit serve the same functions as described previously. A 5 mL aqueous sample containing trace perchlorate is first loaded onto a Dionex IonPac Cryptand C1 concentrator (P/N 062893) to concentrate perchlorate from the sample matrix using a Dionex AS-DV auto sampler which comes in two versions (5 mL vials P/N 046029 and 0.5 mL vials P/N 046028). The AS-DV auto sampler is then used again to deliver 1.0 mL of 10 mM NaOH to rinse the majority of matrix ions off the concentrator column. After the rinse, the concentrator column is switched on-line with the 2 mm Dionex IonPac AS16 separation column where perchlorate is separated from the matrix ions using the NaOH eluent.

Figure 40System Configuration for Determination of Trace Perchlorate

![System Configuration for Determination of Trace Perchlorate](image-url)
This example demonstrates the determination of trace perchlorate in a synthetic water sample using the Dionex IonPac Cryptand C1 concentrator column, 2 mm Dionex IonPac AS16 separation column, and Dionex EGC III NaOH cartridge. In this example, 5 mL of the sample, which contains 5 µg/L perchlorate in 1000 mg/L (each) chloride, sulfate, and bicarbonate, is first loaded onto a Dionex IonPac Cryptand C1 concentrator (P/N 062893) to concentrate perchlorate from the sample matrix. The concentrator column is then rinsed with 1.0 mL of 10 mM NaOH. The concentrator column then is switched on-line with the 2 mm Dionex IonPac AS16 separation column. The Dionex EGC III NaOH cartridge is programmed to generate a 0.5 mM NaOH for 12 minutes and the concentration of the eluent is increased to 60 mM to elute perchlorate from the AS16 column as shown in Figure 41.

Column: Dionex IonPac AG16/AS16, 2 x 250 mm
Concentrator: Dionex IonPac Cryptand C1 Concentrator
Eluent: 0.5 mM sodium hydroxide step to
       60 mM sodium hydroxide at 12 min
Eluent Source: Dionex EGC III NaOH with a Dionex CR-ATC 500
Flow Rate: 0.25 mL/min
Inj. Volume: 5 mL concentrated on Dionex IonPac Cryptand C1 concentrator
Rinse 1 mL of 10 mM NaOH
Temperature: 35 °C
Detection: Suppressed conductivity, Dionex ASRS 300 (2 mm), recycle mode
Sample: Cl⁻, SO₄²⁻, HCO₃⁻

Figure 41 Determination of Trace Perchlorate
4.17 Dual Dionex EGC III NaOH and Dionex EGC III LiOH Applications

4.17.1 System Requirements

Figure 42 illustrates the system setup for electrolytic generation of dual component hydroxide eluents using Dionex EGC III NaOH and Dionex EGC III LiOH cartridges. In this system, the deionized water from the pump is first split equally into two flowing streams through the use of the "Dionex Dual EG Splits/Mixing Tee" kit (P/N 063049). One deionized (DI) water stream goes through the Dionex EGC III NaOH cartridge to generate NaOH eluent and the other stream goes through the Dionex EGC III LiOH cartridge to generate LiOH eluent. The two hydroxide streams are recombined using another Dual EG Splits/Mixing Tee kit to form a dual cation hydroxide eluent. The Dionex CR-ATC 500 and the degas unit serve the same functions as described previously.
4.18 Separation of Ten Anions on a 4 mm Dionex IonPac AS9-HC Column using a Dionex EGC K₂CO₃

Columns: Dionex IonPac AG9-HC, 4 x 50 mm
Dionex IonPac AS9-HC, 4 x 250 mm
Eluent Source: Dionex EGC or premixed
Eluent: (A) 9.0 mM K₂CO₃
(B) 9.0 mM Na₂CO₃
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

4.19 Determination of Trace Bromate in Drinking Water Using a 4 mm Dionex AS9-HC Column and a Dionex EGC K₂CO₃

Column: IonPac AG9-HC, 4 x 50 mm
IonPac AS9-HC, 4 x 250 mm
Eluent: 9.0 mM K₂CO₃
Eluent Source: EGC II K₂CO₃ cartridge
Flow Rate: 1.0 mL/min
Inj. Volume: 225 µL
Detection: Suppressed conductivity
Analyte: Spike level (µg/L)
Peak: 1. Bromate 5 µg/L
4.20 Separation of Seven Anions on a 4 mm Dionex IonPac AS12A Column using a Dionex EGC K₂CO₃ and Dionex EPM

Column: Dionex IonPac AG12A, 4 x 50 mm
Dionex IonPac AS12A, 4 x 200 mm
Eluent Source: Dionex EGC or premixed
Eluent:
(A) 2.7 mM K₂CO₃/0.3 mM KHCO₃
(B) 2.7 mM Na₂CO₃/0.3 mM NaHCO₃
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

4.21 Separation of Ten Anions on a 2 mm Dionex IonPac AS12A Column Using a Dionex EGC K₂CO₃ and Dionex EPM

Columns: Dionex IonPac AG12A, 2 x 50 mm
Dionex IonPac AS12A, 2 x 200 mm
Eluent Source: Dionex EGC or premixed
Eluent:
(A) 2.7 mM K₂CO₃/0.3 mM KHCO₃
(B) 2.7 mM Na₂CO₃/0.3 mM NaHCO₃
Flow Rate: 0.38 mL/ min
Temperature: 35 °C
Inj. Volume: 5 µL
Suppressor: AAES
Peaks: 1. Fluoride 3 mg/L
2. Chloride 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
4.22  Separation of Eight Anions on a 3 mm Dionex IonPac AS14A Column Using a Dionex EGC $K_2CO_3$ and Dionex EPM

- **Column:** Dionex IonPac AG14A, 3 x 30 mm
  - Dionex IonPac AS14A, 3 x 150 mm

- **Eluent Source:** Dionex EGC 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 Replacing the Dionex EGC III or Dionex EGC 500 Cartridge

The Dionex EGC III or Dionex EGC 500 must be replaced when the cartridge is expended, when it leaks, or in order to switch between anion and cation separations with a single Dionex Eluent Generator (EG) Module.

When switching between anion and cation separations on the same system, flush the entire system (excluding the Dionex EGC, column, and suppressor, but including the high pressure degas tubing assembly) with 5 to 10 mL of DI water at 1.0 or 2.0 mL/min before connecting the new cartridge, column, and suppressor.

To remove the old cartridge:

A. Turn off the pump flow either manually or via direct control in the Dionex PeakNet or Dionex Chromeleon software. The power to the Dionex EGC III, Dionex EGC 500, Dionex CR-TC 500, Dionex EPM 500 and Dionex ERS suppressor will automatically shut off.

B. The electrical connector cable for the cartridge is plugged into a connector. Unscrew the plug counter clockwise and pull it straight out of the connector.

C. Unscrew the Luer lock from the Luer adaptor at the top corner of the Dionex EGC III or top of the Dionex EGC 500 and detach the gas vent line.

D. Install the plastic plug in the gas vent port. Use the plug removed from the port during initial installation of the Dionex EGC.

E. With the eluent lines still attached, and the electrical contacts facing you, lift the Dionex EGC from the shelf and turn it so that the electrolysis chamber and liquid line fittings are upward.

F. Unscrew the cartridge inlet line from the Dionex EGC INLET fitting. This line leads to the pump transducer (or to the anion trap column, if present). Unscrew the cartridge outlet line from the OUTLET fitting on the Dionex EGC.

G. Prepare an expended Dionex EGC III or Dionex EGC Capillary cartridge for disposal by completing the following:
   i. Hold the cartridge with the generator chamber upward.
   ii. Unscrew the eluent generation chamber from the electrolyte reservoir.
   iii. Pour the remaining electrolyte solution into an appropriate hazardous waste container.
   iv. Rinse the electrolyte reservoir and membranes with DI water three times.

Refer to the Material Safety Data Sheet (MSDS) shipped with the Dionex EGC III or Dionex EGC 500 for the chemical description.
H. Prepare an expended Dionex EGC 500 cartridge for disposal by completing the following:

i. Wear protective laboratory gloves and remove two 10-32 fittings from eluent inlet and outlet ports as shown in Figure H1.

ii. Use a Philips screwdriver to remove the two screws used to attach the Dionex EGC pod cover to the Dionex EGC reservoir as shown in Figure H2. Detach the pod cover from the reservoir.

iii. Use a Philips screwdriver to detach the Dionex EGC cable clamp from the reservoir as shown in Figure H3.

iv. Use a Philips screwdriver to remove the three screws used to attach one of the pods to the reservoir in Figure H4 and Figure H5. Either pod can be removed.

v. Detach the pod from the reservoir as shown in Figure H6. Dispose of the electrolyte solution into an appropriate hazardous waste container following the local hazard material disposable procedures.
Rinsing should render the reservoir and the membranes nonhazardous; however, check with local, state, and federal regulatory agency regulations for proper disposal.

I. If the cartridge is not expended, plug all fittings.
J. Store the cartridge in a standing 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. The cartridge may be stored for up to two years.
K. To install a new cartridge, follow the procedure in Section 2.

It is recommended the Dionex EPM 500 should be replaced with each third Dionex EGC 500 K₂CO₃.

5.2 Replacing the Dionex EGC III Outlet Frit

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

A. Unscrew the Luer lock from the Luer adaptor at the top corner of the Dionex EGC III electrolyte reservoir and detach the gas vent line.
B. Install the plastic plug in the gas vent port. Use the plug removed from the port during initial installation of the Dionex EGC III.
C. Turn off the pump flow.
D. With the eluent lines and electrical connects still attached, lift the Dionex EGC III from the cartridge shelf, and turn it so the eluent generation chamber and liquid line fittings are upward.
E. Unscrew the cartridge outlet line from the outlet fitting on the Dionex EGC III.

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

F. Using a sharp or pointed tool, such as the mini screwdriver (P/N 046985), carefully puncture and remove the frit body and seal ring.
G. Replace with a new frit assembly (P/N 042310) provided with the Dionex EGC III.
H. Reattach the outlet line.
Invert the Dionex EGC III with the Eluent Generation (EG) Chamber downward. Shake the Dionex EGC III 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. Be sure to repeat this process each time the Dionex EGC III is turned with the eluent generation chamber upward.

I. Position the Dionex EGC III in the eluent generator controller Module with the eluent generation chamber downward by positioning the Dionex EGC 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 Thermo Scientific North America Technical Call Center at 1-800-DIONEX-0 (1-800-346-6390) or the nearest Dionex Office (see “Thermo Scientific Worldwide Offices” on the Reference Library CD-ROM).

6.1 Dionex ICS-3000, Dionex ICS-5000 and Dionex ICS-5000+ EG Error Messages and Troubleshooting

6.1.1 EG1 Cartridge Disconnected and EG2 Cartridge Disconnected

This error occurs if Dionex Chromeleon or Dionex Chromeleon Xpress sends a command to set an EG parameter when the cartridge is disconnected. To troubleshoot: (1) Connect the cartridge and (2) If the error message appears again, contact Dionex for assistance. The cartridge control electronics may have malfunctioned.

NOTE

The Dionex ICS-3000, Dionex ICS-5000 and Dionex ICS-5000+ EG 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 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 Dionex ICS-3000, Dionex ICS-5000 and Dionex ICS-5000+ EG 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, 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 cartridge exceeds the maximum current allowed. (The current is automatically turned off to prevent damage to the cartridge.). If the error message appears, contact Thermo Scientific for assistance. The cartridge control electronics may have malfunctioned.

*NOTE*

*The Dionex ICS-3000, Dionex ICS-5000 and Dionex ICS-5000® EG Ion Chromatography System electronics components and Moduleware cannot be serviced by the user.*

6.1.6 **EG1 over Voltage and EG2 over Voltage**

This error occurs when the cartridge is not connected properly to the EG1 and EG2 current source. To troubleshoot: check the cartridge cable connection to the electrical bulkhead. If the error message appears again, contact Dionex for assistance. The cartridge or Dionex ICS-3000, Dionex ICS-5000 or Dionex ICS-5000® EG control electronics may have malfunctioned.

*NOTE*

*The Dionex ICS-3000, Dionex ICS-5000 and Dionex ICS-5000® EG Ion Chromatography System electronics components and Moduleware cannot be serviced by the user.*

This error may also occur when air bubbles are trapped in the electrolytic chamber. To correct the problem, turn over the Dionex EGC Cartridge (elucent fitting facing down). Shake the Dionex EGC Cartridge vigorously and tap it with the palm of your hand 10 to 15 times, to dislodge the gas bubbles that may be trapped in the electrolytic chamber.
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:** Cartridge leaks.

**ACTION:** Replace the cartridge.

**CAUSE:** RFIC Eluent Degasser leaks.

**ACTION:** Replace the RFIC Eluent Degasser.

**CAUSE:** Cartridge electrical connection is open.

**ACTION:** Tug gently on the 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:** Cartridge input electrical connection has shorted out.

**ACTION:** Replace the cartridge.

**CAUSE:** Cartridge input electrical connection has shorted out.

**ACTION:** Replace the cartridge.

**CAUSE:** Electrical error. The EG current and/or voltage may have become unstable.

**ACTION:** Contact Dionex for assistance.

The Dionex ICS-3000, Dionex ICS-5000 and Dionex ICS-5000+ EG 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:** Cartridge leaks.

**ACTION:** Replace the 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.

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**NOTE**

*The 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 Cartridges, the DP/SP automatically turns off electrical power to the cartridge when excessive current or voltage is detected.

**ACTION:** Ensure the Cartridge electrical cable is properly connected to the ICS 3000 EG module. If failure persists, contact Dionex for assistance.

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**NOTE**

The Dionex ICS-3000, Dionex ICS-5000 and Dionex ICS-5000+ EG Ion Chromatography System electronics components cannot be serviced by the user.

**CAUSE:** 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 EG module) via a USB cable (P/N 960777). In addition, one module in the system must be connected to the PC on which Dionex Chromeleon or Dionex 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 Dionex EGC III 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 Dionex EGC III, adding parts one at a time until an abnormal pressure increase (and hence, the restriction) is found.

6.8 No Peaks

**CAUSE:** Dionex EGC current may not be on. The Chromeleon program may not be started.

**ACTION:** Make sure EG current is applied. Configure Dionex EGC correctly using Dionex 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 program is too large.

**ACTION:** Check the Dionex 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 Dionex EGC leak in the membrane barrier. (This leak will not be detected immediately by the EG Module 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.
Optional Anion Trap Column – High Capacity (Dionex IonPac ATC-HC) or Cation Trap Column (Dionex IonPac CTC-1)

As an alternative to the Dionex CR-ATC 500, the Dionex ATC-HC or Dionex ATC-HC 500 can be used for anion applications (Dionex EGC 500 KOH, Dionex EGC III KOH, Dionex EGC III NaOH or Dionex EGC III LiOH). The Dionex IonPac ATC-HC and Dionex IonPac ATC-HC 500 will require regular off-line chemical regeneration. See the Dionex IonPac ATC-HC Trap Column Product Manual (Document No. 032697) for details.

The Dionex IonPac CTC-1 and Dionex IonPac CTC 500 can be used an alternative to the Dionex CR-CTC 500 for cation applications (Dionex EGC 500 MSA and Dionex EGC III MSA). The Dionex IonPac CTC-1 and Dionex IonPac CTC 500 will require regular off-line chemical regeneration. See the Dionex IonPac CTC-1 Trap Column Product Manual (P/N 031910) for details.

**Do not use the Dionex IonPac ATC-HC, Dionex IonPac ATC-HC 500, Dionex IonPac CTC-1 or Dionex IonPac CTC 500 for capillary applications. Capillary RFIC-EG systems are only compatible with the Dionex CR-TC (Capillary) trap columns.**

A. Prepare the Dionex IonPac ATC-HC (P/N 059604) or Dionex IonPac ATC-HC 500 (P/N 075978) for use by flushing the trap column with 200 mL of 2.0 M NaOH or KOH at 2 mL/min. Alternatively, prepare the Dionex IonPac CTC-1 or Dionex IonPac CTC 500 (P/N 075977) for use by flushing the trap column with 200 mL of 1.0 M H2SO4 or 2.0 M MSA at 2 mL/min.

B. Rinse the Dionex IonPac ATC-HC, Dionex IonPac ATC-HC 500, Dionex IonPac CTC 500 or Dionex IonPac CTC-1 with degassed DI water for 20 minutes at 2 mL/min.

C. Attach the Dionex IonPac ATC/CTC Bracket (P/N 046384) found in the EG Ship Kit.

D. Connect the pump pressure transducer outlet to the Dionex IonPac ATC-HC, Dionex IonPac ATC-HC 500, Dionex IonPac CTC-1 or Dionex IonPac CTC 500 inlet using the tubing connected to the exit of the pump pressure transducer.

E. Connect the outlet of the Dionex IonPac ATC-HC, Dionex IonPac ATC-HC 500, Dionex IonPac CTC-1 or Dionex IonPac CTC 500 to the inlet of the EGC using the tubing labeled TO PUMP OUT / DAMPER at one end and Dionex EGC IN at the other end.

F. Connect the tubing, labeled, DEGAS ELUENT IN, extending from the Degas Assembly to the outlet of the Dionex EGC labeled EGC OUT.