Thermo SCIENTIFIC

Errata

Product Manual for EG50
031908-03

For new orders of the following parts discussed in this manual, please use the updated part numbers listed below.

Part	Old Part Number in this manual	Updated Part Number to use for new orders
ASSY,DG,EG40	*053721*	*AAA-053721*
ASSY,COIL,2ML/MIN 500PSI,EG40	*053762*	*AAA-053762*
ASSY,COIL,2ML/MIN,1000PSI,EG40	*053763*	*AAA-053763*

PRODUCT MANUAL

for

EG50

DIONEX

IC | HPLC | MS | EXTRACTION | PROCESS | AUTOMATION

Product Manual

for

EG50

Document No. 031908
Revision 03
1 April 2009

TABLE OF CONTENTS

SECTION 1 - INTRODUCTION

The EG50 eluent generator is capable of generating high purity acid or base eluents online at the point of use utilizing only deionized water as the carrier. The EG50 eluent generator consists of four major components: a high precision programmable current source (power supply), a DX-LAN automation interface, a high pressure gas removal device, and a disposable eluent generator cartridge. The EG50 eluent generator can be configured with either an EluGen® EGC II KOH Cartridge (P/N 058900) for generation of potassium hydroxide (KOH) eluent for anion separations or an EluGen EGC II MSA Cartridge (P/N 058902) for generation of methanesulfonic acid (MSA) eluent for cation separations.

The use of eluent generators in ion chromatography has several significant advantages. Separations can be performed using only deionized water as the carrier. The need to prepare eluent is eliminated because the base or acid eluent is generated online at the point of use. Eluent generators produce high purity, contaminant free acid and base eluents online. The use of these high purity eluents can significantly improve the performance of ion chromatography methods.

Traditionally, the acid or base eluents are prepared off-line by dilution from reagent-grade chemicals. This process can be tedious, prone to operator errors, and often introduces contaminants. The preparation of carbonate-free NaOH or KOH eluents, which are widely used as eluents in the ion chromatographic separation of anions, is difficult because carbonate can be introduced as an impurity from the source chemical, from the reagent water, or by adsorption of carbon dioxide from air. The presence of carbonate in NaOH or KOH eluents can compromise the performance of an ion chromatographic method by causing undesirable chromatographic baseline drift during the hydroxide gradient and even irreproducible retention times for analytes. The use of the EG50 Eluent Generator System eliminates these problems.

Another advantage of the EG50 is the convenience of eluent generator control. Gradient separations can be performed using electrical current to generate gradients with minimal delay. In addition, the use of the EG50 can reduce the maintenance costs of the pumping system since the pump need only pump deionized water instead of the more corrosive acid or base eluent.

The EG50 also contains a power supply controller for operation of a Continuously Regenerated Trap Column (CR-TC). The CR-TC removes any extraneous contaminants from the DI water source. The Continuously Regenerated Trap Column is electrolytically regenerated, thus eliminating the need for online chemical regeneration. A CR-ATC Trap Column is used for anion exchange applications while a CR-CTC Trap Column is used for cation exchange applications.

1.1 EluGen EGC II KOH Cartridge Principle of Operation

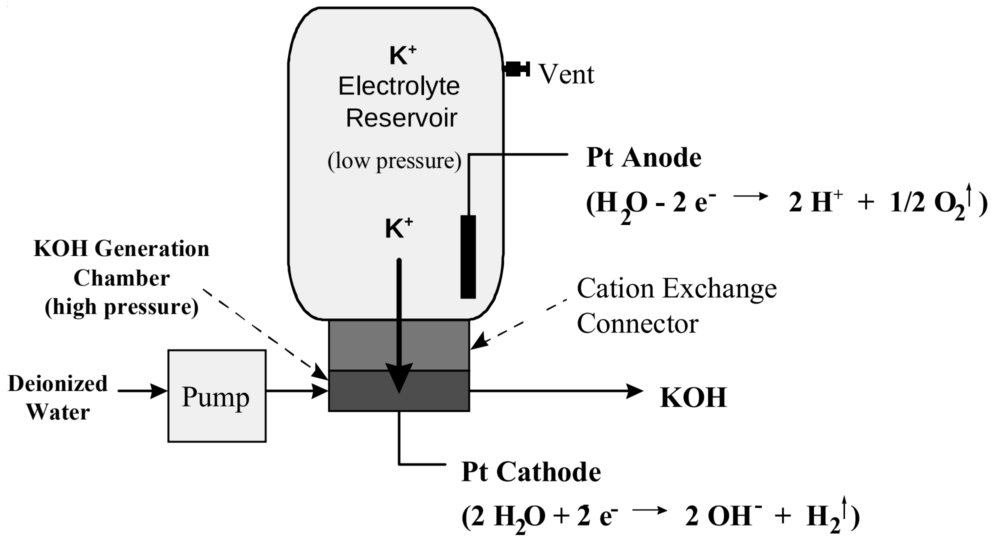


Figure 1
EluGen EGC II KOH Cartridge for
Potassium Hydroxide (KOH) Generation

The eluent generator cartridge is the heart of the eluent generation process. Figure 1, "EluGen EGC II KOH Cartridge for Potassium Hydroxide (KOH) Generation," illustrates the operation principle of an EGC II KOH cartridge. The cartridge consists of a high pressure KOH generation chamber and a low pressure K^+ ion electrolyte reservoir. The KOH generation chamber contains a perforated platinum (Pt) cathode where hydroxide ions are formed. The K^+ ion electrolyte reservoir contains a Pt anode and an electrolyte solution of K^+ ions. The KOH generation chamber is connected to the electrolyte reservoir by means of a cation exchange connector which permits the passage of K^+ ions from the electrolyte reservoir into the high pressure generation chamber, while preventing the passage of anions from the K^+ ion 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 eluent, deionized water is pumped through the KOH generation chamber and a DC current is applied between the anode and cathode of the EluGen cartridge. 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^+ electrolyte reservoir.

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

Water is reduced to form OH^- ions and hydrogen gas at the cathode in the KOH generation chamber,

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

As H^+ ions, generated at the anode, displace K^+ ions in the electrolyte reservoir, the displaced K^+ ions migrate across the cation exchange connector into the KOH generation chamber. These K^+ ions combine with OH^- ions generated at the cathode to produce the KOH solution, which is used as the eluent for anion exchange chromatography. The concentration of generated KOH is determined by the current applied to the KOH generator and the carrier water flow rate through the KOH generation chamber. Therefore, given the carrier flow rate, the EG50 will precisely control the applied current to accurately and reproducibly generate KOH at the desired concentration.

1.2 EluGen EGC II MSA Cartridge Principle of Operation

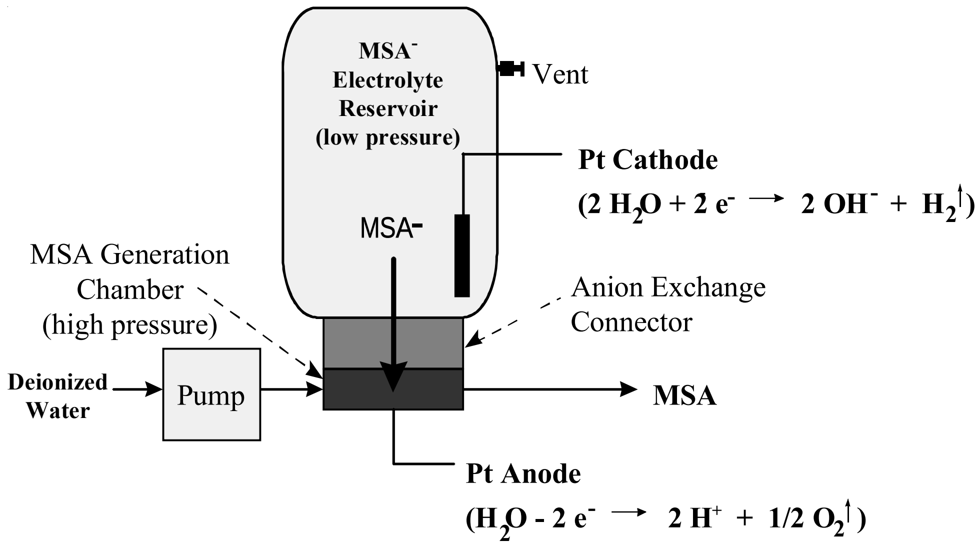


Figure 2
EluGen EGC II MSA Cartridge for Methanesulfonic Acid (MSA) Eluent Generation

The concept described for the generation of KOH can be applied to the generation of acid. Figure 2, "EluGen EGC II MSA Cartridge for Methanesulfonic Acid (MSA) Eluent Generation," illustrates the operation principle of an EGC II MSA cartridge. The cartridge consists of a high pressure methanesulfonic acid (MSA) generation chamber and a low pressure methanesulfonate (MSA^-) ion electrolyte reservoir. The generation chamber contains a perforated platinum (Pt) anode. The electrolyte reservoir contains a Pt cathode and an electrolyte solution of MSA^- ions. The 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 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.

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

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

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

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 EG50 will control the applied current in order to accurately and reproducibly generate MSA at the desired concentration.

1.3 System Flow Diagram

1.3.1 EG50 with CR-TC Trap Column

The use of the EG50 Eluent Generator in a typical ion chromatography system is shown in Figure 3, “System Flow Diagram using EG50 Eluent Generator.” The EG50 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 EG50 Eluent Generator. For anion analysis, a Continuously Regenerated Anion Trap Column (CR-ATC, P/N 060477), should be placed at the EGC outlet to remove dissolved carbon dioxide and other anionic contaminants from the deionized water. For cation analysis, a Continuously Regenerated Cation Trap Column (CR-CTC, P/N 060478) should be placed at the 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 CR-TC Trap Column 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 KOH or MSA eluent passes through the injector, the 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, See Figure 3, “System Flow Diagram for Ion Exchange Applications Using the EG50 Eluent Generator.”

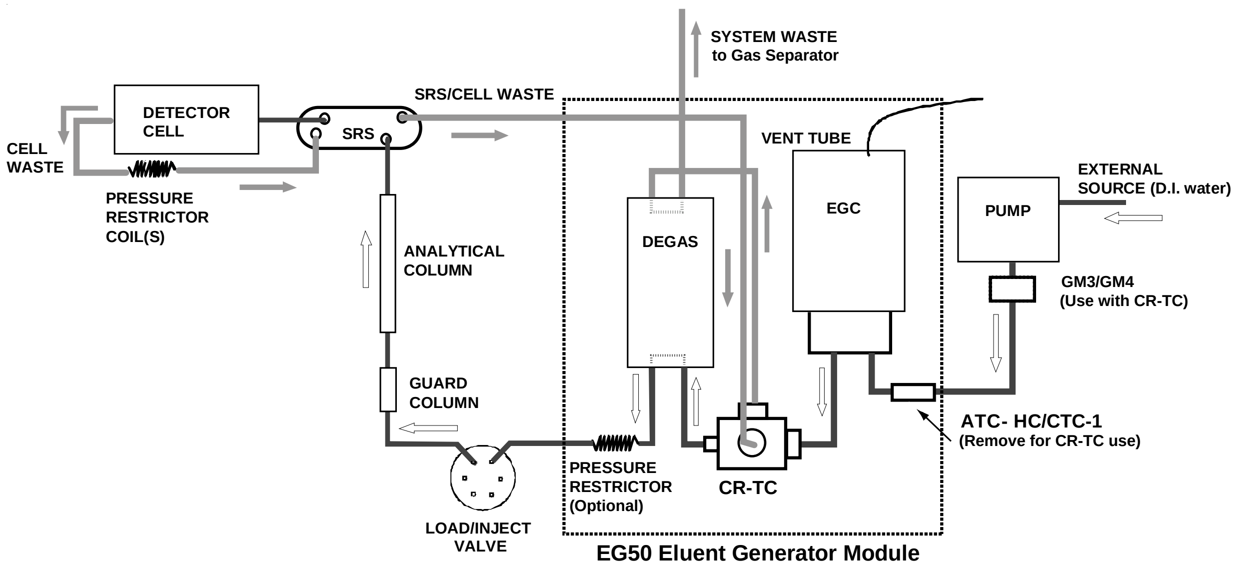


Figure 3
System Flow Diagram for Ion Exchange Applications
Using the EG50 Eluent Generator with CR-TC

1.3.2 EG50 with ATC-HC or CRC Trap Columns

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

1.3.3 EG50 with Ultra Violet (UV) Detection

When using UV detection, the detector effluent is directed to flow through the CR-TC regenerant flow pathway and degas tubing assembly to remove any released hydrogen gas as shown in Figure 4.

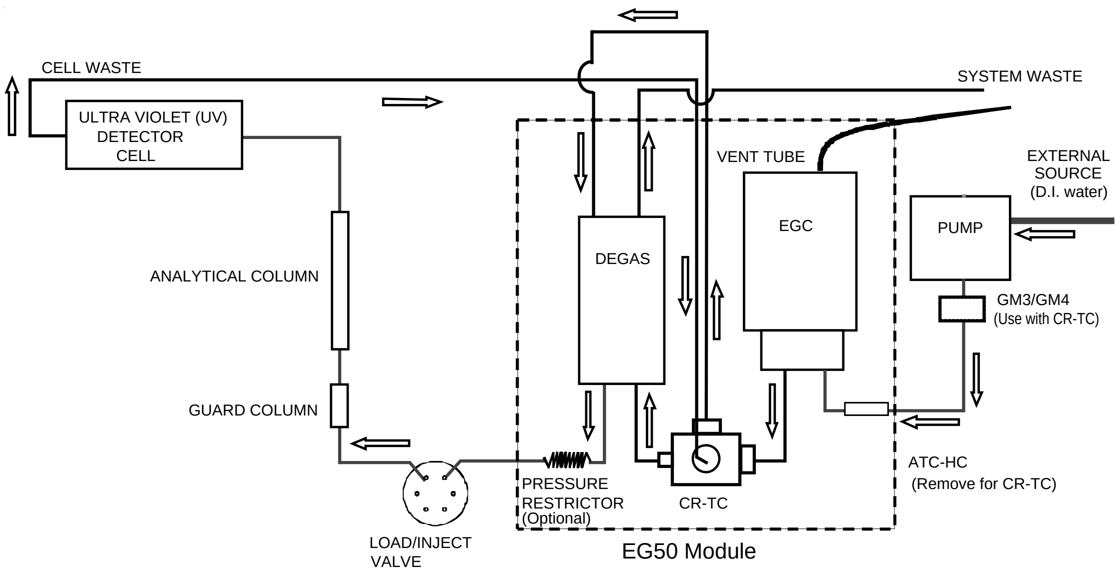


Figure 4
System Flow Diagram for UV Applications
Using the EG50 Eluent Generator

1.3.4 EG50 with Amperometric Detection

For carbohydrate analysis, amperometric detector cell effluent is directed to the CR-ATC REGEN IN and then REGEN OUT is diverted to waste. The EG Vacuum Degas Conversion Kit is installed to vacuum-degas the eluent after the EG and CR-ATC, and prior to the injection valve. A GP40, GP50, GS50, ICS-3000 DP or SP with vacuum degas option is required. The EG Vacuum Degas Conversion Kit P/N 055431 contains all components required to convert the vacuum degas pump inside the GP40, GP50, GS50 model gradient pumps to remove H2 gas from the EG Degas module. The EG/DP/SP Vacuum Degas Conversion Kit P/N 063353 converts the ICS-3000 DP or SP gradient pumps. An external degas pump kit P/N 066463 can also be used without using the GP40, GP50, GS50, DP, or SP internal vacuum degas pump.

Carbohydrate applications that require greater than 100 mM (the upper concentration limit for the EG50), but less than 200 mM KOH or NaOH eluent concentration may use manually prepared eluent to supplement the hydroxide produced by the EG. For example, the EG 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 EG50 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 EG cartridge and the CR-ATC, the EG must be left on at low eluent concentration (e.g., 0.5 mM) to ensure polarization of the EG cartridge membranes and ensure longevity of the device. The use of combined EG50 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 Dionex Technical Note 71.

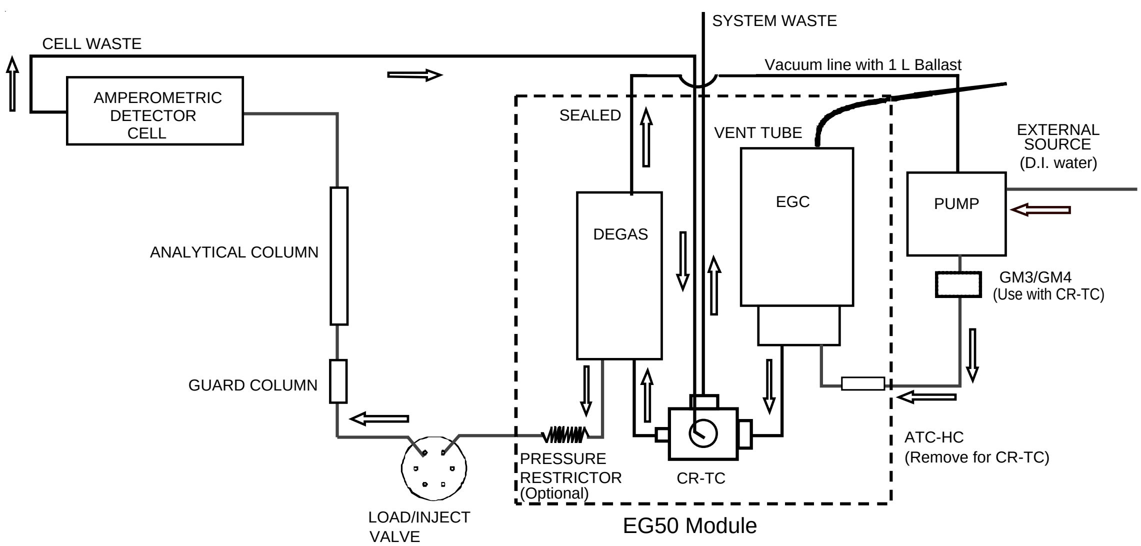


Figure 5
System Flow Diagram for Carbohydrate Applications Using the EG50 Eluent Generator

1.4 EG50 Eluent Generator Module

The EG50 Eluent Generator module includes power supplies for the EGC cartridge and CR-TC Trap Column, a built-in LAN card, a high pressure gas removal device, a bracket for mounting the EluGen cartridge, and a mounting plate for installing the CR-TC Trap Column.

1.4.1 EG50 Module Front Panel

1. The main power switch controls the power to the EG50 Module.

2. The power LED indicator beside the push-button switch is illuminated when the power is turned on.

3. The Leak LED indicator is illuminated when the leak sensor detects liquid leaks inside the EG50 Module.

4. The Fault LED indicator is illuminated when the eluent generator current or voltage output is too low or too high.

5. The small viewing port displays the EG50 system waste line. During operation, the waste line will contain a steady flow of bubbles which are visible through the viewing port.

6. The reservoir container on top of the EG50 module holds two 1-liter (P/N 044128) plastic reservoirs, two 2-liter (P/N 044129) plastic reservoirs, or one reservoir of each size. Place either deionized water or eluents in the reservoirs.

   NOTE: ***Eluent reservoirs are purchased separately.***

7. Tubing chases are located on each side of the EG50 module to allow easy connection of lines between modules.

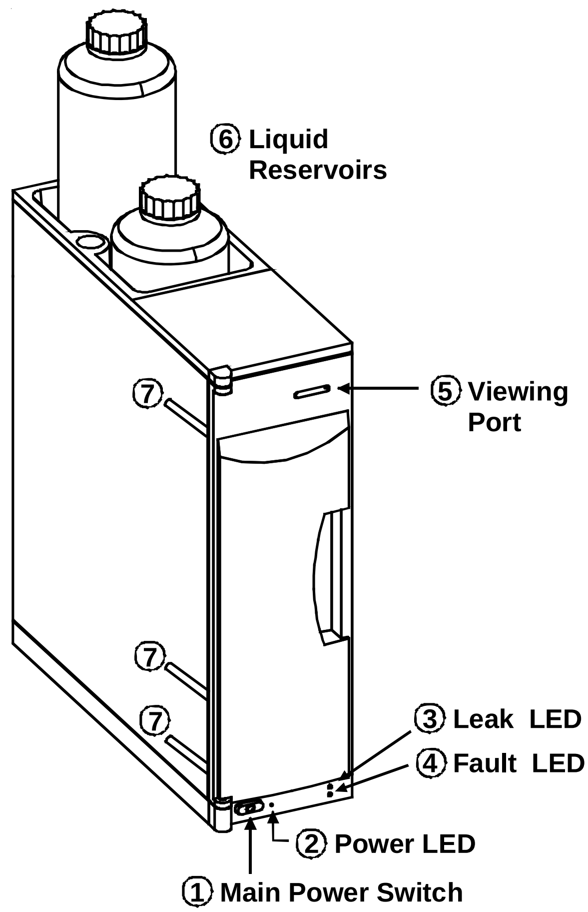


Figure 6
EG50 Module Front Panel

1.4.2 EG50 Module Mechanical Components

The following text is a discussion of the EG50 Module mechanical components illustrated in Figure 7, "EG50 Module Interior":

1. The EG50 is operated with one of two EluGen cartridges: either an EGC II KOH (P/N 058900) for anion separations or an EGC II MSA (P/N 058902) for cation separations. Each EGC cartridge contains 900 mL of the appropriate electrolyte concentrate solution for eluent generation.

2. The high pressure degas tubing assembly (P/N 053721) purges the electrolysis gas from the freshly-generated eluent before it is directed into the analytical column.

3. For anion separations, install a CR-ATC Anion Trap Column to remove anionic contaminants such as carbonate (dissolved carbon dioxide) from the deionized water. For cation applications, install a CR-CTC Cation Trap Column to remove cationic contaminants such as ammonium from the deionized water.

4. The leak sensor detects liquid leaks inside the EG50 Module and sends a signal to illuminate the LED on the front panel and also activates a PeakNet or Chromeleon warning.

5. The EG50 power supply and printed circuit boards are located at the back of the EG50 module.

6. EGC and CR-TC Power Connectors. The EGC cartridge and CR-TC Trap Column are connected to the EG50 power supplies by device power connectors located at the lower back panel.

7. The power LED indicator will illuminate to indicate that the power to the CR-TC is enabled.

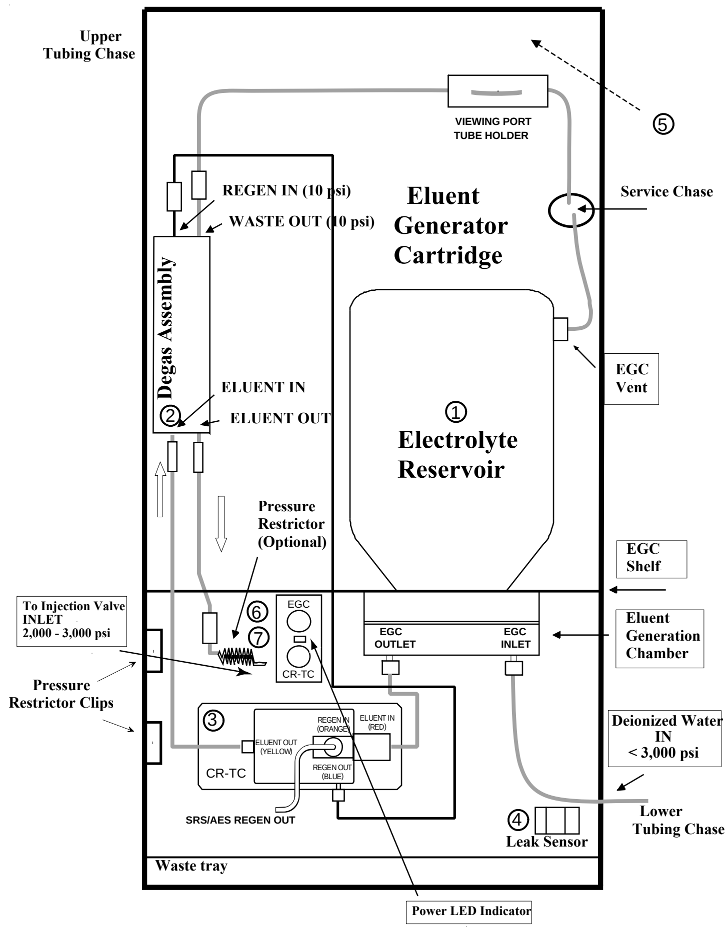


Figure 7
EG50 Module Interior

1.4.3 EG50 Module Rear Panel

1. **DX-LAN Connection:** The DX-LAN cable (P/N 960281) connects from the network hub to the DX-LAN Connector (see Figure 8, "EG50 Module Rear Panel").

2. **Electrical Connections:** The main power receptacle includes a fuse holder with two 3.15 Amp, Fast-Blow IEC127 fuses (P/N 954745) rated at 3.15 amps at 250 VAC. A modular power cord (1EC 320 C13) is required and must be ordered separately.

CAUTION HIGH VOLTAGE

Accessing the EG50 Module electronics compartment by removing the rear panel of the EG50 will expose users to high voltage. There are no user-serviceable components in the electronics compartment.

CAUTION

The power cord is used as the main disconnect device. Make sure a socket-outlet is located near the EG50 Module and is easily accessible.

3. **TTL Inputs:** The two TTL inputs can be connected to devices capable of providing TTL signals such as an AS3500, AS40, or AS50 autosampler.

   TTL-1 IN turns the EG50 on and off.
   TTL-2 IN starts the EG50 method.

4. **TTL Outputs:** EG50 currently provides one TTL output (**TTL-1 OUT**) to control an external device that can be controlled via TTL signals (such as an autosampler or other DX-500 or DX-600 module). **TTL-2 OUT** is not functional and is reserved for future feature expansion.

5. **Drip Tray Drain Line:** Liquid spills in the drip tray are removed from the EG50 via the clear corrugated drip tray waste line.

6. **Gas Waste Line:** Two waste lines exit the EG50 via the vent service chase. The clear tubing is the gas tubing that discharges the electrolysis gas which has been vented from the EGC electrolyte reservoir.

   Gas Generation: The EG50 Module generates eluent by means of electrolysis which results in the production of small amounts of oxygen or hydrogen (up to 2 mL/min at ambient pressure and temperature). Install the SRS Gas Separator Waste Tube, provided with your conductivity detector, according to the instructions that come with the liquid-waste/gas separator. To prevent H_2 and O_2 buildup, operate the EG50 module in properly ventilated areas only. The System Waste Line should be connected to the SRS Gas Separator Waste Tube provided in the detector ship kit.

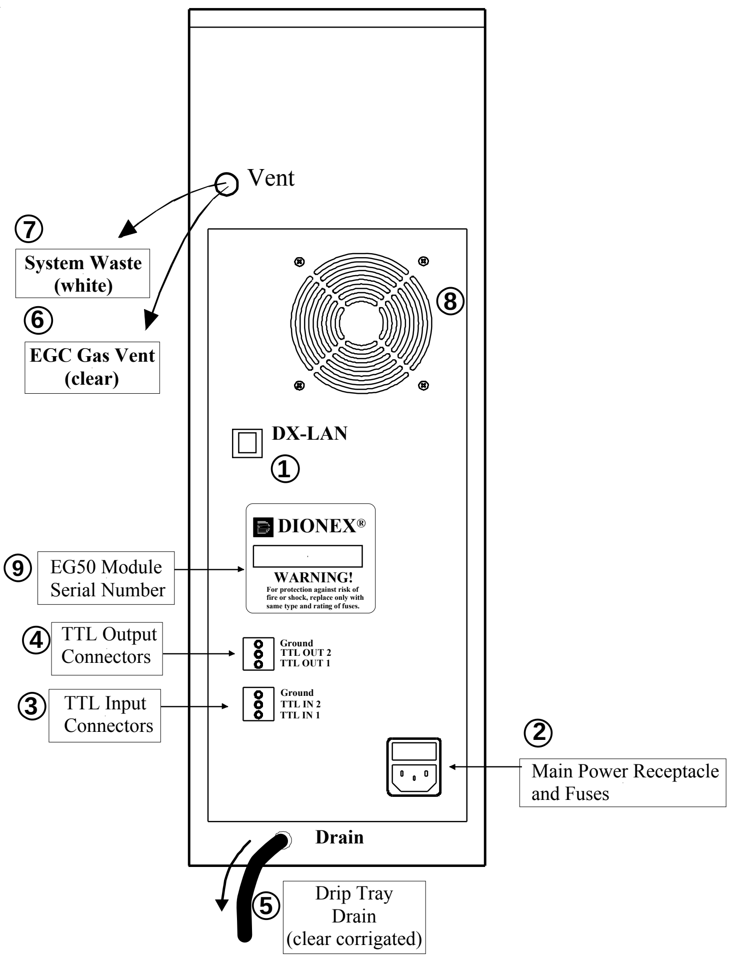


Figure 8
EG50 Module Rear Panel

7. **System Eluent Waste Line:** The system waste line (white tubing) discharges the liquid and gas waste from the high pressure degas tubing assembly and the SRS Suppressor. This line is marked **WASTE OUT** inside the EG50 module.

8. **Exhaust Fan:** The exhaust fan cools the interior of the EG50 and exhausts any stray hydrogen and oxygen gases that may escape during operation.

9. **Model Data Label:** The Model Data Label includes safety warnings, the system serial number, and the model name.

SECTION 2 - INSTALLATION

2.1 Facility Requirements

Power	85 to 265 VAC, 47 to 63 Hz; operates across the entire voltage and frequency range without any switching required
Ambient Temperature	4 to 40°C (39 to 104°F)
Humidity	10 to 90% relative humidity, noncondensing
Deionized Water	ASTM Type I reagent-grade water with a resistivity of 18.2 megohm-cm
Room Air Circulation	To prevent the buildup of hydrogen and oxygen gases, install the EG50 in a well-ventilated site.

2.2 Installing Chromeleon or PeakNet Software

PeakNet® 6.4 SP3 or Chromeleon® 6.5 SP1 or higher is required for EG50 Eluent Generator operation. Refer to "Installing the Dionex PeakNet System" (Document No. 034941) or refer to "Dionex Chromeleon Installation Manual, Rev. 6.5" (Document No. 4829.5060) for software installation instructions.

2.3 EG50 Module Installation

2.3.1 Module Arrangement

Dionex DX-320, DX-500, or DX-600 System modules are designed to be stacked on top of each other up to a maximum height of four units. The EG50 is three units high. No modules should be stacked on top of the EG50. Figure 9, "Typical System Configuration," illustrates a typical system configuration.

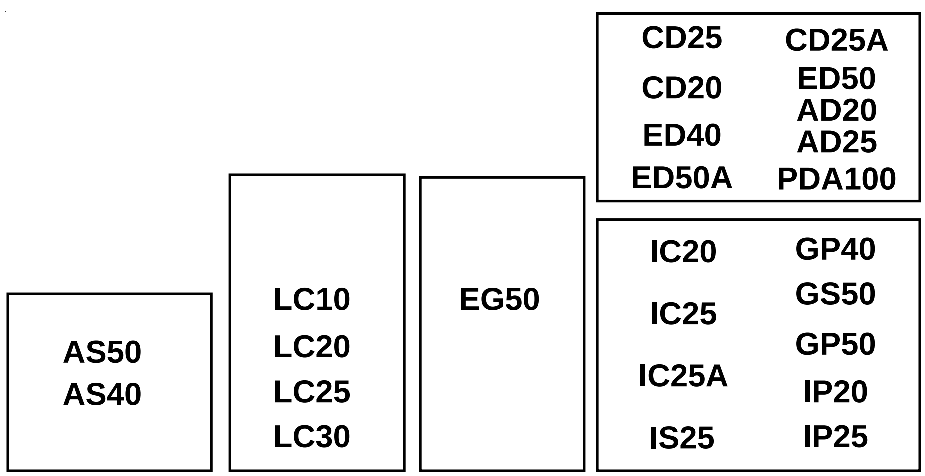


Figure 9
Typical System Configuration

2.3.2 Power Connections

Connect the appropriate 3-prong (grounded) main power cord to the receptacle on the rear panel. Connect the other end of the cord to the correct AC power source.

CAUTION

The power cord is used as the main disconnect device. Make sure a socket-outlet is located near the EG50 Module and is easily accessible.

2.3.3 DX-LAN Cable

The DX-LAN™ cable (P/N 960281) is supplied in the EG50 Module ship kit. Connect the DX-LAN cable from the network hub to the EG50 connector. All system modules are connected together with DX-LAN cables.

2.3.4 TTL Connections and Control

See Section 8 for TTL connections and control instructions.

2.4 EluGen Cartridge Installation

Follow the installation and equilibration steps for the EGC cartridge listed below.

2.4.1 EGC Plumbing

A. Unbox the EG50 Cartridge (EGC II KOH, P/N 058900 or EGC II MSA, P/N 058902). Save the box and foam for future storage.

B. Place the EluGen Cartridge on a flat surface in front of the EG50 Module with the Electrolysis chamber and EGC **INLET** and **OUTLET** fittings facing up. See Figure 10.

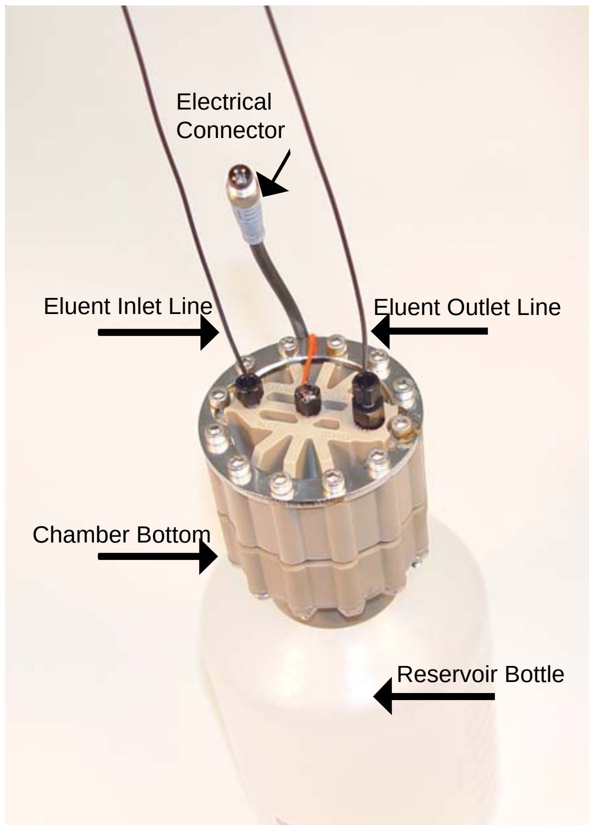


Figure 10
Bottom of EGC II Cartridge

C. Locate the black tubing assembly shipped in a plastic bag and placed in the bottle holder on top of the EG50. This black tubing has a **EGC-IN** at one end and **PUMP OUT** label at the other end. Connect the **PUMP OUT** side of the tubing to the pump. Connect the other end, labeled **EGC-IN** to the **INLET** port of the EGC. See Figure 10.

D. Attach a backpressure restrictor tubing (P/N 053765), supplied with the EG50 ship kit, to the EGC **OUTLET** port on the EGC cartridge. This tubing will produce 2000 psi at a flow rate of 1 mL/min.

E. Divert the other free end of the backpressure restriction tubing to waste.

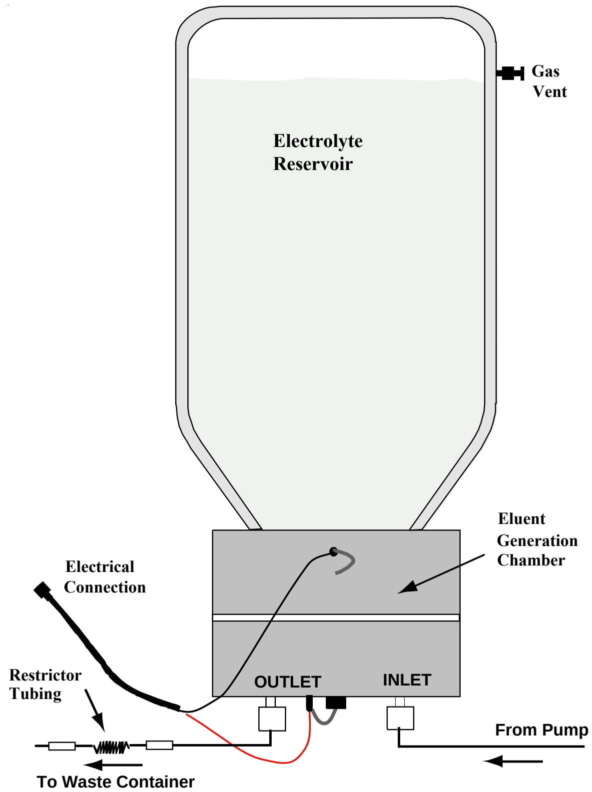


Figure 11
EGC Cartridge

2.4.2 EGC Cartridge Preparation

A. NOTE: Invert the EluGen Cartridge with the Eluent Generation Chamber downward as shown in Figure 11, "EGC Cartridge." Shake the EluGen Cartridge 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 eluent generation chamber are dislodged. Be sure to repeat this process each time the EGC cartridge is turned with the eluent generation chamber upward.

B. Position the EluGen Cartridge in the EG50 Module with the eluent generation chamber downward by positioning the PEEK chamber just below the shelf and the reservoir just above the shelf and sliding the cartridge through the opening in the shelf.

2.4.3 EGC Cartridge Conditioning

A. Turn On the pump from PeakNet or Chromeleon and set the flow rate to 1 mL/min. Set the EGC concentration to 50 mM from the EG50 panel.

B. Condition the EGC cartridge for 30 minutes at 50 mM KOH at 1 mL/min for anion applications or at 50 mM MSA at 1 mL/min for cation applications

C. Disconnect the backpressure restrictor tubing from the EGC cartridge outlet tubing and proceed to Section 2.5.1 for the CR-TC installation.

2.4.4 EluGen Cartridge Replacement

The EluGen cartridge must be replaced when the cartridge is expended, when it leaks, or in order to switch between anion and cation separations with a single eluent generator module such as the Eluent Generator (EG).

To remove the old cartridge:

A. Turn off the pump flow either manually or via direct control in the Chromeleon or PeakNet software. The power to the EluGen Cartridge and SRS suppressor will automatically shut off.

B. The electrical connector cable for the cartridge is plugged into a connector below the EluGen Cartridge shelf. Twist 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 EGC cartridge 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 EG50. The plug should be in the drip tray.

E. With the eluent lines still attached, and the electrical contacts facing you, lift the EluGen Cartridge from the EG50 Cartridge shelf and turn it so that the electrolysis chamber and liquid line fittings are upward.

F. Unscrew the cartridge inlet line from the EluGen Cartridge **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 EluGen Cartridge.

G. Prepare an expanded cartridge for disposal by completing the following: hold the cartridge with the generator chamber upward, unscrew the eluent generation chamber from the electrolyte reservoir, and pour the remaining electrolyte solution into an appropriate hazardous waste container. Refer to the Material Safety Data Sheet (MSDS) shipped with the EluGen Cartridge for the chemical description.

   Rinse the electrolyte reservoir and membranes with DI water three times. Rinsing should render the reservoir and the membranes nonhazardous; however, check with local, state, and federal regulatory agency regulations for proper disposal.

H. If the cartridge is not expended, plug all fittings and 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. To reinstall the cartridge, follow the start-up instructions in Section 2.2.

NOTE: When switching between anion and cation separations on the same system, flush the entire system (excluding the EluGen Cartridge, 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.

2.5 CR-TC Installation

Follow the steps in Section 2.5.1, 2.5.2, and 2.5.3 to install the CR-TC Trap Column. See Figure 12 for an overview of the EG50 plumbing schematic.

For anion exchange applications, use the CR-ATC Continuously Regenerated Anion Trap Column (P/N 060477).
For cation exchange applications, use the CR-CTC Continuously Regenerated Cation Trap Column (P/N 060478).

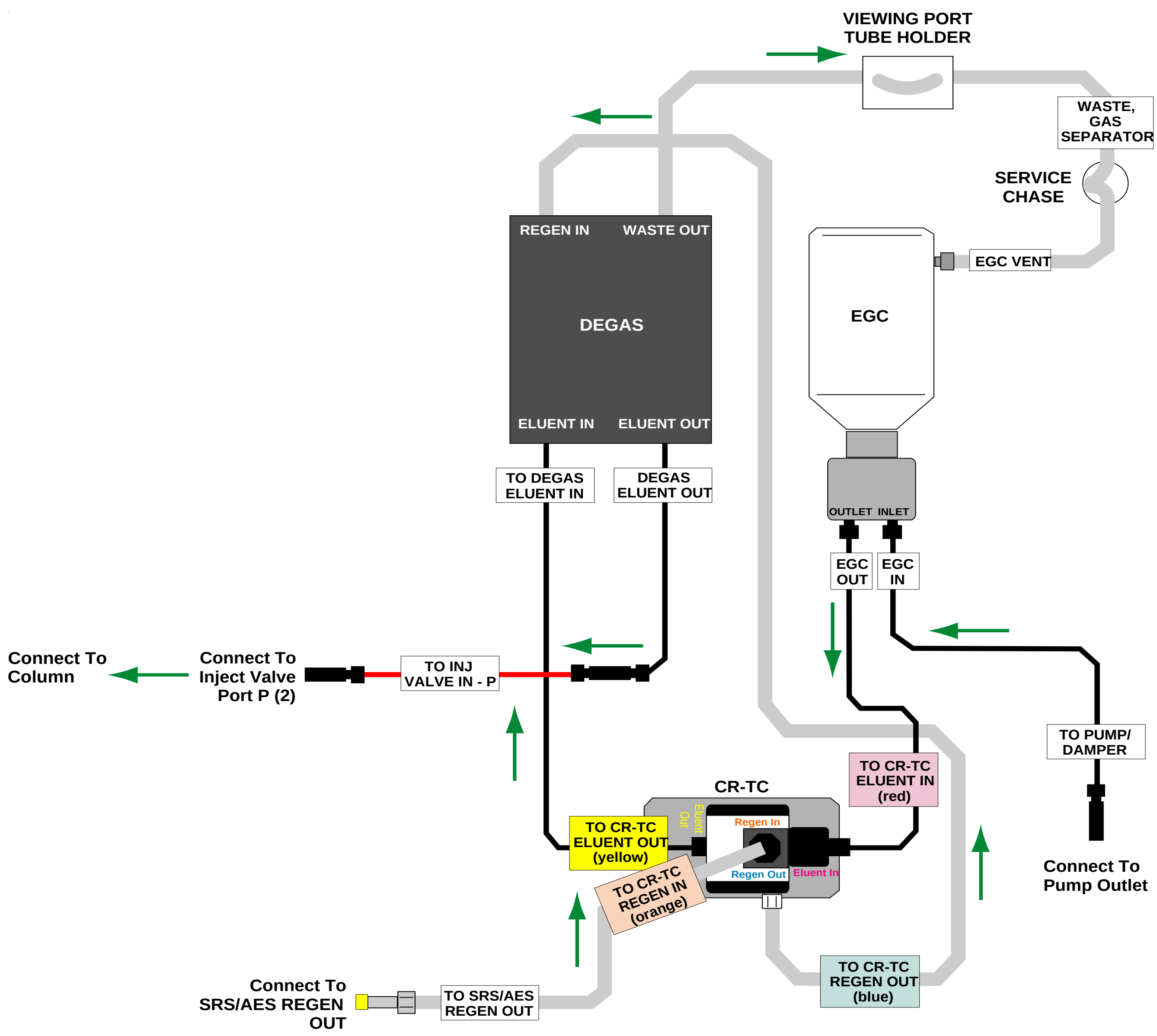


Figure 12
Plumbing Schematic for the EG50 with CR-TC

2.5.1 Initial CR-TC Installation before Hydration

A. To begin installation of the CR-TC tubing,

1. Turn off power to the pump, EGC Cartridge, CR-TC (if already present), and the suppressor (SRS/AES) before making any connections;

2. If present, disconnect all trap columns (ATC or CTC) installed between the EG50 and the Degas Assembly and all trap columns (ATC or CTC) installed between the pump and the EG50 module;

3. Remove the plugs on the CR-TC ports before installation. All fittings should be tightened to finger tight and a 1/4 turn. Note: Do not loosen or remove the fittings with the electrical connections (fittings with wires attached)

B. Identify the tubing with the red label in the ship kit. Connect the white label end marked **EGC OUT** to the outlet port of the EGC cartridge. The red label end of the tubing should be connected to the **Eluent In** port of the CR-TC (label marked Red). See Figure 12.

C. Connect the tubing with the Orange label to the CR-TC **Regen In** port (label marked Orange).

D. Connect the tubing with the Blue label to the CR-TC **Regen Out** port (label marked Blue).

E. Connect the tubing with the Yellow label to the CR-TC **Eluent Out** port (label marked Yellow).

F. The CR-TC is now ready for the hydration step. Go to Section 2.5.2.

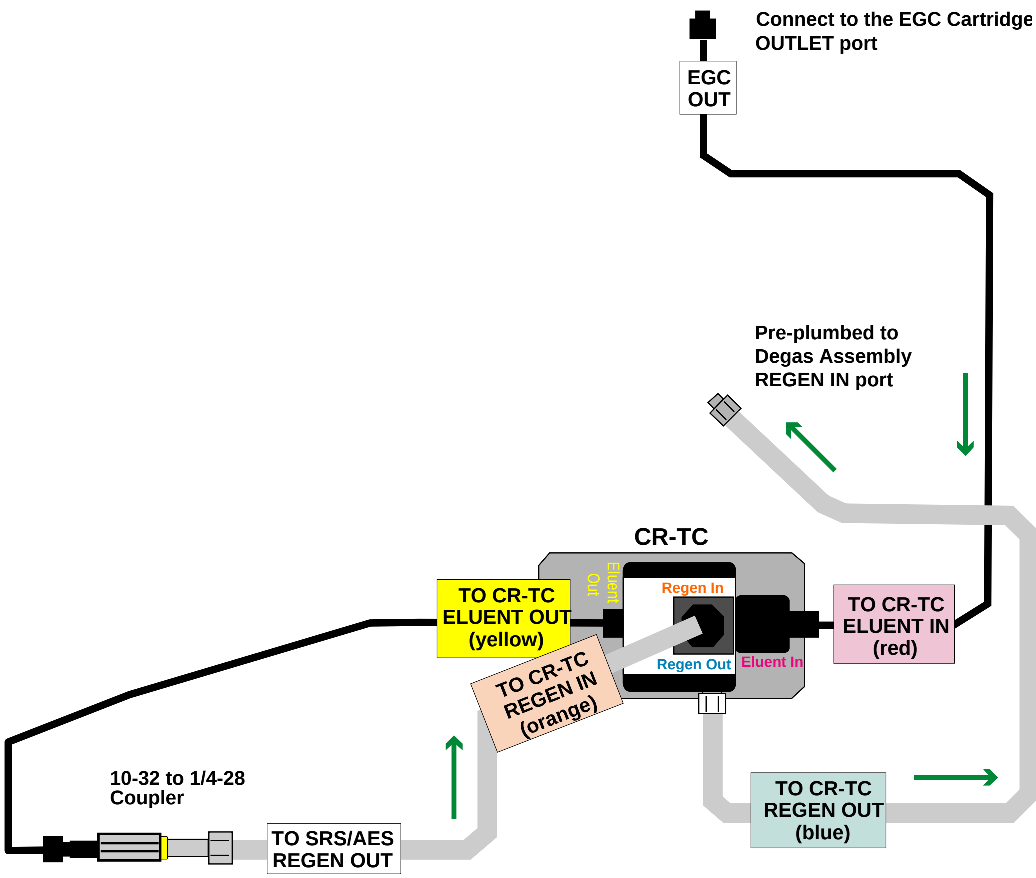


Figure 13
CR-TC Plumbing Diagram for Hydration

2.5.2 CR-TC Trap Column Hydration

The CR-TC should be hydrated prior to operation at first installation or after long-term storage. This process ensures that the CR-TC resin and membranes are fully hydrated and ready for operation

A. Disconnect the **ELUENT OUT** line protruding from the Degas Assembly at the end labeled **TO INJECTION VALVE IN-P** and connect this end to a 10-32 to 1/4-28 coupler (P/N 042806). Connect the free end of the tubing labeled **TO SRS/AES REGEN OUT** to the 1/4-28 end of the coupler. See Figure 13.

B. Ensure that the current to the EGC cartridge and suppressor are turned off. From the pump front panel, turn ON the pump flow rate to hydrate the CR-TC by pumping DI water at the flow rate of your 4-mm, 3-mm or 2-mm application for at least 10 minutes.

C. After the above hydration step, disconnect the coupler and complete the CR-TC installation by following the steps in Section 2.5.3. Ensure that the tubing labeled **TO INJECTION VALVE IN-P** is connected to the injection valve. An optional restricter tubing may be inserted before the injection valve.

2.5.3 Complete CR-TC Trap Column Plumbing for Operation

A. Verify that the tubing with the Red label **(TO CR-TC ELUENT IN)** is connected to the **Eluent In** port of the CR-TC. See Figure 13.

B. Verify that the other end of this tubing, with the White label **(EGC OUT),** is connected to the **OUTLET** port of the EGC Cartridge. See Figure 14.

C. Verify that the tubing with the Yellow label **(TO CR-TC ELUENT OUT)** is connected to the CR-TC **Eluent Out** port. See Figure 14.

D. Verify that the tubing with the Orange label **(TO CR-TC REGEN-IN)** is connected to the CR-TC **Regen In** port. See Figure 14.

E. Connect the other end of this tubing with the White label **(TO SRS/AES, REGEN OUT)** to the suppressor located in the Chromatography Module **REGEN OUT** port. See Figure 13.

F. Verify that the tubing with the Blue label **(TO CR-TC REGEN-OUT)** is connected to the CR-TC **Regen Out** port. See Figure 14.

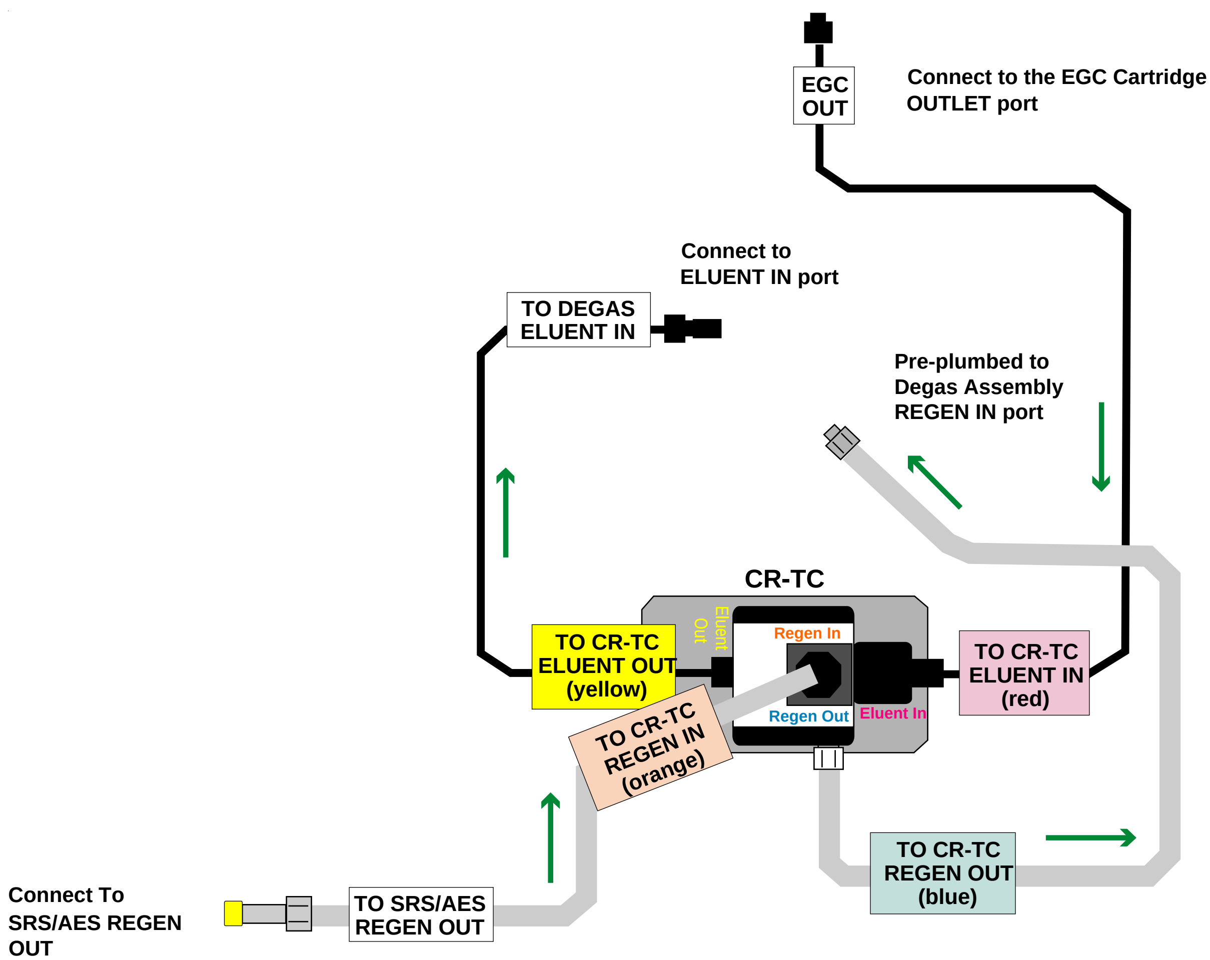


Figure 14
CR-TC Plumbing Diagram for Installation and Equilibration

2.5.4 Plumbing

Figure 15, "Plumbing Schematic for the EG40 with CR-TC," illustrates the EGC cartridge and CR-TC Trap Column plumbed and ready for operation.

2.5.5 Mounting CR-TC

A. The CR-TC is mounted on to the mounting plate by aligning the hole on the CR-TC back plate with the ball stud on the mounting plate and pushing the CR-TC firmly onto the mounting ball stud. The CR-TC will click into place when properly installed.

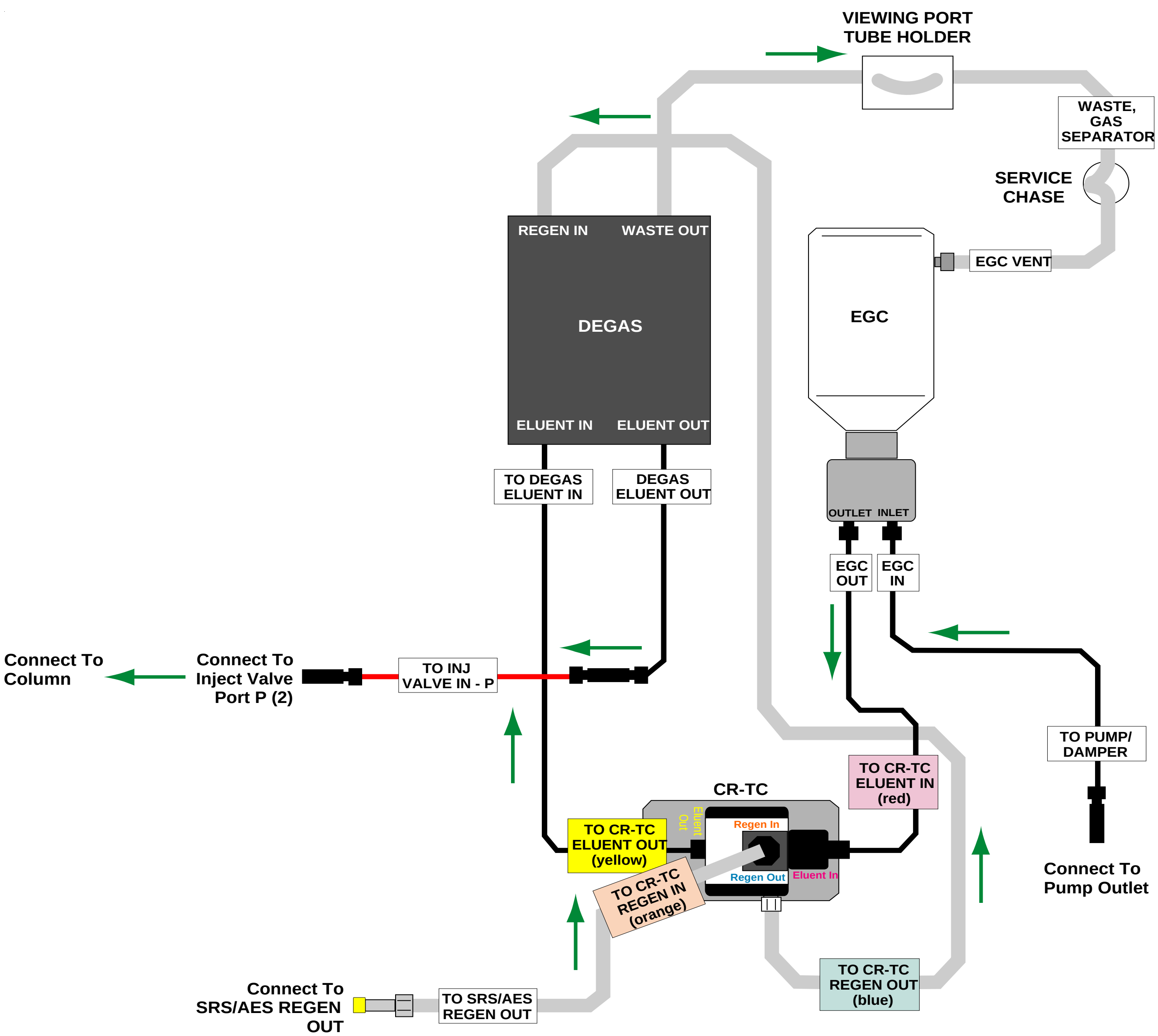


Figure 15
Plumbing Schematic for the EG50 with CR-TC

2.6 SRS Suppressor Plumbing for Recycle or External Water Mode

A. Plumb the SRS or Atlas Suppressor **REGEN OUT** port to the CR-TC **Regen In** port. See Figure 15 and 16 for plumbing diagram. (If using a ATC-HC or CTC-1 Trap Column, see Figure 43 in Appendix A for the plumbing diagram.)

B. The Self-Regenerating Suppressor may be operated in the SRS Recycle Mode or in the External Water Mode. See the SRS Product Manual for details. Be sure the entire system is plumbed according to either Figure 15 for the SRS Recycle Mode or Figure 16 for the SRS External Water Mode.

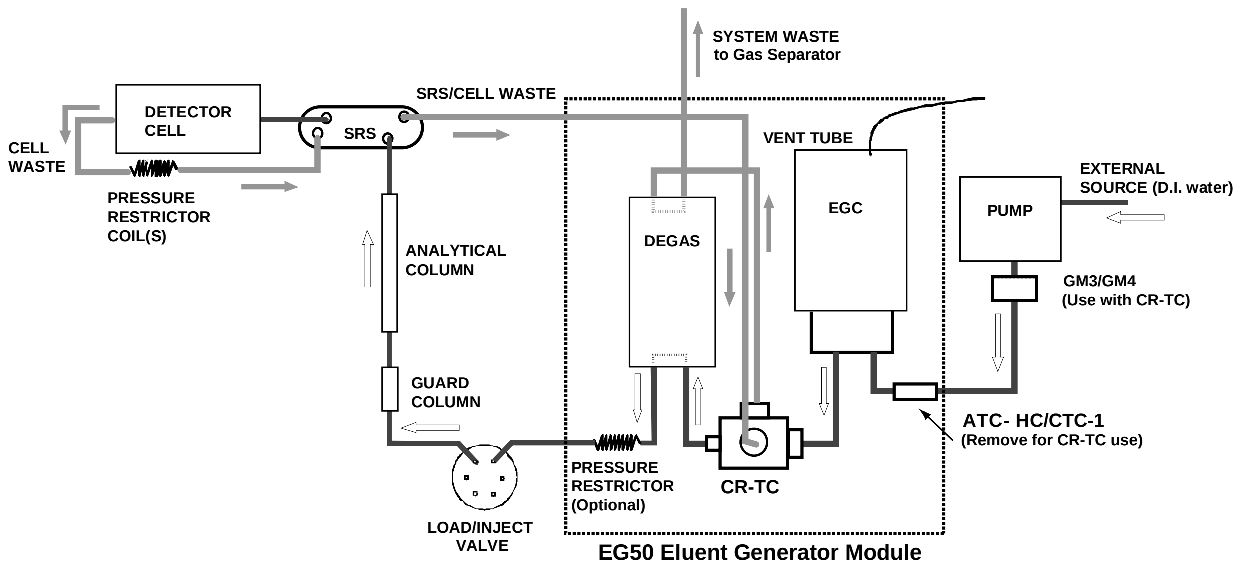


Figure 15
System Flow Diagram Using the SRS Recycle Water Mode

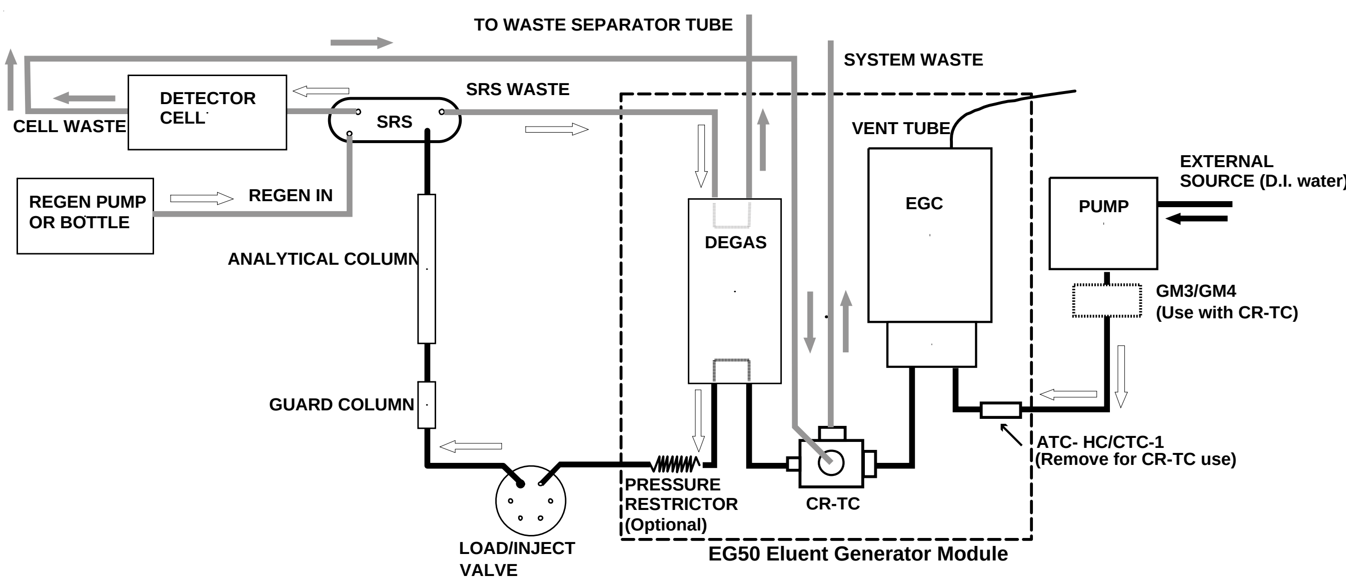


Figure 16
System Flow diagram using the SRS External Water Mode

2.7 Attaching the System Waste Lines

A. The EG50 requires a system waste line. The EG50 Module generates eluent by means of electrolysis which results in the production of small amounts of oxygen or hydrogen (up to 2 mL/min at ambient pressure and temperature). See Figure 17.

1. Install the SRS Gas Separator Waste Tube provided with your conductivity detector, according to the instructions that come with the liquid-waste/gas separator. Operate the EG50 module in properly ventilated areas only.

2. The System Waste Line should be connected to the SRS Gas Separator Waste Tube. Place the free end of the system waste line (located at the back of the EG50) into a waste container below the level of the EG50 to maintain a positive siphon.

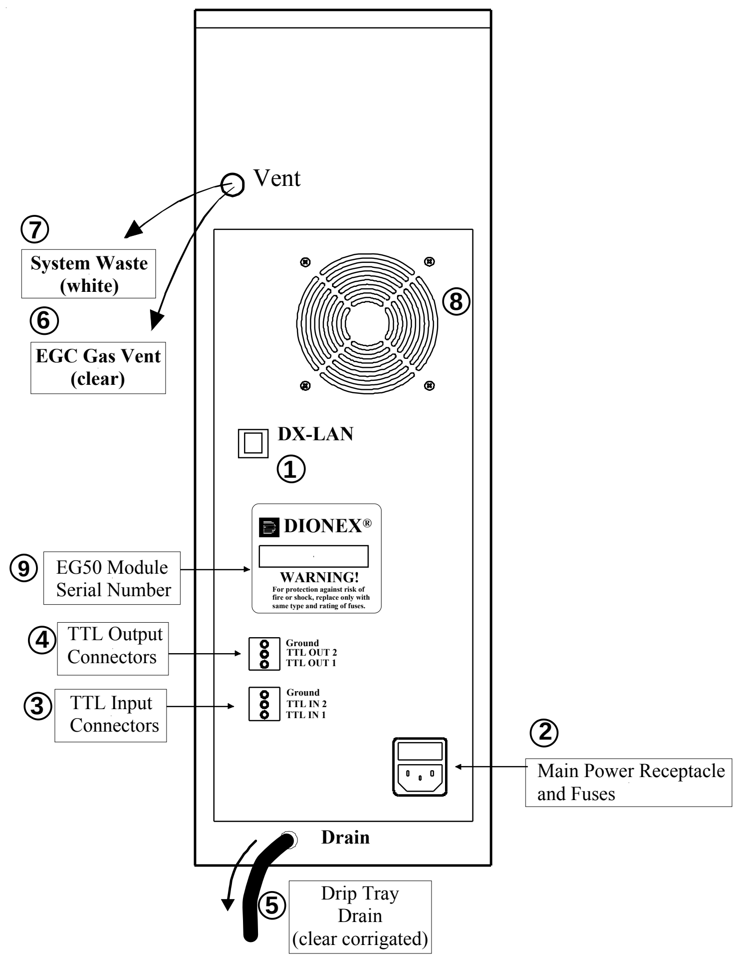


Figure 17
EG50 Module Rear Panel

The EG50 requires a drip tray drain line. Rest the corrugated drip tray drain line (located at the lower back of the EG50) on the tabletop and direct the line into a waste container. The drip tray line should not be pushed into the EG50.

C. The EluGen Cartridge is shipped with a vent line plug installed in the gas vent port of the EGC electrolyte reservoir.

1. Unscrew the plug and store it in the drip tray until required for disposal or storage of the EluGen Cartridge.

2. Screw the Luer adaptor, provided with the EGC Cartridge, into the vent hole. Using the Luer lock provided with the EGC Cartridge, connect the EluGen Cartridge Vent to the EG50 Module Vent Line. See Figure 18.

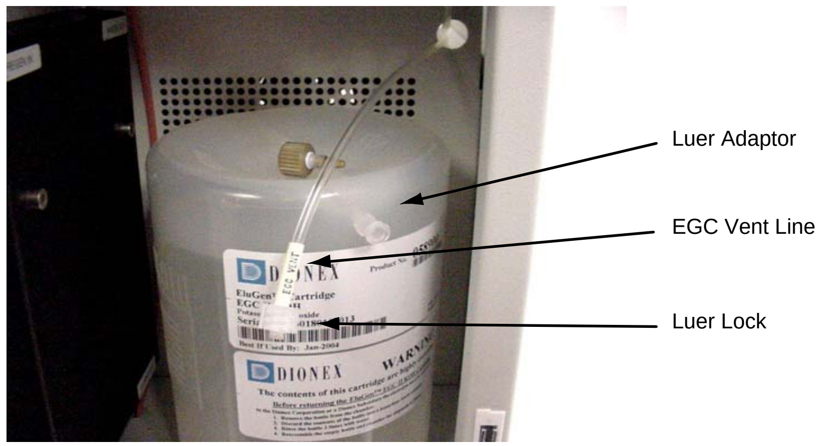


Figure 18
EGC II Cartridge Showing Vent and Line for Vent

3. Position the EluGen Cartridge with the gas vent pointing toward the right front corner of the EG50 Module with the gas waste line draped along the side of the module. You may need to feed additional waste line into the module to reach the Luer connection. See Figure 19.

Figure 19
Bottle with Vent Line

2.8 Completed Installation of EGC and CR-TC

The EGC Cartridge and CR-TC Trap Column are now installed for operation. See Figure 20.

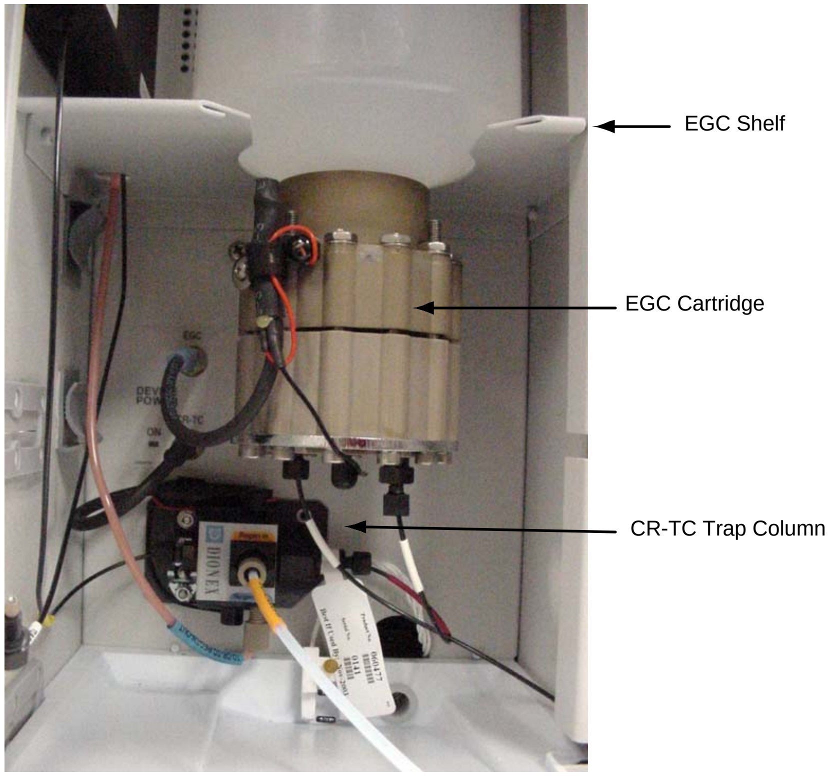


Figure 20
Placement of the CR-TC and the EGC Cartridge within the EG50

2.9 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 EluGen cartridge. A system backpressure of 2,300 psi is ideal. The degas tubing is functional at pressures below 2,000 psi (14 MPa) but 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 (see Table 1).

A. Configure the appropriate DX-320, DX-500 or DX-600 chromatography system, by configuring PeakNet or Chromeleon for the appropriate EluGen cartridge, analytical and guard columns, and suppressor. Program PeakNet or Chromeleon to deliver the eluent required in your method.

B. Turn the pump flow on. Confirm the eluent flow at the desired flow rate. If the method is a gradient method, it should be run to completion.

C. Monitor the pump pressure throughout the method, noting 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, the system back pressure is adequate.

E. If the maximum pressure exceeds 3,000 psi, the method will terminate prematurely. 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. The eluent generator can not 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. Table 1, “Optional Back Pressure Restrictors,” below can be used to determine the appropriate pressure restrictor to adjust the system pressure between 2,000 to 3,000 psi (14-21 MPa). A system back pressure of 2,300 psi is ideal.

G. The backpressure restrictors listed in Table 1, “Optional Back Pressure Restrictors,” are supplied in the EG50 Module ship kit. 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. Two coil clips are provided on the left lower wall of the EG50 Module to secure the back pressure restrictor coils.

Table 1
Optional Back Pressure Restrictors

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

2.10 Chromeleon or PeakNet Control

PeakNet software 6.4 SP3 or Chromeleon software 6.5 SP1 (or higher) provides control and status monitoring of all EG50 functions. New software users should refer to the PeakNet or Chromeleon User’s Guide or online Help for step-by-step instructions on PeakNet or Chromeleon control of the EG50. A summary of the typical sequence of events is outlined in this section.

2.10.1 Configure Chromeleon or PeakNet

A. Turn power ON to all modules and configure the system.

B. One EG50, one (and only one) pump, and up to 4 detectors may be configured in one system. The pump may be any of the following Gradient or Isocratic pumps: GS50, GP50, GP40, IP25, IP20, IC20, IC25, or IC25A.

C. Configure the EG50 to PeakNet or Chromeleon, using the Server Configuration. Enter the EGC cartridge serial number.

SECTION 3 - OPERATION

3.1 Routine Operation

For routine operation, the recommended system backpressure is 2000 - 3000 psi (14 - 21 MPa); 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 EG50 ship kit. See Section 2.4.1 for instructions.

3.2 Operating Precautions

CAUTION 1

The EG50 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. Operate the EG50 in properly ventilated areas only.

CAUTION 2: DO NOT CAP THE WASTE RESERVOIR!

The small amount of gas generated by the EG50 and the SRS is not dangerous unless the gas is trapped in a closed container and allowed to concentrate. The Gas Separator Waste Tube must be open to the atmosphere in order to operate properly.

CAUTION 3

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

A. The recommended maximum operating pressure for the EG50 Module is 3000 psi (21 MPa); however, 2,300 psi is ideal. This pressure limit protects the degas tubing assembly from mechanical failure.

   Due to the high backpressure, do not use solvents when operating with the following columns: the IonPac® AS11-HC or CarboPac™ PA10. Excessive backpressure may cause the degas tubing assembly to rupture.

NOTE:* *Solvents may be used if the flow rate is reduced sufficiently to reduce the system pressure to less than 3,000 psi (21 MPa).

B. Due to the high backpressure, do not operate the EG50 with the following columns: the IonPac AS5A, IonPac AS10, OmniPac® PAX-100, or OmniPac PAX-500 unless the flow rate has been reduced to lower the system pressure to less than 3,000 psi (21 MPa). Excessive backpressure may cause the degas tubing assembly to rupture.

C. Do not operate the EluGen II KOH cartridge with solvents other than methanol (maximum 25%) for anion separations. Solvents cannot be used with the EluGen II MSA Cartridge for cation separations.

D. To prevent the buildup of hydrogen and oxygen gases, install the EG50 Module in a well-ventilated site.

E. Make sure the SRS Gas Separator Waste Tube (P/N 045460) is correctly installed. The tube is used to dissipate the small amounts of hydrogen and oxygen gases that are generated during EG50 and SRS (Self-Regenerating Suppressor) operation.

3.3 System Shut-Down

3.3.1 Short Term Shutdown

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

The EluGen cartridge may be left in the EG50 Module for short-term storage up to three months. The system should be shutdown using the following methods:

A. Turn System OFF Completely:

Turn the pump, EG50, CR-TC, and SRS off. Before leaving the system be sure the current to the EG50 cartridge and to the SRS is off. To restart the system, apply the required system settings. Allow the system to equilibrate for 30-45 minutes prior to collecting data.

If the system has been shut down for more than 3-4 days, the suppressor should be hydrated. See the appropriate SRS manual for SRS start-up details.

B. Low Flow Rate Methods and Cautions:

CAUTION 1

Dionex does not recommend operating the EG50 at low flow rates that allow the system pressure to drop below 2,000 psi (14 MPa). The degas assembly will <u>not</u> properly degas the eluent if the system pressure is below 2,000 psi and gas will build up on the analytical column.

CAUTION 2

If you enter a lower flow rate, note the following: The Eluent Generator continues to generate eluent at the concentration set in the last step of the last Method. If the low flow rate Method does not include the Eluent Generator system, the EG50 will continue to generate eluent at the rate required for the higher flow rate set in the last Method. If this occurs, the eluent concentration will increase (in proportion to the decrease in the flow rate). In extreme cases, excessive heat buildup can occur, causing damage to the EluGen cartridge.

CAUTION 3

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.

3.3.2 Long Term Shutdown

For long-term storage, the EluGen cartridge may be left in the EG50 module. If you need to remove the cartridge and store it, follow the directions in Section 5.4. 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.

SECTION 4 - APPLICATIONS

4.1 Principles of Operation

4.1.1 Anion Exchange Applications

The EluGen Cartridges may be used to generate isocratic or gradient eluents. The EluGen EGC II KOH (P/N 058900) can generate up to 100 mN KOH at 1.0 mL/min. Eluent concentrations up to 50 mN KOH can be produced at 2.0 mL/min. Up to 25% methanol may be used in the eluent.

4.1.2 Cation Exchange Applications

The EluGen EGC II MSA (P/N 058902) can generate up to 100 mN methanesulfonic acid (MSA) at a flow rate of 1.0 mL/min. Eluent concentrations up to 50 mN MSA can be produced at 2.0 mL/min. Solvents should not be used in the eluent.

4.1.3 EluGen Operating Conditions

The EGC II KOH and EGC II MSA Cartridges may be used with the columns and eluent conditions listed below. Verify the performance of the entire system by duplicating the column test chromatogram.

EG50 Operating Conditions and Applications

Maximum Flow Rate (4-mm operation):	3.0 mL/min
Maximum Flow Rate (2-mm operation):	0.75 mL/min
Maximum System Pressure:	3,000 psi (21 MPa)
Minimum Recommended System Pressure:	2,000 psi (14 MPa); use optional Pressure Restrictor as required

Anion Exchange

Concentration Range for 4-mm operation:	Concentrations up to 100 mM KOH at 1.0 mL/min; 50 mM at 2.0 mL/min
Concentration Range for 2-mm operation:	Concentrations up to 100 mM KOH at 0.25 mL/min; 100 mM at 0.5 mL/min
Solvent Concentration Range:	Up to 25% Methanol
Columns:	IonPac AS11, AS11-HC, AS15, AS15-5µm, AS16, AS17, AS18, CarboPac PA1, CarboPac PA10, and CarboPac PA20

NOTE:* *The IonPac AS5A or AS10 may be used with the EG50 if the flow rate is reduced so that system pressure is less than 3,000 psi (21 MPa).

Cation Exchange

Concentration Range for 4-mm operation:	Concentrations up to 100 mM MSA at 1.0 mL/min; 50 mM at 2.0 mL/min
Concentration Range for 2-mm operation:	Concentrations up to 100 mM MSA at 0.25 mL/min; 100 mM at 0.5 mL/min
Solvent Concentration Range:	No solvents allowed
Columns:	IonPac CS12, CS12A, CS14, CS15, CS16 and CS17 without solvents, CS11 or CS10 (without DAP·HCl)

4.1.4 Duplication of Conventional GP40, GP50, or GS50 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. PeakNet or 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 you use an offset volume of 0 µL for most applications. However, users may specify offset volumes of 0 - 2000 µL in the Eluent Generator system software. The default value is 400 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 may 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 PeakNet 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.

   1. The first increase in detector response is the new eluent concentration arriving from the Eluent Generator system. Note the time this occurs.

   2. The second increase in detector response is the new eluent concentration arriving from the pump. Note the time this occurs.

   3. Calculate the time difference between the first and second increases in detector response.

   4. 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.

4.2 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.

1. If the chromatogram obtained matches the test chromatogram included with the column, the system is operating correctly for that set of system operating parameters.

2. If the chromatogram obtained does not match the sample chromatogram, see Section 6 for troubleshooting

4.3 Using the EluGen EGC II KOH Cartridge for IonPac AS11 Hydroxide Gradients

This application demonstrates the comparison of an IonPac AS11 gradient separation using conventional gradient pump delivery with the gradient separation using EG50 gradient delivery. Figure 21, "Conventional Hydroxide Gradient on the IonPac AS11," illustrates the use of a conventional pump method. Since the EG50 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 22, "EluGen EGC II KOH Gradient on the IonPac AS11." Figure 22 illustrates the use of the EG50 with an identical gradient program using the default OFFSET VOLUME of 0 µL. In Figure 23, "EluGen EGC II KOH Gradient on the IonPac AS11 (OFFSET VOLUME = 400 µL)," the default value for the OFFSET VOLUME (400 µL) is used. PeakNet uses this value to delay the EG50 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 EG50 to generate carbonate-free hydroxide reduces the baseline shift to approximately 50 nS.

Trap Column:	ATC-1, (Located between pump and injection valve); NOTE: The ATC-1 Trap Column may be replaced with an ATC-HC Trap Column after the pump. NOTE: For systems with the EG50, EG40 Add-on Kit or RFC-30 Module, use the CR-ATC continuously Generated Trap Column instead of the ATC-1 or ATC-HC Trap Columns. The CR-ATC is located after the EGC II KOH cartridge.	
Sample Volume:	10 µL	
Column:	IonPac AS11 Analytical and AG11 Guard (4-mm)	
Eluent:	See table of conditions	
Eluent Flow Rate:	2.0 mL/min	
Suppressor:	Anion Self-Regenerating Suppressor ULTRA (4-mm) AutoSuppression® Recycle Mode	
Expected Background Conductivity:		
(GP40 or GP50)	0.5 mM NaOH: 1 µS	35 mM NaOH: 2.5 µS
(EG50)	0.5 mM NaOH: 0.7 µS	35 mM NaOH: 0.75 µS
Typical Operating Back Pressure:		
(GP40 or GP50)	1850 psi (12.75 MPa)	
(EG50)	2200 psi (15.15 MPa) Pressure Restrictor, (P/N 53762) was used with the EG50	

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

GP50GP40 Conditions

E1: Deionized water
E2: 5.0 mM NaOH
E3: 100 mM NaOH

Time (min)	**%E1**	**%E2**	**%E3**	**Comments**
Equilibration				
0	90	10	0	0.5 mM NaOH for 7 min
7.0	90	10	0	
Analysis				
0.0	90	10	0	0.5 mM NaOH, Inject
0.2	90	10	0	Inject Valve to Load Position
2.5	90	10	0	0.5-5.0 mM NaOH in 3.5 min
6.0	0	100	0	5.0-38.25 mM NaOH in 12 min
18.0	0	65	35	

EG50 Conditions

Eluent: Deionized water

Time (min)	**Eluent Conc. (mM)**	**Comments**
Equilibration		
0	0.5	0.5 mM KOH for 7 min
7.0	0.5	
Analysis		
0.0	0.5	0.5 mM KOH, Inject
0.2	0.5	Inject Valve to Load Position
2.5	0.5	0.5-5.0 mM KOH in 3.5 min
6.0	5.0	5.0-38.3 mM KOH in 12 min
18.0	38.3	

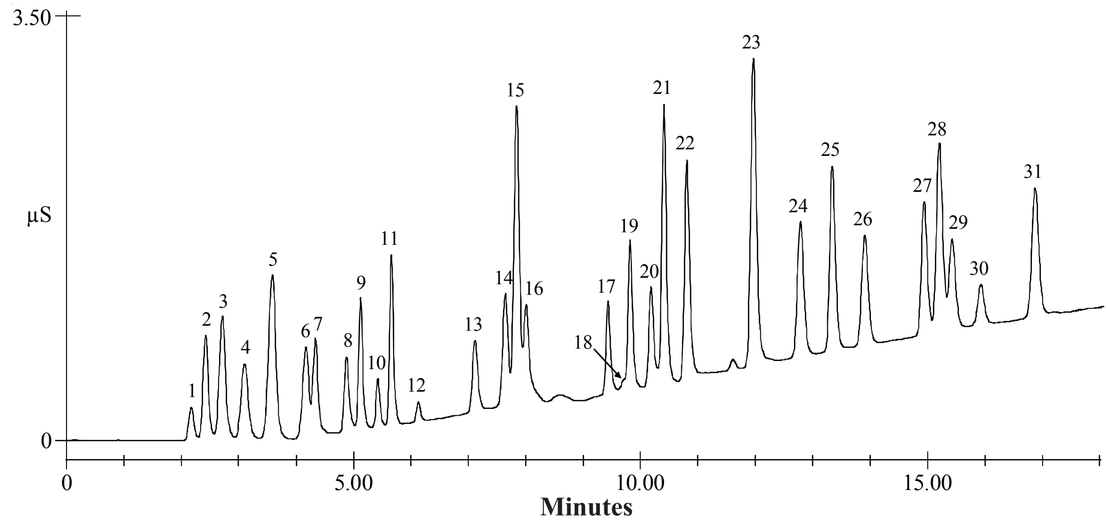


Figure 21
Conventional Hydroxide Gradient on the IonPac AS11

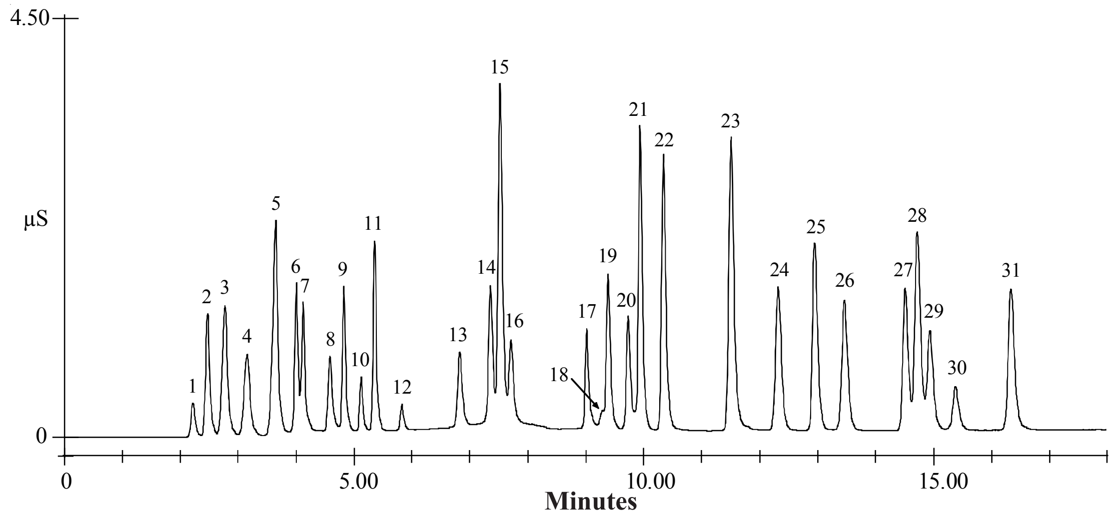


Figure 22
EluGen EGC II KOH Gradient on the IonPac AS11 (OFFSET VOLUME = 0 µL)

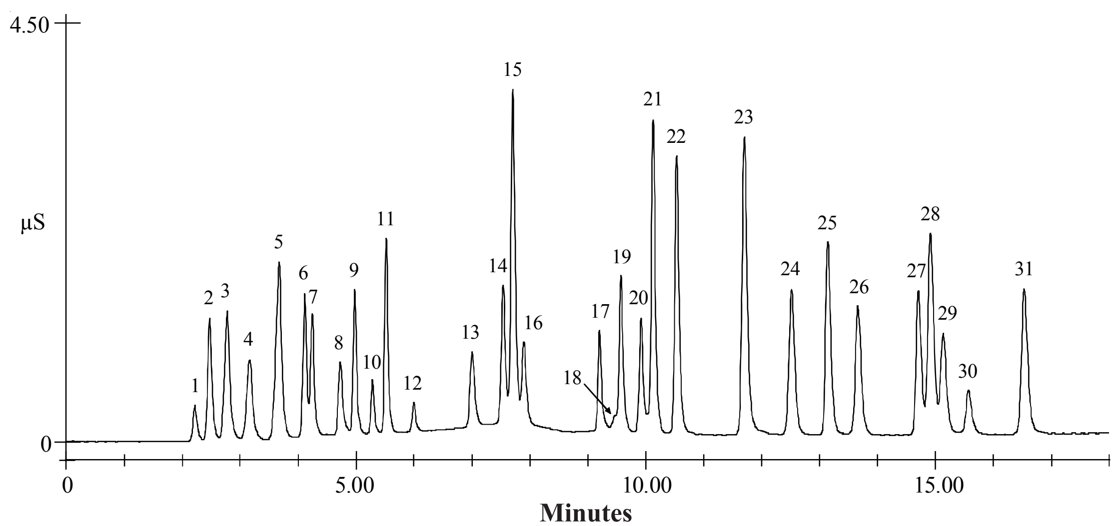


Figure 23
EluGen EGC II KOH Gradient on the IonPac AS11 (OFFSET VOLUME = 400 µL)

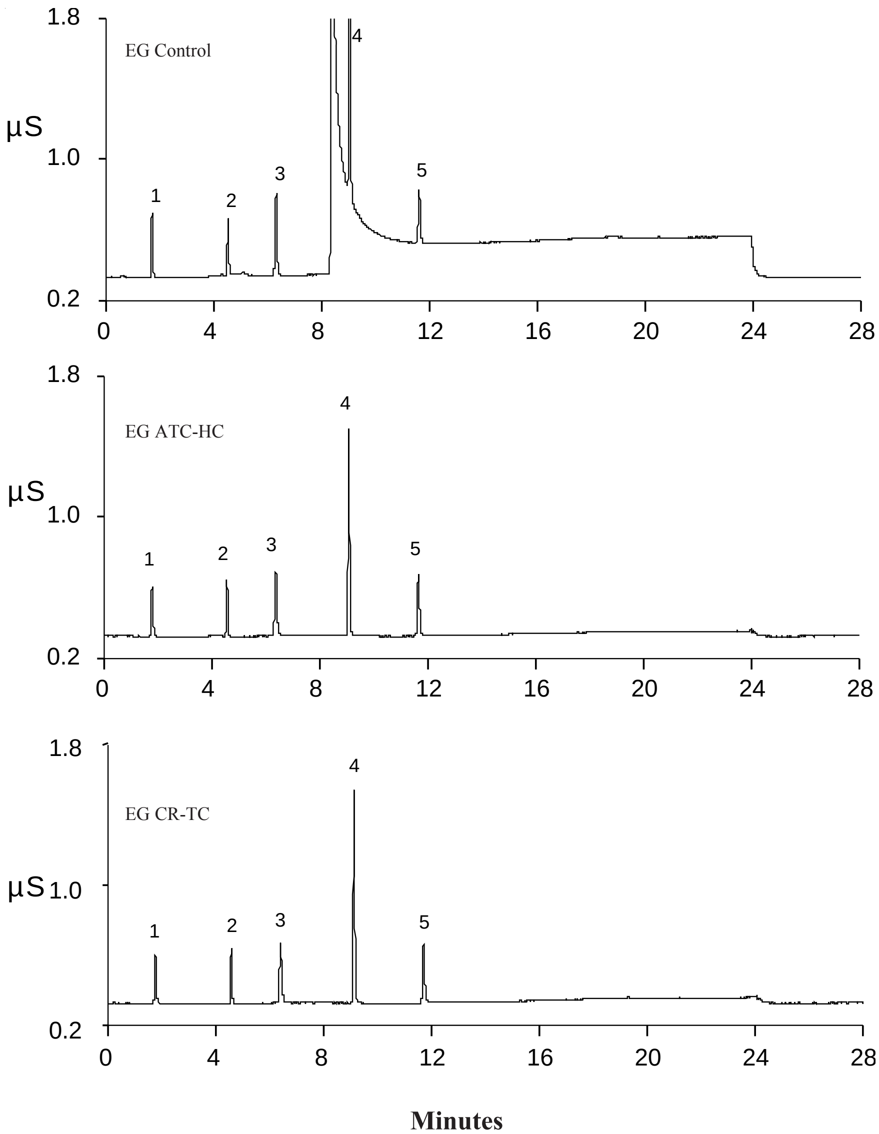
4.4 Comparison of EG50 with ATC-HC and CR-ATC for IonPac AS11 Gradient

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

Column:	IonPac AS11 Analytical (4-mm)
Eluent:	EG50 generated KOH
Flow Rate:	2.0 mL/min
Inj. Volume:	10 µL
Detection:	Suppressed Conductivity
Temperature:	30°C
Suppressor:	ASRS® ULTRA (4-mm), Recycle Mode

Gradient Program

Time (min)	**Concentration (mN)**
0	0.5
2.5	0.5
6.0	5.0
18.0	38.3
23.0	38.3



	Analyte	**mg/L(ppm)**
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)

	Start	**End**	**Drift**
EG50	0.33	0.56	0.23
ATC-HC	0.32	0.36	0.04
CR-ATC	0.32	0.36	0.04

Figure 24
Comparison of EG50 with ATC-HC and CR-ATC for IonPac AS11 Gradient

4.5 Using the EluGen EGC II KOH Cartridge for IonPac AS15 Isocratic Elution

This application demonstrates the comparison of an IonPac AS15 isocratic separation using conventional pump delivery to EG50 eluent delivery. Figure 25, "Conventional Hydroxide Eluent on the IonPac AS15," illustrates use of a conventional method. Figure 26, "EluGen EGC II KOH Eluent on the IonPac AS15," illustrates the use of the EG50 with an identical isocratic program using an OFFSET VOLUME of 400 µL. The offset volume has no effect on isocratic EG50 eluent delivery. In Figure 26, the chromatogram generated using the 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 EG50 eliminates the eluent contamination problem, resulting in baseline resolution of nitrate and phosphate.

Sample Volume:	25 µL
Column:	IonPac AS15 analytical (4-mm) and AG15 guard (4-mm)
Eluent:	40 mM KOH
Eluent Flow Rate:	2.0 mL/min
Suppressor:	Anion Self-Regenerating Suppressor ULTRA (4-mm)
Temperatures:	30°C
Expected Background Conductivity:	AutoSuppression® Recycle Mode
	0.8-1.2 µS (EG50) 2-3 µS (GP40, GP50, or GS50)
Typical Operating Back Pressure:	2100 psi (EG50) 1700 psi (GP40, GP50, or GS50)
	Back pressure restrictor was not used with the EG50

	Analyte	mg/L (ppm)
1.	Fluoride	2.0
2.	Acetate	2.0
3.	Chloride	5.0
4.	Carbonate	10.0
5.	Nitrite	10.0
6.	Sulfate	10.0
7.	Bromide	20.0
8.	Nitrate	20.0
9.	Phosphate	30.0

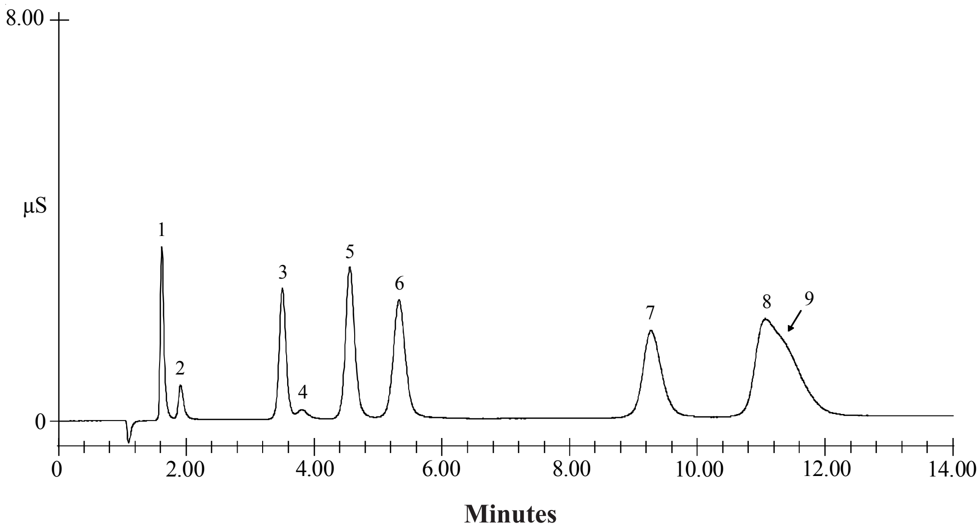


Figure 25
Conventional Hydroxide Eluent on the IonPac AS15

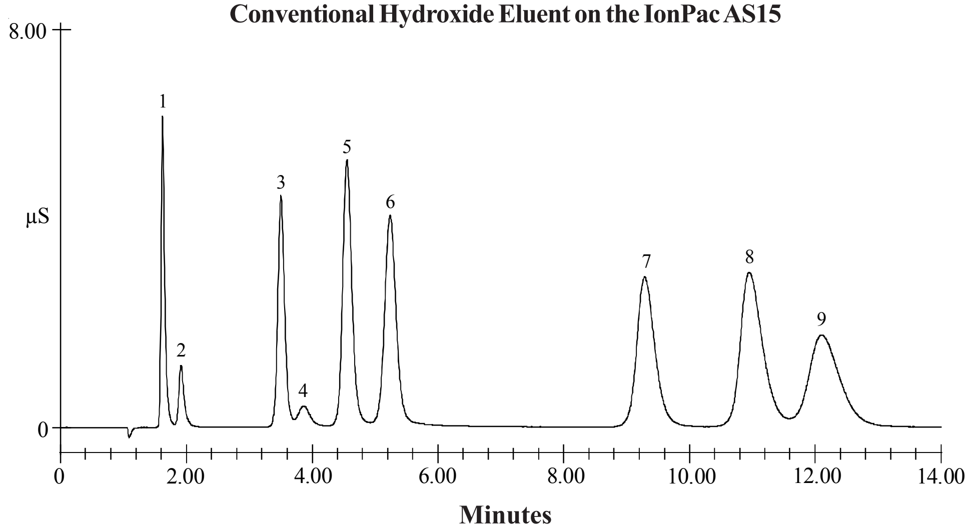


Figure 26
EluGen EGC II KOH Eluent on the IonPac AS15

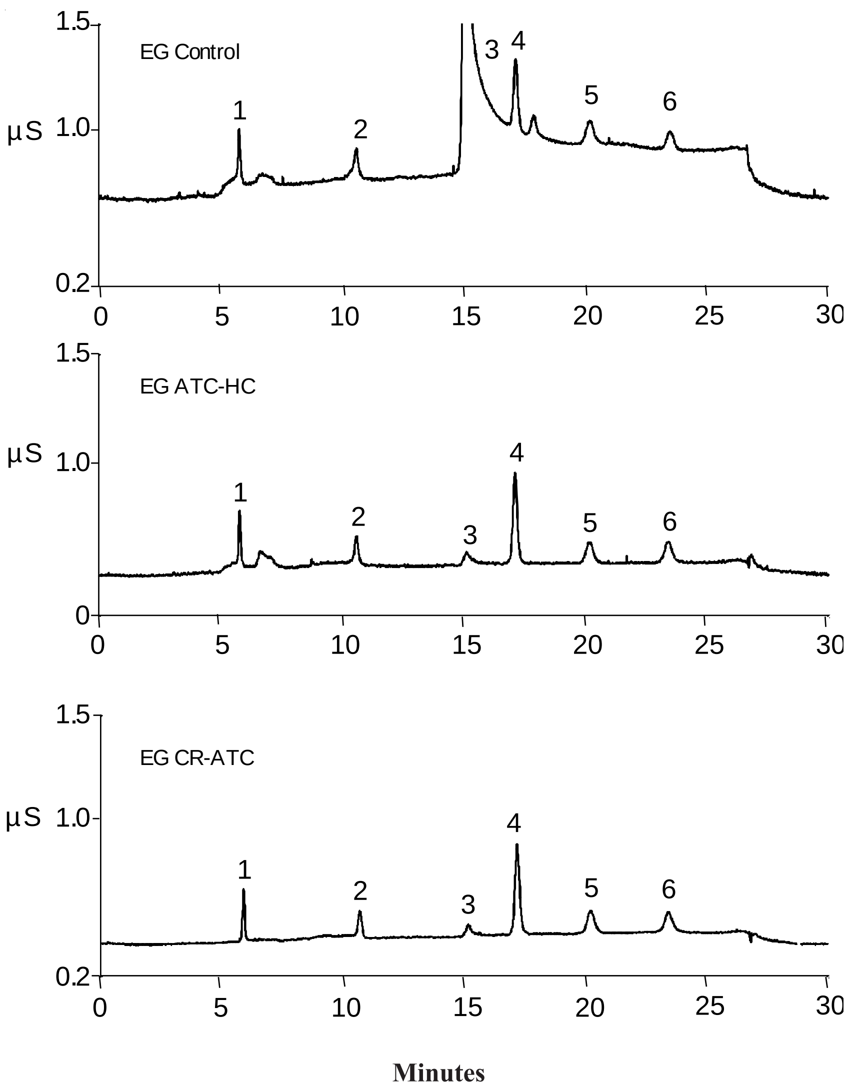
4.6 Comparison of EG50 Using ATC-HC and CR-ATC for IonPac AS15 Gradient

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

Column:	IonPac® AS15 (4- mm)
Eluent:	EG50 generated KOH
Flow Rate:	1.5 mL/min
Inj. Volume:	10 µL
Detection:	Suppressed conductivity
Temperature:	30°C
Suppressor:	ASRS® ULTRA (4-mm), Recycle Mode

Gradient Program

Time (min)	Concentration (mN)
0	1.0
20.0	50.0
25.0	50.0



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

Background (µS/cm)

	Start	End	Drift
EG50	0.64	0.88	0.24
ATC-HC	0.41	0.49	0.08
CR-ATC	0.37	0.43	0.06

Figure 27
Comparison of EG50 Using ATC-HC and CR-ATC for IonPac AS15 Gradient

4.7 Comparison of Conventional Bottle Eluent System and EG50 Eluent Generator System

The following example illustrates a comparison of a gradient delivered using conventional pump delivery and using the EG50 Eluent Generator system. 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 EG50 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:	IonPac ATC-1 (2), 1 after pump; 1 between EG50 degas assembly and injector. NOTE: The ATC-1 Trap Columns should be replaced with one ATC-HC Trap Column after the pump. NOTE: For systems with the EG50, EG40 Add-on Kit or RFC-30 Module, use the CR-ATC continuously Generated Trap Column instead of the ATC-1 or ATC-HC Trap Columns. The CR-ATC is located after the EGC II KOH cartridge.
Column:	IonPac AS15 + IonPac AG15 (4-mm)
Eluent:	See Chromatogram
Eluent Source:	See chromatogram
Eluent Flow Rate:	1.6 mL/min.
Temperature:	30° C
SRS Suppressor:	Anion Self-Regenerating Suppressor ULTRA AutoSuppression Recycle Mode
MMS Suppressor	Anion MicroMembrane Suppressor, AMMS III
MMS Regenerant:	50 mN H_2SO_4
Expected Background Conductivity:	EG50 eluent: 0.8-1.2 µS Bottle eluent: 2-3 µS

	Analyte	Example A µg/L (ppb)	Example B µg/L (ppb)
1.	Fluoride	1.08	2.0
2.	Glycolate	3.35	4.0
3.	Acetate	3.86	4.0
4.	Formate	3.63	2.0
5.	Chloride	1.03	2.0
6.	Carbonate	-	-
7.	Nitrite	1.17	2.0
8.	Sulfate	0.91	2.0
9.	Oxalate	0.97	2.0
10.	Bromide	2.87	4.0
11.	Nitrate	0.89	4.0
12.	Phosphate	3.07	6.0

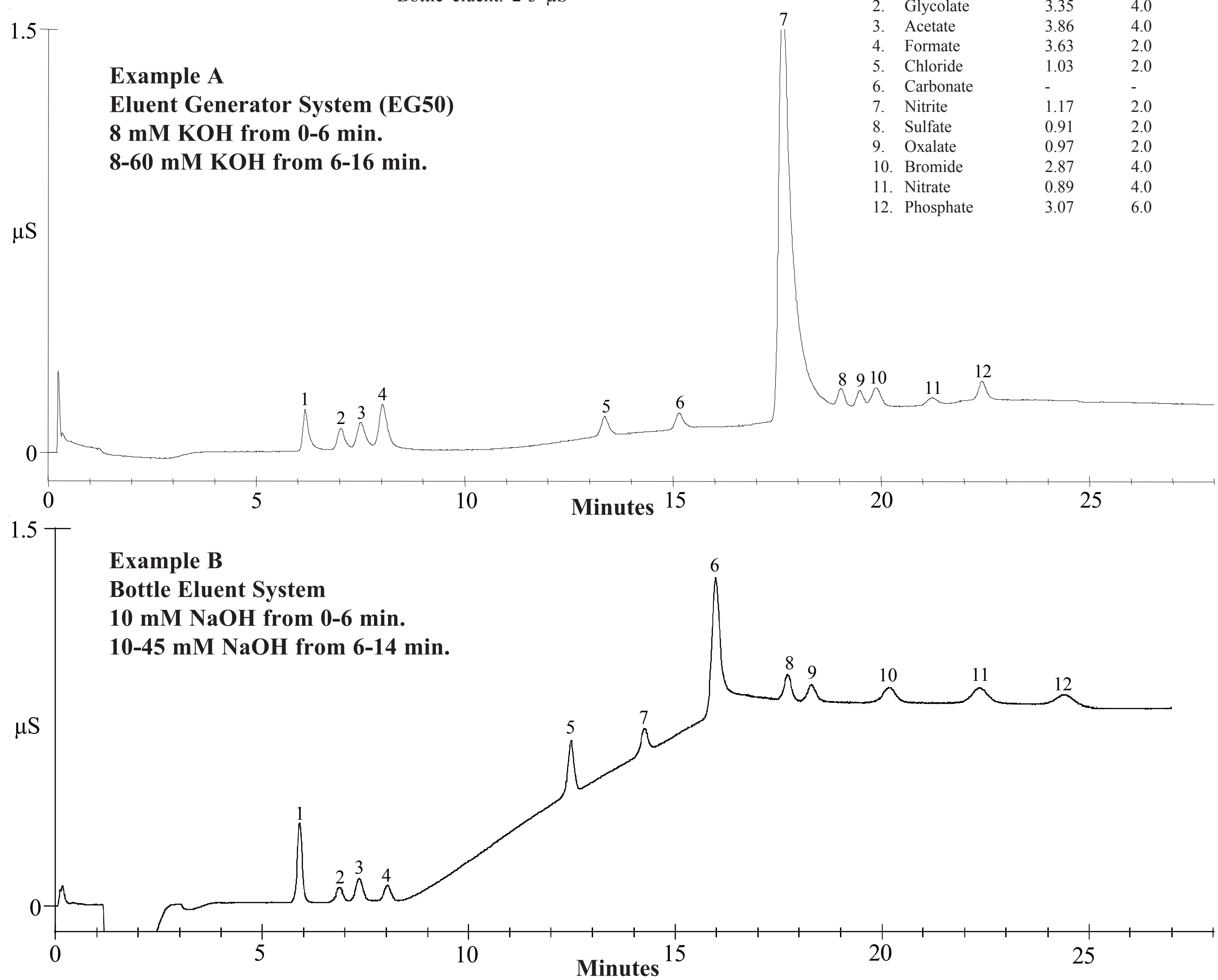


Figure 28

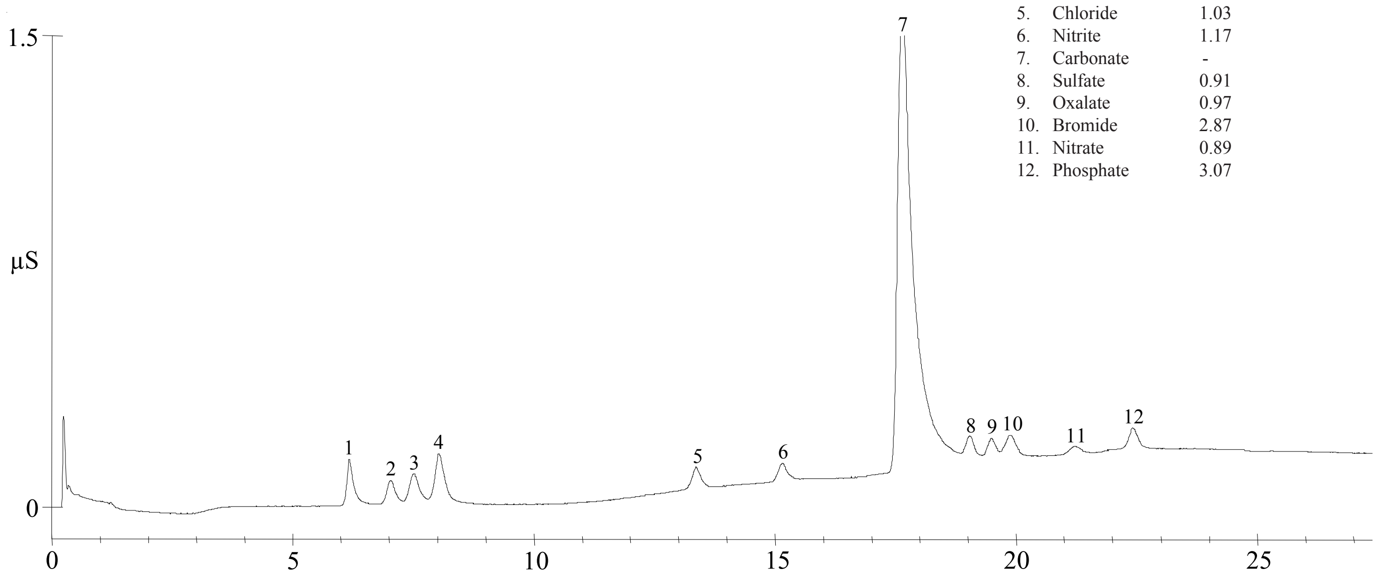
Comparison of Eluent Generator System with Conventional Bottle Eluent System

4.8 Large Loop Injection for µg/L (ppb) Level Analysis on 2-mm AS15

High capacity of the 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 AS15 column. Notice the much lower baseline shift produced when using the EG50 as the eluent source. To ensure reproducible retention times, the AS15 column must be operated at an elevated temperature (30° C).

Sample Loop Volume:	1 mL
Trap Columns:	IonPac ATC-1 (2), 1 after pump; 1 between EG50 degas assembly and injector. NOTE: The ATC-1 Trap Columns should be replaced with one ATC-HC Trap Column after the pump. NOTE: For systems with the EG50, EG40 Add-on Kit or RFC-30 Module, use the CR-ATC continuously Generated Trap Column instead of the ATC-1 or ATC-HC Trap Columns. The CR-ATC is located after the EGC II KOH cartridge.
Column:	IonPac AS15 + IonPac AG15 (2-mm).
Eluent Source:	EG50
Eluent:	8 mM KOH (0-6 min.) 8-60 mM KOH (6-16 min.)
Eluent Flow Rate:	0.5 mL/min.
Temperature:	30° C
SRS Suppressor:	Anion Self-Regenerating Suppressor ULTRA AutoSuppression External Water Mode
or MMS Suppressor:	Anion MicroMembrane Suppressor, AMMS III
MMS Regenerant:	50 mN H_2SO_4
Expected Background Conductivity:	0.8-1.2 µS

	Analyte	µg/L (ppb)
1.	Fluoride	1.08
2.	Glycolate	3.35
3.	Acetate	3.86
4.	Formate	3.63
5.	Chloride	1.03
6.	Nitrite	1.17
7.	Carbonate	-
8.	Sulfate	0.91
9.	Oxalate	0.97
10.	Bromide	2.87
11.	Nitrate	0.89
12.	Phosphate	3.07



Minutes

Figure 29

Large Loop Injection for µg/L (ppb) analysis on 2-mm AS15

4.9 Comparison of Conventional Eluent System and EG50 for Gradient Elution on the 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 IonPac AS16 column.

The following example also illustrates a comparison of a gradient delivered using a bottle eluent system and using the EG50 Eluent Generator 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 EG50 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, ATC-1 located after pump. NOTE: The ATC-1 Trap Column should be replaced with an ATC-3 (4-mm) Trap Column (P/N 059660). EG50 system, ATC-1 (2), 1 located after pump; 1 located between EG50 degas assembly and injector. NOTE: The ATC-1 Trap Columns should be replaced with one ATC-HC Trap Column after the pump. NOTE: For systems with the EG50, EG40 Add-on Kit or RFC-30 Module, use the CR-ATC continuously Generated Trap Column instead of the ATC-1 or ATC-HC Trap Columns. The CR-ATC is located after the EGC II KOH cartridge.
Sample Volume:	10 µL
Column:	IonPac AS16 4-mm analytical and 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
SRS Suppressor:	Anion Self-Regenerating Suppressor ULTRA (4-mm) AutoSuppression® Recycle Mode
or MMS Suppressor:	Anion MicroMembrane Suppressor, AMMS III
MMS Regenerant:	50 mN H_2SO_4
Expected Background Conductivity:	1.5 mM NaOH: 1 µS 55 mM NaOH: 2.5 - 3.5 µS
Typical Operating Back Pressure:	2,300 psi (15.15 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

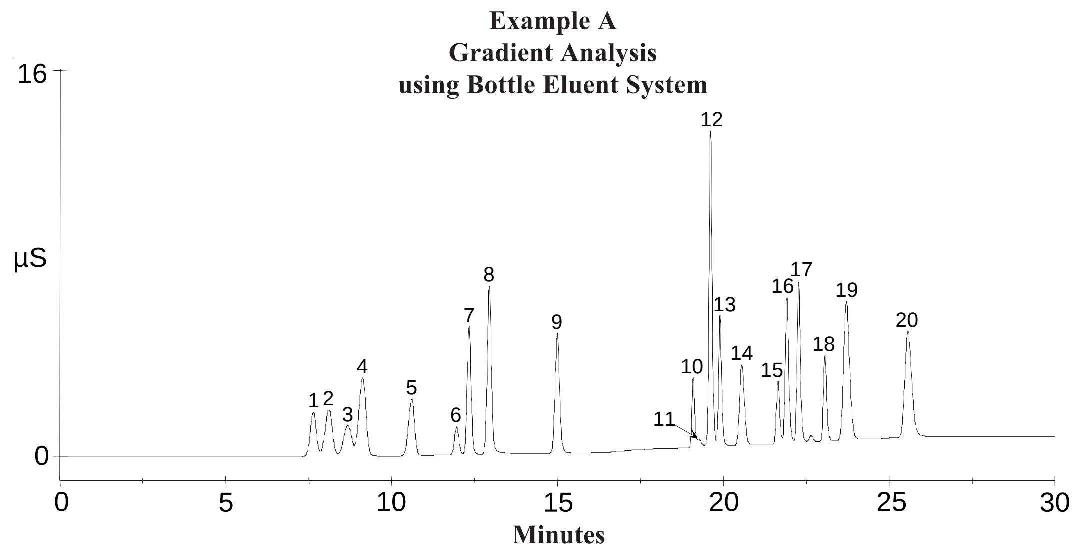
Gradient Conditions with bottle eluent system

TIME (min)	%E1	%E2	%E3	Comments
Equilibration				
0	30	70	0	1.5 mM NaOH for 7 min.
7.0	30	70	0	
Analysis				
7.1	30	70	0	Start isocratic analysis
7.5	30	70	0	Inject Valve to Load Position
14.0	30	70	0	End Isocratic analysis, Begin Gradient analysis
20.0	0	90	10	
30.0	0	45	55	

EG50 Conditions

Eluent: Deionized water
Offset volume = 0.0 µL

Time (min)	Eluent Conc. (mM)	Comments
Equilibration		
0	1.5	1.5 mM KOH for 7 min
7.0	1.5	
Analysis		
7.1	1.5	Start isocratic analysis
7.5	1.5	Inject Valve to Load Position
15.3	1.5	End Isocratic analysis, Begin Gradient analysis
21.3	10.0	
31.3	55.0	



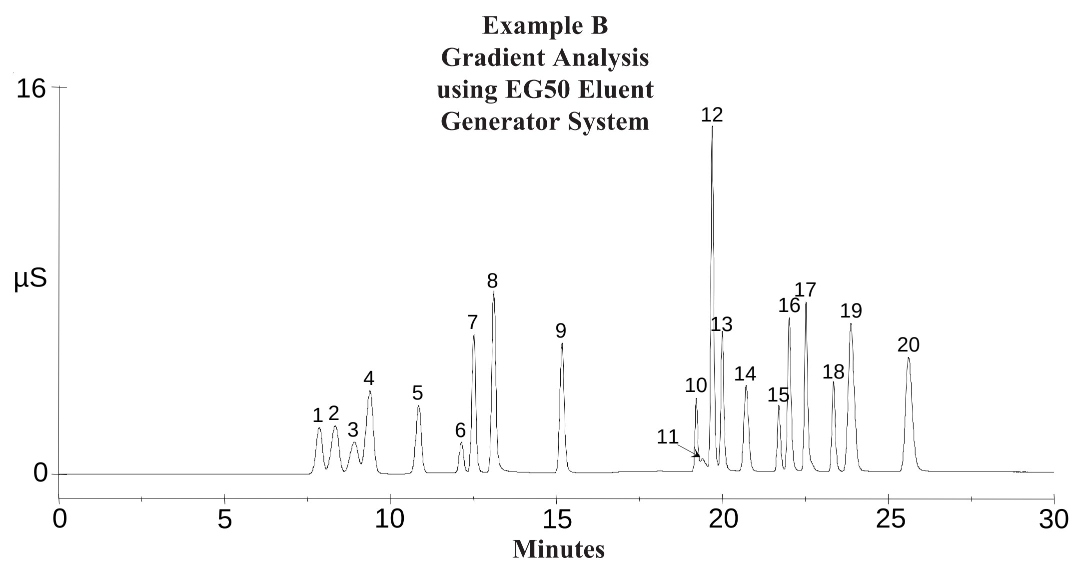


Figure 30
Separation of Polarizable Anions and Inorganic Anions using Gradient Elution

4.10 Using the EG50 for KOH Elution of Inorganic Anions, Oxyhalides, and Organic Acids on the IonPac AS17

The following chromatograms compare the EG50 eluent delivery system with the bottle eluent delivery system at room temperature (22°C) for the determination of inorganic anions, oxyhalides, and organic acids. Notice, due to the large system void volume with the bottle eluent system, a longer equilibration time is required before injection.

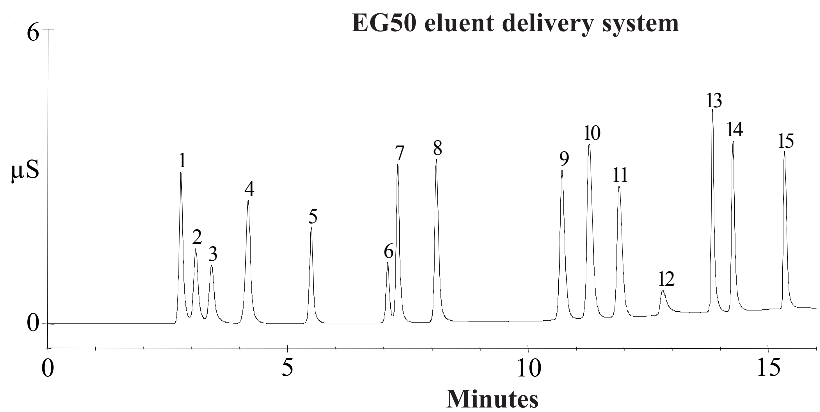
Trap Column:	Bottle Eluent System, ATC-1 located after pump. NOTE: The ATC-1 Trap Column should be replaced with an ATC-3 (4-mm) Trap Column (P/N 059660). EG50 Eluent System, ATC-1 (2), 1 located after pump; 1 located at eluent outlet of EG50 degas assembly and before injector. NOTE: For systems with the EG50, EG40 Add-on Kit or RFC-30 Module, use the CR-ATC continuously Generated Trap Column instead of the ATC-1 or ATC-HC Trap Columns. The CR-ATC is located after the EGC II KOH cartridge.
Sample Volume:	4-mm: 10 µL Loop + 0.8 µL Injection valve dead volume
Column:	IonPac® AG17, AS17 4-mm
Eluent Source	See table
Eluent:	See table
Eluent Flow Rate:	1.5 mL/min (4-mm)
Temperature:	Room temperature (22°C)
SRS Suppressor:	Anion Self-Regenerating Suppressor ULTRA (4-mm) AutoSuppression® Recycle Mode
MMS Suppressor:	AMMS III
MMS Regenerant:	50 mN H_2SO_4
Expected Background Conductivity:	0.5-1.0 µS
Storage Solution:	Eluent

	Analyte	mg/L(ppm)
1.	Fluoride	2.0
2.	Acetate	5.0
3.	Propionate	5.0
4.	Formate	5.0
5.	Chlorite	5.0
6.	Bromate	5.0
7.	Chloride	3.0
8.	Nitrite	5.0
9.	Bromide	10.0
10.	Nitrate	10.0
11.	Chlorate	10.0
12.	Carbonate	20.0
13.	Sulfate	5.0
14.	Oxalate	5.0
15.	Phosphate	10.0

Eluent: Deionized water

Offset volume = 0.0 µL

Time (min)	Eluent Conc. (mM)	Comments
Equilibration		
0	1.0	1.0 mM KOH for 4 min
4.0	1.0	
Analysis		
4.1	1.0	Start isocratic analysis
4.5	1.0	Inject valve to load position
7.0	1.0	Begin gradient analysis
14.0	10.0	
18.0	35.0	End gradient



Gradient Conditions:

E1: 5 mM NaOH
E2: DI water
E3: 100 mM NaOH

Time (min)	%E1	%E2	%E3	Comments
Equilibration				
0	20	80	0	1.0 mM NaOH for 5 min
5.0	20	80	0	
Analysis				
5.1	20	80	0	Start isocratic analysis
5.5	20	80	0	Inject valve to load position
7.0	20	80	0	Begin gradient analysis
14.0	0	90	10	
18.0	0	65	35	End gradient

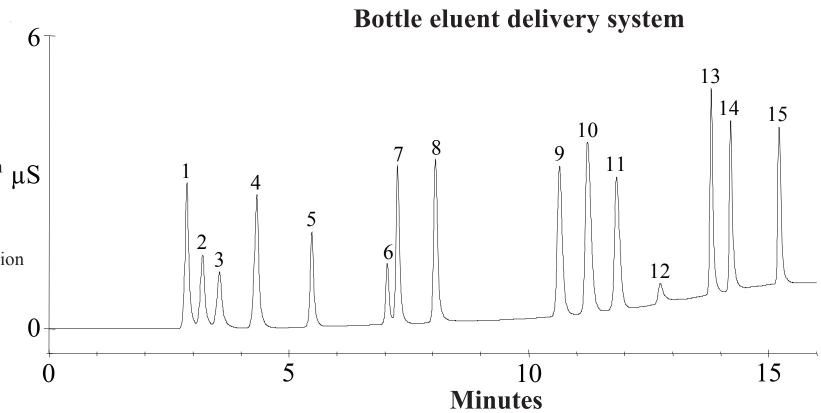


Figure 31
Determination of Inorganic Anions, Oxyhalides, and Organic Acids at Room Temperature

4.11 Using the EluGen EGC II MSA Cartridge for IonPac CS12A Isocratic MSA Elution on the IonPac CS12A

This application demonstrates the comparison of an IonPac CS12A isocratic separation using conventional isocratic pump delivery with EG50 isocratic delivery. Figure 32, "Conventional MSA Isocratic Elution on the IonPac CS12A," illustrates the use of a conventional pump method. Figure 33, "EluGen EGC II MSA Isocratic Elution on the IonPac CS12A," illustrates the use of the EG50 with an identical isocratic program using an OFFSET VOLUME of 0.0 µL.

Sample Volume:	25 µL
Column:	IonPac CS12A analytical (4-mm) and CG12A guard (4-mm)
Eluent:	18 mM MSA
Eluent Flow Rate:	1.0 mL/min
Oven Temperature:	30° C
Cell Temperature:	35°C
Suppressor:	Cation Self-Regenerating Suppressor ULTRA (4-mm) AutoSuppression® Recycle Mode
Expected Background Conductivity:	0.3 µS (EG50) 0.4 µS (GP40, GP50, or GS50)
Typical Operating Back Pressure:	1980 psi (EG50) 970 psi (GP40, GP50, or GS50) Back pressure restrictor (P/N 53763) was used with the EG50

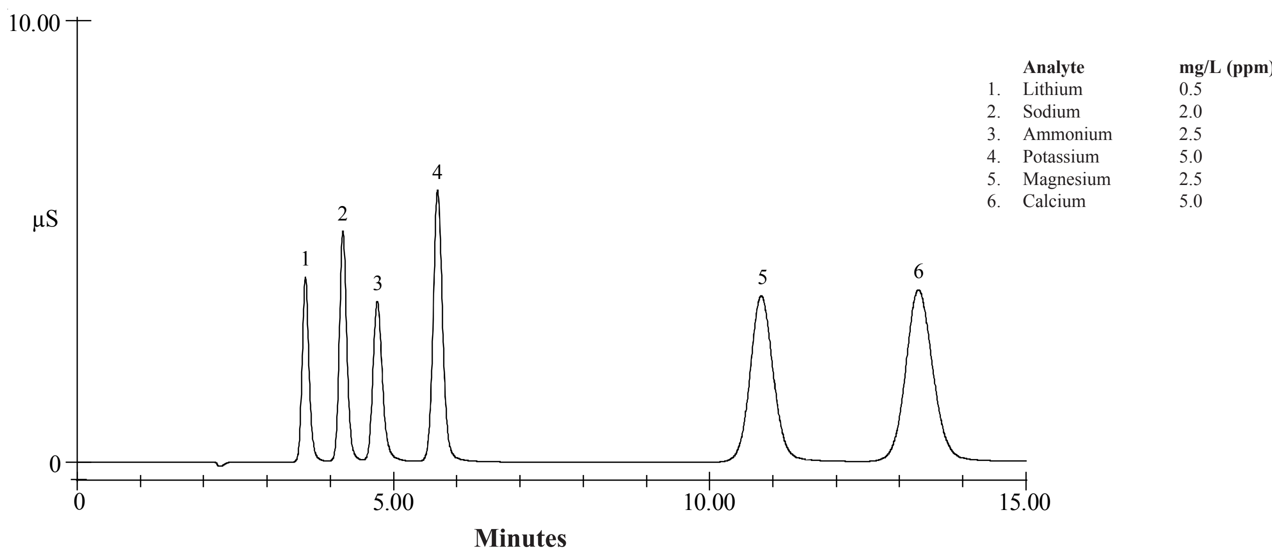


Figure 32
Conventional MSA Isocratic Elution on the IonPac CS12A.

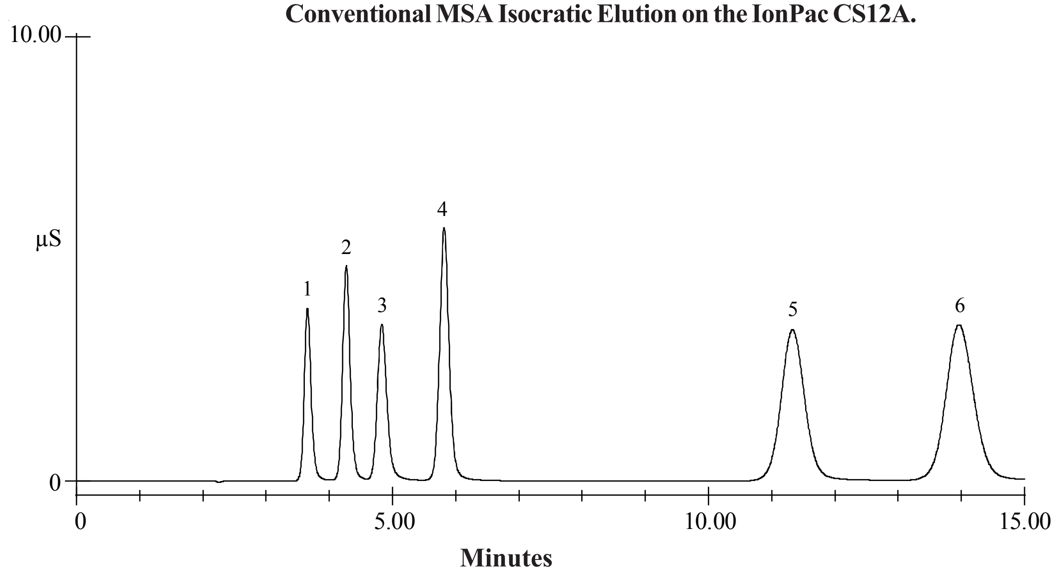


Figure 33
EluGen EGC II MSA Isocratic Elution on the IonPac CS12A.

4.12 Using the EluGen EGC II MSA Cartridge for IonPac CS12A MSA Gradient

This application demonstrates the comparison of an IonPac CS12A gradient separation using conventional gradient pump delivery to the gradient separation using EG50 gradient delivery. Figure 34, "Conventional MSA Linear Gradient on the IonPac CS12A," illustrates the use of a conventional pump method. Figure 35, "EluGen EGC II MSA Linear Gradient on the IonPac CS12A," illustrates the use of the EG50 with an identical gradient program using the OFFSET VOLUME of 0 µL. Note the smaller baseline shift during the gradient when using the EG50. Since the EG50 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 the EluGen EGC II MSA cartridge.**

Sample Volume:	25 µL		
Column:	IonPac CS12A analytical and 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:	Cation Self-Regenerating Suppressor ULTRA (4-mm)		
	AutoSuppression® Recycle Mode		
Expected Background Conductivity:	(GP40 or GP50)	11 mM MSA: 0.4 µS	57 mM MSA: 0.8 µS
	(EG50)	11 mM MSA: 0.4 µS	57 mM MSA: 0.44 µS
Typical Operating Back Pressure:	(GP40 or GP50)	960 psi (6.61 MPa)	
	(EG50)	1880 psi (12.95 MPa)	
	Pressure Restrictor, (P/N 53763) was used with the EG50		
Offset Volume:	0.0 µL		

	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

GP40 Conditions

E1: Deionized water
E2: 100 mM MSA

Time (min)	%E1	%E2	Comments
Equilibration			
0	89	11	11 mM MSA for 7 min.
7.0	89	11	
Analysis			
0.0	89	11	11 mM MSA
0.1	89	11	Inject Valve to Load Position
9.1	55	45	Step change to 45 mM MSA
14.0	55	45	45-57 mM MSA in 3.0 min.
17.0	43	57	57 mM MSA
20.0	43	57	57 mM MSA (end)

EG50 Conditions

Eluent: Deionized water

Time (min)	Eluent conc. (mM)	Comments
Equilibration		
0	11	11 mM MSA for 7 min.
7.0	11	
Analysis		
0.0	11	11 mM MSA
0.1	11	Inject Valve to Load Position
9.1	45	Step change to 45 mM MSA
14.0	45	45-57 mM MSA in 3.0 min.
17.0	57	57 mM MSA
20.0	57	57 mM MSA (end)

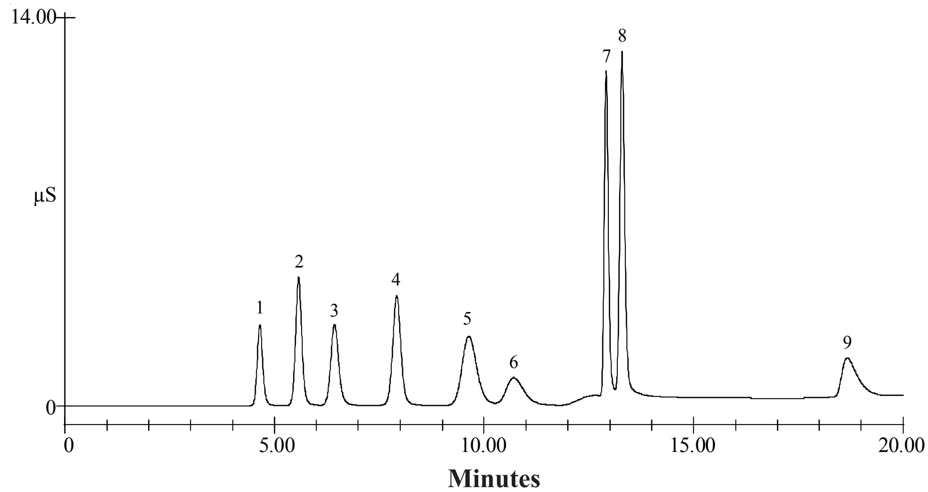


Figure 34
Conventional MSA Linear Gradient on the IonPac CS12A.

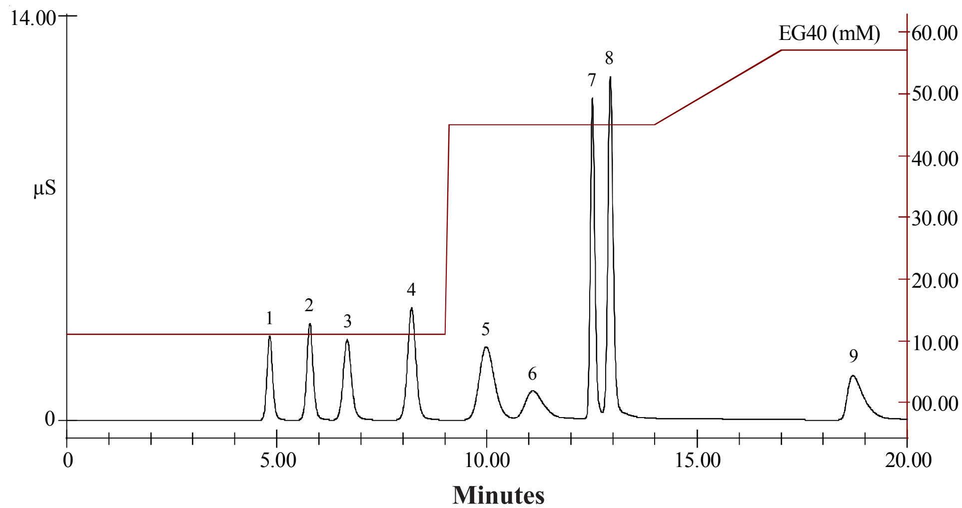


Figure 35
EluGen EGC II MSA Linear Gradient on the IonPac CS12A.

4.13 Comparison of the EG50 Using a CTC and a CR-CTC Trap Column in IonPac CS12A Gradient

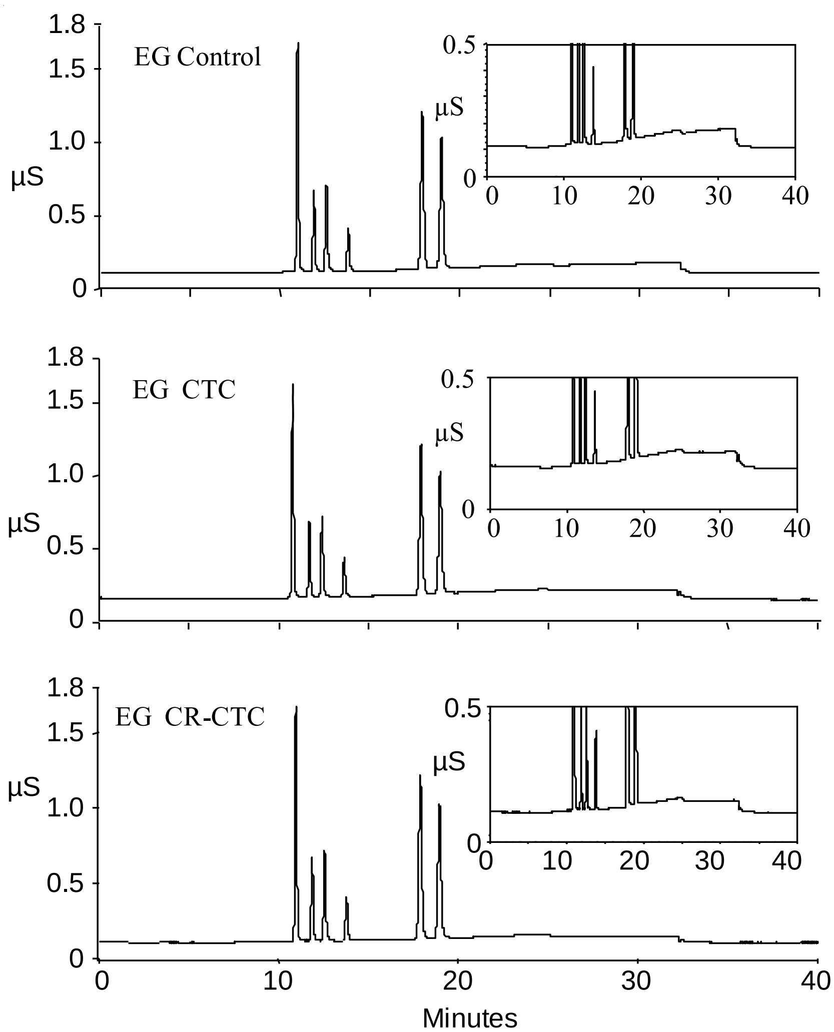
The set of chromatograms in Figure 36 demonstrates the decrease in baseline shift during a gradient when the CTC-1 or CR-CTC is used. The CR-CTC does not require off-line chemical regeneration.

Column:	IonPac® CS12A (4-mm)
Eluent:	EG50 generated MSA
Flow Rate:	1.0 mL/min
Inj. Volume:	10 µL
Detection:	Suppressed Conductivity
Temperature:	30°C
Suppressor:	CSRS® ULTRA (4-mm), Recycle Mode

	Analytes	mg/L
1.	Lithium	0.5
2.	Sodium	0.5
3.	Ammonium	0.5
4.	Potassium	0.5
5.	Magnesium	0.5
6.	Calcium	0.5

Gradient Program

Time (min)	Concentration (mN)
0	1
5	1
25.0	50
30	50
30.1	1.0
40	1.0



Baseline Drift

EG50	70 nS/cm
EG50 CTC	57 nS/cm
EG50 CR-CTC	42 nS/cm

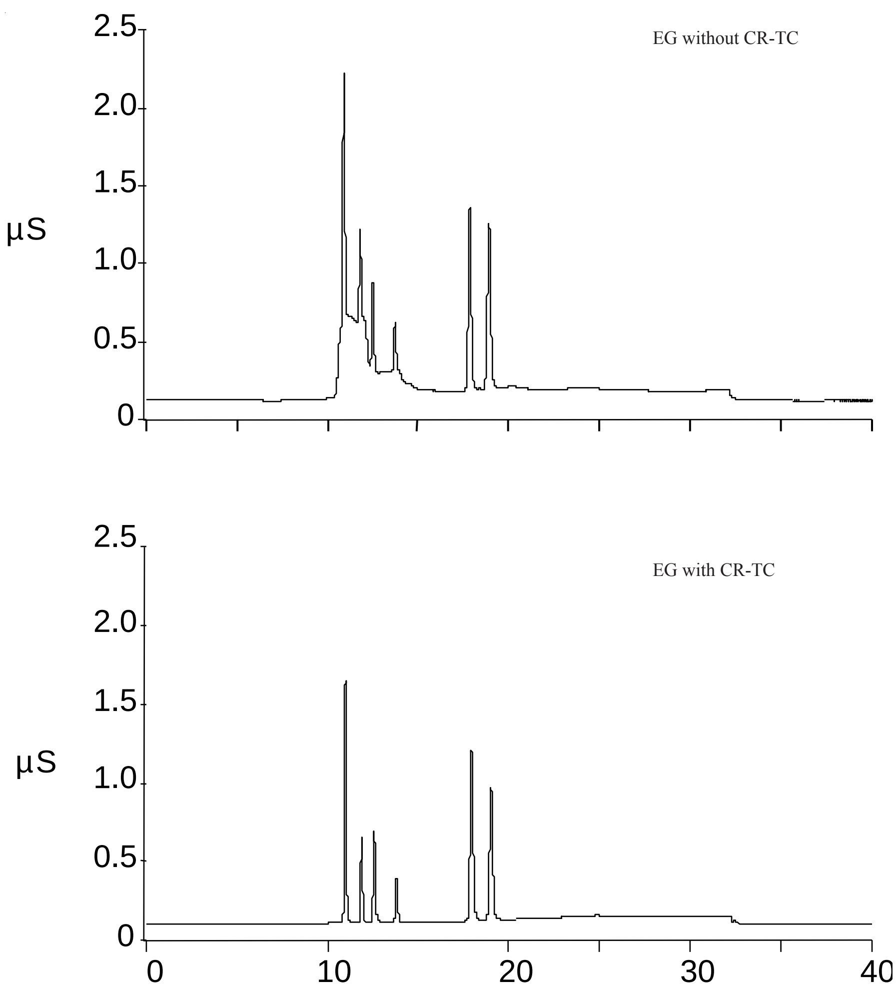
Figure 36
Comparison of the EG50 Using a CTC and a CR-CTC Trap Column in IonPac CS12A Gradient

4.14 Comparison of EG50 Using No Trap and the CR-CTC for IonPac CS12A Gradients

The set of chromatograms in Figure 37 demonstrates the decrease in baseline shift during a gradient with and without the CR-CTC. The CR-CTC does not require off-line chemical regeneration. The water source was contaminated but could be readily cleaned using the CR-CTC.

Column:	IonPac® CS12A (4-mm)
Eluent:	EG50 generated MSA
Flow Rate:	1.0 mL/min
Inj. Volume:	10 µL
Detection:	Suppressed Conductivity
Temperature:	30 °C
Suppressor:	CSRS® ULTRA (4-mm), Recycle Mode

	Analytes	mg/L
1.	Lithium	0.5
2.	Sodium	0.5
3.	Ammonium	0.5
4.	Potassium	0.5
5.	Magnesium	0.5
6.	Calcium	0.5



Gradient Program

Time (min)	Concentration (mN)
0	1
5	1
25.0	50
30	50
30.1	1.0
40	1.0

Figure 37
Comparison of EG50 Using No Trap and the CR-CTC for IonPac CS12A Gradients

4.15 Glycoconjugate Monosaccharide Analysis with the EG50 KOH Generator

This application demonstrates the use of the EGC II 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 EGC II KOH method, (see Figure 38, "Analysis of Monosaccharide Standards Showing a Fast Cycle Time with EG50-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:	CarboPac PA10 (Analytical) and AminoTrap
Flow:	1.0 mL/min
Pressure:	2,800 psi

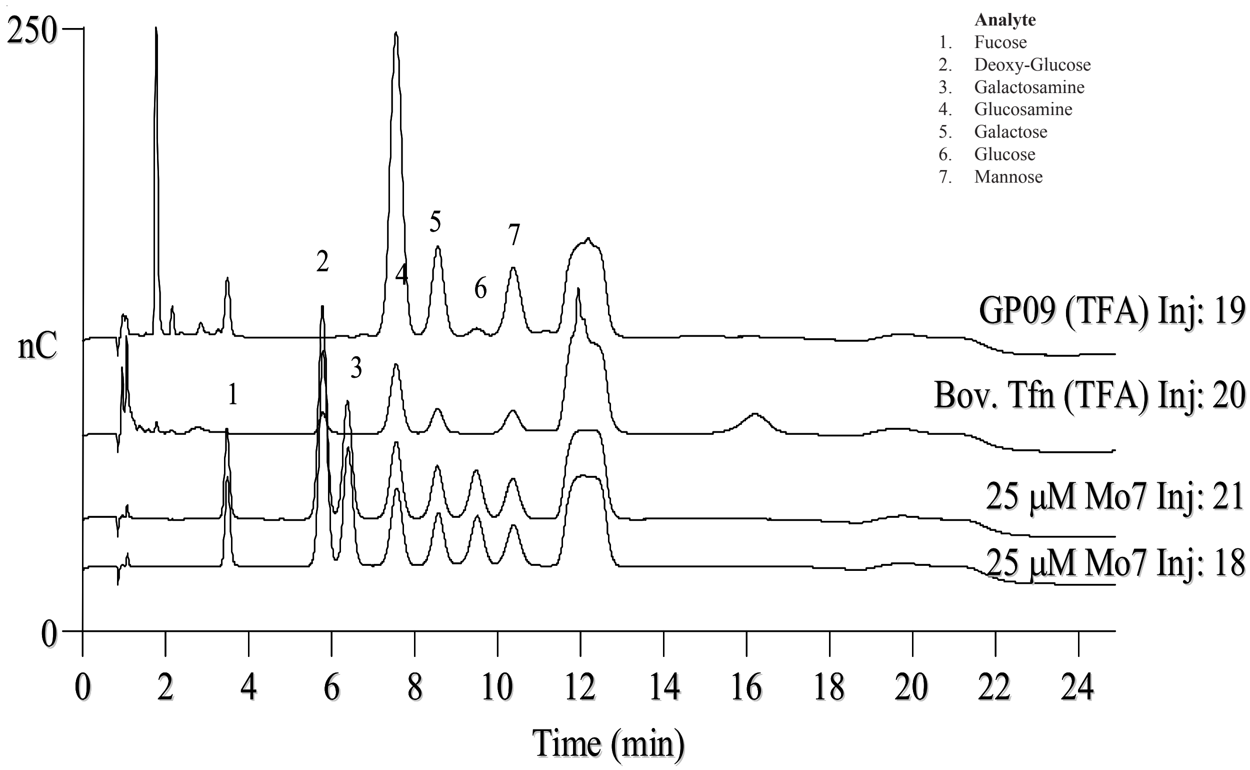


Figure 38
Analysis of Monosaccharide Standards Showing a Fast Cycle Time with EG50-Generated Carbonate-Free Eluent

4.16 Analysis of Mono- and Disaccharides Found in Foods and Beverages Using the EG50-Generated KOH as Eluent

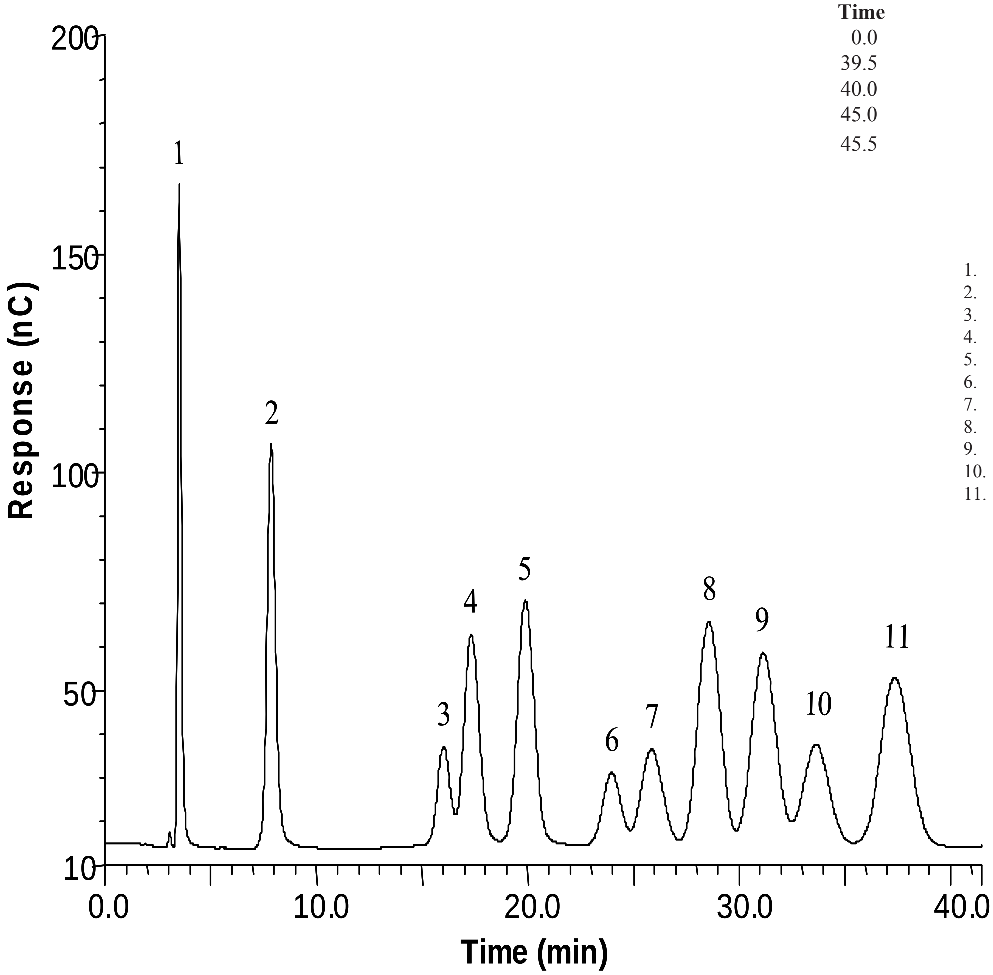
This application demonstrates the use of the EGC II KOH generator for resolving carbohydrates found in foods and beverages (Figure 39, "Analysis of Monsaccharides in Foods and Beverages with the EG50-Generated Carbonate-Free Eluent"). Resolution of galactose, glucose, mannose and xylose, as well as other 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 application and 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 EGC II 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:	CarboPac PA10 (4-mm) + AminoTrap (4-mm)
Flow:	1.0 mL/min
Pressure:	2,800 psi

Gradient Program

Time	KOH mM
0.0	2.3
39.5	2.3
40.0	100
45.0	100
45.5	2.3



Analyte
1. Mannitol
2. Fucose
3. Arabinose
4. Rhamnose
5. Galactose
6. Glucose
7. Sucrose
8. Xylose
9. Mannose
10. Fructose
11. Ribose

Figure 39
Analysis of Monosaccharides in Foods and Beverages with EG50-Generated Carbonate-Free Eluent

4.17 Analysis of Carbohydrates using both EG50-Generated KOH and Manually Prepared NaOH or KOH as Eluent

This application demonstrates the use of the EGC II 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 40, "Analysis of carbohydrates in corn stover hydrolysate with EG50-Generated Carbonate-Free and Manually Prepared Eluent" shows the resolution of arabinose, galactose, glucose, xylose, mannose, fructose using EG50-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 EG50), but less than 200 mM KOH or NaOH eluent concentration may use manually prepared eluent to supplement the hydroxide produced by the EG. For example, the EG 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 EG50 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 EG cartridge and the CR-ATC, the EG must be left on at low eluent concentration (e.g., 0.5 mM) to ensure polarization of the EG cartridge membranes and ensure longevity of the device. The use of combined EG50 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 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: CarboPac PA1 (4-mm)
Flow: 1.0 mL/min
Pressure: 1400 psi
Gradient Program:

Time	%A	%B	mM KOH (EG)	mM NaOH*
0.0	100	0	0.50	0
35.0	100	0	0.50	0
35.1	0	100	0.50	200
50.0	0	100	0.50	200
50.1	100	0	0.00	0
55.0	100	0	0.00	0
55.1	100	0	0.50	0

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

* Manually prepared eluent

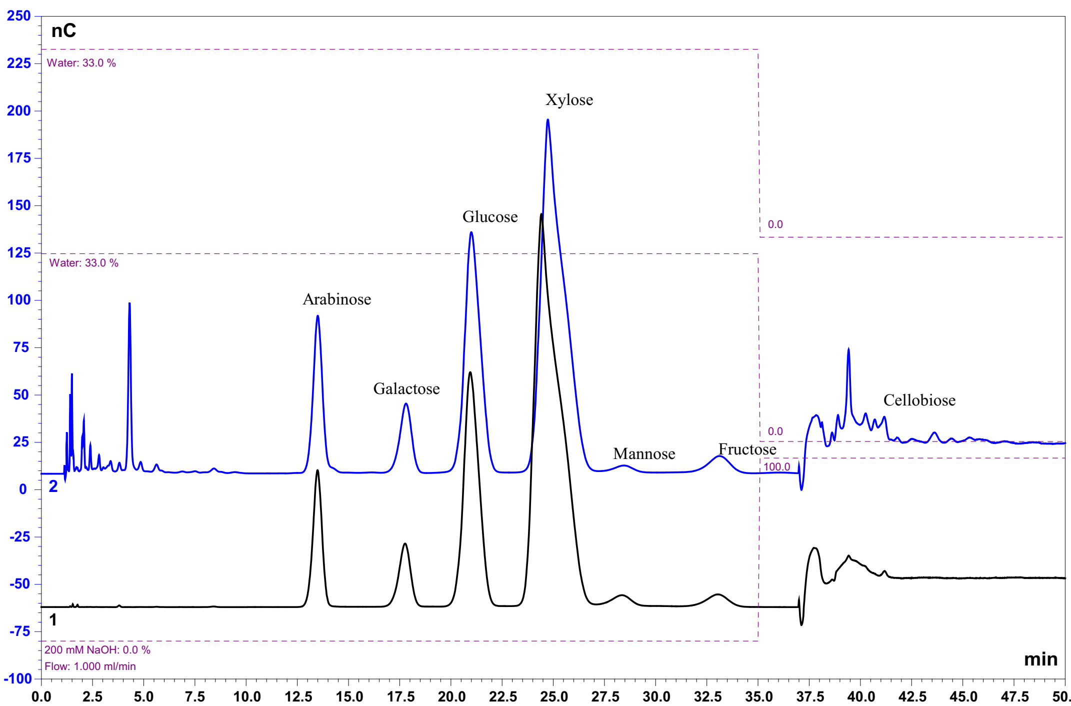


Figure 40
Analysis of carbohydrates in corn stover hydrolysate with EG50-Generated Carbonate-Free and Manually Prepared Eluent

SECTION 5 - MAINTENANCE

5.1 Routine Maintenance

A. Locate and repair leaks (see Section 6.2) and clean up spills. Rinse dried eluents off system components with deionized water. Rinse the EG50 drip tray with DI water to prevent formation of salt crystals and then dry it. Rinse and dry the leak sensor.

B. Periodically check all air and liquid lines for crimping. Move or reroute pinched lines and replace damaged lines (see Section 7).

5.2 Calibrating the Leak Sensor

After eliminating the cause of a liquid leak inside the EG50 (see Section 6.2), the leak sensor may need to be recalibrated. Complete the following procedure:

A. Open the PeakNet Configuration Editor.

B. Select Calibrate EG50 Leak Sensor from the Configure menu. A message box will appear. After following the preliminary instructions in the message box, click the Start button to begin the calibration procedure or click the Exit button to abort it. Exit is disabled once the procedure has begun.

C. Upon completion of the calibration procedure, a message box indicating the result is displayed. If the leak sensor was not successfully calibrated, contact Dionex for help. In the US, call 1-800-DIONEX-0 (1-800-346-6390). Outside the US, contact the nearest Dionex office listed in your Resource Library CD-ROM.

5.3 Monitoring the EluGen Cartridge Lifetime

The Module Status Display in the PeakNet or Chromeleon software displays important information about the EluGen cartridge currently being used by the EG50.

A. EluGen Serial Number:
This number is a unique 12-digit number that identifies the cartridge.

B. Remaining EluGen Lifetime:
This value is expressed as a percentage and counted down in 1% increments. At 10%, the software displays a warning each time a program with an EG50 is loaded. After the cartridge has expired (0%), the software can no longer load a program with an EG50 until the EluGen Cartridge is replaced.

C. EluGen Expiration Date:
This date is 2 years from the date of manufacture. One month before expiration, the software displays a warning each time a program with an EG50 is loaded. On the expiration date, the software displays a message that the cartridge has expired, however, you may continue operation with this cartridge provided EluGen lifetime remains. Be aware that use beyond the expiration date may affect your chromatographic results.

D. EluGen Cartridge Properties:
The EluGen cartridge properties for all EluGen Cartridges that have been utilized on a system can be viewed by selecting "View the EluGen Properties."

5.4 Replacing the EluGen Cartridge

The EluGen cartridge must be replaced when the cartridge is expended, when it leaks, or in order to switch between anion and cation separations with a single EG50 Module.

The label on the inside of the EG50 door illustrates the tubing connections to the cartridge.

To remove the old cartridge:

A. Turn off the EG50 pump flow either manually or via direct control in the PeakNet or Chromeleon software. The power to the EluGen Cartridge and SRS suppressor will automatically shut off.

B. Open the door of the EG50.

C. The electrical connector cable for the cartridge is plugged into a connector below the EluGen Cartridge shelf. Twist the plug counter clockwise and pull it straight out of the connector.

D. Unscrew the Luer lock from the Luer adaptor at the top corner of the EGC cartridge and detach the gas vent line.

E. Install the plastic plug in the gas vent port. Use the plug removed from the port during initial installation of the EG50. The plug should be in the drip tray.

F. With the eluent lines still attached, and the electrical contacts facing you, lift the EluGen Cartridge from the EG50 Cartridge shelf and turn it so that the electrolysis chamber and liquid line fittings are upward.

G. Unscrew the cartridge inlet line from the EluGen Cartridge **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 EluGen Cartridge.

H. Prepare an expanded cartridge for disposal by completing the following: hold the cartridge with the generator chamber upward, unscrew the eluent generation chamber from the electrolyte reservoir, and pour the remaining electrolyte solution into an appropriate hazardous waste container. Refer to the Material Safety Data Sheet (MSDS) shipped with the EluGen Cartridge for the chemical description.

   Rinse the electrolyte reservoir and membranes with DI water three times. 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 and 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. To reinstall the cartridge, follow the start-up instructions in Section 2.5.

J. To install a new cartridge, follow the procedure in Section 2.4.

NOTE: ***When switching between anion and cation separations on the same system, flush the entire system (<u>excluding</u> the EluGen Cartridge, column, and suppressor, but <u>including</u> 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.***

5.5 Replacing the EluGen Cartridge Outlet Frit

A. If the source of the system high backpressure is isolated to the EluGen Cartridge, the outlet frit should be replaced. The EluGen cartridge should add < 100 psi of backpressure.

B. Unscrew the Luer lock from the Luer adaptor at the top corner of the EGC electrolyte reservoir and detach the gas vent line.

C. Install the plastic plug in the gas vent port. Use the plug removed from the port during initial installation of the EG50. The plug should be in the drip tray.

D. Turn off the EG50 pump flow. The power to the EG50 and the SRS will automatically shut off.

E. With the eluent lines and electrical connects still attached, lift the EluGen Cartridge from the cartridge shelf, and turn it so the eluent generation chamber and liquid line fittings are upward.

F. Unscrew the cartridge outlet line from the **OUTLET** fitting on the EluGen Cartridge. The outlet frit is located in the electrolysis chamber at the base of this fitting. Using a sharp or pointed tool, such as the mini screwdriver (P/N 46985), carefully puncture and remove the frit body and seal ring. Replace with a new frit assembly (P/N 42310) provided with the EluGen cartridge.

G. Reattach the outlet line.

H. **IMPORTANT**
Invert the EluGen Cartridge with the Eluent Generation Chamber downward as shown in Figure 11, "EGC Cartridge." Shake the EluGen Cartridge 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 EGC cartridge is turned with the eluent generation chamber upward.

I. Position the EluGen Cartridge in the EG50 Module with the eluent generation chamber downward by positioning the PEEK chamber just below the shelf and sliding the cartridge through the opening in the shelf.

SECTION 6 - TROUBLESHOOTING GUIDE

The purpose of the Troubleshooting Guide is to help solve operating problems that may arise while using the EG50 Eluent Generator. For more information on problems that originate with the Ion Chromatograph (IC), column, or suppressor, refer to the Troubleshooting Guide in the appropriate operator's manual. If you cannot solve the problem on your own, contact the Dionex North America Technical Call Center at 1-800-DIONEX-0 (1-800-346-6390) or the nearest Dionex Office (see "Dionex Worldwide Offices" in the Reference Library CD-ROM).

6.1 EG50 Error Codes in PeakNet

The PeakNet or Chromeleon software may report the following error messages for the EG50. The following table lists the cause of each error code. This information may be helpful in troubleshooting the cause of the EG50 internal abort problem.

Table 2
EG50 Error Codes

Error Code	PeakNet message*	Cause of Error
8526	The pump is not responding	No communication with pump
8527	The pump's flow rate is less than 0.1 mL/min.	Pump flow rate is < 0.1 mL/min.
8528	There is a pump and pressure alarm condition	Pump pressure alarm
8529	Pump leak condition has been detected	A pump leak condition
8530	The pump motor has failed	Pump motor failed

*These messages will only appear if you have the PeakNet 5.01d patch or higher version installed. If you do not have the patch installed the error message will read, a "Unknown Error."

6.2 EG50 Troubleshooting

Table 3, "EG50 Troubleshooting," is a troubleshooting summary, listing an observed problem when operating the EG50 Module, one or more causes for the problem, and the appropriate corrective action.

For CR-TC troubleshooting refer to the CR-TC Product Manual (Document No. 031910).

Table 3
EG50 Troubleshooting Summary

Observation	Cause	Action
Leak LED Indicator is illuminated (This error does not shut off the EG50.)	Leaking fitting	Locate the source of the leak. Tighten or replace liquid line connections. See Section 7.2 for details on making line fittings.
	Blocked or improperly installed waste line	Check the 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 EG50.
	EluGen cartridge leaks	The cartridge must be replaced (see Section 5.4). After replacing the cartridge, recalibrate the leak sensor (see Section 5.2).
	Degas Assembly leaks	The Degas Assembly must be replaced See Section 7.3
	Leak sensor is not calibrated	Calibrate the leak sensor (see Section 5.2).
Fault LED Indicator is illuminated (This error shuts off the EG50.).	EluGen Cartridge electrical connection is open	Tug gently on the EluGen Cartridge 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. See Section 5.4 for instructions
	EluGen Cartridge input electrical connection has shorted out.	The cartridge must be replaced. See Section 5.4 for instructions
	EG50 Module electrical error.	This is an EG50 Module error. PeakNet has a diagnostic procedure intended for use by Dionex Service Personnel only. The procedure reports the EG50 current and voltage stability. Use this service command only when instructed to by a Dionex Service Representative
Power LED is not illuminated	No power	Make sure the EG50 module main power cord is plugged in.
		Make sure the wall outlet has power.
		Make sure the power switch is in the depressed position.
		If the Power LED fails to illuminate, contact the Dionex North America Technical Call Center at 1-800-DIONEX-0 (1-800-346-6390) or the nearest Dionex Office (see “Dionex Worldwide Offices”).
No eluent flow	Pump is not operating	Make sure the main power to the pump is turned on. Reprime the pump and then resume operation. Refer to the pump manual for priming instructions.
		The pump pressure limit has been tripped. Refer to the troubleshooting instructions in the pump manual.
	High pressure degas tubing assembly ruptured	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. See Section 7.3 for instructions.

EG50 Troubleshooting Summary (cont.)

Observation	Cause	Action
EG50 stops operation	Pump is off. (When the pump is off, the EG50 and SRS are automatically turned off.)	Make sure the main power to the pump is turned on. Reprime the pump and then resume operation. Priming instructions are in the pump manual.
	Flow rate is too low or too high	Select a flow rate between 0. 1 and 3.0 mL/min.
	Pump pressure limit tripped	When a system includes an EG50 Module, the high pressure limit for the pump is 21 MPa (3000 psi) and the low pressure limit is 1.4 MPa (200 psi). Make sure the system pressure is within this range. For more information, refer to the troubleshooting instructions in the pump manual.
	No communication with pump	Refer to the troubleshooting instructions in the pump manual.
	Pump motor fails	Refer to the troubleshooting instructions in the pump manual.
	Fault error detected (Fault LED indicator is lighted)	To prevent damage to the EluGen cartridge, the pump automatically turns off electrical power to the cartridge when excessive current or voltage is detected. See “Fault LED Indicator” section of Table 3.
	EluGen cartridge is expended	The cartridge must be replaced. See Section 5.4 for instructions
	No communication with PeakNet or Chromeleon	Make sure the EG50 Module is configured in PeakNet and the power is on.
		Make sure the EG50 is connected to the hub via a DX-LAN cable (P/N 960281).
	EG50 Module electrical error	PeakNet has a diagnostic procedure intended for use by Dionex Service Personnel only. The procedure reports the EG50 current and voltage stability. Use this service command only when instructed to do so by a Dionex Service Representative

EG50 Troubleshooting Summary (cont.)

Observation	**Cause**	**Action**
Excessive system back pressure	Restriction in the liquid line plumbing	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 EG50 Cartridge is identified as the source of the high backpressure, the outlet frit should be replaced. See Section 5.5. 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 EG50, adding parts one at a time until an abnormal pressure increase (and hence, the restriction) is found.
No Peaks	EG50 current may not be on. The PeakNet program may not be started.	See "Power LED is not illuminated" section of Table 3. Make sure that the EG50 is configured in PeakNet and the power is turned on.
Peak retention times are too short	Gradient method timing is too fast or concentration settings are too high. Pump flow rate is low. The OFFSET VOLUME in the EG50 program is too small.	Check the PeakNet or Chromeleon RC program for correct concentration and flow rate combinations. See Appendix B. Check the pump flow rate. Calibrate the pump flow rate if necessary. See the pump manual for details. To match the retention times from conventional gradients, methods use an OFFSET VOLUME in the EG50 setup. See Section 4.1.4 for details. The OFFSET VOLUME can be specified in the PeakNet EG50 system configuration as 0 - 2,000 µL. The default value for the EG50 is 400 µL but the actual value may be greater depending on the system configuration. The software uses this value to calculate the time delay in starting the EG50 program and EG50 timed events.

EG50 Troubleshooting Summary (cont.)

Observation	Cause	Action
Peak retention times are too long	Gradient method timing is too slow or concentration settings are too low	Check the PeakNet or Chromeleon RC Program for correct concentration and flow rate combinations. See Appendix B.
	Pump flow rate is high	Check the pump flow rate. Calibrate the pump flow rate if necessary. See the pump manual for details.
	The OFFSET VOLUME in the EG50 program is too large.	Use a smaller OFFSET VOLUME in the EG50 setup. See Section 4.1.4 for details
		The OFFSET VOLUME can be specified in the software server configuration as 0 – 2,000 µL. The default value for the EG50 is 400 µL but the actual value may be greater depending on the system configuration. The software program uses this value to calculate the time delay in starting the EG50 program and EG50 timed events.
Baseline noise	Pump not primed	Prime the pump. Refer to the pump manual for priming instructions.
	System backpressure is < 2,000 psi (14 MPa)	Noise increases as the gradient concentration increases Add backpressure restrictor after Degas Assembly See Section 2.4.1.
High background	Anion Trap Column (ATC-HC) is contaminated.	Clean ATC-HC column. See ATC-HC manual for instructions.
	Large carbonate peak and/or smaller chloride and sulfate peaks may appear during gradient.	Prepare the Anion Trap Column for use by flushing with 200 mL of 2.0 N KOH at 2 mL/min. Rinse the ATC-HC column with 50 mL of DI water at 2 mL/min.
Low system backpressure	Loose fitting	Check all system fittings.
	High pressure degas tubing assembly ruptured	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 See Section 7.3 for instructions.
	Internal EluGen Cartridge leak in the membrane barrier. (This leak will not be detected immediately by the EG50 leak sensor since the liquid leak will pass out through the vent line.)	This type of leak may trip the pump pressure limit and the pump will shut off. The cartridge must be replaced. See Section 5.4.

SECTION 7 - SERVICE

This section describes routine service procedures that users may perform for the EG50 Eluent Generator. Other service procedures not included here must be performed by Dionex personnel. In the US, call 1-800-DIONEX-0 (1-800-346-6390). Outside the US, call the nearest Dionex office listed in the Reference Library CD-ROM.

NOTE 1:* *The EG50 electronics components are not user-serviceable. Any repair involving the electronics must be performed by Dionex personnel.

NOTE 2:* *The CPU card contains a lithium battery. If it is necessary to replace the CPU card, dispose of the used battery according to the manufacturer's instructions.

Before repairing or replacing a mechanical part, review the troubleshooting information in Section 6 to be sure you have correctly identified the source of the operating problem. When ordering replacement parts provide the part number, revision number (if applicable), EG50 model number, and serial number from the data label on the rear panel.

7.1 Changing Main Power Fuses

CAUTION: HIGH VOLTAGE

Disconnect the main power cord from its source, and also from the EG50 rear panel.

A. Press the main power button on the front of the EG50 to turn off the power. Unplug the power cord.

B. The fuse holder is in the main power receptacle on the rear panel of the EG50 (see Figure 8, "EG50 Module Rear Panel"). Using a small screwdriver (or your fingernails), push the recessed lock on each side of the fuse holder toward the center and then release the locks; the fuse holder will pop out about 2 mm. Pull the fuse holder straight out of the compartment.

C. The fuse holder contains two fuses. Replace these with new 3.15 Amp, Fast-Blow IEC127 fuses (P/N 954745). Always replace both fuses, even though only one is open. Because the other fuse may have been stressed, it may fail soon even under normal operation.

D. The fuse holder is keyed to fit in the compartment only in its proper orientation. After noting the orientation, reinsert the fuse holder into the compartment, applying just enough pressure evenly against the fuse holder to engage the two recessed locks. When both locks are engaged, the fuse holder is flush against the panel.

E. Reconnect the main power cord and press the main power button to turn on the power.

7.2 Replacing Tube Fittings

Liquid line connections throughout the EG50 are made with PEEK tubing, Dionex 10-32 ferrules (P/N 043276), and 10-32 fittings (P/N 043275).

7.3 Replacing the High Pressure Degas Tubing Assembly

The degas tubing assembly may rupture if subjected to excessive pressure.

A. Turn off the pump.

B. Open the door of the EG50 Module. The degas tubing assembly is mounted on the left-hand wall (see Figure 7, "EG50 Module Interior").

C. Disconnect the lines connected to the **REGEN IN** and **WASTE OUT** fittings on the Degas Assembly.

D. Disconnect the lines connected to the **ELUENT IN** and **ELUENT OUT** fittings on the Degas Assembly.

E. Remove the two screws that secure the Degas Assembly to the wall. Retain the mounting screws. Dispose of the faulty Degas Assembly.

F. Mount the new Degas Tubing Assembly (P/N 053721) on the wall using the two screws from Step E.

G. Complete the installation as follows (See Figure 15 for details):

1. Connect the outlet line from the CR-TC **ELUENT OUT** port to the Degas Assembly fitting labeled **ELUENT IN**.

2. Connect the line from the injection valve to the Degas Assembly fitting labeled **ELUENT OUT**.

3. Connect the **TO CR-TC REGEN-OUT** line to the Degas Assembly fitting labeled **REGEN IN**.

4. Connect the Degas Assembly line, labeled **WASTE OUT,** to the system waste line fitting. To prevent waste siphoning back into the system, make sure the tubing is not bent, pinched, or elevated at any point.

H. Close the EG50 door. Turn on the pump and resume operation.

7.4 Running the Eluent Generator System Diagnostic Routine

You may be asked by Dionex Service Personnel to run the Eluent generator System Diagnostic Routine. The diagnostic is run with the chromatography system configured to run an analysis method. The diagnosis routine will run the EG50 and EGC at low and high levels of eluent generation and determine whether it can detect any problems. The diagnostic routine, and its interpretation, is described below.

The diagnostic routine generates a linear ramp from 0 to 100 mM and then returns to 0 mM in a stair-step fashion, i.e., it runs isocratically for brief periods at successively lower concentrations.

CAUTION

To avoid damaging the EluGen cartridge, the pump must be operating at or above 1.0 mL/min during the diagnostic routine.

A. To start the routine, open PeakNet or Chromeleon and select "System Configuration with EG50 Installed" Diagnostic

B. The diagnostic takes about 10 minutes to complete, after which a graph and table of data can be viewed. See Figure 41, "MSA Generator," for an example of normal graph and data results.

C. The graph shows the current generated during the routine. The current present at specific times can be read directly from the graph by placing the cursor on the graph at the desired time.

D. Normal graph results are as follows:

- The linear ramp at the start of the graph should appear straight.
- The level portion of each stair step should appear flat, the vertical portion straight, and the corners sharp.

E. Normal data results are as follows:

- Except at the very lowest concentrations, the %RSD for the current should be less than 4%.
- The voltage should be less than 25 volts at the maximum concentration.

F. Abnormal data results indicate the following:

- %RSDs higher than 4% indicate possible damage to the programmable current generator.
- Voltages higher than 25 volts indicate possible damage to the EluGen cartridge.

G. If abnormal results are obtained, contact Dionex for assistance.

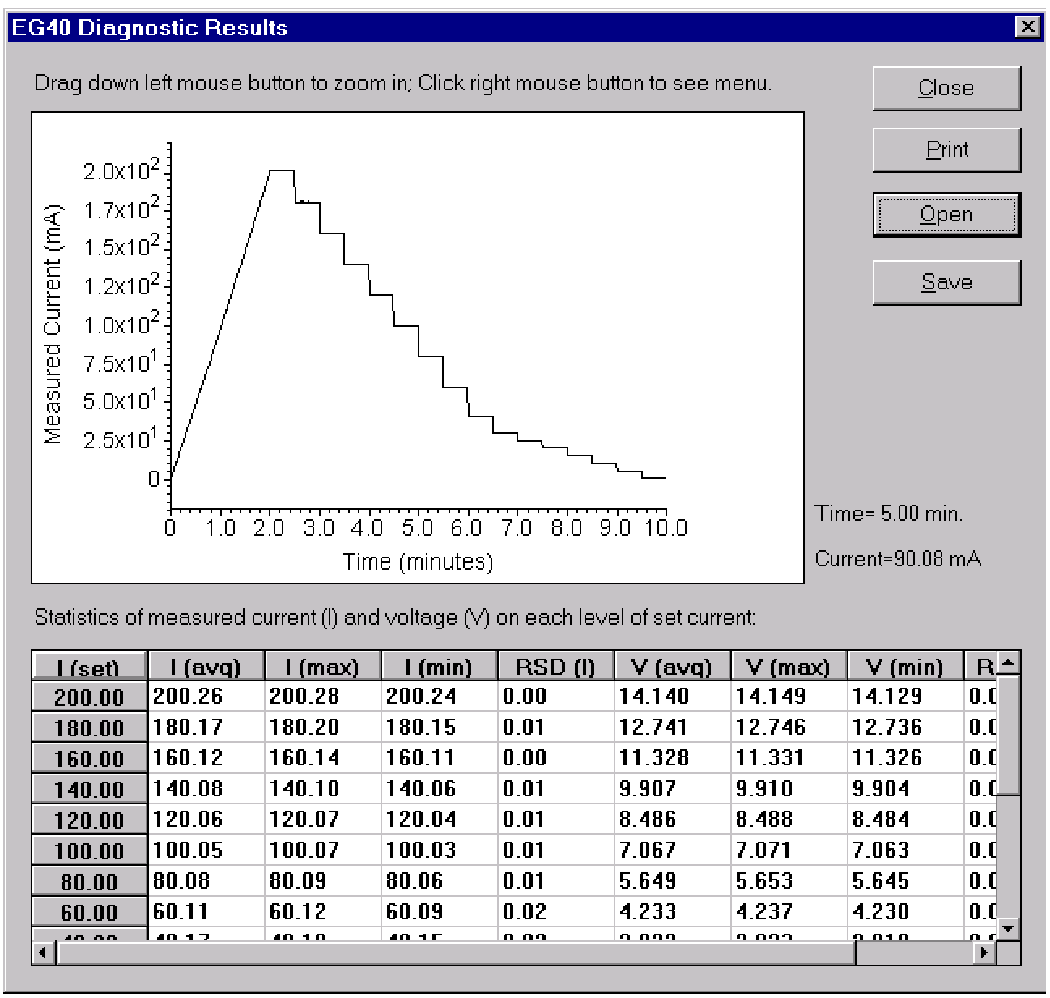


Figure 41
MSA Generator
The Maximum Current (I) and Voltage (V) are lower for a KOH Generator

SECTION 8 - TTL CONTROL OF THE EG50

8.1 TTL Connections

Locate the following items in the EG50 ship kit:

Description	Part Number	Quantity
2-pin connector plug	921185	1
Green 3-pin Connector	921186	1
1 pair Twisted Red and Black wires	043598	2

To connect the TTL output:

A. Plug a 2-pin plug into the **GND** and **TTL-1 OUT** connections on the rear of the EG50. (The **TTL-2 OUT** connector is reserved for future expansion.)

B. Note which connections on the plug are the ground (**GND**) and signal (**TTL-1**) connections.

C. Remove the plug from the rear of the EG50.

D. Attach the black wire from the twisted pair to the **GND** connection on the 2-pin plug.

E. Attach the red wire from the twisted pair to the **TTL-1** connection on the 2-pin plug.

F. Connect this plug to the **GND** and **TTL-1 OUT** connections on the EG50.

G. Connect the wires from the EG50 connector to TTL, or relay connectors input pins, on the other module. Be sure to use the correct connector plug and connections on the other module. For example, for DX-500 modules, attach a second two-pin plug (provided in the DX-500 ship kit).

To connect a TTL input:

A. Plug a 3-pin plug into the TTL input connections on the rear of the EG50 (**GND**, **TTL-1 IN** and **TTL-2 IN**).

B. Note which connection on the plug is the ground (**GND**) and signal (**TTL-1** or **TTL-2**) connections.

C. Remove the plug from the rear of the EG50.

D. Attach the black wire from the twisted pair to the **GND** connection on the 3-pin plug.

E. Attach the red wire from the twisted pair to the **TTL-1** (or **TTL-2**) connection on the 3-pin plug.

F. Connect this plug to the TTL IN connections on the EG50.

G. Connect the wires from the EG50 input connector to TTL, or relay connector output pins, on the other module. Be sure to use the correct connector plug and connections on the other module. For example, for DX-500 modules, attach a second two-pin plug (provided in the DX-500 ship kit).

NOTE

After the TTL connections are made at both ends of the twisted pair of wires, verify that the connections were made properly. To do this, verify that the black wire is connected to ground, and the red wire is connected to the signal (e.g., TTL-1 or TTL-2). If necessary, remove wires from the plugs and reinsert them in the correct positions.

8.2 TTL-Controlled Operation

TTL Inputs

Two TTL inputs are provided: **TTL-1 IN** and **TTL-2 IN**.

TTL-1 IN

TTL-1 IN operates only when the Eluent Generator system is in Direct Control mode (the Direct Control dialog box is open). **TTL-1 IN** controls the current to the EluGen cartridge. A falling edge (from +5 VDC to ground) turns the EluGen cartridge current on and a rising edge (from ground to +5 VDC) turns the cartridge current off, i.e., the logic type is normal edge.

Notes on using TTL-1 IN:

A. The falling edge must remain down, or the rising edge must remain up, for a minimum of 0.020 seconds for the transition to be recognized. (NOTE: A normal pulse can be used to control the current if the pulse's leading and trailing edges are more than 0.020 seconds apart. The normal pulse input for a DX-500 will work correctly.

B. The TTL input requires at least 20 mA of current at standard TTL voltage levels (0 - 5 volts).

C. **TTL-1 IN** is ignored if the Eluent Generator system is not in Direct Control; no error is sent if a signal attempts to trigger **TTL-1 IN** while the Eluent Generator system is not in Direct Control mode.

D. While the Eluent Generator system is in Direct Control, both PeakNet and **TTL-1 IN** can turn the current on and off. The last command from either source is the one in effect (e.g., a command from PeakNet can stop the current and then a TTL command can start it).

E. If PeakNet and **TTL-1 IN** both send the same command to the EG50, the second command is ignored, with no error.

F. Do not use TTL control from another module to the EG50 when both modules are configured in the same DX-LAN PeakNet system.

The reason for this is as follows: PeakNet's Direct Control commands are issued at the same time for all modules in a system. PeakNet's Direct Control commands include both TTL out signals and the Eluent Generator system's concentration. If a PeakNet Direct Control command directs a module to sends a TTL out signal to an EG50 TTL input, and also sends a second command directly to the same EG50, then it is difficult to predict which command will arrive first and which will arrive last. Thus, it may be difficult to predict the final state of the Eluent Generator system after both commands arrive.

However, PeakNet is intended to be the Eluent Generator system's primary control and can direct any action without TTL inputs. Thus, there is no technical requirement to control the Eluent Generator system from the TTL output of a PeakNet-controlled module.

TTL-2 IN

TTL-2 IN operates only when the Eluent Generator system is in Method mode. The Eluent Generator system is set to Method mode whenever a Method has been loaded. **TTL-2 IN** starts running the currently loaded Method. A falling edge (from +5 VDC to ground) starts the Method. A rising edge (from ground to +5 VDC) is ignored, i.e., the logic type is normal edge.

Notes on using TTL-2 IN:

A. The falling edge must remain down, or the rising edge must remain up, for a minimum of 0.020 seconds for the transition to be recognized. (NOTE: A normal pulse can be used to control the current if the pulse's leading and trailing edges are more than 0.020 seconds apart. The normal pulse input for a DX-500 will work correctly.

B. The TTL input requires at least 20 mA of current at standard TTL voltage levels (0 - 5 volts).

C. **TTL-2 IN** is ignored while the Eluent Generator system is in Direct Control; no error is sent if a signal attempts to trigger **TTL-2 IN** while the Eluent Generator system is in Direct Control mode.

D. While the Eluent Generator system is in Method control, both PeakNet and **TTL-2 IN** can start a Method, but only PeakNet can stop a Method.

E. If PeakNet and **TTL-1 IN** both send the same command to the Eluent Generator system, the second command is ignored, with no error.

To use TTL input control, follow these basic steps:

A. Connect wires between the TTL input connector pins on the EG50 rear panel and TTL/relay output pins on the other module(s) in the system (see Section 8.1).

B. Create a Method for the other module that turns the EG50 TTL input function on and off at the appropriate times. For testing purposes, Direct Control can be used to turn the input on and off.

C. Run the Method.

TTL Output

TTL-1 OUT drives a normal edge output signal, i.e., the transition goes from +5 VDC to ground for "on" and ground to +5 VDC for "off." **TTL-1 OUT** can drive up to 500 mA of current at standard TTL voltage levels (0 - 5 volts).

TTL-2 OUT is not functional and is reserved for further expansion.

To use TTL output control, follow these basic steps:

A. Connect wires between the TTL output connector pins on the EG50 rear panel and the TTL/relay input pins on the other module(s) in the system (see Section 8.1).

B. Create an Eluent Generator system Method that includes timed events for turning the TTL output on and off at the appropriate times. For testing purposes, Direct Control can also be used to turn the TTL on and off.

C. Run the Method.

APPENDIX A - OPTIONAL ATC-HC OR CTC-1

A1. Install the ATC-HC Trap Column

As an alterative to the CR-ATC, the ATC-HC Trap can be used for anion applications (EGC II KOH). The ATC-HC Trap Column will require off-line chemical regeneration. See the ATC-HC Trap Column Product Manual (Document No. 032697) for details.

A. Prepare the Anion Trap Column (ATC-HC, P/N 059604) for use by flushing the ATC-HC column with 200 mL of 2.0 M NaOH or KOH at 2 mL/min.

B. Rinse the ATC-HC column with degassed DI water for 20 minutes at 2 mL/min.

C. Using the screws provided, attach the ATC/CTC Bracket (P/N 046384) found in the EG50 ShipKit. See Figure 42.

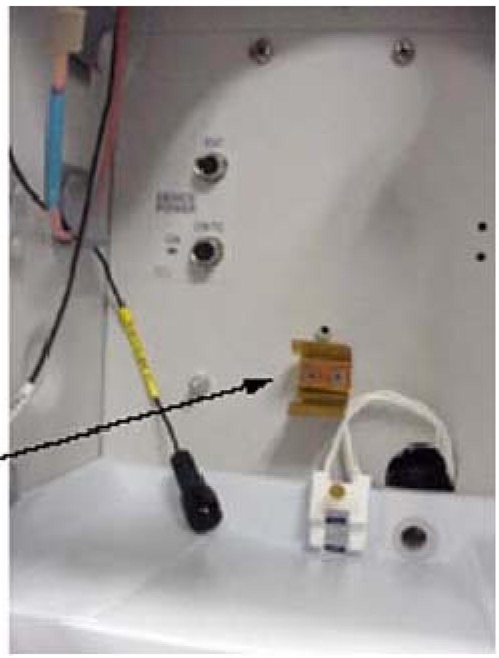


Figure 42
EG50 with Optional ATC Bracket

D. Connect the pump pressure transducer outlet to the Anion Trap Column (ATC-HC) inlet using the PEEK tubing connected to the exit of the pump pressure transducer. See Figure 43.

E. Guide the tubing through the lower tubing chase at the lower edge of the EG50 module.

F. Connect the outlet of the ATC-HC to the inlet of the EluGen Cartridge using the PEEK tubing labeled **TO PUMP OUT/ DAMPER** at one end and **EGC IN** at the other end.

G. Mount the ATC-HC in the bracket below the EluGen Cartridge shelf.

H. Connect the PEEK tubing, labeled, **DEGAS ELUENT IN**, extending from the Degas Assembly to the outlet of the EluGen Cartridge labeled **EGC OUT**.

A2. Install the CTC-1 Trap Column

As an alterative to the CR-CTC, the CTC-1 Trap can be used for cation applications (EGC II MSA). The CTC-1 Trap Column will require off-line chemical regeneration. See the CTC-1 Trap Column Product Manual (Document No. 034536) for details.

A. Prepare the Cation Trap Column (CTC-1, P/N 040192) for use by flushing the CTC column with 200 mL of 100 mN MSA at 2 mL/min.

B. Rinse the CTC column with degassed DI water for 20 minutes at 2 mL/min.

C. Using the screws provided, attach the ATC/CTC Bracket (P/N 0046384) found in the EG50 ShipKit. See Figure 42.

D. Connect the pump pressure transducer outlet to the Cation Trap Column (CTC-1) inlet using the PEEK tubing connected to the exit of the pump pressure transducer. See Figure 43.

E. Guide the tubing through the lower tubing chase slot at the lower edge of the EG50 module.

F. Connect the outlet of the CTC to the inlet of the EluGen Cartridge using the PEEK tubing labeled **PUMP OUT** at one end and **EGC IN** at the other end.

G. Mount the CTC in the lower bracket below the EluGen Cartridge shelf.

H. Connect the PEEK tubing, labeled, **DEGAS ELUENT IN**, extending from the Degas Assembly to the outlet of the EluGen Cartridge labeled **EGC OUT**.

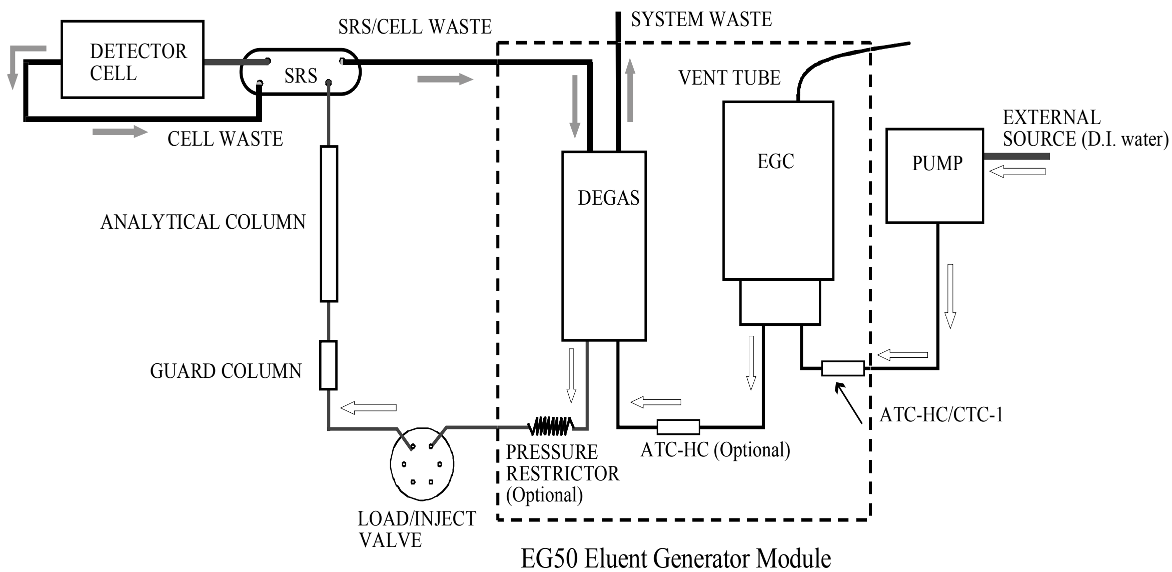


Figure 43
System Flow Diagram for Ion Exchange Applications Using the EG50 Eluent Generator with ATC-HC or CTC-1

APPENDIX B - EG50 SPECIFICATIONS

Dimensions	(H x W x D) 50 cm x 14 cm x 42 cm deep (20 in x 5.6 in x 16.8 in); at least 5 cm (2 in) clearance behind the EG50 is required
Weight	11 kg (25 lbs)
System Operating Pressure	Minimum: 2,000 psi (14 MPa) Maximum: 3,000 psi (21 MPa)
Concentration Ranges and Formula	0.1 to 100 mM at flow rate of 0.1 to 1.0 mL/min 0.1 to X mM at flow rate of 1.0 to 3.0 mL/min; where X mM = 100/ Flow Rate in mL/min
Delay Volume	User-settable from 0 to 2000 µL; Default setting is 400 µL
Decibel Level	<50 dBA

SAFETY COMPLIANCE

The EG50 Eluent Generator meets European, EMC, and safety requirements per Council Directives 73/72/EEC and 89/336/EEC, EN61010-1:+A2, CAN/CSA C22.2 Mp. 1010-92 UL 3101:93 (safety). The CE safety label on the EG50 attests to compliance with these standards.

The EG50 Eluent Generator is designed for ion exchange and HPLC applications and should not be used for any other purpose. If there is a question regarding appropriate usage, contact Dionex before proceeding.