Dionex ERS 500 Suppressor

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Product Manual

for

Dionex Anion Electrolytically Regenerated Suppressor 500

(Dionex AERS 500 (4 mm), Item # 082540)
(Dionex AERS 500 (2 mm), Item # 082541)

Dionex Cation Electrolytically Regenerated Suppressor 500

(Dionex CERS 500 (4 mm), Item # 082542)
(Dionex CERS 500 (2 mm), Item # 082543)

Dionex Anion Electrolytically Regenerated Suppressor 500e

(Dionex AERS 500e (4 mm), Item # 302661)
(Dionex AERS 500e (2 mm), Item # 302662)

Dionex Cation Electrolytically Regenerated Suppressor 500e

(Dionex CERS 500e (4 mm), Item # 302663)(Dionex CERS 500e (2 mm), Item # 302664)

Dionex Anion Electrolytically Regenerated Suppressor 500 for Carbonate Eluents

(Dionex AERS 500 Carbonate (4 mm), Item # 085029)
(Dionex AERS 500 Carbonate (2 mm), Item # 085028)

Revision History:

Revision 08, April 24, 2013, Rebranded for Thermo Scientific. Product name changed from Dionex SRS 300 to Dionex ERS 500.

Revision 09, November, 2013, Updated External Water Mode flow rate recommendations, Updated hydration procedure.

Revision 10, August, 2015, Added support for the Neutralization mode. Added support for Carbonate Eluents.

Revision 11, January, 2017, Updated the recommended suppressor hydration procedure. Edited for length and clarity. Added Dionex ERS 500e product.

Safety and Special Notices

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

Safety and special notices include the following:

SAFETY	***Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.***
WARNING	***Indicates a potentially hazardous situation which, if not avoided, could result in damage to equipment.***
CAUTION	***Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury. Also used to identify a situation or practice that may seriously damage the instrument, but will not cause injury.***
NOTE	***Indicates information of general interest.***
IMPORTANT	***Highlights information necessary to prevent damage to software, loss of data, or invalid test results; or might contain information that is critical for optimal performance of the system.***
Tip	***Highlights helpful information that can make a task easier.***

Contents

1. Introduction

Suppressor: The role of a suppressor in Ion Chromatography is to remove the eluent and sample counterions and replace this with regenerant ions thereby converting the eluent to a weakly dissociated form prior to detection. Detection of analyte ions particularly with conductivity detection is therefore feasible against a low background. The suppressor not only reduces the background signal but also the noise associated with the signal. Furthermore, the analytes are converted to the more conductive acid or base form, which enhances the signal, particularly for fully dissociated species. Thus overall improvement in detection limits, as observed from the signal to noise ratio, is achieved. When compared to, applications that do not use a suppressor, i.e., single column ion chromatography, the improvement in noise with suppressed ion chromatography far exceeds the noise performance of single column chromatography applications. Hence the suppressor has become an integral part of the ion chromatography instrument.

The suppressors from Thermo Fisher Scientific are designed for continuous operation and do not require any switching or offline regeneration. Furthermore, the standards and the samples are always exposed to the same suppressor device when pursuing ion analysis, thus ensuring that the analytical parameters are consistent between calibration and analysis. From a simplistic perspective there are two types of suppressors offered for continuous operation; electrolytically regenerated suppressors and chemically regenerated suppressors. The electrolytic suppressors operate continuously with a water source as a regenerant. In the recycle mode of operation the water source is derived from the suppressed eluent, thereby making the suppressor operation facile. The chemical suppressors operate continuously with an external regenerant source.

The electrolytic suppressor device also permits recycle of the eluent when installed in a system with Eluent Recycle (ER) system.

Additionally, an electrolytic suppressor can also act as an electrolytically regenerated neutralizer for the neutralization of basic or acidic matrices prior to injection. By neutralizing the matrix ions, trace anionic or cationic species can be detected in strong acid or base samples.

1.1 Electrolytically Regenerated Suppressor

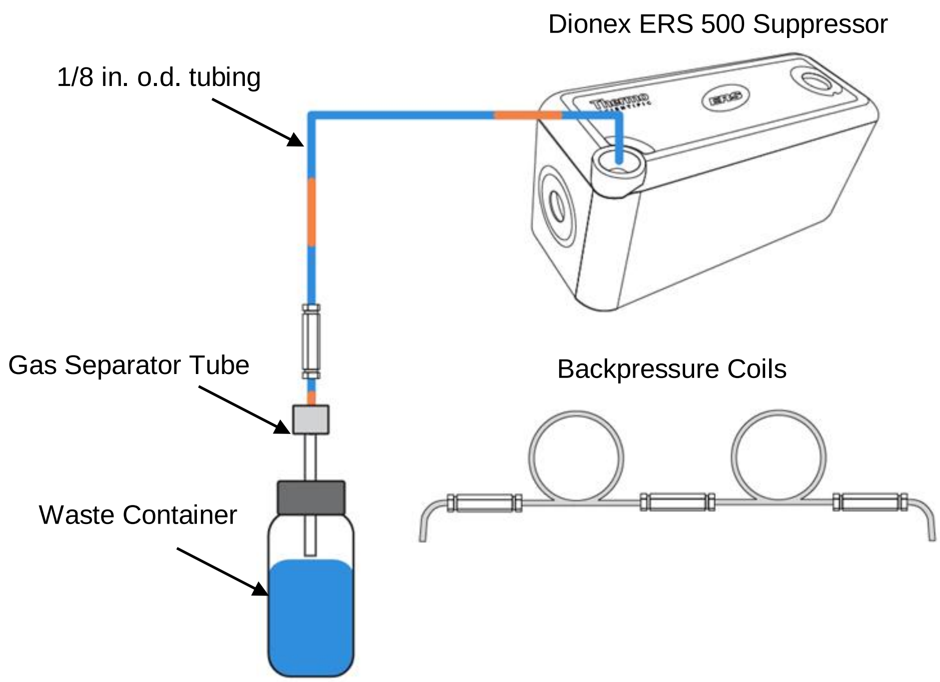
The Thermo Scientific™ Dionex™ Electrolytically Regenerated Suppressor (Dionex ERS™ 500 Suppressor) replaces the Thermo Scientific Dionex Self-Regenerating Suppressor (Dionex SRS™ 300 Suppressor) product line. The Dionex ERS 500 is an electrolytic suppressor with a new hardware design that allows the suppressor to be more pressure tolerant than previous generation suppressor devices. The suppressor flow pathway has been redesigned to optimize band dispersion and improve the flow and sealing properties. The Dionex ERS 500 continues to use the same cleaned ion exchange components (screens and membranes) as the Dionex SRS 300 suppressor devices; however the Dionex ERS 500 eluent channel uses an ion exchange resin bed as opposed to a gasketed screen.

The Dionex Electrolytically Regenerated Suppressor (Dionex ERS 500) is available in two versions: the Anion Electrolytically Regenerated Suppressor (Dionex AERS™ 500) and the Cation Electrolytically Regenerated Suppressor (Dionex CERS™ 500) to support anion and cation analysis applications. The Dionex ERS 500 system consists of an Electrolytically Regenerated Suppressor, the Suppressor Control, back pressure coils, and the Gas Separator Waste Tube, see Figure 1. This high performance, low maintenance AutoSuppression system provides a reliable solution for Ion Chromatography.

Additionally, the Dionex ERS 500 offers high capacity suppression while adding minimal delay volume to the analytical system. The Dionex AERS 500 provides continuous suppression of traditional eluents, and more concentrated eluents up to 200 mM NaOH. The Dionex CERS 500 offers continuous suppression of concentrated eluents up to 100 mN H2SO4 or MSA. This high capacity significantly expands the capabilities and simplifies the operation of Ion Chromatography.

The Dionex ERS 500, Dionex ERS 500e and Dionex AERS 500 Carbonate suppressors are available in 2 mm and 4 mm formats for use with 2, 3, 4, or 5 mm Ion Chromatography columns and systems. The 2 mm Dionex ERS 500, Dionex ERS 500e and Dionex AERS 500 Carbonate are specially designed with reduced internal volume to ensure optimum performance with 2 mm columns and systems.

Figure 1 The Electrolytically Regenerated Suppressor and Accessories



Tip

For assistance, contact Technical Support for Dionex Products. In the U.S., call 1-800-346-6390. Outside the U.S., call the nearest Thermo Fisher Scientific office.

The Dionex ERS 500 design comprises of three channels defined by two ion exchange membranes. The central channel is the eluent channel and the two side channels are regenerant channels. Two PEEK plates form the outer wall of the regenerant channels and have ¼-24 ports for bringing in the regenerant liquid into and out of the device. The eluent channel is physically defined by a PEEK plate that seals against the ion exchange membrane and a thin elastomeric O-ring installed in the regenerant channel. The eluent in and out ports are independent ports that define the fluidic pathway, similar to a column. The regenerant flow is arranged to be counter-current to the eluent flow. This orientation ensures complete regeneration of the device

Electrodes are placed along the length of the regenerant channels to completely cover the eluent channel. In operation, when a DC voltage is applied across the electrodes and the voltage exceeds the standard potential for the electrolysis of water (approximately 1.5 V), water is electrolytically split to form electrolysis ions.

At the anode $H_2O \rightarrow 2H^+ + 1/2O_2 + 2e^-$

At the cathode $H_2O + 2e^- \rightarrow 2OH^- + H_2$

The electrolysis ions are then available for the suppression reactions. The Dionex ERS 500 suppressor design allows facile transport of cations or anions depending on which type of suppressor is used for the application. For example, when pursuing anion analysis with a Dionex

AERS 500, cation exchange functionality extends across the electrodes. The function of this is to lower the resistance and aid in the transport of ions in and out of the eluent channel. In the Dionex ERS 500 the eluent channel is filled with ion exchange resin and provides a static capacity which is particularly useful when eluent is pumped into the device with the power off.

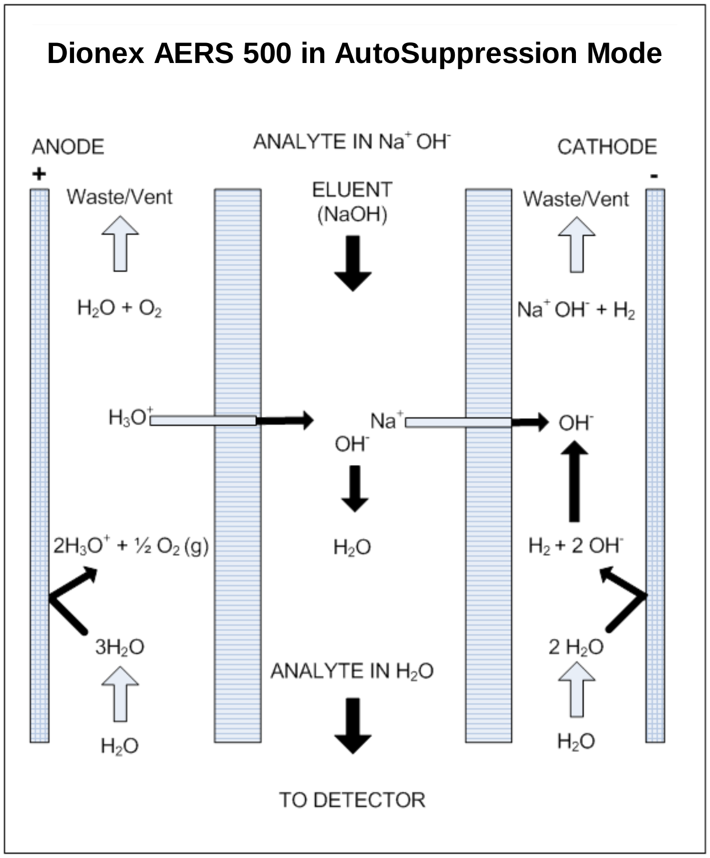
In operation the electrolytically generated hydronium ions in the Dionex AERS 500 are driven towards the cathode along with eluent cations by the applied voltage. The membrane allows hydronium ions to pass into the eluent chamber resulting in the conversion of the electrolyte of the eluent to a weakly ionized form. For each hydronium ion entering the eluent channel one hydronium or a cation exits the device and is driven towards the cathode. At the cathode the cations combine with the electrolytically generated hydroxide ions to form water or base. Overall the current dictates the concentration of hydronium and hydroxide ions.

The eluent suppression process is illustrated for Anion Suppressor in Figure 2 and for Cation Suppressor in

Figure 3.

As shown in Figure 2, the water regenerant undergoes electrolysis to form hydroxide ions on the cathode surface along with hydrogen gas while hydronium ions are formed in the anode surface along with oxygen gas. In the Anion Suppressor, cation exchange materials such as screens, membranes and resins allow hydronium ions to move from the anode chamber into the eluent chamber to neutralize the hydroxide eluent. Sodium ions or eluent or sample counter-ions in the eluent are driven by the applied electric potential towards the cathode and combine with the hydroxide ions generated at the cathode to form sodium hydroxide waste. Hydronium ions can also travel all the way to the cathode to form water, thus effecting suppression of the eluent and conversion of the analyte to typically a more conductive acid form.

Figure 2 AutoSuppression with the Dionex AERS 500



The Dionex Electrolytically Regenerated Suppressor for External Water Mode (Dionex ERS 500e) is optimized for use in the external water mode. The Dionex ERS 500e hardware design is similar to the Dionex ERS 500 hardware design from a sealing perspective and is optimized for minimal band dispersion and improved flow performance. The Dionex ERS 500e uses the same ion exchange membranes, screens, and resin materials as the standard Dionex ERS 500 suppressor. The Dionex ERS 500e is configured with a parallel regenerant flow to facilitate easy supply and removal of regenerant and waste from the regenerant compartments making it suitable for external water applications, as well as applications where organic modifiers (up to 40%) are present in the eluent or sample. The Dionex ERS 500e is required for applications where borate is used as an eluent.

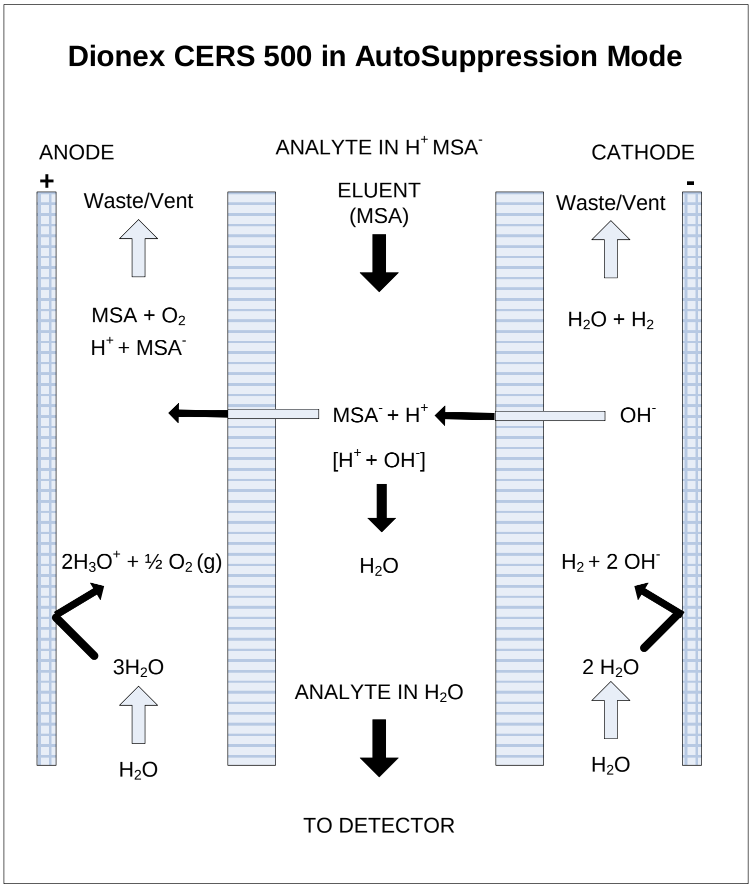
The Dionex ERS 500e (2 mm) suppressor is compatible with MS detection; the suppressor has been designed to have minimal interference for MS applications and is designed for operation in external water mode. The 2 mm suppressor is recommended for applications that use MS detection due to the improved efficiency, and since less eluent enters the MS at the lower operational flow rate.

The Dionex Anion Electrolytically Regenerated Suppressor for Carbonate Eluents (Dionex AERS 500 Carbonate) is optimized for use with carbonate or carbonate/bicarbonate based eluents and is available only as an anion version. The Dionex AERS 500 Carbonate hardware design is similar to the Dionex AERS 500 hardware design from a sealing perspective and is optimized for minimal band dispersion and improved flow performance. The Dionex AERS 500 Carbonate uses the same ion exchange membranes, screens, and resin materials as the standard Dionex AERS 500 suppressor. The Dionex AERS 500 Carbonate is configured with a parallel regenerant flow to facilitate easy supply and removal of regenerant and waste from the regenerant compartments. The Dionex AERS 500 Carbonate operates similar to the Dionex AERS 500 suppressor using electrolysis derived regenerant ions; however, it uses a three-electrode design for the electrolysis function. The anode electrode is segmented into two portions with an electrical gap. The anode electrodes are connected via a resistor thus resulting in a lower applied current across the outlet section of the suppressor relative to the inlet section of the suppressor. This design results in decreased gas production at the outlet, and as a consequence, results in less variation in the suppressed background and is able to achieve low noise.

As shown in

Figure 3, the water regenerant undergoes electrolysis to form hydroxide ions in the cathode surface along with hydrogen gas while hydronium ions are formed in the anode surface along with oxygen gas. In the cation suppressor, anion exchange materials such as screens, membranes and resins allow hydroxide ions to move from the cathode chamber into the eluent chamber to neutralize the acid eluent. MSA ions or eluent or sample counter-ions in the eluent are driven by the applied electric potential towards the anode and combine with the hydronium ions generated at the anode to form methane sulfonic acid waste. Hydroxide ions can also travel all the way from the cathode and combine with hydronium ions at the anode to form water, thus effecting suppression of the eluent and conversion of the analyte to a typically more conductive base form.

Figure 3 AutoSuppression with the Dionex CERS 500



1.2 Overview of Suppression and Neutralization Modes

Four basic modes of suppression can be performed with the Dionex Electrolytically Regenerated Suppressor (Dionex ERS 500, Dionex ERS 500e and Dionex AERS 500 Carbonate):

- AutoSuppression Recycle Mode
- AutoSuppression External Water Mode
- MPIC Suppression Mode
- Neutralization Mode

NOTE

The Dionex ERS 500 is not compatible with the Chemical Suppression Mode. The Dionex CRS 500 or equivalent should be used when Chemical Suppression Mode is required.

1.2.1 Mode of Operation Selection

The Dionex ERS 500 mode of operation depends mainly on the eluent composition, the analysis sensitivity requirements and the sample matrix. The compatibilities are shown in Table 1. For example, eluents containing organic solvents that tend to oxidize easily are not compatible with the AutoSuppression Recycle Mode. The AutoSuppression External Water Mode should be used instead, or a Dionex CRS suppressor employed in Chemical Suppression Mode. The MPIC Suppression Mode is specifically designed for applications where ion-pair reagents and solvents are present in the eluent. The Neutralization Mode can be used with any eluent composition.

Table 1 Eluent Composition and Suppression Mode Compatibility

Eluent Composition	Suppression Recycle	Suppression External Water(1)	Chemical Suppression(2)	MPIC Suppression
Aqueous Eluents (excluding borate)	Yes	Yes	Yes	N/A
Borate Eluents	No	Yes(3)	Yes	N/A
Eluents containing Organic Solvents that are easily oxidized	No	Yes (Up to 40%)(3)	Yes (Up to 100%)	N/A
Eluents containing Organic Solvents that are not easily oxidized	Yes	Yes	Yes	Yes
Eluents Containing Ion Pair Reagents with or without Solvents	No	No	No	Yes
Simple Aqueous Samples	Yes	Yes	Yes	Yes (assuming Ion Pairing Reagent)
Complex Samples or Samples containing Solvents	No	Yes(3)	Yes	Yes (assuming Ion Pairing Reagent)

(1)The Dionex ERS 500 is not recommended for External Water Mode; the Dionex ERS 500e is recommended for External Water Mode applications.
(2)The Dionex ERS 500 does not support Chemical Suppression Mode. Use of a Chemically Regenerated Suppressor such as the CRS 500 or equivalent is recommended.
(3)Only the Dionex ERS 500e is compatible with Borate Eluents and Eluents or Samples containing Organic Solvents that are easily oxidized.

1.2.2 The AutoSuppression Recycle Mode

The AutoSuppression Recycle Mode uses the suppressed conductivity cell effluent as the source of water for the regenerant. ***This is the preferred method of operation for the Dionex ERS 500 and Dionex AERS 500 Carbonate. The Dionex ERS 500e is also compatible with this mode.*** The advantage of this mode of operation is simplicity and ease of use. This mode reliably provides AutoSuppression for most suppressed conductivity applications using solvent-free eluents. For solvents that are not easily oxidized, such as iso-propyl alcohol, the AutoSuppression recycle mode is preferred. As the eluent passes through the suppressor's eluent channel it is converted to a weakly ionized form. After detection, the cell effluent can be routed back to the regenerant channel to provide the water required for the electrolysis reactions. The amount of water flowing through the regenerant chambers is therefore limited to the eluent flow rate. See Section 3 for complete operating instructions.

NOTE

The AutoSuppression Recycle Mode is not compatible with eluents containing Borate or Organic Solvents that tend to oxidize easily, such as methanol.

1.2.3 The AutoSuppression External Water Mode

The AutoSuppression External Water Mode is used for any application requiring organic solvents in the eluent or sample, or for applications using borate as the eluent ion. ***This is the preferred method of operation for the Dionex ERS 500e. The Dionex ERS 500 and Dionex AERS 500 Carbonate are compatible with this mode, but not with applications requiring organic solvents in the eluent, or for applications using borate as the eluent ion.*** This mode uses a constant source of deionized water from a pressurized bottle or other source of deionized water that delivers 0.25 to 2 mL/min for 2 mm applications and 1.0 to 5 mL/min for 4 mm applications, although the eluent flow rate is typically recommended as double the regenerant flow rate. The amount of water flowing through the regenerant chambers is independent of the eluent flow rate. The AutoSuppression External Water Mode eliminates the potential for build-up of contaminating ions resulting from the oxidation of solvents. It is also recommended when pursuing analysis with high concentrations of matrix ions. Any analysis performed using the AutoSuppression Recycle Mode can also be performed using the AutoSuppression External Water Mode. See Section 3 for complete operating instructions.

1.2.4 The Chemical Suppression Mode

The Dionex ERS 500 cannot be used in the Chemical Suppression Mode. The peak response will not be maintained to a constant level in this mode. Thermo Scientific Dionex recommends the use of a Chemically Regenerated Suppressor (Dionex CRS 500 or equivalent) for chemical suppression applications. Please refer to the Dionex CRS Manual, Document No. 031727, and the DCR Kit Manual, Document No. 031664.

The Dionex AERS 500 Carbonate and Dionex ERS 500e can be used in the Chemical Suppression Mode; however the total suppression capacity is reduced compared to a Chemically Regenerated Suppressor. Thermo Scientific recommends the use of a Chemically Regenerated Suppressor such as the Dionex CRS 500 for chemical suppression applications.

1.2.5 The MPIC Suppression Mode

1.2.5.1 Anion MPIC

The Dionex AERS 500e is used for eluent suppression of Mobile Phase Ion Chromatography (MPIC or ion-pairing) eluents by using the MPIC Suppression Mode. The Dionex AERS 500 and Dionex AERS 500 Carbonate are not recommended for this mode. The MPIC Suppression Mode is a combination of the AutoSuppression External Water Mode augmented with a chemical regenerant such as sulfuric acid (H_2SO_4). The MPIC Suppression Mode uses an applied current and a constant source of dilute sulfuric acid solution from a pressurized bottle delivery system. This mode must be used for MPIC applications requiring an ion pair reagent and organic solvents in the eluent. The MPIC Suppression Mode reliably provides suppression of typical eluents for MPIC applications using suppressed conductivity detection. The ion pair reagents, such as tetrabutylammonium hydroxide (TBAOH), are used in concentrations typically ranging from 1.0 to 5.0 mM. See Section 3 for complete operating instructions.

1.2.5.2 Cation MPIC

The Dionex CERS 500e is used for eluent suppression of MPIC eluents by using the AutoSuppression External Water Mode or the MPIC Suppression Mode depending on the specific MPIC application. The Dionex CERS 500 is not recommended for this mode. The MPIC Suppression Mode uses an applied current and a constant source of dilute boric acid regenerant solution from a pressurized bottle delivery system. Dilute boric acid is added to the water regenerant to enhance detection and improve linearity of weak bases such as ammonia and amines. This mode is used for MPIC applications requiring an ion pair reagent and organic solvents in the eluent. The MPIC Suppression Mode reliably provides suppression of typical eluents for MPIC applications using suppressed conductivity detection. The ion pair reagents, such as octanesulfonic acid (OSA), are used in concentrations typically ranging from 1.0 to 5.0 mM. Organic solvent concentrations should not exceed 40%. See Section 3 for complete operating instructions.

1.2.6 The Neutralization Mode

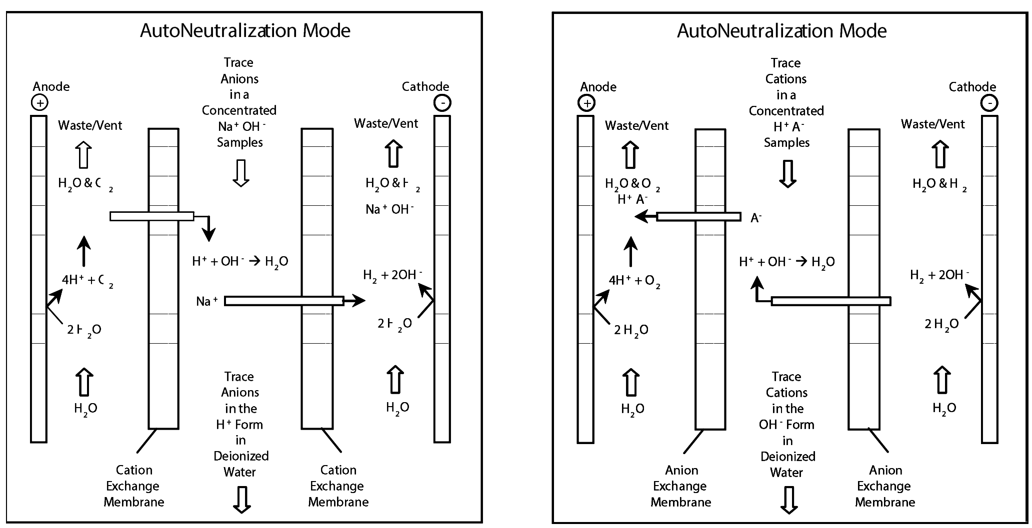
The Dionex ERS 500 (4 mm) when operated in this mode requires a constant deionized water flow of 3 to 5 mL/min through the regenerant chambers. The regenerant water can be delivered from a pressurized bottle or pump. If using a pressurized bottle, it is recommend to use the Dionex ERS 500e.

IMPORTANT

The Dionex AERS 500 Carbonate, Dionex ERS 500 (2 mm) and Dionex ERS 500e (2 mm) suppressors are not designed or validated for the Neutralization Mode. The Dionex ERS 500e (4mm) suppressor is recommended and validated for this mode. The Dionex ERS 500 (4 mm) suppressor may also be used for this mode.

1.2.6.1 Neutralization Theory

Figure 4 AutoNeutralization of Concentrated Acid/Base with the Self-Regenerating Neutralizer



Dionex AERS 500 **Dionex CERS 500**

As shown in Figure 4, when a potential is applied across the two electrodes, the water regenerant undergoes electrolysis, forming hydronium ions at the anode and hydroxide ions at the cathode.

In the Dionex AERS 500, hydronium is transported from the anode towards the cathode and enters the sample chamber. At the same time, the matrix cations in the sample move towards the cathode and enter the cathode chamber. The matrix cations combine with the hydroxide ions at the cathode forming a base, and are removed from the regenerant chamber. The net effect of this transport of ions is neutralization of the sample matrix ions to a weakly ionized form while the sample anions are typically converted to a strongly ionized form. The sample anions are now in a weakly dissociated matrix such as water and are ready for analysis.

In the Dionex CERS 500 hydroxide is transported from the cathode towards the anion and enters the sample chamber. At the same time, the matrix anions in the sample move towards the anode and enter the anode chamber. The matrix anions combine with the hydronium ions at the anode forming an acid and are removed from the regenerant chamber. The net effect of this transport of ions is neutralization of the sample matrix ions to a weakly ionized form, while the sample cations are typically converted to a strongly ionized form. The sample cations are now in a weakly dissociated matrix such as water and are ready for analysis

1.2.6.2 Trace Ion Analysis After Neutralization

After neutralization, the sample can be fed into any Dionex Ion Chromatography system and operated in the concentrator mode. It is important that only low pressure concentrator columns, such as the Dionex UTAC-XLP2 (Item # 072781) and Dionex TCC-XLP1 (Item # 063889), be used to protect the Dionex ERS 500 from damage.

1.3 Shipment and Storage

1.3.1 Shipment

CAUTION

The Electrolytically Regenerated Suppressors (Dionex ERS 500, Dionex ERS 500e, and Dionex AERS 500 Carbonate) should not be subjected to temperatures above 50°C for long durations during shipment, storage or operation, or for any duration above 80°C.

1.3.2 Storage

CAUTION

Ensure the suppressor is stored in a temperature controlled environment away from direct exposure to sunlight or other sources of heat. Do not store the suppressor in an environment where temperatures in excess of 50°C may be experienced, such as a parked car.

2. Installation

2.1 System Requirements

The Dionex ERS 500 and Dionex ERS 500e are designed to be direct replacements for the Dionex SRS series of suppressors, such as the Dionex SRS I, Dionex SRS II, Dionex SRS ULTRA, Dionex SRS ULTRA II and Dionex SRS 300. The Dionex ERS 500 can be used in place of any of these suppressors where recycled eluent mode is employed.

The Dionex ERS 500e is designed to be a direct replacement for the Dionex SRS series of suppressors where external water mode is employed. The Dionex ERS 500e features a hardware design that significantly improves regenerant flow when operated in external water mode.

The Dionex AERS 500 Carbonate suppressor is designed for operation with carbonate and carbonate/bicarbonate eluents. The Dionex AERS 500 Carbonate features a hardware design that significantly improves noise performance with carbonate eluents without sacrificing performance or ease-of-use. The unique hardware design delivers the lowest noise level of any electrolytic suppressor for carbonate eluents.

The Dionex ERS 500 and Dionex ERS 500e are not designed to be direct replacements for the Dionex SRS series of suppressors where these suppressors are being used in Chemical Suppression Mode. If Chemical Suppression Mode is being used, the Chemically Regenerated Suppressor (Dionex CRS 500) or equivalent is recommended. The Dionex AERS 500 Carbonate and Dionex ERS 500e can be used in the Chemical Suppression Mode; however the total suppression capacity is reduced compared to a Chemically Regenerated Suppressor.

The Dionex ERS 500e is also designed to be a direct replacement for the Dionex SRN series of neutralizers, such as the Dionex SRN 300, Dionex SRN-II and Dionex SRN products.

The Dionex ERS 500, Dionex ERS 500e and Dionex AERS 500 Carbonate are designed to be run on any Dionex Ion Chromatography System (ICS) equipped with an analytical Anion or Cation exchange column set and an electrolytic suppressor controller, such as the Thermo Scientific Dionex ICS-5000$^+$, Dionex Integrion, or Dionex Aquion. They are not designed to be run on a Dionex Capillary Ion Chromatography Systems, such as the ICS-4000, or on Dionex Ion Chromatography Systems that do not have an electrolytic suppressor controller, such as the Dionex ICS-90A, Dionex ICS-600 or Dionex ICS-900. ***Some legacy systems require a standalone controller for installation of the Dionex ERS 500, Dionex ERS 500e or Dionex AERS 500 Carbonate. See, "Electrolytically Regenerated Suppressor Requirements for Selected IC Modules."***

The Dionex ERS control is provided by discrete (50, 100, 300, and 500mA) or non-discrete (0 to 500 mA in 1 mA increment) power supplies. Discrete Dionex ERS Control is integrated into older systems, such as the CDM-3 and PED-2 of the Dionex DX-300, the Dionex DX-100 (Model 1-03), Dionex DX-120, Dionex DX-320 (IC20 and IC25 models), Dionex DX-500 (CD20 and ED40 detectors), and Dionex DX-600 (CD25 and ED50 detectors). ***The use of discrete power supplies may not be suitable for optimal suppressor performance and may affect the suppressor noise performance and life time.***

It is therefore recommended to use a non-discrete power supply, such as the Thermo Scientific Dionex RFC-10 or Dionex RFC-30. It is also possible to use the discrete power supplies with a Dionex SCC-10 controller that provides twelve discrete current settings. Non-discrete Dionex ERS Control is integrated into modern instruments, including the Dionex ICS series (excluding Dionex ICS-90, Dionex ICS-90A, Dionex ICS-600 and Dionex ICS-900), Dionex Integrion and Dionex Aquion.

The older Dionex SRC-1 controller has been discontinued. The replacement product is either the Dionex RFC-10 controller or the Dionex RFC-30 controller. The Dionex RFC-10 controller provides 1 mA graduated control of an electrolytic suppressor. The Dionex RFC-30 controller provides 1 mA graduated control of an electrolytic suppressor in addition to providing control of an Eluent Generator Cartridge (Dionex EGC) and a Continuously Regenerated Trap Column (Dionex CR-TC). The Dionex SCC-10 suppressor current controller can be used in conjunction with the Dionex SRC-1 controller to provide a current output of twelve settings.

For optimal suppressor performance it is important to operate the suppressor at the recommended current settings as recommended by Chromeleon or as calculated from Section 2.6.1. It is highly recommended to set the current setting for the Dionex ERS 500 or Dionex AERS 500 Carbonate to the exact calculated current (within 1 mA). Older power supplies do not have the 1 mA graduated control. ***Failure to set the current accurately could reduce suppressor performance and life-time***

Table 2 Self-Regenerating Suppressor Requirements for Selected Ion Chromatographs

Dionex Ion Chromatograph Series Module	**Dionex RFC-10, Dionex RFC-30 or Dionex SCC-10 Controller Requirement**
2000i	YES
QIC	YES
2000 SP	YES
4000i	YES
4500i	YES
8000	YES
8100	N/A
8200	N/A
DX-100	YES
Model DX 1-03	RECOMMENDED
DX-120	RECOMMENDED
DX-300	N/A
CDM-2, PED	YES
CDM-3, PED-2	RECOMMENDED
DX-320 with IC20 or IC25	RECOMMENDED
DX-320 with IC25A	NO
DX-500	RECOMMENDED
DX-600 with CD25A or ED50A	NO
DX-600 with CD25 or ED50	RECOMMENDED
DX-800	RECOMMENDED

The Dionex ERS 500, Dionex ERS 500e or Dionex AERS 500 Carbonate is installed in the column compartment or detector compartment of the chromatography module immediately after the analytical column and before the conductivity detector cell. All components required for installation of the suppressor are included with the system.

- Gas Separator Waste Tube (Item # 045460)
- Backpressure coil(s)
  - 4 mm (Item # 045877)
  - 2 mm (Item # 045878)
- Microbore Tubing (2 mm only) (Item # 052324)
- Mounting clip (Item # 045612)

Options:

- Dionex CRS/ERS Installation Kit (Item # 038018)
  (Pressurized Water Delivery System used with AutoSuppression External Water Mode, Chemical Suppression Mode, or MPIC Suppression Mode).
- Peristaltic Pump Kit (Item #: 064508). (Water delivery system used with AutoSuppression External Water Mode, Chemical Suppression Mode, or MPIC Mode).

CAUTION

The Dionex ERS 500, Dionex ERS 500e and Dionex AERS 500 Carbonate must be operated with the Gas Separator Waste Tube (Item # 045460)

NOTE

The use of ¼-28 or 10-32 ferrule/bolt style liquid lines may be required for installation and use of ERS 500. See "Dionex Liquid Line Fittings" for complete details.

2.2 Electrolytically Regenerated Suppressor Control

CAUTION

Always turn the pump and the Dionex ERS Control on and off at the same time. Eluent flow through the Dionex ERS 500 is required for proper operation. Without current, the membranes and screens in the Dionex ERS 500 will become exhausted by the flowing eluent resulting in small analyte peak areas. If this should occur, perform the procedure in Section 5.2.

CAUTION

The Dionex AERS 500 Carbonate suppressor is not compatible with discrete power supplies and should only be operated with power supplies that can deliver current in 1 mA increments.

NOTE

If an ERS Mode is not available, select the equivalent SRS Mode on the power supply to support the Dionex ***ERS 500 suppressor. The Dionex ERS 500 and Dionex ERS 500e are fully compatible with SRS settings.***

NOTE

The Dionex AERS 500 Carbonate suppressor has different electrical current requirements than the Dionex AERS 500 suppressor. If an AERS Carbonate mode is not available the current applied to a Dionex AERS 500 Carbonate should be adjusted by a factor of 1.30 compared to a standard AERS 500 suppressor. Chromeleon 7.2 SR3 MUa and later versions have an option for selecting an AERS_Carbonate suppressor in the Instrument Method Wizard and Editor dialog box. Selecting this suppressor from the drop-down list will automatically apply the recommended current setting for Dionex AERS 500 Carbonate suppressors.

2.2.1 Dionex Reagent-Free Controller (Dionex RFC)

The Dionex Reagent-Free Controller (Dionex RFC) is an external power supply available in two versions.

- The Dionex RFC-10 controls the Dionex ERS 500 Electrolytically Regenerated Suppressor. Current is delivered at 1 mA resolution.
- The Dionex RFC-30 controls an Dionex ERS 500 Electrolytically Regenerated Suppressor, as well as a Dionex Eluent Generator Cartridge (Dionex EGC) and a Dionex CR-TC Continuously Regenerated Trap Column. Current is delivered at 1 mA resolution.

NOTE

If an ERS Mode is not available, select the equivalent SRS Mode on the power supply to support the Dionex ERS 500 suppressor. The Dionex ERS 500 and Dionex ERS 500e are fully compatible with SRS settings.

NOTE

The Dionex AERS 500 Carbonate suppressor has different electrical current requirements than the Dionex AERS 500 suppressor. If an AERS Carbonate mode is not available the current applied to a Dionex AERS 500 Carbonate should be adjusted by a factor of 1.30 compared to a standard AERS 500 suppressor.

The Dionex RFC controls these devices by supplying current to the suppressor and for the Dionex RFC-30, current to the eluent generator and voltage to the Dionex CR-TC. Please see the Dionex RFC Operator’s Manual for suppressor operating and installation instructions with the following Dionex products:

- Dionex DX-320/320J
- Dionex DX-500, Dionex DX-600, or Dionex ICS-2500
- Dionex DX-120

2.3 Dionex SCC-10 Suppressor current controller (Item # 074053)

The Dionex SCC-10 is an external controller designed for use with legacy instruments that only offer four settings for suppressor current, and is recommended for optimal performance. The Dionex SCC-10 is powered from the existing suppressor current supply, and can output twelve discrete current settings from 10 mA to 250 mA.

NOTE

The Dionex SCC-10 external controller is recommended when using legacy instruments that only offer four settings for suppressor current to achieve optimum performance.

2.4 Back Pressure Coils for the Dionex ERS 500, Dionex ERS 500e and Dionex AERS 500 Carbonate

All detector cells require enough back pressure to prevent eluent in the cell from out-gassing due to abrupt volume changes between the small inner diameter of the connecting tube and the relatively larger volume of the cell; out-gassing creates bubbles in the cell and disrupts detector responsiveness. For example, carbonate eluent is suppressed to carbonic acid, which is CO_2 gas in equilibrium with DI water, and CO_2 gas can come out of solution if adequate pressure is not applied. The above out-gassing can trap bubbles in the cell causing high noise. Therefore, Thermo Scientific Dionex recommends the addition of 30-40 psi of backpressure after the cell.

It should be noted that for RFIC hydroxide or MSA applications it may be possible to operate the cell without backpressure. However, for carbonate and/or bicarbonate applications it is highly recommended to install backpressure coils.

Back pressure coil components are shipped with your system. For 4 mm systems, locate assembly Item # 045877. For 2 mm systems, locate assembly Item # 045878 (for 2 mm systems, the backpressure coils are available in the microbore tubing kit, Item # 052324). Alternatively, lengths and diameters of tubing necessary for proper back pressure are given in Table 3, "Coils for ERS 500 Back Pressure Requirements." Adjust the tubing length to achieve a backpressure of approximately 40 psi.

CAUTION

If back pressure coils become damaged or plugged, they may cause irreversible damage to the suppressor.

2.4.1 Assembly

A. Slip PEEK liquid line bolts and ferrules onto the ends of the tubing. Refer to Table 3, "Coils for ERS 500 Back Pressure Requirements," and determine the correct number of coils required for your application based on the eluent flow rate.

B. After assembly of the coils, see Figure 5 The Auto Suppression Recycle Mode Plumbing Diagram" for the proper placement of the completed coils and couplers between the suppressor and the Gas Separator Waste Tube.

Table 3 Coils for Dionex ERS 500, Dionex ERS 500e and Dionex AERS 500 Carbonate Back Pressure Requirements

ERS 500 Type	Item #	Flow Rate	I.D. of Tubing	Length of Each Coil	Number of Coils
4 mm	045877	0.5–1.5 mL/min	0.010" (Black)	2.5 ft.	2
4 mm	045877	1.5–3.0 mL/min	0.010" (Black)	2.5 ft.	1
2 mm	045878	0.12–0.25 mL/min	0.005" (Red)	1.0 ft.	2
2 mm	045878	0.25–0.75 mL/min	0.005" (Red)	1.0 ft.	1

CAUTION

The correct amount of back pressure for optimum operation is 40 psi. Back pressure over 450 psi after the Dionex ERS 500, Dionex ERS 500e or Dionex AERS 500 Carbonate can cause irreversible damage.

2.5 Gas Separator Waste Tube for the Dionex ERS 500

The Gas Separator Waste Tube (Item # 045460) is an integral part of the Dionex ERS 500 system. It separates any electrolytic gases generated in the Dionex ERS 500, Dionex ERS 500e or Dionex AERS 500 Carbonate during electrolysis. The Gas Separator Waste Tube is used to avoid concentrating the gases (particularly hydrogen gas) in the waste container. The Gas Separator Waste Tube is shipped in one of the Ship Kits of your system.

CAUTION

Do not cap the waste reservoir.

SAFETY

Minimal hydrogen gas generated by the Dionex ERS 500, Dionex ERS 500e or Dionex AERS 500 Carbonate 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 and not in a confined space to operate properly.

2.5.1 Assembly

A. Assemble and install the Gas Separator Waste Tube and waste line following the steps below. See Figure 5 The Auto Suppression Recycle Mode Plumbing Diagram”.

B. Use one or two couplers (Item # 045463) to connect two or three lengths of ½” i.d. black polyethylene tubing (Item # 045462) depending on the waste container depth. Extend the top of the Waste Separator Tube above the top of the Waste container.

C. Place the Gas Separator Waste Tube with the 1/8” o.d. tubing attached into the waste container. Ensure the bottom of the Gas Separator Waste Tube is resting on the floor of the waste container, the top of the device (where the white 1/8” o.d. tubing meets the black ½” o.d. tubing) is above the top of the container, and that both the Gas Separator Waste Tube and the waste container are open to the atmosphere.

2.6 Electrolytically Regenerated Suppressor Current Selection

Lower current is better for the performance of the Dionex ERS 500, Dionex ERS 500e and Dionex AERS 500 Carbonate suppressors. Excess current through the suppressor devices causes excess heat generation and over time will cause the ion exchange materials to degrade, thus shortening suppressor lifetime. Excess current can also cause poor recoveries of certain analytes, particularly magnesium, manganese, and phosphate. No more than 10% above the optimum current setting is recommended for extended periods of time.

Cooling the suppressor would provide improved noise and lifetime performance. A temperature setting of 20˚C for the thermal compartment, such as the DC, is recommended.

2.6.1 Calculating the Optimum Current Setting

The optimum current setting depends on the eluent concentration, sample counterion concentration, flow rate, and mode of operation. If the sample counterion concentration exceeds the eluent concentration, use the sample counterion concentration in the calculation discussed below.

These calculations are specific for the type of suppressor. These settings are also applicable in the presence of standard solvents such as methanol or isopropyl alcohol for anion applications and acetonitrile for cation applications.

When operated in the Neutralization Mode, the Dionex ERS 500e current should always be set to 500 mA.

Current (mA) = [flow rate (mL/min)] × [eluent concentration (mN)] × [suppressor specific factor]

The factors are listed in the table below. The unit for eluent concentration is mN (not mM).

Table 4 Optimum Suppressor Settings

Suppressor Type	**Suppressor Specific Factor**
Dionex AERS 500 and AERS 500e	2.47
Dionex CERS 500 and CERS 500e	2.94
Dionex Atlas (Anion and Cation) **Dionex** AERS 500 Carbonate	3.22

NOTE

Always round the calculated optimum current up to the nearest whole integer.

All modern Thermo Scientific Dionex detectors and suppressor power supplies can be used to set the current at the calculated value with a minimum current resolution of 1 mA. ***A Dionex RFC-10, Dionex RFC-30, or Dionex SCC-10 Controller is recommended for older systems that only set the current in discrete values of 50, 100, 300 or 500 mA.***

NOTE

A lower flow rate requires a lower current. A 2 mm Dionex ERS 500 or Dionex ERS 500e should NEVER be operated at a current above 100 mA. A 2 mm Dionex AERS 500 Carbonate should NEVER be operated at a current above 30 mA.

CAUTION

The Dionex AERS 500 Carbonate suppressor is not compatible with discrete power supplies and should only be operated with power supplies that can deliver current in 1 mA increments.

NOTE

Chromeleon 7.2 SR3 MUa and later have an option for selecting an AERS_Carbonate suppressor in the Instrument Method Wizard and Editor dialog box. Selecting this suppressor from the drop-down list will automatically apply the recommended current setting for the Dionex AERS 500 Carbonate suppressors. Earlier versions of Chromeleon do not include the correct Suppressor Specific Factor; therefore, the correct current must be calculated and entered manually if the Dionex AERS 500 Carbonate suppressor is used.

A. Maximum Suppression Capacity

The Maximum Suppression Capacity (MSC) depends on the eluent concentration and flow rate. The MSC can be calculated using the following equation.

MSC (mN * mL/min) = flow rate (mL/min) * sum of eluent concentration (mN)

Table 5 Maximum Suppression Capacity for Dionex ERS 500 and Dionex ERS 500e

Suppressor	Flow Rate (mL/min)	Maximum Suppression Capacity
Dionex AERS 500 4 mm	0.5 - 3.0	≤ 200 µ equivalents
Dionex AERS 500 2 mm	0.25 - 0.75	< 50 µ equivalents
Dionex AERS 500 2 mm	0.10 - 0.25	< 30 µ equivalents
Dionex CERS 500 4 mm	0.5 - 3.0	< 100 µ equivalents
Dionex CERS 500 2 mm	0.25 - 0.75	< 35 µ equivalents
Dionex CERS 500 2 mm	0.10 - 0.25	≤ 20 µ equivalents

Dionex AERS 500e: Same as Dionex AERS 500
Dionex CERS 500e: Same as Dionex CERS 500
Dionex AERS 500 Carbonate 4 mm : 0.5 – 3.0 : ≤ 30 µ equivalents
Dionex AERS 500 Carbonate 2 mm : 0.25 – 1.0 : ≤ 7.5 µ equivalents

B. Sum of Eluent Concentration Calculation

When using a Dionex AERS 500, Dionex AERS 500e or Dionex AERS 500 Carbonate, the sum of the eluent concentration can be calculated from the equations below.

Dionex **AERS 500 (4 mm) or Dionex AERS 500 Carbonate (4 mm)**

Sum of eluent concentration (mN) = {2* Carbonate (mM) + Bicarbonate (mM) + hydroxide (mM) + 2 * Tetraborate (mM) + custom eluent cation (mN)}

where Tetraborate is <= 50 mM

Dionex **AERS 500 (2 mm) or Dionex AERS 500 Carbonate (2 mm)**

Sum of eluent concentration (mN) = {2 * Carbonate (mM) + Bicarbonate (mM) + hydroxide (mM) + 2 * Tetraborate (mM) + custom eluent cation (mN)}

where Tetraborate is <= 75 mM

Custom eluent cation (mN) can be calculated from the normality of the eluent concentration.

NOTE

Normality is Equivalents/L of solution. For example, 20.0 mM sodium acetate (CH_3COONa) has 20.0 mN sodium as the cation and 20.0 mM sodium sulfate (Na_2SO_4) has 40.0 mN sodium as the cation.

When using the Dionex CERS 500 or Dionex CERS 500e, the sum of the eluent concentration can be calculated using the equations below.

Dionex **CERS 500**

Sum of eluent concentration (mN) ={2 * Sulfuric Acid (mM) + MSA (mM) + custom eluent anion (mN)}

Custom eluent anion (mN) can be calculated from the normality of the eluent concentration.

NOTE

Normality is Equivalents/L of solution. For example, 20.0 mM sodium sulfate (Na_2SO_4) has 40.0 mN sulfate as the anion.

3. Operation

This section provides instructions for the start-up and operation of the ERS series suppressors, including the selection process and suppression modes of operation.

3.1 Chemical Purity Requirements

Precise and accurate results require eluents free of ionic impurities; chemicals and deionized water used to prepare eluents must be pure as described below. Low trace impurities and low particulate levels in eluents and regenerants also help protect the Dionex ERS 500 and system components from contamination. Dionex ERS 500 performance is not guaranteed when the quality of the chemicals and water used to prepare eluents has been compromised.

3.1.1 Inorganic Chemicals

Reagent Grade inorganic chemicals should always be used to prepare ionic eluents. Preferably, a lot analysis on each label will certify each chemical as meeting or surpassing the latest American Chemical Society standard for purity, a universally accepted standard for reagents.

3.1.2 Solvents

Since solvents used with the Dionex ERS 500e are added to ionic eluents to modify the ion exchange process or improve sample solubility, the solvents used must be free of ionic impurities. However, since most solvent manufacturers do not test for ionic impurities, the highest grade of solvents available should be used. Currently, several manufacturers are making ultra-high purity solvents that are compatible for HPLC and spectrophotometric applications. These ultra-high purity solvents will usually ensure that your chromatography is not affected by ionic impurities in the solvent. Dionex has obtained consistent results using High Purity Solvents manufactured by Burdick and Jackson and Optima® Solvents by Thermo Fisher Scientific.

3.1.3 Deionized Water

The deionized water used to prepare eluents should be degassed Type I Reagent Grade Water with a specific resistance of 18.2 megohm-cm. The water used for the AutoSuppression External Water Mode should have a specific resistance of 18.2 megohm-cm or greater. The deionized water should be free of ionized impurities, organics, microorganisms and particulate matter larger than 0.2 µm. It is good practice to filter eluents through a 0.2 µm filter whenever possible. Bottled HPLC-Grade Water should not be used since most bottled water contains an unacceptable level of ionic impurities. Finally, thoroughly degas all deionized water prior to preparing any eluents or regenerants.

3.2 Start-up

The Dionex ERS 500, Dionex ERS 500e or Dionex AERS 500 Carbonate is installed in the column or detector chamber of the chromatography module right after the analytical column and before the conductivity detector cell. On the Dionex ICS-5000^{+}, the suppressor mounts on the conductivity detector module in the DC. On the Dionex Integrion, the suppressor mounts on the conductivity detector module in the detector compartment. On the Dionex Aquion, the suppressor mounts on the component panel behind the front door. Refer to the Dionex IC System Operator's Manual for further details.

Orient the suppressor with the ELUENT IN port and the cable at the top if installed vertically; align the slots on the back of the Dionex ERS 500 with the tabs on the panel. Press in, and then down to lock the Dionex ERS 500 in place. Lift up and pull out to remove the suppressor. Ensure the suppressor is plumbed properly according to the selected mode of operation. Refer to Section 2, "Installation," for complete installation instructions.

WARNING

Keep the regenerant chambers full with the appropriate regenerant solution or water. The membranes and screens in the Dionex ERS 500, Dionex ERS 500e or Dionex AERS 500 Carbonate must be completely hydrated to maintain liquid seals and chromatographic performance.

CAUTION

The correct amount of back pressure on the conductivity detector for optimum operation is 40 psi. Connect the back pressure coil(s) appropriate for your column i.d. and flow rate. Back pressures over 450 psi after the Dionex ERS 500, Dionex ERS 500e or Dionex AERS 500 Carbonate can cause irreversible damage.

CAUTION

Do not cap the waste reservoir.

SAFETY

Hydrogen gas generated by the Dionex ERS 500, Dionex ERS 500e or Dionex AERS 500 Carbonate is not dangerous unless the gas is trapped in a closed container and allowed to accumulate. The Gas Separator Waste Tube must be open to the atmosphere, and not in a confined space, to operate properly.

3.2.1 Hydration

Hydrating the suppressor ensures that the ion exchange membranes are in a swollen form for proper operation. A 20 minute static step is recommended during first time installation to ensure complete hydration.

1. If also installing a new guard and/or analytical column, follow the column startup procedure(s) before moving on to Step 2. The column waste should be diverted to waste for at least 10 column volumes before installing the new suppressor.

2. Install the suppressor in the system and plumb the unit in the recycle mode (refer to Figure 5, below).

3. Pump ≤10 mM eluent at the application flow rate into the suppressor for 5 minutes, from the Eluent IN port. ***The power to the suppressor must be off during this step.***

   Care should be taken not to exceed 100 psi of backpressure on the ERS suppressor. The backpressure to the suppressor includes any tubing, cell and backpressure coils that are connected to the eluent out port of the suppressor.

4. Turn off the pump and allow the suppressor to sit for approximately 20 minutes to fully hydrate the suppressor resin, screens, and membranes.

5. After completion of Steps 1 through 4, normal operation may resume using the application eluent strength and current recommendation.

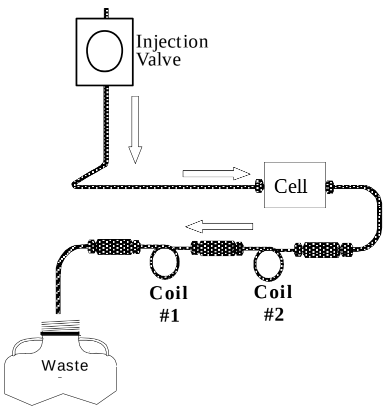
NOTE

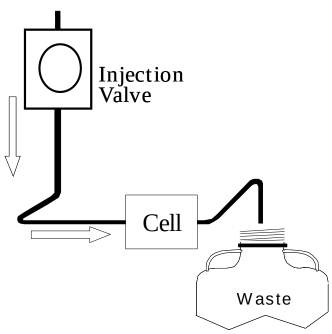
Care should be taken with this procedure not to exceed 100 psi of backpressure on the suppressor.

NOTE

A short piece of waste tubing should be installed in the Eluent In port during this procedure to ensure that liquid exiting the suppressor does not well up and flow back into the cover. This can give a false impression of an internal leak.

3.2.2 Back Pressure Coil Pressure Test





1. Disconnect the eluent line from the injection valve to the column at the column inlet.
2. Connect the eluent line from the injection valve directly to the detector cell inlet with the recommended number of back pressure coils attached for your application (see the table below). Turn the pump on at your application flow rate. After 2 to 3 minutes of equilibration record pressure P_1.
3. Disconnect the back pressure coils and with the pump on measure the system pressure P_2.

4 mm Chromatography	2 mm Chromatography
1.0 mL/min. = 2 black backpressure coils (Item # 045877)	0.25 mL/min. = 2 red backpressure coils (Item # 045878)
2.0 mL/min. = 1 black backpressure coil (Item # 045877)	0.50 mL/min. = 1 red backpressure coil (Item # 045878)

4. The correct operating pressure range for the backpressure coil being tested is

   Dionex ERS 500 $P_1 – P_2$ = 30–40 psi

   If the pressure is greater than 40 psi, then trim the back pressure coil and repeat step 2 and 3 to achieve 30-40 psi in step 4.

   If it is less than 30 psi, then add more tubing to achieve 30 – 40 psi.

3.2.3 Quick Back Pressure Check

This section describes how to measure the backpressure to the suppressor. Install the system for the application of choice.

1. Measure the system pressure P1 with the suppressor powered
2. Unplug the line from the “Eluent Out” port on the suppressor and measure system pressure P_2

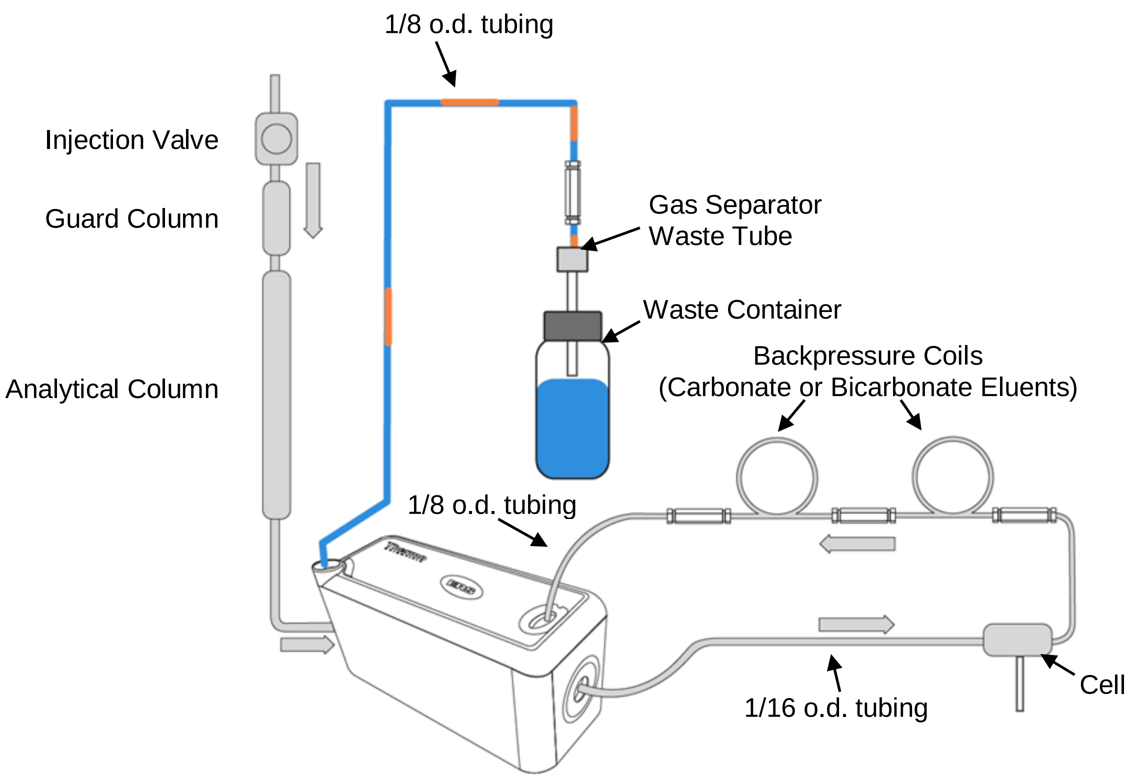
CAUTION

Do not leave the port open for more than 2 minutes.

3. P_1-P_2 < 150 psi.
4. Adjust the backpressure coils if needed to achieve the < 150 psi value. Refer to 3.2.2 to measure the back pressure contribution from the back pressure coil.

3.3 Plumbing for the AutoSuppression Recycle Mode Operation

Figure 5 The Auto Suppression Recycle Mode Plumbing Diagram



As the eluent passes through the suppressor, it is neutralized to produce its weakly ionized form. After passing through the conductivity cell, this effluent can be redirected to the regenerant inlet on the suppressor, thus supplying it with a source of water containing a small amount of diluted analyte (see Figure). The main advantage of this mode is its simplicity and ease of use. It is not necessary to have an external supply of water available for the suppressor.

CAUTION

Only use the AutoSuppression Recycle Mode for eluents and samples without organic solvents or metallic contaminants such as iron in ground water.

3.3.1 Eluent Flow Path Connections in the AutoSuppression Recycle Mode

Depending on the specific components (analytical column, conductivity cell, back pressure coils) in the system, ¼-28 or 10-32 ferrule/bolt liquid lines may be required. All necessary tubing and fittings are supplied in the detector or Dionex RFC-10 or Dionex RFC-30 Ship Kits. To purchase or assemble ¼-28 or 10-32 ferrule/bolt liquid lines, refer to, "Dionex Liquid Line Fittings." Always use 0.005" i.d. PEEK tubing with 10-32 ferrule/bolt fittings on 2 mm systems. Use 0.010" i.d. PEEK tubing with 10-32 ferrule/bolt fittings on 4 mm systems when possible. Avoid adding dead volume to the system by keeping all eluent lines as short as possible.

A. Install the Dionex ERS 500, Dionex ERS 500e or Dionex AERS 500 Carbonate inside the Dionex ICS Module.

B. Connect the outlet of the analytical column to the ELUENT IN of the suppressor (see Figure).

C. Connect the ELUENT OUT port of the suppressor to the inlet of the conductivity cell (see Figure).

3.3.2 Regenerant Flow Path Connections in the AutoSuppression Recycle Mode

Connect the back pressure coil(s) between the CELL OUTLET port and the REGEN IN port (see Figure and Section 2). The back pressure coils are provided in the Gas Separator Waste Tube Components Assembly (Item # 045825) for 4 mm systems. The backpressure coils for 2 mm systems are provided in the microbore tubing kit (Item # 052324) (see Figure 5 and Section 2). The back pressure coils are provided in the Gas Separator Waste Tube Components Assembly (Item # 045825) for 4 mm systems. The backpressure coils for 2 mm systems are provided in the microbore tubing kit (Item # 052324).

CAUTION

The Dionex ERS 500, Dionex ERS 500e or Dionex AERS 500 Carbonate must be operated with the Gas Separator Waste Tube (Item # 045460).

3.3.3 Installation in Thermal Chamber

A. Installation instructions for Dionex ICS-3000/5000/5000+ DC.

1. Install the suppressor using the suppressor holder on the CD in the upper compartment. Ensure the upper compartment temperature is set to a value no greater than 40°C and temperature control is turned on. It is recommended that the upper compartment is kept cooler than the lower compartment. If using a single zone DC, do not set the temperature above 40°C. For best noise performance the upper compartment can be set to 20° C.

B. Installation instructions for Dionex Integrion:

2. Install the suppressor using the suppressor holder on the Conductivity Detector in the detector compartment (bottom right door). If the Dionex Integrion is fitted with detector compartment temperature control, ensure the detector compartment temperature is set to a value less than 40°C and temperature control is turned on. It is recommended that the detector compartment is kept cooler than the column

compartment (left door). For best noise performance the detector compartment can be set to 20° C.

C. Installation instructions for Dionex Aquion, Dionex ICS 1100/1600/2100, AS50 thermal chamber TC and CC:

1. Install the suppressor using the suppressor holder. The suppressor is installed outside the heated column enclosure. It can support all high temperature applications up to 60° C. Add a length of tubing (up to 20”, 50 cm) between the column outlet and the suppressor inlet to allow time for the eluent to cool to room temperature if operating the column above 35°C.

D. Installation instructions for LC30 and LC25 ovens:

1. For all ANION and CATION applications up to 40° C, install the suppressor in the oven using the suppressor holder.

2. For operation above 40° C and up to 60° C, it is recommended that the suppressor be installed outside the oven; this ensures optimal performance of the suppressor in terms of noise and background. The Dionex CERS 500 and Dionex CERS 500e suppressors are fully compatible with operation up to 60° C. The noise performance would be slightly inferior at 60° C versus 30° C.

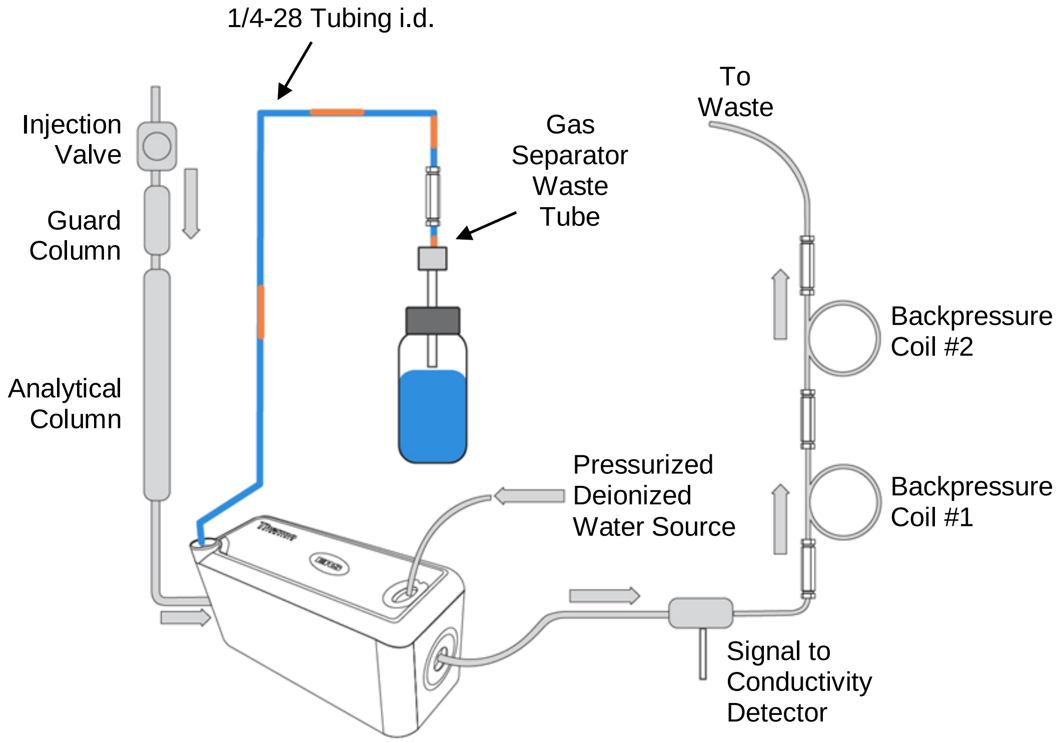
NOTE

For best performance and suppressor longevity, the suppressor should be kept as cool as possible; 20° C is ideal.

Set the required current based on your specific application requirements for column flow rate and temperature in addition to eluent concentration. If using Chromeleon software, the Wizards can greatly assist you in determining the correct requirements. Refer to Section 2.6.1 for suppressor current calculations and Appendix A for examples.

3.4 Plumbing for the AutoSuppression External Water Mode Operation

Figure 6 The AutoSuppression External Water Mode Plumbing Diagram



Any analysis that can be performed using the AutoSuppression Recycle Mode can be done using the AutoSuppression External Water Mode. A constant source of deionized water having a specific resistance of 18.2 megohm or greater is supplied to the regenerant chambers to generate hydronium or hydroxide ions for neutralization.

NOTE

AutoSuppression External Water Mode is used when organic solvents or metallic contaminants are present in the eluent or sample, or borate is used as the eluent.

NOTE

Because of its simplicity and equivalent performance, Thermo Fisher Scientific recommends the use of Recycled Eluent Mode unless organic solvents or metallic contaminants are present in the eluent or sample, or borate is used as the eluent.

3.4.1 Eluent Flow Path Connections for the AutoSuppression External Water Mode

Depending on the specific components in the system (such as analytical column, conductivity cell, and back pressure coils), ¼-28 or 10-32 ferrule/bolt liquid lines may be required. All necessary tubing and fittings are supplied in the detector, or Dionex RFC-10, or Dionex RFC-30 Ship Kits. To purchase or assemble ¼-28 or 10-32 ferrule/bolt liquid lines, refer to, “Dionex Liquid Line Fittings.” Always use 0.005” i.d. PEEK tubing with 10-32 ferrule/bolt fittings on 2 mm systems. When possible, use 0.010” i.d. PEEK tubing with 10-32 ferrule/bolt fittings on 4 mm systems. Avoid adding dead volume to the system by keeping all eluent lines as short as possible.

A. Install the Dionex ERS 500, Dionex ERS 500e or Dionex AERS 500 Carbonate in the first slot inside the Chromatography Module.

B. Connect the outlet of the analytical column to the ELUENT IN of the suppressor (see Figure).

C. Connect the ELUENT OUT port of the suppressor to the inlet of the conductivity cell (see Figure).

D. Install a waste line from the conductivity cell that generates 40 psi back pressure at the flow rate required by the application. Use the appropriate i.d. tubing depending on your application requirements. Refer to Section 2.4 and see Table 3 for the correct back pressure tubing requirements.

Install and adjust the flow rate of water from the pressurized water delivery system to the regenerant chambers of the suppressor (see Table 6).

3.4.2 Regenerant Flow Path Connections in the AutoSuppression External Water Mode

The Dionex ERS 500 Pressurized Bottle Installation Kit (Item # 038018) contains all of the components needed to install and operate the Dionex ERS 500, Dionex ERS 500e or Dionex AERS 500 Carbonate with a pressurized water reservoir. The kit contains the Dionex ERS Installation Parts Kit (Item # 039055), a 25 psi regulator (Item # 038201), and a 4 liter water reservoir (Item # 039164).

A. Make the following air line connections:

   1. Locate the pieces of tinted 1/8” o.d. plastic tubing (Item # 030089) supplied in the Installation Parts Kit.

   2. Push the end of one piece of 1/8” o.d. tubing over the barbed fitting of the regulator. Connect the other end of the tubing to the source of air pressure.

   3. Push one end of the second piece of 1/8” o.d. tubing over the other barbed fitting of the regulator. Push the other end of this tubing over the barbed fitting (Item # 030077) in the pressure inlet of the plastic reservoir (see Figure).

B. Make the following water line connection.

   1. Use a coupler (Item # 039056) to connect one end of the 30” tubing assembly (Item # 035727) that comes in the Installation Kit to the water reservoir. Connect the other end of this tubing to the REGEN IN port of the suppressor.

2. Using a coupler (Item # 039056) and a 1/8" o.d. piece of tubing (Item # 035728) from the Installation Kit, connect one end of this line to the REGEN OUT port of the suppressor and then connect the other end of the line to the Gas Separator Waste Tube.

C. Fill the water source reservoir. Make sure that the O-ring is inside the cap of the reservoir before screwing the cap onto the reservoir. Screw the cap onto the reservoir tightly and place the reservoir near the Chromatography Module.

D. ***With current applied***, adjust the external water flow rate to match the eluent flow rate by using a graduated cylinder and measuring the flow from the REGEN OUT waste line. The pressure applied to the reservoir can vary from 0–25 psi (the lower and upper pressure limits of the water reservoir) but the typical operating pressure is between 10 –15 psi for the Dionex ERS 500, or 5 – 10 psi for the Dionex ERS 500e or Dionex AERS 500 Carbonate suppressor. Please note that this value is highly system dependent and may vary from one suppressor to the next. In summary, the final external water flow rate is dependent on two factors: the pressure applied to the water reservoir and the current setting. It is best to measure it with the current on since the application of current can affect the final flow rate significantly.

SAFETY

A safety relief valve on the reservoir regulator prevents pressure greater than 25 psi from being applied to the water reservoir.

Table 6 Recommended External Water Flow Rate for Dionex ERS 500

Recommended External Water Flow Rate	Equal to the Eluent Flow Rate
Maximum External Water Flow Rate	2 mL/min (2 mm suppressors) 5 mL/min (4 mm suppressors)
Recommended External Flow Rate (Neutralization Mode)	5 mL/min (4 mm suppressor only)

Table 7 Recommended External Water Flow Rate for Dionex ERS 500e and Dionex AERS 500 Carbonate

Recommended External Water Flow Rate	At least 2x the eluent flow rate
Maximum External Water Flow Rate	2 mL/min (2 mm suppressors) 5 mL/min (4 mm suppressors)

3.4.3 Regenerant Flow Path Connections in the AutoSuppression External Water Mode with Peristaltic Pump

For peristaltic pump plumbing refer to the "MASTERFLEX® C/L® Peristaltic Pump Quick Start Guide" (Item # 065203). For the Dionex ERS 500, Dionex ERS 500e or Dionex AERS 500 Carbonate plumbing refer to Figure , The AutoSuppression External Water Mode Plumbing Diagram and pump the Deionized water into the "Regen in" port of the suppressor using the peristaltic pump at the same flow rate as the eluent flow rate, see Table 6.

3.4.4 Installation in Thermal Chamber

Refer to Section 3.3.3.

3.4.5 Dionex SRD-10 Suppressor Regenerant Detector

The Dionex SRD-10 Suppressor Regenerant Detector is a stand-alone device that monitors liquid flow to a suppressor. If the flow is restricted or stops, the Dionex SRD-10 automatically disables the eluent pump via a TTL command, thus preventing irreversible damage being done to the suppressor. In the external water mode, if the water runs out in the source reservoir then the suppressor would be powered without any regenerant flow; this condition results in irreversible damage to the suppressor. Installing the Dionex SRD-10 suppressor regenerant detector avoids this issue, as the system is turned off if the regenerant flow is interrupted either due to a plumbing leak or due to the source reservoir becoming empty.

3.5 Plumbing for Chemical Suppression Mode Operation

The Dionex ERS 500 is not compatible with the chemical suppression mode. Therefore Thermo Scientific Dionex recommends the Dionex CRS 500 or equivalent for chemical suppression mode applications.

The Dionex ERS 500e and Dionex AERS 500 Carbonate can be used in the Chemical Suppression Mode; however the total suppression capacity is reduced compared to a Chemically Regenerated Suppressor. Thermo Scientific recommends the use of a Chemically Regenerated Suppressor such as the Dionex CRS 500 for chemical suppression applications.

NOTE

The Dionex ERS 500 is not compatible with the Chemical Suppression Mode. The Dionex CRS 500 or equivalent should be used when Chemical Suppression Mode is required.

3.6 Plumbing for MPIC Suppression Mode of Operation

The Dionex AERS 500e can be used with current applied to the suppressor augmented by dilute sulfuric acid in the regenerant solution. If you intend to use an AutoRegen Accessory, configure the system as described in Section 3.4, "Plumbing for the AutoSuppression External Water Mode Operation," and use the appropriate sulfuric acid concentration instead of water. The Dionex CERS 500e can be used with current applied to the suppressor augmented by diluted boric acid in the regenerant solution.

NOTE

The following installation instructions are based on a system configured with a pressurized water delivery system, but apply equally well to peristaltic pump delivery systems.

NOTE

The Dionex ERS 500 suppressor is not recommended for use with the MPIC Suppression Mode of Operation. The Dionex ERS 500e should be used.

NOTE

The Dionex AERS 500 Carbonate suppressor is not compatible with the MPIC Suppression Mode of Operation.

3.6.1 Eluent Flow Path Connections in MPIC Suppression Mode

To operate a system in the MPIC Suppression Mode, configure the system as described in Section 3.4.1, "Eluent Flow Path Connections in the AutoSuppression External Water Mode."

3.6.2 Regenerant Flow Path Connections in MPIC Suppression Mode Using Pressurized Water Delivery System

The Dionex ERS Installation Kit (Item # 038018) contains all of the components needed to install and operate the Dionex ERS 500e with a pressurized regenerant reservoir. The kit contains the Dionex ERS Installation Parts Kit (Item # 039055), a 25 psi regulator (Item # 038201), and a 4-liter regenerant reservoir (Item # 039164).

To operate a system in the MPIC Suppression Mode, configure the system and use the appropriate sulfuric acid concentration as described in Section 3.6.3.

3.6.3 MPIC Suppression Mode Operation

A. Anion MPIC

The Dionex AERS 500e can be used for suppression of MPIC (ion-pairing) eluents by using the MPIC Suppression Mode. The MPIC Suppression Mode is a combination of the AutoSuppression External Water Mode augmented with a chemical regenerant such as sulfuric acid (H_2SO_4). When the Dionex AERS 500e is operating in this mode, it uses an applied current and a constant source of dilute sulfuric acid solution from a pressurized bottle delivery system or additional pump.

Table 8, " Matching the Current Setting and Regenerant Flow Rate to the Eluent Concentration and Flow Rate," lists the eluent concentrations and flow rates of standard eluents used in Anion MPIC separations and the current level and regenerant flow rate required to suppress them.

NOTE

The Dionex ERS 500 suppressor is not recommended for use with the MPIC Suppression Mode of Operation. The Dionex ERS 500e should be used.

Table 8 Matching the Current Setting and Regenerant Flow Rate to the Eluent Concentration and Flow Rate for the Dionex AERS 500e (4 mm) in the MPIC Suppression Mode

Eluent	Eluent Flow Rate (mL/min)	Current (mA)	Regenerant Flow Rate (mL/min)*	Regenerant Concentration (mN)
0.1–2.0 mM TBAOH	0.5–2.0	50/100	3–5	5–10
2.0–5.0 mM TBAOH	0.5–1.0	100/300	3–5	10
	1.1–1.5	300/500	3–5	10

*Measured with power ON using a graduated cylinder

NOTE

For lower eluent concentration in a given range, choose lower corresponding current; for higher eluent concentration, choose higher current setting. Higher current settings require higher pressures applied to the pressurized regenerant delivery bottle to maintain adequate regenerant flow.

B. Cation MPIC

The Dionex CERS 500e can be used for suppression of MPIC (ion-pairing) eluents by using the AutoSuppression External Water Mode or the MPIC Suppression Mode depending on the specific MPIC application. The MPIC Suppression Mode is a combination of the AutoSuppression External Water Mode augmented with a chemical regenerant if necessary, such as boric acid (H_3BO_3). When the Dionex CERS 500e is operating in this mode, it uses an applied current and a constant source of dilute boric acid solution from a pressurized bottle delivery system.

The separation of alkanolamines by ion-pairing using the Dionex CERS 500e requires adding 10 mM boric acid to the regenerant to increase the ionization of the ethanolamines, thereby increasing the conductivity of the alkanolamines. Boric acid regenerant should not be used for the separations of the fully ionized alkali and alkaline earth metals as the borate will displace the hydroxide counter ion and reduce the conductance of these ions. Table 9, “ Matching the Current Setting and Regenerant Flow Rate to the Eluent Concentration and Flow Rate ,” lists the eluent concentrations and flow rates of standard eluents used in cation MPIC separations and the current level and regenerant flow rate required to suppress them.

NOTE

The Dionex ERS 500 suppressor is not recommended for use with the MPIC Suppression Mode of Operation. The Dionex ERS 500e should be used.

Table 9 Matching the Current Setting and Regenerant Flow Rate to the Eluent Concentration and Flow Rate Dionex CERS 500 (4 mm)

Eluent	Eluent Flow Rate (mL/min)	Current (mA) [1]	Regenerant Flow Rate (mL/min) [2]
0.1–2.0 mM Hexanesulfonic acid (HSA)	0.5–1.0	50/100	3–5
2.0–5.0 mM Hexanesulfonic acid	0.5–1.0	100/300	3–5
0.1–2.0 mM Octane sulfonic acid (OSA)	0.5–1.0	50/100	3–5
2.0–5.0 mM OSA	0.5–1.0	100/300	3–5
0.1–2.0 mM Nonafluoropentanoic acid	0.5–1.0	50/100	3–5
2.0–5.0 mM Nonafluoropentanoic acid	0.5–1.0	100/300	3–5

1. CERS 500 applications will operate best at current settings of 300 mA or lower. Operating the CERS 500 at current settings over 300 mA can reduce the life of the suppressor and produce unnecessary baseline noise.
2. Measured with power ON using a graduated cylinder

NOTE

For the lower eluent concentration in a given range, choose the lower corresponding current; for the higher eluent concentration, choose the higher current setting. Higher current settings require higher pressures applied to the pressurized regenerant delivery bottle to maintain adequate regenerant flow. Organic eluent solvents levels should be kept below 40%.

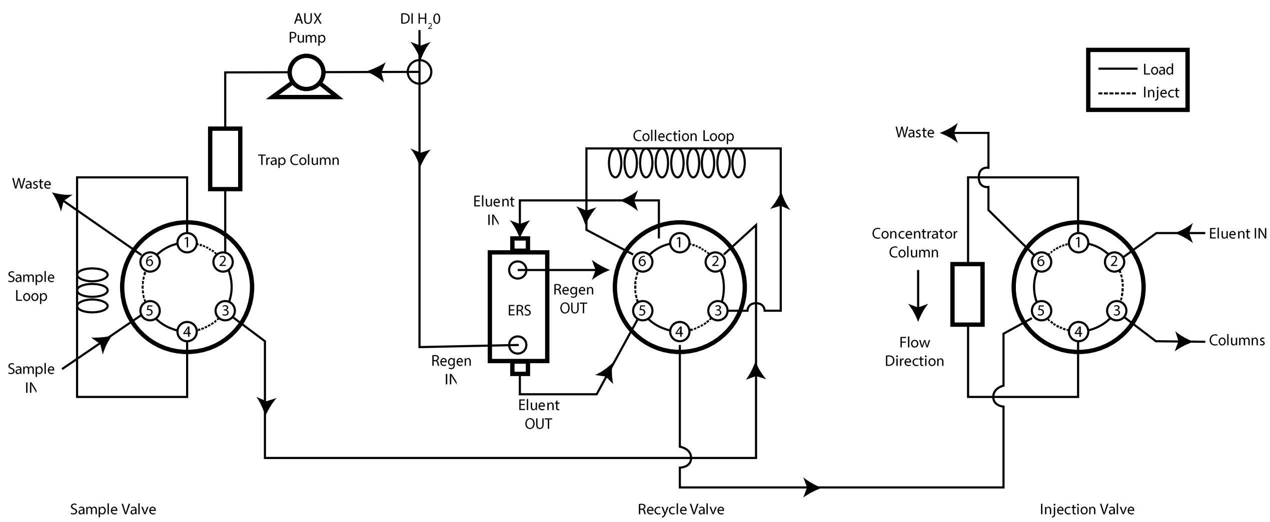
3.7 Plumbing for Neutralization Mode Operation

For detailed information on installation of the Dionex ERS 500e on Dionex ICS systems for Neutralization Mode, refer to Thermo Scientific Dionex Application Notes 93 and 94.

NOTE

The Dionex ERS 500 suppressor is not recommended for use with the Neutralization Mode of Operation. The Dionex ERS 500e should be used.

Figure 7 The Dionex ERS 500e Neutralization Mode Plumbing Diagram



3.7.1 Sample Liquid Line Connections for Dionex ERS 500e in Neutralization Mode

A. Install the Dionex ERS 500e in the chromatography module.

B. Connect the eluent line from Port 1 on the Recycle Valve to the ELUENT IN port of the Dionex ERS 500e.

C. Connect the ELUENT OUT port of the Dionex ERS 500e to Port 5 of the Recycle Valve.

3.7.2 Regenerant Liquid Line Connections for Dionex ERS 500e in Neutralization Mode

The SP10 AutoNeutralizer Ship Kit (Item # 047950) contains all the components needed to install and operate the Dionex ERS 500e in Neutralization Mode with a pressurized water reservoir.

A. Make the following air line connections.

1. Locate the pieces of tinted 1/8” OD plastic tubing (Item # 030089) supplied in the Ship Kit.
2. Push the end of piece of 1/8” OD tubing over the barbed fitting of the regulator. Connect the other end of the tubing to the source of air pressure.
3. Push one end of the second piece of 1/8” OD tubing over the other barbed fitting of the regulator. Push the other end of this tubing over the barbed fitting (Item # 030077) in the pressure inlet of the plastic reservoir.

B. Make the following liquid line connections:

1. Use a coupler (Item # 039056) to connect one end of the 30” tubing assembly (Item # 035727) that comes in the AutoNeutralization Ship Kit to the water reservoir. Connect the other end of this tubing to the REGEN IN port of the Dionex ERS 500e.
2. Using a coupler (Item # 039056) and a 1/8” OD piece of tubing (Item # 035728) from the AutoNeutralization Ship Kit, connect one end of this line to the REGEN OUT port of the Dionex ERS 500 and then connect the other end of the line to the Gas Separator Waste Tube.
3. Fill the reservoir with water. Make sure the o-ring is inside the cap of the reservoir before screwing the cap onto the reservoir. Screw the cap onto the reservoir tightly and place the reservoir near or on top of the instrument in a secondary waste container such as the Dionex EO.

3.7.3 Pump Trap Column Installation and Regeneration

A. Installation of the Dionex ATC-HC Trap Column
The Dionex ATC-HC Trap Column (Item # 059604) is used to trap anions that may be in the carrier solution that could result in high blanks. The Dionex ATC-HC should be regenerated prior to installation.

B. Regeneration of the Dionex ATC-HC Trap Column
Using a pump other than the carrier pump, the Dionex ATC-HC should be regenerated and rinsed using the following two steps.

1. Regenerate the Dionex ATC-HC with 0.5 M NaOH for 50 minutes at a flow rate of 1 mL/min.

2. Rinse the Dionex ATC-HC with deionized water for 30 minutes at a flow rate of 1 mL/min. If the carrier solution is different from water, equilibrate it to the carrier solution for 30 minutes at a flow rate of 1 mL/min.

C. Installation of the Dionex CTC-1 Trap Column
The Dionex CTC-1 Trap Column (Item # 040192) is used to trap cations that may be in the carrier solution that could result in high blanks. The Dionex CTC-1 should be regenerated prior to installation.

D. Regeneration of the Dionex CTC-1 Trap Column
Using a pump other than the carrier pump, the Dionex CTC-1 should be regenerated and rinsed using the following two steps.

1. Regenerate the Dionex CTC-1 with 0.5 M H_2SO_4 for 50 minutes at a flow rate of 1 mL/min.

2. Rinse the Dionex CTC-1 with deionized water for 30 minutes at a flow rate of 1 mL/min. If the carrier solution is different from water, equilibrate it to the carrier solution for 30 minutes at a flow rate of 1 mL/min.

3.7.4 Neutralization Mode Operation

For detailed operation of Dionex IC systems, consult the accompanying Product Manuals.

NOTE

The Dionex ERS 500 suppressor is not recommended for use with the Neutralization Mode of Operation. The Dionex ERS 500e should be used.

Neutralization pretreatment coupled with Ion Chromatography involves the following steps:

A. The concentrated sample is loaded into the sample loop of the “Sample Valve” with either a syringe or an Autosampler.

B. The sample loop is switched in-line and flushed with a stream of deionized water.

C. The deionized water pushes the sample through the Dionex ERS 500, where neutralization begins.

D. Common bases or acids that have been diluted fourfold or more can be completely neutralized after one pass through the Dionex ERS 500e at flow rates ≤ 0.5 mL.min.

E. For more concentrated bases or acids or faster flow rates, multiple passes through the Dionex ERS 500e will be required for complete neutralization.

F. The partially neutralized sample is passed down to the 2 mL collection loop on the Recycle Valve.

G. The recycle valve is actuated so that the sample flow is directed to pass through the Dionex ERS 500e a second time (or multiple times) to neutralize the sample completely.

H. The Recycle Valve can be actuated multiple times if multiple passages are necessary for complete neutralization.

I. After complete neutralization, the sample is delivered to the injection valve of the Dionex Ion Chromatography system and a low pressure trap column such as the Dionex UTAC-XLP2 (Item # 072781) for the Dionex AERS 500e (4 mm) or Dionex TCC-XLP1 (Item # 063889) for the Dionex CERS 500e (4 mm).

J. The trace ions are then analyzed by the Dionex Ion Chromatography system.

For detailed information on the timing and configuration of the Sample Valve, Recycle Valve, and Injection Valve, refer to Thermo Scientific Dionex Application Note 93 or 94, or to the Dionex SP10 AutoNeutralizer Operator's Manual (Document Number 034980).

3.8 Dionex ERS 500, Dionex ERS 500e or Dionex AERS 500 Carbonate Storage

The Dionex ERS 500, Dionex ERS 500e and Dionex AERS 500 Carbonate are shipped with deionized water as the storage solution. If the suppressor will not be used for more than three days, prepare it for storage. The resin, screens and membranes in the suppressor must be completely hydrated to maintain liquid seal and chromatographic performance. Plug all of the ports after hydration.

3.8.1 Short Term Storage (3 to 7 days)

A. Using a plastic syringe, push 5 mL of deionized water through the REGEN IN port, and 3 mL of Deionized Water through the ELUENT IN port until all bubbles are removed. Plug all the ports (both REGEN and ELUENT ports).

B. To resume operation, connect the suppressor to the system. Allow the system to equilibrate before starting analysis.

NOTE

If the eluent last used contained organic solvents, flush the Dionex ERS 500, Dionex ERS 500e or Dionex AERS 500 Carbonate with deionized water for 10 minutes through both chambers before plugging the fitting ports.

3.8.2 Long Term Storage (More than 7 days)

A. Connect the eluent and regenerant chambers in series and flush the Dionex ERS 500, Dionex ERS 500e or Dionex AERS 500 Carbonate with deionized water for 10 minutes at 1.0 mL/min (4 mm) or 0.25 mL/min (2 mm).

B. Plug all suppressor ELUENT ports and REGEN ports.

C. To resume operation, complete the hydration steps and connect the suppressor to the system. Allow the system to equilibrate before starting analysis.

D. If small or increasing analyte peak areas are observed, perform steps A–G as outlined in Section 5.2, "Small or increasing Analyte Peak Area or Regeneration."

4. Example Neutralizer Mode Applications

The following examples are presented to highlight the analysis of trace anions or cations found in the concentrated matrices that have been treated using a Dionex Electrolytically Regenerated Suppressor (Dionex ERS 500e) in Neutralizer Mode.

The analysis may be done on any one of a number of Dionex anion or cation exchange column sets. Please refer to the Product Manual for the particular anion or cation exchange column set installed in your system for detailed operation and troubleshooting information.

Because of its low operating pressure, the Dionex UTAC-XLP2 (Item # 072781) or Dionex TCC-XLP1 (Item # 063889) should be used to concentrate the trace anions or cations in the sample neutralized by the Dionex ERS 500e. The use of other concentrators may result in excessive back pressure to the Dionex ERS 500e, thus damaging the Dionex ERS 500e.

NOTE

The Dionex ERS 500 suppressor is not recommended for use with the Neutralization Mode of Operation. The Dionex ERS 500e should be used.

4.1 System Blank

4.1.1 Anion System Blank

Trace anion contamination in the deionized water used for the carrier solution, the Dionex AERS 500e and eluent create the analytical blank. For trace analysis, the analytical blank usually determines the detection limits of the system. Anion contaminants in deionized water can be removed by installing Dionex IonPac ATC-HC column between the sample carrier pump and the Sample Valve. The major source of sulfate contamination is usually from the Dionex AERS 500e. Since this device uses high capacity surface sulfonated ion exchange screens and membranes, sulfate is released from the screen and membrane surfaces, especially in a newly installed Dionex AERS 500e.

To reduce the sulfate blank, follow the Dionex ERS 500e startup procedure in Section 3.3, "Start-up Procedure for the Dionex Electrolytically Regenerated Suppressor (Dionex ERS 500e)." The sulfate blank is normally reduced to a constant level after 24 hours of operation. Typical blanks are shown in Figure , "Dionex IonPac AS11 Gradient Analysis of Blank, Standard, 10% NaOH Sample and spiked 10% NaOH Sample" and Figure , "Dionex IonPac AS12A Isocratic Analysis of Blank, Standard, 25% NaOH Sample and Spiked 25% NaOH Sample." Finally, anion contaminants in the eluent (e.g., Na2CO3/NaHCO3 and NaOH) also contribute to the analytical blank. A choice of high purity chemicals helps to reduce the blank concentrations.

4.1.2 Cation System Blank

Trace cation contamination in the deionized water used for the carrier solution, the Dionex CERS 500e and eluent create the analytical blank. For trace analysis, the analytical blank usually determines the detection limits of the system. Cation contaminants in deionized water can be removed by installing Dionex CTC-1 Column between the sample carrier pump and the Sample Valve. The major source of ammonia and amine contamination is usually from the Dionex CERS 500e. Since this device uses high capacity aminated ion exchange screens and membranes, ammonia and amines are released from the screen and membrane surfaces, especially in a newly installed Dionex CERS 500e.

To reduce the amine blank, follow the Dionex ERS 500e start-up procedure in Section 3.2, "Start-up Procedure for the Dionex Electrolytically Regenerated Suppressor (Dionex ERS 500)." The amine blank is normally reduced to a constant level after 24 hours of operation. A typical blank is shown in Figure , "Dionex IonPac CS12A Blank and Standard Analysis." The use of high purity chemicals helps to reduce the blank concentrations.

4.2 Dionex CERS 500e Conditioning

Since the Dionex CERS 500e is a high-capacity anion exchange device which supplies the high concentration of hydroxide for acid neutralization, the hydrolysable ions such as Mg^{2+} and Ca^{2+} in hydroxide forms may be precipitated in the Dionex CERS 500e. In general, when standard cation in water solutions are employed for system calibration, it is possible that Mg^{2+} and Ca^{2+} may be precipitated due to the high hydroxide concentration. These cations are then "carried over" to the first acid run. To avoid the hydrolysis of the alkaline earth metals during standard calibration, the Dionex CERS 500e is "conditioned" by running a complete pretreatment cycle of acid (preferably 24% sulfuric acid) prior to standard runs. Follow the Dionex CERS 500e acid treatment procedure below prior to each standard run.

A. Confirm that the system functions properly.
B. Set "Sample Valve" to Load Position and load 24% sulfuric acid.
C. Switch the sample valve to Inject position and flush the sample loop with deionized water.
D. After the sulfuric acid passes through the neutralizer and IC injection valve (approximately 4–6 minutes with the collection coil installed or 1-2 minutes without the collection coil installed), the system is ready for standard injection.

The above steps are applied only when standard calibration is performed. However, if the standard injection is made immediately after the sample runs (acid samples) the Dionex CERS 500e acid pretreatment is not required.

If the standard run is not started within 20 minutes after the acid calibration step, the overall process must be repeated. When multiple point calibration is performed, the Dionex CERS 500e acid pretreatment can be made any time after the beginning of the analytical separation.

4.3 System Calibration

The analytical blank should be incorporated into the calibration curve. One or two level standards are usually required to calibrate the Ion Chromatograph. For trace analysis, typical standard concentrations are 2 to 5 times sample concentrations. For example, for anions, if the sample contains 50 ppb each of Cl^-, NO^{3-} and SO_4^{2-}, the standard calibration should not exceed 250 ppb each of these anions. For cations, if the sample contains 10 ppb each of K^+, Mg^{2+} and Ca^{2+}, the standard calibration should not exceed 50 ppb each of these cations.

4.3.1 Analysis of Acid Samples Containing High Concentrations of Transition Metals

If a sample contains transition metals in ppm (mg/L) levels, these elements may interfere with cation detection by suppressed conductivity. The additional of complexing agent such as pyridine-2,6-dicarboxylic acid (PDCA, Item # 039671) to the CS12A eluent is required to selectively remove transition metals from the eluent via the suppression system.

Detection Limits of Dionex ERS 500e Sample Pretreatment and Subsequent Ion Chromatography

Anion	**ppb***
Chloride	4
Bromide	20
Chlorate	30
Nitrate	20
Phosphate	50
Sulfate	30
Oxalate	50

* Estimated values in NaOH matrix

Cation	**ppb***
Lithium	0.03
Sodium	1.0
Potassium	2.0
Magnesium	0.6
Calcium	0.8

* Estimated values in H_2SO_4 matrix

4.4 Recovery Data for Trace Anions in 25% Sodium Hydroxide

Anion	**25% NaOH* (ppb)**	**Spike (ppb)**	**Expected (ppb)**	**Found* (ppb)**
Chloride	155 + 3	100	255	258 + 4
Bromide	—	100	100	99 + 8
Chlorate	—	100	100	96 + 9
Nitrate	11 + 6	100	111	119 + 13
Phosphate	106 + 25	100	206	183 + 17
Sulfate	348 + 4	200	548	553 + 11
Oxalate	134 + 28	100	234	238 + 22

* n = 8

Separation Conditions are shown in Section 4.7, “Dionex IonPac AS12A Isocratic Analysis of 25% Sodium Hydroxide.”

4.5 Recovery Data for Trace Cations in 24% Sulfuric Acid

Cation	**24% H_2SO_4* (ppb)**	**Spike (ppb)**	**Expected (ppb)**	**Found* (ppb)**
Lithium	---	2.0	2.0	1.993 ± 0.008
Sodium	7.4 ± 0.4	8.0	15.4	14.3 ± 0.1
Potassium	3.3 ± 0.5	20.0	23.3	22.5 ± 0.2
Magnesium	2.0 ± 0.2	10.0	12.0	12.2 ± 0.2
Calcium	10.6 ± 0.1	20.0	30.6	33 ± 1

* n = 8

Separation Conditions are shown in Section 4.8, “Dionex IonPac CS12A Isocratic Analysis of 24% Sulfuric Acid”.

4.6 Anion Example Applications

4.6.1 Dionex IonPac® AS11 Gradient

A. Without Guard

Eluent 1: Type I DI Water Eluent Flow Rate: 2.0 mL/min
Eluent 2: 5.0 mM NaOH
Eluent 3: 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
2.0	90	10	0	0.5-5.0 mM NaOH in 3 min
5.0	0	100	0	5.0-38.25 mM NaOH in 10 min
15.0	0	65	35	

B. With Guard

Eluent 1: Type I DI Water Eluent Flow Rate: 2.0 mL/min
Eluent 2: 5.0 mM NaOH
Eluent 3: 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	

NOTE

The steps for sample neutralization can be performed while the Thermo Scientific Dionex IonPac AS11 is equilibrating with the starting eluent (90% E1/10% E2).

Seven minutes are required at the beginning of the above program for equilibration of the Dionex IonPac AS11 with E1 prior to injecting the next sample. If the system is not used continuously, that is, the run program (equilibration plus analysis) is not started exactly every 22 minutes (without Dionex IonPac AG11) or 25 minutes (with Dionex IonPac AG11), the run program can be modified to start with 2 minutes of the highest eluent concentration for regeneration and then to equilibrate with E1 for 7 minutes with the next injection 9 minutes into the program.

4.6.2 Dionex IonPac AS11 Gradient Analysis of 10% Sodium Hydroxide

Sample:	100 µL of 10% NaOH neutralized in the SP10 AutoNeutralizer
Concentrator Column:	Low Pressure Trace Anion Concentrator (i.e., Dionex UTAC-XLP2, Item # 072781)
Trap Column:	Anion Trap Column (i.e., Dionex ATC-HC 500, Item # 075978)
Guard Column:	Dionex IonPac AG11 Guard Column
Analytical Column:	Dionex IonPac AS11 Analytical Column
Eluents	E1: Type I Deionized Water E2: 5.0 mM NaOH E3: 100 mM NaOH
Eluent Flow Rate:	2.0 mL/min (4-mm)
Electrolytic Suppressor:	Dionex Anion Electrolytically Regenerated Suppressor, Dionex AERS 500 Recycled Eluent Mode
or Chemical Suppressor:	Dionex Anion Chemically Regenerated Suppressor, Dionex ACRS 500
Chemical Regenerant:	50 mN H_2SO_4
Expected Background Conductivity:	0.5 mM NaOH: 1 µS 35 mM NaOH: 3.5 µS
Expected System Operating Back Pressure:	Without Guard: 1,600 psi (11.03 MPa) With Guard: 1,850 psi (12.75 MPa)

Figure 8 Dionex IonPac AS11 Gradient Analysis of Blank, Standard, 10% NaOH Sample and Spiked 10% NaOH Sample

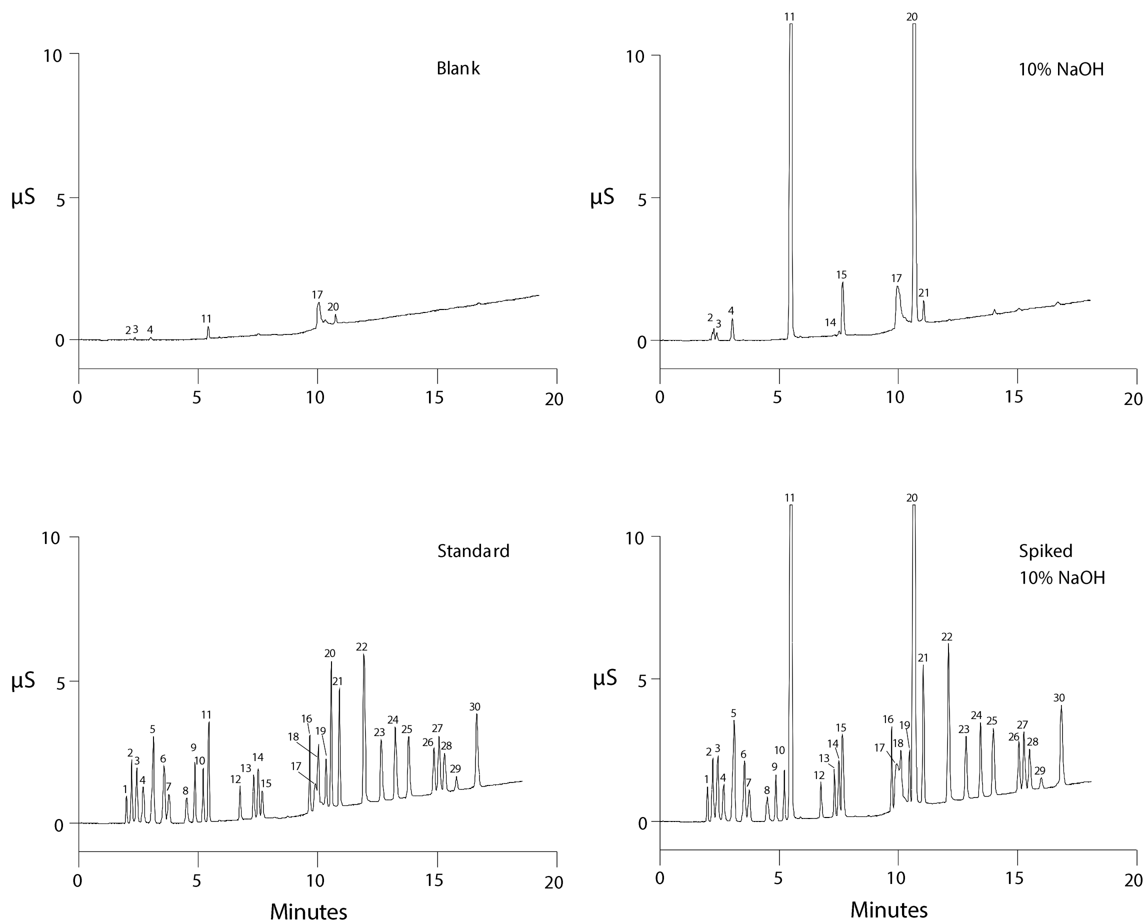


Table 10 Recovery Data for the Dionex IonPac AS11 Analysis of 10% NaOH

	Standard Conc. (mg/L)	10% NaOH Conc. (mg/L)	Expected Spiked Value Conc. (mg/L)	10% NaOH Spiked Conc. (mg/L)
1. Quinate	1.000	ND	1.000	1.435
2. Fluoride	0.200	0.030	0.230	0.244
3. Acetate	1.000	0.081	1.081	1.301
4. Propionate	1.000	ND	1.000	1.069
5. Formate	1.000	0.213	1.213	1.216
6. Methylsulfonate	1.000	ND	1.000	1.070
7. Pyruvate	1.000	ND	1.000	1.103
8. Valerate	1.000	ND	1.000	1.009
9. Monochloroacetate	1.000	ND	1.000	0.811
10. Bromate	1.000	ND	1.000	1.036
11. Chloride	0.400	8.750	9.150	9.095
12. Trifluoroacetate	1.000	ND	1.000	1.055
13. Bromide	0.600	ND	0.600	0.640
14. Nitrate	0.600	0.048	0.648	0.657
15. Chlorate	0.600	1.178	1.778	1.870
16. Selenite	1.000	ND	1.000	0.990
17. Carbonate	---	---	---	---
18. Malonate	1.000	ND	1.000	1.303
19. Maleate	1.000	ND	1.000	1.026
20. Sulfate	1.000	9.842	10.842	10.925
21. Oxalate	1.000	0.166	1.166	1.244
22. Tungstate	2.000	ND	2.000	2.201
23. Phthalate	2.000	ND	2.000	2.086
24. Phosphate	2.000	ND	2.000	2.120
25. Chromate	2.000	ND	2.000	2.287
26. Citrate	2.000	ND	2.000	2.214
27. Tricarballylate	2.000	ND	2.000	2.098
28. Isocitrate	2.000	ND	2.000	2.112
29. cis-Aconitate	2.000	ND	2.000	1.512
30. trans-Aconitate	2.000	0.072	2.072	2.303

ND = None Detected

4.6.3 Dionex IonPac AS12A Isocratic Analysis of 25% Sodium Hydroxide

Sample:	100 µL of 25% NaOH neutralized in the SP10 AutoNeutralizer
Concentrator Column:	Low Pressure Trace Anion Concentrator (i.e., Dionex UTAC-XLP2, Item # 072781)
Column:	Dionex IonPac AG12A + Dionex IonPac AS12A
Eluent:	2.7 mM Na_2CO_3/0.3 mM $NaHCO_3$
Eluent Flow Rate:	1.5 mL/min
Electrolytic Suppressor:	Dionex Anion Electrolytically Regenerated Suppressor, Dionex AERS 500 Recycled Eluent Mode
or Chemical Suppressor:	Dionex Anion Chemically Regenerated Suppressor, Dionex ACRS 500
Chemical Regenerant:	50 mN H_2SO_4
Expected Background Conductivity:	14–16 µS

Figure 5 Dionex IonPac AS12A Isocratic Analysis of Blank, Standard, 25% NaOH Sample and Spiked 25% NaOH Sample

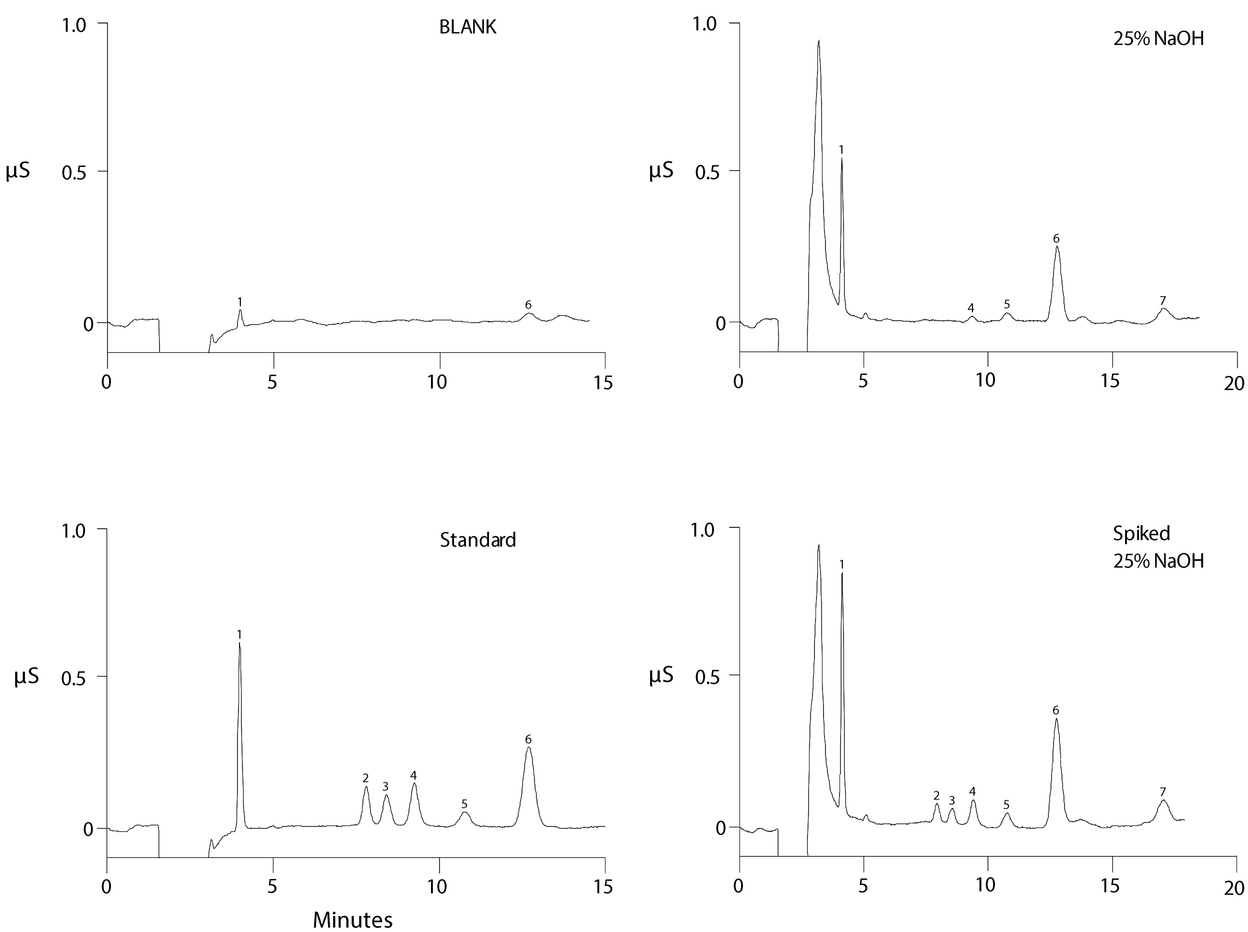


Table 11 Recovery Data for the Dionex IonPac AS12A Analysis of 25% NaOH

	Standard Conc. (mg/L)	Spiking Standard Conc. (mg/L)	25% NaOH Conc. (mg/L)	Expected Spiked Value Conc. (mg/L)	25% NaOH Spiked Conc. (mg/L)
1. Chloride	0.200	0.100	0.155 ± 0.003	0.255	0.258 ± 0.004
2. Bromide	0.200	0.100	ND	0.100	0.099 ± 0.008
3. Chlorate	0.200	0.100	ND	0.100	0.099 ± 0.009
4. Nitrate	0.200	0.100	0.011 ± 0.006	0.111	0.199 ± 0.013
5. Phosphate	0.200	0.100	0.106 ± 0.025	0.206	0.183 ± 0.017
6. Sulfate	0.400	0.200	0.348 ± 0.004	0.548	0.553 ± 0.011
7. Oxalate	---	0.100	0.134 ± 0.028	0.234	0.238 ± 0.022

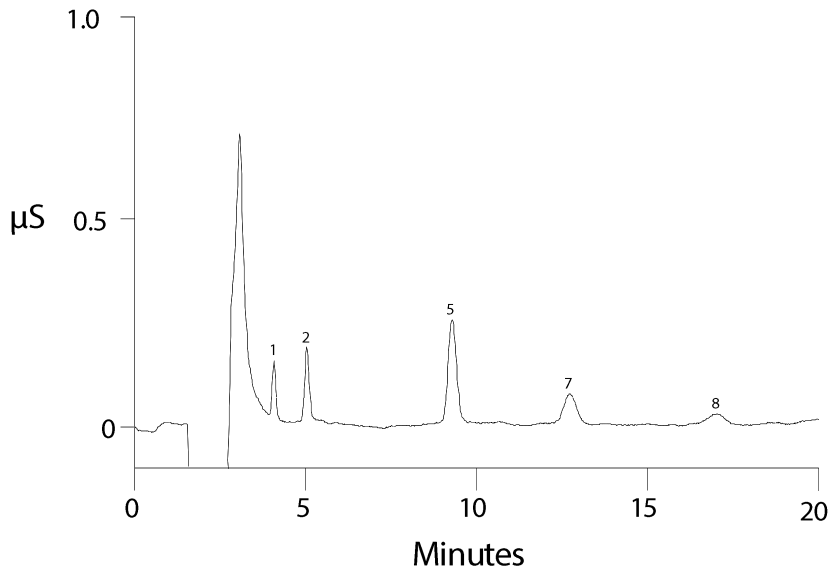
Based on 8 runs

ND = None Detected

4.6.4 Dionex IonPac AS12A Isocratic Analysis of 20% Ammonium Hydroxide

Sample:	100 µL of 20% NH_4OH neutralized in the SP10 AutoNeutralizer
Concentrator Column:	Low Pressure Trace Anion Concentrator (i.e., Dionex UTAC-XLP2, Item # 072781)
Column:	Dionex IonPac AG12A + Dionex IonPac AS12A
Eluent:	2.7 mM Na_2CO_3/0.3 mM $NaHCO_3$
Eluent Flow Rate:	1.5 mL/min
Electrolytic Suppressor:	Dionex Anion Electrolytically Regenerated Suppressor, Dionex AERS 500 Recycled Eluent Mode
or Chemical Suppressor:	Dionex Anion Chemically Regenerated Suppressor, Dionex ACRS 500
Chemical Regenerant:	50 mN H_2SO_4
Expected Background Conductivity:	14–16 µS

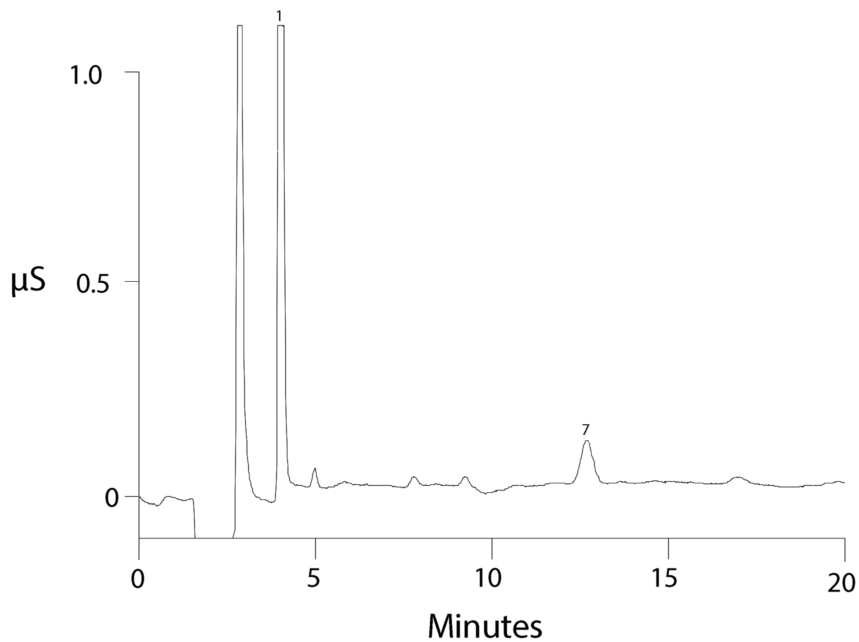
Figure 6 Dionex IonPac AS12A Analysis of 20% Ammonium Hydroxide



4.6.5 Dionex IonPac AS12A Isocratic Analysis of 25% Tetramethylammonium Hydroxide

Sample:	100 µL of 25% TMAOH neutralized in the SP10 AutoNeutralizer
Concentrator Column:	Low Pressure Trace Anion Concentrator (i.e., Dionex UTAC-XLP2, Item # 072781)
Column:	Dionex IonPac AG12A + Dionex IonPac AS12A
Eluent:	2.7 mM Na_2CO_3/0.3 mM $NaHCO_3$
Eluent Flow Rate:	1.5 mL/min
Electrolytic Suppressor:	Dionex Anion Electrolytically Regenerated Suppressor, Dionex AERS 500 Recycled Eluent Mode
or Chemical Suppressor:	Dionex Anion Chemically Regenerated Suppressor, Dionex ACRS 500
Chemical Regenerant:	50 mN H_2SO_4
Expected Background Conductivity:	14–16 µS

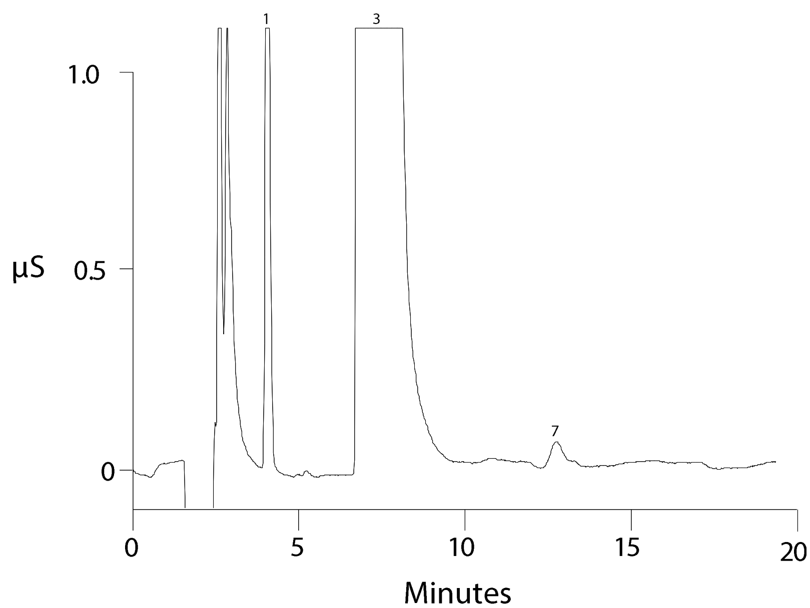
Figure 7 IonPac AS12A Analysis of 25% Tetramethylammonium Hydroxide



4.6.6 IonPac AS12A Isocratic Analysis of 25% Tetrabutylammonium Hydroxide

Sample:	100 µL of 25% TBAOH neutralized in the SP10 AutoNeutralizer
Concentrator Column:	Low Pressure Trace Anion Concentrator (i.e., Dionex UTAC-XLP2, Item # 072781)
Column:	Dionex IonPac AG12A + Dionex IonPac AS12A
Eluent:	2.7 mM Na_2CO_3/0.3 mM $NaHCO_3$
Eluent Flow Rate:	1.5 mL/min
Electrolytic Suppressor:	Dionex Anion Electrolytically Regenerated Suppressor, Dionex AERS 500 Recycled Eluent Mode
or Chemical Suppressor:	Dionex Anion Chemically Regenerated Suppressor, Dionex ACRS 500
Chemical Regenerant:	50 mN H_2SO_4
Expected Background Conductivity:	14–16 µS

Figure 8 Dionex IonPac AS12A Analysis of 25% Tetrabutylammonium Hydroxide



4.7 Cation Example Applications

4.7.1 Dionex IonPac CS12A Blank and Standard Analysis

Sample:	100 µL of Standard or Blank neutralized in the Dionex CERS 500
Concentrator Column:	Low Pressure Trace Cation Concentrator (i.e. Dionex TCC-XLP1, Item # 063889)
Guard Column:	Dionex IonPac CG12A Guard Column
Analytical Column:	Dionex IonPac CS12A Analytical Column
Eluent:	20 mM Methanesulfonic acid
Eluent Flow Rate:	1.0 mL/min
Electrolytic Suppressor:	Dionex Cation Electrolytically Regenerated Suppressor, Dionex CERS 500 Recycled Eluent Mode
or Chemical Suppressor:	Dionex Cation Chemically Regenerated Suppressor, Dionex CCRS 500
Chemical Regenerant:	100 mN TBAOH
Expected Background Conductivity:	20 mM MSA: <1 µS
Expected System Operating Back Pressure:	Without Guard: 1,400 psi (9.65 MPa) With Guard: 1,850 psi (12.75 MPa)

	Analyte	**Conc.. (µg/L)**
1.	Lithium	5.0
2.	Sodium	20.0
3.	Ammonium	25.0
4.	Dimethylamine	B
5.	Potassium	50.0
6.	Trimethylamine	B
7.	Magnesium	25.0
8.	Calcium	50.0

Figure 9 Dionex IonPac CS12A Blank and Standard Analysis

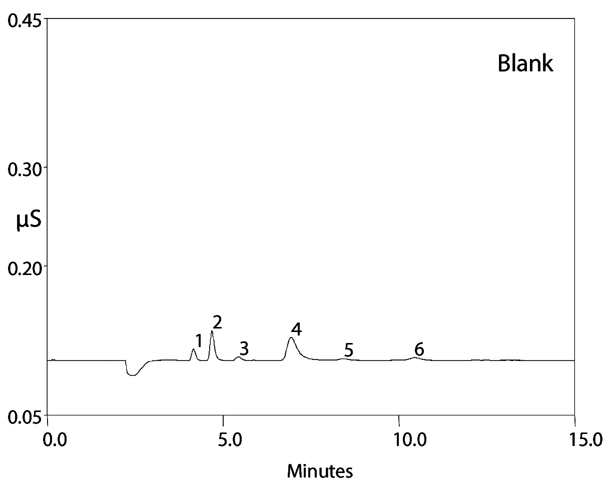


Figure 14A

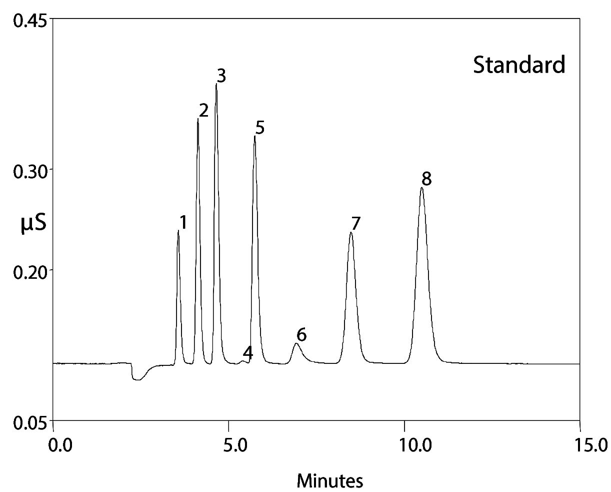


Figure 14B

4.7.2 Dionex IonPac CS12A Analysis of 24% Sulfuric Acid

Sample:	100 µL of 24% sulfuric acid neutralized in the Dionex CERS 500
Concentrator Column:	Low Pressure Trace Cation Concentrator (i.e. Dionex TCC-XLP1, Item # 063889)
Guard Column:	Dionex IonPac CG12A Guard Column
Analytical Column:	Dionex IonPac CS12A Analytical Column
Eluent:	20 mM Methanesulfonic acid (MSA)
Eluent Flow Rate:	1.0 mL/min
Electrolytic Suppressor:	Dionex Cation Electrolytically Regenerated Suppressor, Dionex CERS 500 Recycled Eluent Mode
or Chemical Suppressor:	Dionex Cation Chemically Regenerated Suppressor, Dionex CCRS 500
Chemical Regenerant:	100 mN TBAOH
Expected Background Conductivity:	20 mM MSA: <1 µS
Expected System Operating Back Pressure:	Without Guard: 1,400 psi (9.65 MPa) With Guard: 1,850 psi (12.75 MPa)

Figure 10 Dionex IonPac CS12A Analysis of 24% H_2SO_4 Sample

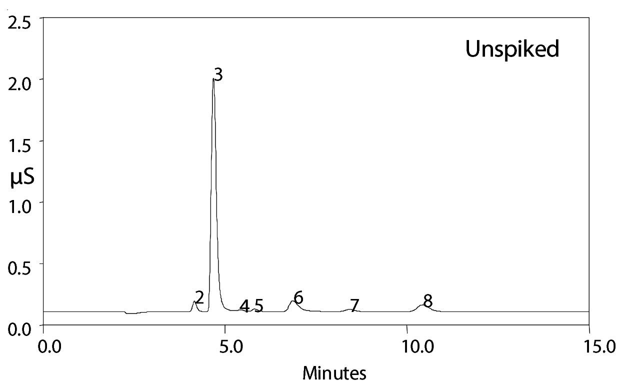


Figure 14A
24% H_2SO_4 Sample

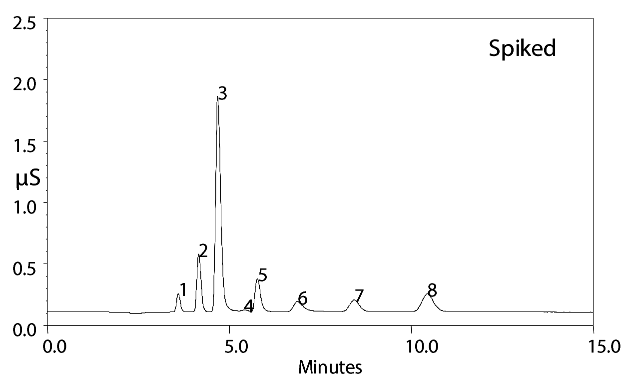


Figure 14B
Spiked 24% H_2SO_4 Sample

Table 12 Recovery Data for the Dionex IonPac CS12A Analysis of 24% H_2SO_4

	Spiking Standard Conc. (µg/L)	24% H_2SO_4* Unspiked Value Conc. (µg/L)	Expected Spiked Value Conc. (µg/L)	24% H_2SO_4* Spiked Value Conc. (µg/L)
1. Lithium	2.0	ND	2.0	1.993 ± 0.008
2. Sodium	8.0	7.4 ± 0.4	15.4	14.3 ± 0.1
3. Ammonium	B	B	B	B
4. Dimethylamine	B	B	B	B
5. Potassium	20.0	3.3 ± 0.5	23.3	22.5 ± 0.2
6. Trimethylamine	B	B	B	B
7. Magnesium	10.0	2.0 ± 0.2	12.0	12.2 ± 0.2
8. Calcium	20.0	10.6 ± 0.1	30.6	33 ± 1

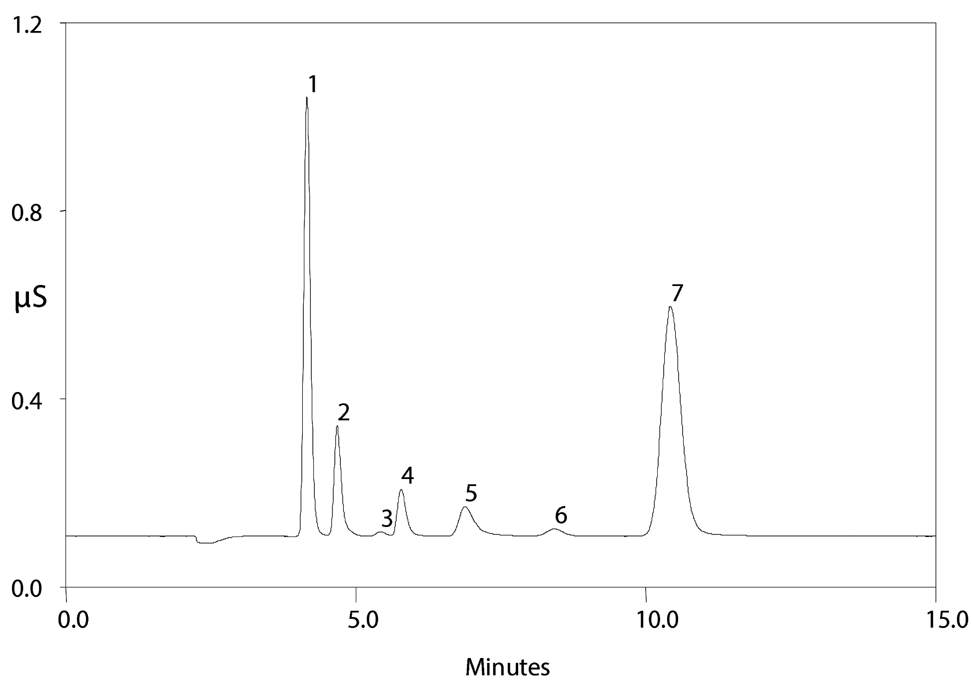
* Based on 8 runs
ND = None Detected, B = Blank

4.7.3 Dionex IonPac CS12A Analysis of 25% Acetic Acid

Sample:	100 µL of 25% acetic acid neutralized in the Dionex CERS 500
Concentrator Column:	Low Pressure Trace Cation Concentrator (i.e. Dionex TCC-XLP1, Item # 063889)
Guard Column:	Dionex IonPac CG12A Guard Column
Analytical Column:	Dionex IonPac CS12A Analytical Column
Eluent:	20 mM Methanesulfonic acid (MSA)
Eluent Flow Rate:	1.0 mL/min
Electrolytic Suppressor:	Dionex Cation Electrolytically Regenerated Suppressor, Dionex CERS 500 Recycled Eluent Mode
or Chemical Suppressor:	Dionex Cation Chemically Regenerated Suppressor, Dionex CCRS 500
Chemical Regenerant:	100 mN TBAOH
Expected Background Conductivity:	20 mM MSA: <1 µS
Expected System Operating Back Pressure:	Without Guard: 1,400 psi (9.65 MPa) With Guard: 1,850 psi (12.75 MPa)

	Analyte	Conc.. (µg/L)
1.	Sodium	86.7
2.	Ammonium	33.7
3.	Dimethylamine	B
4.	Potassium	21.6
5.	Trimethylamine	B
6.	Magnesium	2.5
7.	Calcium	133.0

Figure 11 Dionex IonPac CS12A Analysis of 25% Acetic Acid

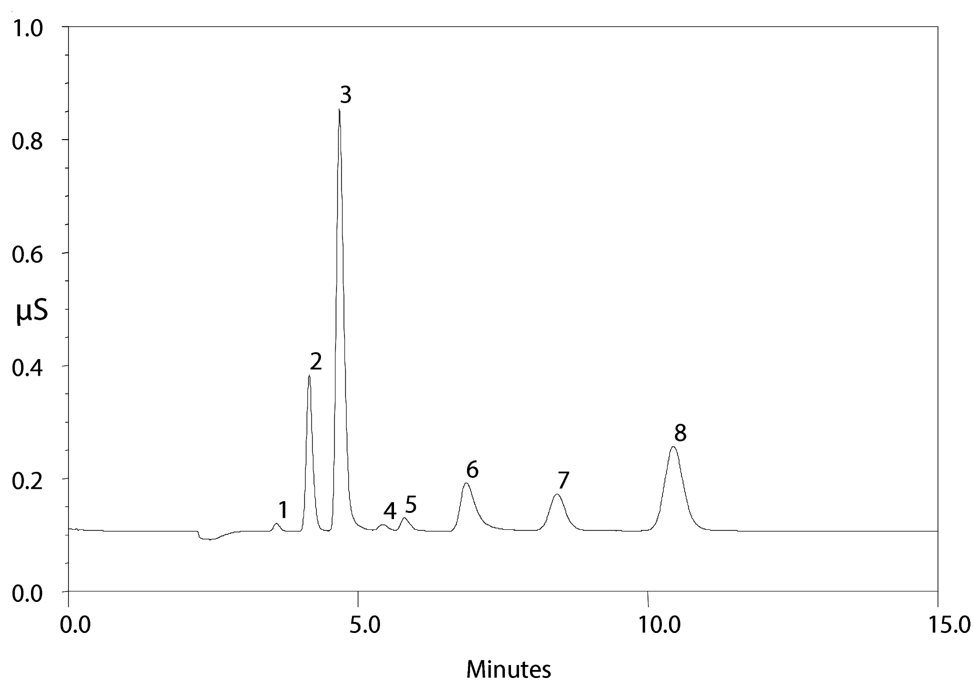


4.7.4 Dionex IonPac CS12A Analysis of 10% Hydrofluoric Acid

Sample:	100 µL of 10% hydroflouric acid neutralized in the Dionex CERS 500
Concentrator Column:	Low Pressure Trace Cation Concentrator (i.e. Dionex TCC-XLP1, Item # 063889)
Guard Column:	Dionex IonPac CG12A Guard Column
Analytical Column:	Dionex IonPac CS12A Analytical Column
Eluent:	20 mM Methanesulfonic acid (MSA)
Eluent Flow Rate:	1.0 mL/min
Electrolytic Suppressor:	Dionex Cation Electrolytically Regenerated Suppressor, Dionex CERS 500 Recycled Eluent Mode
or Chemical Suppressor:	Dionex Cation Chemically Regenerated Suppressor, Dionex CCRS 500
Chemical Regenerant:	100 mN TBAOH
Expected Background Conductivity:	20 mM MSA: <1 µS
Expected System Operating Back Pressure:	Without Guard: 1,400 psi (9.65 MPa) With Guard: 1,850 psi (12.75 MPa)

	Analyte	**Conc. (µg/L)**
1.	Lithium	0.4
2.	Sodium	66.7
3.	Ammonium	110.5
4.	Dimethylamine	B
5.	Potassium	8.4
6.	Trimethylamine	B
7.	Magnesium	15.3
8.	Calcium	59.6

Figure 126 Dionex IonPac CS12A Analysis of 10% Hydrofluoric Acid

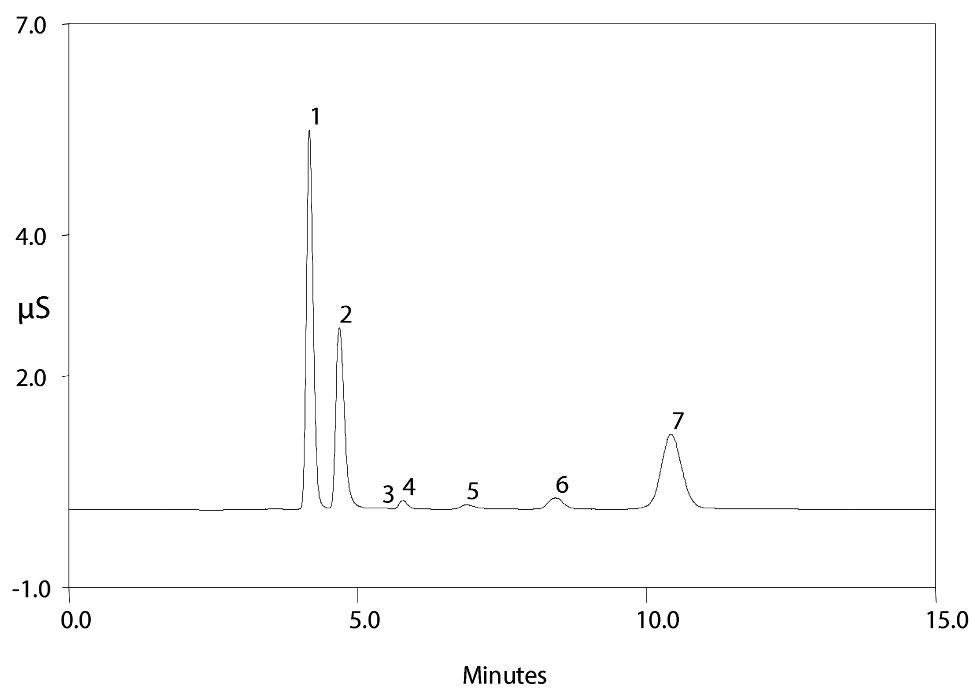


4.7.5 Dionex IonPac CS12A Analysis of 22% Phosphoric Acid

Sample:	100 µL of 22% phosphoric acid neutralized in the Dionex CERS 500
Concentrator Column:	Low Pressure Trace Cation Concentrator (i.e. Dionex TCC-XLP1, Item # 063889)
Guard Column:	Dionex IonPac CG12A Guard Column
Analytical Column:	Dionex IonPac CS12A Analytical Column
Eluent:	20 mM Methanesulfonic acid (MSA)
Eluent Flow Rate:	1.0 mL/min
Electrolytic Suppressor:	Dionex Cation Electrolytically Regenerated Suppressor, Dionex CERS 500 Recycled Eluent Mode
or Chemical Suppressor:	Dionex Cation Chemically Regenerated Suppressor, Dionex CCRS 500
Chemical Regenerant:	100 mN TBAOH
Expected Background Conductivity:	20 mM MSA: <1 µS
Expected System Operating Back Pressure:	Without Guard: 1,400 psi (9.65 MPa) With Guard: 1,850 psi (12.75 MPa)

	Analyte	Conc.. (µg/L)
1.	Sodium	509.1
2.	Ammonium	438.6
3.	Dimethylamine	B
4.	Potassium	25.8
5.	Trimethylamine	B
6.	Magnesium	22.4
7.	Calcium	144.1

Figure 13 Dionex IonPac CS12A Analysis of 22% Phosphoric Acid



5. Troubleshooting Guide

The purpose of the Troubleshooting Guide is to help you solve operating problems that may arise while using the Dionex ERS 500, Dionex ERS 500e or Dionex AERS 500 Carbonate. For more information on problems that originate with the Ion Chromatograph System or the specific exchange column set in use, refer to the Troubleshooting Guide in the appropriate Product Manual. If you cannot solve the problem on your own, contact the Thermo Fisher Scientific Regional Office nearest you.

CAUTION

Do not allow eluent to flow through the Dionex ERS 500, Dionex ERS 500e or Dionex AERS 500 Carbonate without the power turned on for more than a few minutes. Doing so will cause noticeable reduction of analyte peak areas. If this should occur, perform the procedure outlined in Section 5.2***, "Small or increasing Analyte Peak Areas."***

5.1 Electrolytically Regenerated Suppressor Operational Status Displays Alarm State

ERS or SRS Alarm:

Alarm state indicates that there is high resistance or an open circuit in the suppressor device typically in the regenerant channel or there is an issue with connectivity of the suppressor to a power supply.

High resistance or an open circuit occurs when:

1. The suppressor is not connected to the power supply or has a defective cable. In this state the only indicator from the system is a high voltage alarm. In this state no current can be applied to the suppressor.

2. The suppressor is operated with higher currents than the recommended currents.

   Refer to the current settings section to determine the correct current and lower the current.

3. The suppressor is exposed to contaminants such as iron, other metals or organics.

   Refer to the appropriate cleanup procedure and implement the recommended cleanup. In cases when the contamination is continuous, a routine cleanup step on a weekly basis is recommended as part of preventive maintenance.

NOTE

If the above problem is encountered on a routine basis particularly with samples containing high levels of metals or solvents, the chemical mode of operation is recommended. The Dionex CRS 500 is recommended for the chemical mode of operation; the Dionex ERS 500 cannot be operated in the chemical mode.

Refer to Appendix C for alarm state information on discontinued models.

5.2 Small or Increasing Analyte Peak Areas

This problem is caused by running eluent through the Dionex ERS 500, Dionex ERS 500e, or Dionex AERS 500 Carbonate with the power off while using the AutoSuppression Recycle Mode or the AutoSuppression External Water Mode. It may also be caused by application to too little current to the suppressor for an extended period of time. A regeneration protocol is needed to ensure good operation.

NOTE

The Dionex AERS 500 Carbonate suppressor has different electrical current requirements than the Dionex AERS 500 and Dionex ERS 500e, suppressors. If an AERS_Carbonate mode is not available the current applied to a Dionex AERS 500 Carbonate should be adjusted by a factor of 1.30 compared to a standard AERS 500 suppressor. Chromeleon 7.2 SR3 MUa and later versions have an option for selecting an AERS_Carbonate suppressor in the Instrument Method Wizard and Editor dialog box. Selecting this suppressor from the drop-down list will automatically apply the recommended current setting for Dionex AERS 500 Carbonate suppressors.

5.2.1 Suppressor Chemical Regeneration Steps

For fast regeneration it is recommended to follow the steps below for Chemical Regeneration of the suppressor.

A. Disconnect the eluent line from the analytical column attached to the ELUENT IN port of the Dionex ERS 500, Dionex ERS 500e or Dionex AERS 500 Carbonate at the analytical column end of the line. Direct this line to a separate waste beaker.

B. Disconnect the eluent line from the ELUENT OUT port of the suppressor.

C. For the Dionex AERS 500, Dionex AERS 500e or Dionex AERS 500 Carbonate:

   Using a plastic syringe push approximately 3 mL of 200 mN H_2SO_4 through the ELUENT OUT port and approximately 5 mL of 200 mN H_2SO_4 through the REGEN IN port. Flush with 3 mL degassed, deionized water through the ELUENT OUT port and 5 mL degassed, deionized water through the REGEN IN port.

D. For the Dionex CERS 500 or Dionex CERS 500e:

   Using a plastic syringe slowly push approximately 3 mL of freshly prepared 200 mN NaOH (made up using degassed, deionized water) through the ELUENT OUT port and approximately 5 mL of 200 mN NaOH through the REGEN IN port. Flush with 3 mL degassed, deionized water through the ELUENT OUT port and 5 mL degassed, deionized water through the REGEN IN port.

E. Reconnect the eluent line from the ELUENT IN port of the suppressor to the analytical column and the eluent line from the eluent out port of the suppressor to the conductivity detector cell.

F. If you are in the Auto Suppression Recycle mode of operation, begin pumping eluent and immediately turn on the power. DO NOT LET THE ELUENT FLOW THROUGH THE SUPPRESSOR FOR MORE THAN A FEW MINUTES WITHOUT TURNING ON THE POWER.

   If you are in the Auto Suppression External water mode of operation, establish water flow through the regenerant chambers, begin pumping eluent and immediately turn on the power. DO NOT LET THE ELUENT FLOW THROUGH THE SUPPRESSOR FOR MORE THAN A FEW MINUTES WITHOUT TURNING ON THE POWER.

5.2.2 Suppressor Electrolytic Regeneration Steps

A. The Dionex ERS 500, Dionex ERS 500e and Dionex AERS 500 Carbonate are unique that they can be regenerated electrolytically. Although this is slower than Chemical Regeneration, it does not require the suppressor to be disconnected or the use of any reagents.

B. Turn on the system with the normal application settings, if using gradient elution, set the eluent concentration to the maximum value usually seen in the gradient.

C. Set the current of the suppressor to 60% higher than the optimal current. e.g., if the optimal current is 50 mA, set the current to 80 mA. This is the maximum suppressor current reported by Chromeleon in the Instrument Program settings.

D. Leave the system running with the suppressor set to the higher current for a minimum of 3 hours, up to 6 hours.

E. Set the current back to the optimal current.

CAUTION

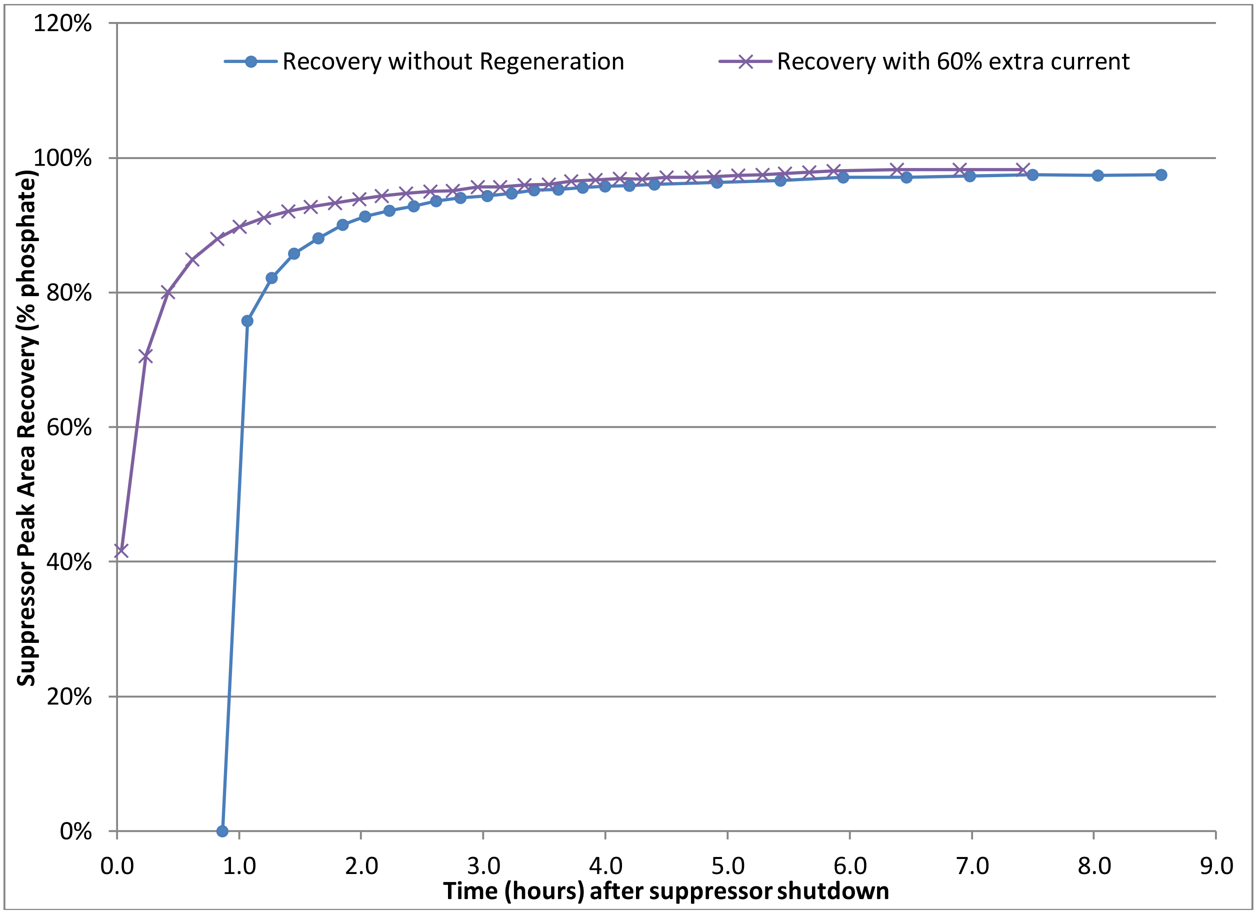
Do not exceed the maximum allowed current for a suppressor:
Dionex ERS 500 (4 mm) and Dionex ERS 500e (4 mm): 500 mA
Dionex ERS 500 (2 mm) and Dionex ERS 500e (2 mm): 100 mA
Dionex AERS 500 Carbonate (4 mm): 125 mA
Dionex AERS 500 Carbonate (2 mm): 30 mA.

5.2.3 Full or Extended Regeneration:

Depending on the extent of capacity loss of the suppressor, the regeneration procedure as outlined above may be inadequate to fully regenerate the suppressor. In order to fully regenerate the suppressor an extended rinse (for at least two hours) with 200 mN sulfuric acid (for Dionex AERS 500, Dionex AERS 500e or Dionex AERS 500 Carbonate) or 200 mN NaOH (for Dionex CERS 500 or Dionex CERS 500e) at the application flow rate is needed. Pump the acid or base (as the case may be) through the eluent out port of the suppressor, with a line connecting the eluent in port to the regen in port. Divert a line from the Regen out port to waste. A standalone pump or a trap column/suppressor clean-up kit (Item # 059659) could be used for the above regeneration. Another option is to pursue the regeneration as outlined in steps 5.2.1. C or D above and then allow the acid or base to soak in the suppressor overnight. In the morning repeat the regeneration as outlined in steps 4.2.1. C or D and then displace the acid or base with DI water.

If the correct peak areas are not observed following two injections of a standard test solution, contact the nearest Thermo Fisher Scientific Regional Office (see Thermo Fisher Scientific Worldwide Offices on the Reference Library CD-ROM).

Figure 14 Trend plot showing Increasing Peak Areas after a suppressor was operated with the power off for 40 minutes. Blue trace shows recovery without following the Regeneration steps, Purple trace show recovery during Suppressor Electrolytic Regeneration process.



NOTE

The sulfuric acid in the above steps could be replaced with a non-oxidizing strong acid such as Methanesulfonic acid (MSA) which is recommended when pursuing MS applications.

NOTE

Do not use the Analytical pump for regeneration purpose as this would contaminate the pump

5.3 High Background Conductivity

A. Check the Dionex ERS 500, Dionex ERS 500e or Dionex AERS 500 Carbonate current settings.
Refer to the suppressor current settings section.

B. Check for eluent flow out of the suppressor ELUENT OUT port.

1. If there is no flow out of the suppressor ELUENT OUT port, make sure that eluent is entering the suppressor at the ELUENT IN port. If there is no flow at this point, trace the eluent flow path backward through the system to find and remove the blockage.

2. If there is flow into the suppressor but not out, and there are no visible leaks from the rear seam of the suppressor, a break in the suppressor seal is probably allowing eluent to leak into the regenerant chambers. If this is the case, then the suppressor should be replaced. The suppressor is sealed during manufacture; attempting to open it will destroy it.

SAFETY

Do NOT attempt to disassemble the Dionex ERS 500, Dionex ERS 500e or Dionex AERS 500 Carbonate.

3. If there is flow from the ELUENT OUT port, but no eluent suppression, the membrane may have been contaminated. Try to restore system performance by cleaning the membrane (see Section 6, "Electrolytically Regenerated Suppressor Cleanup").

C. Remake the eluent to be sure that the concentration is correct. Be sure that chemicals of the required purity were used to make the eluent (see Section 3.1, "Chemical Purity Requirements"). If the eluent concentration is high, the suppressor may not be set up to suppress the high concentration resulting in high background conductivity. Refer to Tables 13–17 in Appendix A, "Matching the Current Setting to the Eluent Concentration and Flow Rate," for Dionex AERS 500, Dionex AERS 500e and Dionex AERS 500 Carbonate suppressors and the Tables 18–20 in Appendix A for the Dionex CERS 500 and Dionex CERS 500e.

D. Contact the nearest Thermo Fisher Scientific Regional Office (see, "Thermo Fisher Scientific Worldwide Offices") if you cannot solve the problem on your own.

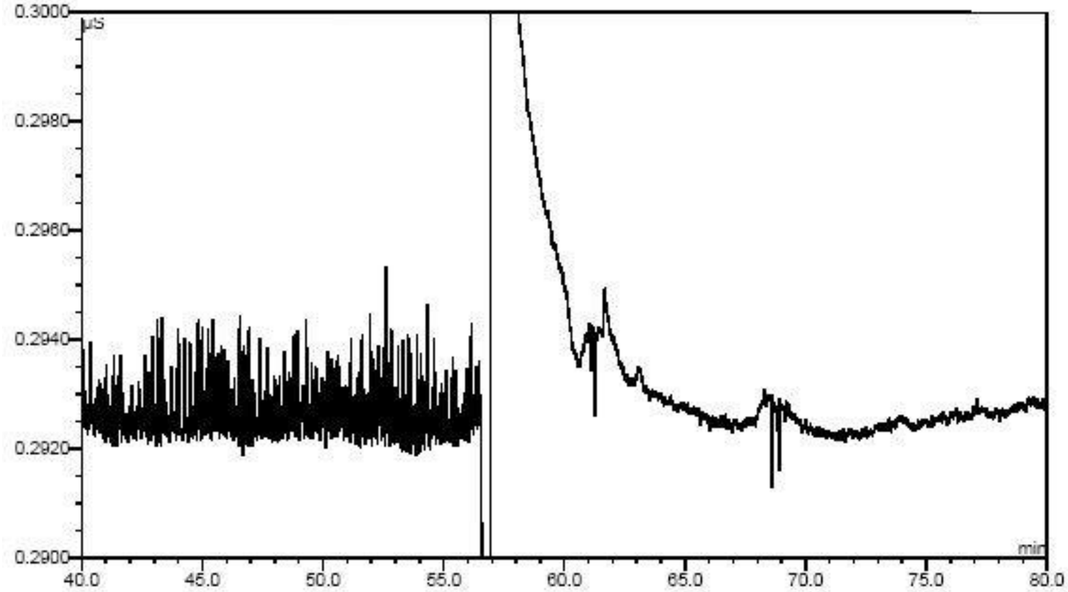
5.4 Drifting Baseline

If the baseline drifts steadily upward, increase the current setting by 5-10% to reduce the background conductivity. As the background conductivity decreases, the baseline drift should decrease.

5.5 Noisy Baseline

If the baseline is noisy (> 3 nS with hydroxide or MSA eluents, > 10 nS with borate eluents, > 7 nS with carbonate or carbonate/bicarbonate eluents and the Dionex AERS 500 or Dionex AERS 500e, > 2 nS with carbonate or carbonate/bicarbonate eluents and the Dionex AERS 500 Carbonate), it could be caused by trapped air bubbles in the cell or tubing. Burp or release the trapped bubbles by gently tapping on the cell while the fittings are slightly loosened or bleeding the tubing. Below is an example:

**Figure 19 Effect of Air Bubbles on Baseline
Dionex AERS 500 (4 mm), Recycle Eluent Mode**



In the above figure, a bubble is released from ELUENT IN line by loosening and tightening the fitting at 56.6 minutes into the run.

Noise:

~2.5 nS before

< 0.5 nS after

5.6 Decreased Sensitivity

A. Check for leaks throughout the system. If a fitting is leaking, tighten it carefully until the leak stops. Do not over tighten. If the Dionex ERS 500, Dionex ERS 500e or Dionex AERS 500 Carbonate is observed to be leaking from the center or bottom seam, see Section 5.8, “Liquid Leaks.” If you cannot cure the problem yourself, call the nearest Thermo Fisher Scientific Regional Office (see, “Thermo Fisher Scientific Regional Offices”) for assistance.

B. Ensure that the injection valve is operating correctly. Refer to the valve manuals that accompany the chromatography module for troubleshooting assistance. For slider valves, be sure to check the slider port faces for damage.

C. Pursue regeneration of the suppressor as outlined in Section 5.2

D. If sensitivity remains low, clean the suppressor membrane (see Section 6, “Dionex ERS 500, Dionex ERS 500e and Dionex AERS 500 Carbonate Suppressor Cleanup”).

E. Check the backpressure coils. Verify that they are not exceeding 40 psi in the current plumbing configuration and flow rate.

F. Replace the suppressor if cleaning the suppressor membrane does not restore sensitivity.

G. Contact the nearest Thermo Fisher Scientific Regional Office (see, “Thermo Fisher Scientific Worldwide Offices”) if you cannot solve the problem on your own.

5.7 System Back Pressure Increases Over Time

If the increased back pressure does not affect system performance, no maintenance is necessary.

A. Check the inlet frits on the guard and analytical column and replace them if necessary. The most common cause of increasing system back pressure is a contaminated frit in the analytical or guard column inlet end fitting. The complete instructions for replacing column bed support assemblies are in Document No. 032285. Recheck the system back pressure. If it remains high, go on to the next step.

B. Check the backpressure coils. If removing the backpressure coils lowers the pressure by more than 40 psi, replace the coils or remove the blockage causing the increased pressure. Backpressure over 450 psi after the suppressor can cause irreversible damage.

C. Find and eliminate any system blockage. Bypass the Dionex ERS 500, Dionex ERS 500e or Dionex AERS 500 Carbonate by coupling the lines attached to the ELUENT IN and ELUENT OUT ports. If the back pressure decreases by less than 150 psi with the suppressor out of line, a blockage in the system rather than in the suppressor is causing the high pressure.

D. Remove a blockage from the suppressor by reversing the eluent flow. If the back pressure decreases by more than 150 psi with the suppressor out of line, the high pressure may be caused by a blockage in the suppressor. Reverse the direction of flow of both the eluent and the external water through the suppressor. After the pressure drops, allow eluent, or eluent and regenerant, to flow to waste for several minutes after the pressure drops. Perform step A of Section 3.2, “Startup” and reinstall the suppressor in the appropriate configuration.

E. Clean the suppressor membranes if reversing the flow through the suppressor does not decrease the pressure. (See Section 6, "Dionex ERS 500, Dionex ERS 500e and Dionex AERS 500 Carbonate Suppressor Cleanup").

F. Replace the suppressor if cleaning the suppressor membrane does not reduce the pressure.

G. Contact the nearest Thermo Fisher Scientific Regional Office (see, "Thermo Fisher Scientific Regional Offices") if you cannot solve the problem on your own.

5.8 Liquid Leaks

A. If there is leakage from the side seam of the Dionex ERS 500, Dionex ERS 500e or Dionex AERS 500 Carbonate, check for leakage from one of the four ports of the Dionex ERS 500 into the housing and check the back pressure after the suppressor.

B. If there is liquid coming out of any of the four ports of the Dionex ERS 500, Dionex ERS 500e or Dionex AERS 500 Carbonate, carefully tighten the fittings in the leaking port – the fittings do not need to be more than ¼-turn past finger tight. If tightening the fittings does not stop the leak, replace the ferrules and bolts on the tubing.

C. If the system back pressure is greater than 450 psi, the leaks are likely caused by excessive back pressure downstream from the suppressor. Find and eliminate the source of the pressure. The suppressor will usually recover from momentary overpressure conditions if allowed to stand approximately 20 minutes with the membranes fully hydrated. See the Caution Note in Section 3.2, "Start-Up" If the suppressor continues to leak when operated within the proper back pressure range, it must be replaced.

5.9 Poor or unstable recovery of certain peaks.

If one or two peaks are experiencing poor or unstable recoveries while the other peaks are stable, it could be that the current to the suppressor is set too high. Recalculate the correct current setting (see Section 2.6, or use the "signal parameters" tool in Chromeleon). Do not exceed the recommended current setting unless necessary to stabilize a drifting baseline.

Alternatively the system may be contaminated with a transition metal that is binding to the analyte of interest (See Section 6.1, "Metal Contaminants or Precipitates").

5.10 Peaks and spikes in the absence of an injection

A. Excessive current applied to the suppressor: Recalculate the optimum current and apply; never apply more than 10% above the optimum current except when executing the Electrolytic Regeneration Steps. When operating with gradient eluents, apply the minimum current setting for the maximum eluent concentration at the eluent flow rate. *During a low flow method (stand-by mode), ensure that the current is lowered to the optimal value based on the reduced flow rate and/or eluent concentration.*

B. Precipitation on the suppressor membrane or screens (calcium, magnesium and other metals): Follow the Metal Contaminants or Precipitates procedure from Section 6.1. To prevent contaminants from reaching the suppressor, a CP1 cation polisher column (Item # 064930) can be used during anion analysis to strip cationic contaminants from the sample. Refer to the CP1 Operator's Manual for detailed instructions.

C. Outgassing or trapped bubbles in the suppressor regenerant chambers: Ensure that the external water (if used) is degassed before use; do not pressurize the external water with air, use nitrogen or helium. Eliminate causes of excessive backpressure between the cell outlet and the regenerant inlet if recycled eluent mode is used.

D. Excess suppressor temperature: Ensure liquid entering the suppressor is at or less than 35°C. Ensure the suppressor is operated in an environment that does not exceed 35°C during operation. Refer to Section 3.3.3 Installation in thermal chamber. 20°C is the optimum temperature for Dionex ERS 500, Dionex ERS 500e or Dionex AERS 500 Carbonate operation.

E. Large changes to the flow rate or applied current of the suppressor: When changing eluent concentration or flow rate, recalculate the optimum current using the attached calculator; do not allow the suppressor to operate for more than 5 minutes with excessive or insufficient current. If the current is changed, allow the suppressor a few hours to reestablish baseline stability. Ensure that shut-down, stand-by and start-up methods are applying the correct suppressor current.

F. Operating the suppressor with power but no eluent or regenerant flow: Operation of the suppressor without flow may irreversibly damage the suppressor, depending on amount of applied current and duration. Ensure that the regenerant lines are connected and flow is established when powering on the suppressor at all times. Ensure that during external water operation that the suppressor is never operated without regenerant flow. When operating properly, bubbles interspersed with liquid exiting the regenerant chamber indicates good flow. Replace the suppressor if operation without flow is known to have occurred. Confirm that the minimum pressure limit on the pump is set to a non-zero value to ensure that the system turns off in the event of a leak.

G. Incorrect current setting during shutdown, stand-by or startup method: Shut-down methods should shut the pump flow off at the same time as the suppressor current. Stand-by methods should reset the suppressor current to the optimum level for the reduced flow rate and/or concentration. Do not reduce the flow rate on RFIC-EG systems; this will lower the backpressure on the degasser below 2,000 psi and cause out-gassing. Stand-by methods for RFIC-EG systems should reduce eluent concentration to preserve Dionex EGC ion count; reset the suppressor current accordingly. Do not turn the Dionex EGC concentration to zero with flow; use a low setting. Consider using the smart-shutdown and smart-startup feature of Chromeleon instead of standby conditions and configure the system for smart-startup two hours before use is anticipated so the system is equilibrated and ready to run. Consider using RFIC-ER; no shut-down, stand-by or start-up procedure is needed with an Always On, Always Ready system. Start-up settings should turn on the pump flow and suppressor current simultaneously.

5.11 Low Sample Response (Neutralization Mode Only)

A. If the Dionex ERS 500e is observed to be leaking, see Section 5.8. "Liquid Leaks."

B. Ensure the Sample Injection Valve and Recycle Valve are operating correctly. Refer to the valve manuals that accompany the valves. Be sure to check the port faces for damage.

C. If the neutralization requires excessive recycling, clean the suppressor membranes (see Section 6, Dionex ERS 500, Dionex ERS 500e and Dionex AERS 500 Carbonate Cleanup).

D. If cleaning the suppressor membranes does not restore neutralization efficiency, the suppressor may need to be replaced.

E. If you cannot solve the problem on your own, contact the Thermo Scientific Regional Office nearest you.

5.12 Low Neutralization Capacity (Neutralization Mode Only)

For the Dionex AERS 500e this problem is caused when the ion exchange sites in the suppressor are converted from the hydronium form to the salt form. They must be converted back to the hydronium form for efficient operation.

For the Dionex CERS 500e this problem is caused when the ion exchange sites in the suppressor are converted from the hydroxide form to a salt form. They must be converted back to the hydroxide form for efficient operation.

Pursue regeneration of the suppressor as outlined in Section 5.2. If capacity remains low, clean the suppressor membrane (see Section 6, “Dionex ERS 500, Dionex ERS 500e and Dionex AERS 500 Carbonate Suppressor Cleanup”).

6. Dionex ERS 500, Dionex ERS 500e and Dionex AERS 500 Carbonate Suppressor Cleanup

This section describes routine cleanup procedures for the Dionex Electrolytically Regenerated Suppressors (Dionex ERS 500, Dionex ERS 500e or Dionex AERS 500 Carbonate) in the case of contamination. Consult the Troubleshooting Guide (see Section 5, "Troubleshooting Guide") to first determine that the system is operating properly. If the suppressor is determined to be the source of higher than normal back pressure, higher than anticipated conductivity, decreased suppression capacity or decreased sensitivity, cleaning the membrane may restore the performance of the system. Use the following procedures to clean the membrane.

6.1 Metal Contaminants or Precipitates

NOTE

The suppressor voltage is a good indicator of the resistance across the suppressor. Higher resistance may indicate contamination of the suppressor. For more information regarding monitoring the voltage, see Document No. 031841-02 "Removal of Iron Contamination from Electrolytic Suppressors."

A. Turn off the Dionex ERS or Dionex SRS Control unit and system pump.

B. Disconnect the analytical (and guard) column(s) from the injection valve and the suppressor. Refer to the specific analytical column Product Manual for column cleanup procedures.

C. If you are running in the AutoSuppression External Water Mode, turn off the external water and disconnect the external water line from the suppressor REGEN IN port.

D. Disconnect the liquid line from the suppressor ELUENT OUT port to the cell at the cell fitting and reconnect it to the REGEN IN port.

E. If iron is present then connect a temporary line from the priming block or the low-pressure tee on the isocratic or gradient pump to a container with a solution of 0.2 M oxalic acid. For 4 mm systems pump this solution through the suppressor at 1 – 2 mL/min for 30 minutes. For 2 mm systems pump this solution through the suppressor at 0.25–0.50 mL/min for 30 minutes. Proceed to step G.

F. If iron is not present then proceed to step G.

NOTE

Bypassing internal pump manifolds when temporarily pumping high concentration cleaning solutions significantly reduces the time required to re-equilibrate the system to low concentration eluents.

G. Pursue an extended regeneration as outlined in Section 5.2.3

H. Reinstall the analytical (and guard) column(s). Begin pumping eluent through the system at the flow rate required for your analysis and equilibrate the system and resume normal operation.

NOTE

Chromeleon 6.5 and later includes a feature to Trend various parameters. Trend plotting the suppressor voltage will reveal if there is a build-up of metal contaminants or precipitates in the suppressor. A slow but steady increase in voltage indicates such a contamination build-up

6.2 Organic Contaminants

A. Turn off the ERS Control or SRS Control unit and system pump.

B. Disconnect the analytical (and guard) column(s) from the injection valve and the Dionex ERS 500, Dionex ERS 500e or Dionex AERS 500 Carbonate. Refer to the specific analytical column Product Manual for column cleanup procedures.

C. If you are running in the AutoSuppression External Water Mode, turn off the external water and disconnect the external water line from the suppressor REGEN IN port.

D. Disconnect the liquid line from the suppressor ELUENT OUT port to the cell at the cell fitting and reconnect it to the REGEN IN port.

E. Connect a temporary line from the priming block or the low-pressure tee on the isocratic or gradient pump to a container with a solution of freshly prepared 10% 1.0 N methane sulfonic acid or sulfuric acid and 90% acetonitrile or methanol. Acid/acetonitrile solutions are not stable during long term storage so this cleanup solution must be made immediately before each column cleanup. Alternatively, it can be proportioned from 1 bottle containing 1.0 N acid and another bottle containing 100% acetonitrile. For 4 mm systems pump this solution through the suppressor at 1 – 2 mL/min for 30 minutes. For 2 mm systems, pump this solution through the suppressor at 0.25–0.50 mL/min for 30 minutes.

NOTE

Bypassing internal pump manifolds when temporarily pumping high concentration cleaning solutions significantly reduces the time required to re-equilibrate the system to low concentration eluents.

F. Flush the suppressor with deionized water for 10 minutes.

G. Reinstall the analytical (and guard) column(s). Begin pumping eluent through the system at the flow rate required for your analysis and equilibrate the system and resume normal operation.

Appendix A – Current Settings

A.1. Optimum Current Settings for Common Eluents; Dionex AERS 500 (4 and 2 mm) and Dionex AERS 500e (4 and 2 mm)

The Dionex Anion Electrolytically Regenerated Suppressor (Dionex AERS 500 and Dionex ERS 500e) uses water as the regenerant and has the ability to provide continuous suppression. Table 13 and Table 17 list the eluent concentrations and flow rates of commonly used mobile phases used in anion separations and the optimum / recommended current level to suppress the eluent. The operation of the Dionex AERS 500 and Dionex ERS 500e requires a constant flow of water over the electrodes in a direction that is countercurrent to the flow of the eluent.

In the AutoSuppression Recycle Mode, the eluent leaving the conductivity cell is recycled through the regenerant chambers as the water supply. This eliminates the need for an external regenerant water supply and delivery system. When the Dionex AERS 500 is operating in this mode, the amount of water flowing through the regenerant chambers is limited to the eluent flow rate. The AutoSuppression Recycle Mode cannot be used with eluents containing any organic solvents.

The AutoSuppression External Water Mode requires an external source of deionized water for the regenerant chambers. When the Dionex AERS 500e is operating in this mode, the amount of water flowing through the regenerant chambers is independent of the eluent flow rate. Because of this, higher regenerant flow rates are achievable, see Table 15. The AutoSuppression External Water Mode is the mode used if organic solvents (up to 40%) are present in the eluent. It eliminates the potential for buildup of contaminating ions resulting from the oxidation of solvents.

Table 13 Optimum Current Settings for the Dionex AERS 500 and Dionex ERS 500e in the AutoSuppression Recycle and External Water Modes

Column	Eluent	Eluent Flow Rate (mL/min)		Optimum Current (mA)	
		(2 mm)	(4 mm)	(2 mm)	(4 mm)
AS4A-SC	1.8 mM CO_3^{2-} / 1.7 mM HCO_3^-	0.5	2.0	7	27
AS9-HC	9.0 mM CO_3^{2-}	0.25	1.0	12	45
AS12A	2.7 mM CO_3^{2-} / 0.3 mM HCO_3^-	0.38	1.5	6	22
AS14	3.5 mM CO_3^{2-} / 1.0 mM HCO_3^-	0.3	1.2	6	24
AS14A	8.0 mM CO_3^{2-} / 1.0 mM HCO_3^-	0.5(1)	1.0	21	42
AS22	4.5 mM CO_3^{2-} / 1.4 mM HCO_3^-	0.3	1.2	8	31
AS23	4.5 mM CO_3^{2-} / 0.8 mM HCO_3^-	0.25	1.0	7	25
AS10	80 mM OH^-	0.25	1.0	50	198
AS11	12 mM OH^-	0.25	1.0	8	30
	38.3 mM OH^-	0.5	2.0	48	190
AS11-HC	30 mM OH^-	0.38	1.5	29	112
	60 mM OH^-	0.38	1.5	57	223
AS15	38 mM OH^-	0.3	1.2	29	113
	40 mM OH^-	0.5(1)		50	
AS16	35 mM OH^-	0.25	1.0	22	87
	55 mM OH^-	0.38	1.5	52	204
AS17-C	15 mM OH^-	0.25	1.0	10	38
	40 mM OH^-	0.5	2.0	50	198
AS18	23 mM OH^-	0.25	1.0	15	57
	39 mM OH^-	0.25	1.0	25	97
AS19	20 mM OH^-	0.25	1.0	13	50
	45 mM OH^-	0.25	1.0	28	112
AS20	35 mM OH^-	0.25	1.0	22	87
	55 mM OH^-	0.25	1.0	34	136
AS21	15 mM OH^-	0.35		13	
AS24	55 mM OH^-	0.30		41	
AS25	36 mM OH^-	0.25	1.0	23	92
AS26	55 mM OH^-	0.30	1.2	41	164

(1) 3 mm format

The Dionex AERS 500 and Dionex AERS 500e can be used with legacy systems that only provide discrete (50, 100, 300 and 500 mA) current settings, see **Error! Reference source not ound.** and **Error! Reference source not found.**; note that some compromise in performance and product life-expectancy may be observed. For optimum performance it is recommended to use a Dionex RFC-10 or Dionex RFC-30 power supply to provide fine current control with the optimum setting.

Table 14 Recommended Current Settings for the Dionex AERS 500 and Dionex AERS 500e in the AutoSuppression Recycle and External Water Modes with legacy discrete power supplies

Column	Eluent	Eluent Flow Rate (mL/min)		Recommended Current (mA)	
		(2 mm)	(4 mm)	(2 mm)	(4 mm)
AS4A-SC	1.8 mM CO_3^{2-} / 1.7 mM HCO_3^-	0.5	2.0	50	50
AS9-HC	9.0 mM CO_3^{2-}	0.25	1.0	50	50
AS12A	2.7 mM CO_3^{2-} / 0.3 mM HCO_3^-	0.38	1.5	50	50
AS14	3.5 mM CO_3^{2-} / 1.0 mM HCO_3^-	0.3	1.2	50	50
AS14A	8.0 mM CO_3^{2-} / 1.0 mM HCO_3^-	0.5[1]	1.0	50	50
AS22	4.5 mM CO_3^{2-} / 1.4 mM HCO_3^-	0.3	1.2	50	50
AS23	4.5 mM CO_3^{2-} / 0.8 mM HCO_3^-	0.25	1.0	50	50
AS10	80 mM OH^-	0.25	1.0	50	300
AS11	12 mM OH^-	0.25	1.0	50	50
	38.3 mM OH^-	0.5	2.0	50	300
AS11-HC	30 mM OH^-	0.38	1.5	50	300
	60 mM OH^-	0.38	1.5	100	300
AS15	38 mM OH^-	0.3	1.2	50	300
	40 mM OH^-	0.5[1]		50	
AS16	35 mM OH^-	0.25	1.0	50	100
	55 mM OH^-	0.38	1.5	100	300
AS17-C	15 mM OH^-	0.25	1.0	50	50
	40 mM OH^-	0.5	2.0	50	300
AS18	23 mM OH^-	0.25	1.0	50	100
	39 mM OH^-	0.25	1.0	50	100
AS19	20 mM OH^-	0.25	1.0	50	50
	45 mM OH^-	0.25	1.0	50	300
AS20	35 mM OH^-	0.25	1.0	50	100
	55 mM OH^-	0.25	1.0	50	300
AS21	15 mM OH^-	0.35		50	
AS24	55 mM OH^-	0.30		50	
AS25	36 mM OH^-	0.25	1.0	50	100
AS26	55 mM OH^-	0.30	1.2	50	300

[1] 3 mm format

Table 15 External Water Flow Rates for Dionex AERS 500 and Dionex AERS 500e (4 and 2 mm)

Dionex AERS 500 Format	Regenerant Flow Rate (mL/min)[1]
Dionex AERS 500 (4 mm)	1 – 5 mL/min equal to the eluent flow rate recommended
Dionex AERS 500 (2 mm)	0.25 – 2 mL/min equal to the eluent flow rate recommended
Dionex AERS 500e (4 mm)	2 – 10 mL/min equal to 2x eluent flow rate recommended
Dionex AERS 500e (2 mm)	0.5 – 4 mL/min equal to 2x eluent flow rate recommended

[1] Measured with power ON using a graduated cylinder

Refer to Section A.3, of this manual for recommended Current Switch settings required for the chromatographic conditions required in the specific application being performed.

A.2. Optimum Current Settings for Common Eluents; Dionex AERS 500 Carbonate (4 and 2 mm)

The Dionex Anion Electrolytically Regenerated Suppressor for Carbonate Eluents (Dionex AERS 500 Carbonate) uses water as the regenerant and has the ability to provide continuous suppression. Table 13 to Table 17 list the eluent concentrations and flow rates of commonly used mobile phases used in anion separations and the optimum / recommended current level to suppress the eluent. The operation of the Dionex AERS 500 Carbonate requires a constant flow of water over the electrodes in a direction that is countercurrent to the flow of the eluent.

In the AutoSuppression Recycle Mode, the eluent leaving the conductivity cell is recycled through the regenerant chambers as the water supply. This eliminates the need for an external regenerant water supply and delivery system. When the Dionex AERS 500 Carbonate is operating in this mode, the amount of water flowing through the regenerant chambers is limited to the eluent flow rate. The AutoSuppression Recycle Mode cannot be used with eluents containing any organic solvents.

The AutoSuppression External Water Mode requires an external source of deionized water for the regenerant chambers. When the Dionex AERS 500 Carbonate is operating in this mode, the amount of water flowing through the regenerant chambers is independent of the eluent flow rate. Because of this, higher regenerant flow rates are achievable, see Table 17. The AutoSuppression External Water Mode is the mode used if organic solvents (up to 40%) are present in the eluent. It eliminates the potential for buildup of contaminating ions resulting from the oxidation of solvents.

Table 16 Optimum Current Settings for the Dionex AERS 500 Carbonate in the AutoSuppression Recycle and External Water Modes

Column	Eluent	Eluent Flow Rate (mL/min)		Optimum Current (mA)	
		(2 mm)	(4 mm)	(2 mm)	(4 mm)
AS4A-SC	1.8 mM CO_3^{2-} / 1.7 mM HCO_3^-	0.5	2.0	9	34
AS9-HC	9.0 mM CO_3^{2-}	0.25	1.0	15	58
AS12A	2.7 mM CO_3^{2-} / 0.3 mM HCO_3^-	0.38	1.5	7	28
AS14	3.5 mM CO_3^{2-} / 1.0 mM HCO_3^-	0.3	1.2	8	31
AS14A	8.0 mM CO_3^{2-} / 1.0 mM HCO_3^-	0.5(1)	1.0	28	55
AS22	4.5 mM CO_3^{2-} / 1.4 mM HCO_3^-	0.3	1.2	11	41
AS22-Fast	4.5 mM CO_3^{2-} / 1.4 mM HCO_3^-	0.5	2.0	17	67
AS23	4.5 mM CO_3^{2-} / 0.8 mM HCO_3^-	0.25	1.0	8	32

(1) 3 mm format

The Dionex AERS 500 cannot be used with legacy systems that only provide discrete (50, 100, 300 and 500 mA) current settings.

Table 17 External Water Flow Rates for Dionex AERS 500 Carbonate (4 and 2 mm)

Dionex AERS 300 Format	Regenerant Flow Rate (mL/min)(1)
4 mm	3 – 5 mL/min; at least 2x the eluent flow rate
2 mm	1 – 2 mL/min; at least 2x the eluent flow rate

(1) Measured with power ON using a graduated cylinder

A.3. Optimum Current Settings for Common Eluents; Dionex CERS 500 (4 mm and 2 mm) and Dionex CERS 500e (4 mm and 2 mm)

The Dionex Cation Electrolytically Regenerated Suppressor (Dionex CERS 500 and Dionex CERS 500e) uses water as the regenerant and has the ability to provide continuous suppression. Table 18 - 20 list the eluent concentrations and flow rates of commonly used mobile phases used in cation separations and the optimum / recommended current level to suppress the eluent. The operation of the Dionex CERS 500 and Dionex CERS 500e requires a constant flow of water over the electrodes in a direction that is countercurrent to the flow of the eluent.

In the AutoSuppression Recycle Mode, the eluent leaving the conductivity cell is recycled through the regenerant chambers as the water supply. This eliminates the need for an external regenerant water supply and delivery system. When the Dionex CERS 500 is operating in this mode, the amount of water flowing through the regenerant chambers is limited to the eluent flow rate. The AutoSuppression Recycle Mode cannot be used with eluents containing any organic solvents.

The AutoSuppression External Water Mode requires an external source of deionized water for the regenerant chambers. When the Dionex CERS 500 is operating in this mode, the amount of water flowing through the regenerant chambers is independent of the eluent flow rate. Because of this, higher regenerant flow rates are achievable, see Table 20. Higher regenerant flow rates translate in improved signal-to-noise ratios compared to the AutoSuppression Recycle Mode. The AutoSuppression External Water Mode is the mode used if organic solvents (up to 40%) are present in the eluent. It eliminates the potential for buildup of contaminating ions resulting from the oxidation of solvents.

Table 18 Optimum Current Settings for the Dionex CERS 500 and Dionex CERS 500e in the AutoSuppression Recycle and External Water Modes

Column	Eluent	Eluent Flow Rate (mL/min) (4 mm)	(2 mm)	Optimum Current (mA) (2 mm)	(4 mm)
CS12A	20 mM MSA	0.25	1.0	15	59
	33 mM MSA	0.25	1.0	25	98
CS12A-5µm	20 mM MSA	0.5[1]		30	
	33 mM MSA	0.5[1]		49	
CS14	10 mM MSA	0.25	1.0	8	30
CS15	10 mM H_2SO_4/9% AcN[2]	0.3	1.2	18	71
	14 mM H_2SO_4	0.3	1.2	25	99
CS16	30 mM MSA	0.36[1]	1.0[3]	32	89
	48 mM MSA	0.36[1]	1.0[3]	51	142
CS17	6 mM MSA	0.25	1.0	5	18
	40 mM MSA	0.25	1.0	30	118
CS18	5 mM MSA	0.25		4	
CS19	8 mM MSA	0.25	1.0	6	24
	60 mM	0.3	1.2	53	212

(1) 3 mm format
(2) Compatible with External Water Mode only
(3) 5 mm format

The Dionex CERS 500 and Dionex CERS 500e can be used with legacy systems that only provide discrete (50, 100, 300 and 500 mA) current settings, see **Error! Reference source not ound.** and **Error! Reference source not found.** note that some compromise in performance may be observed. For optimum performance it is recommended to use a Dionex RFC-10 or Dionex RFC-30 power supply to provide graduated current control with the optimum setting.

Table 19 Recommended Current Settings for the Dionex CERS 500 and Dionex CERS 500e in the AutoSuppression Recycle and External Water Modes with legacy discrete power supplies

Column	Eluent	Eluent Flow Rate (mL/min)		Recommended Current (mA)	
		(2 mm)	(4 mm)	(2 mm)	(4 mm)
CS12A	20 mM MSA	0.25	1.0	50	100
	33 mM MSA	0.25	1.0	50	100
CS12A-5µm	20 mM MSA	0.5[1]		50	
	33 mM MSA	0.5[1]		50	
CS14	10 mM MSA	0.25	1.0	50	50
CS15	10 mM H_2SO_4/9% AcN[2]	0.3	1.2	50	100
	14 mM H_2SO_4	0.3	1.2	50	100
CS16	30 mM MSA	0.36[1]	1.0[3]	50	100
	48 mM MSA	0.36[1]	1.0[3]	100	300
CS17	6 mM MSA	0.25	1.0	50	50
	40 mM MSA	0.25	1.0	50	300
CS18	5 mM MSA	0.25		50	
CS19	8 mM MSA	0.25	1.0	50	50
	60 mM	0.3	1.2	100	300

(1) 3 mm format
(2) Compatible with External Water Mode only
(3) 5 mm format

Table 20 External Water Flow Rates for Dionex CERS 500 and Dionex CERS 500e (4 mm and 2 mm)

Dionex CERS 500 Format	Regenerant Flow Rate (mL/min)[1]
Dionex CERS 500 (4 mm)	1 – 5 mL/min equal to the eluent flow rate
Dionex CERS 500 (2 mm)	0.25 – 2 mL/min equal to the eluent flow rate
Dionex CERS 500e (4 mm)	2 – 10 mL/min equal to 2x eluent flow rate
Dionex CERS 500e (2 mm)	0.5 – 4 mL/min equal to 2x eluent flow rate

(1) Measured with power ON using a graduated cylinder

A.2 Current Settings for Older Detectors

On CD20 and ED40 detectors in Dionex DX-500 instruments, the correct current is set by navigating to the SRS field in the "Main" menu and using the "Select" keys to change the setting. The readout is the approximate current level.

NOTE

For optimal performance Dionex recommends the use of a Dionex RFC-10 or Dionex RFC-30 power supply.

Appendix B – Suppressor Controller

B.1 Dionex ERS 500 and Dionex ERS 500e Control for the CD20/CD25/CD25A and ED40/ED50/ED50A (Dionex DX-500 instruments)

Dionex ERS 500 and Dionex ERS 500e control for these instruments is accessible from the detector front panel or Chromeleon software. For information on operation from Chromeleon, please see the Help file in the Run or Method files.

NOTE

If using the ED40, first select Conductivity Mode from the Main Screen.

NOTE

There will not be an "ERS" setting on older instruments, use the SRS setting. The Dionex ERS 500 and Dionex ERS 500e are fully backwards compatible with all SRS power adapters and settings.

To operate the Dionex ERS 500 or Dionex ERS 500e from the front panel of these detectors:

A. Make sure the detector is in one of the main conductivity screens by choosing "Main Screen" or "Detail Screen." Press the "Menu" button until you see this as an option. Press the appropriate number.

B. Make sure you are in the "Local" mode. If you are in the "Remote" mode use the arrow keys to select "Local" and press "Enter."

C. In the "Main" or "Detail" screens, navigate, using the arrow keys, to the field labeled "SRS." Set the current output level. Increase or decrease the levels by using the select keys. These are labeled 50, 100, 300 and 500 mA. Remember to hit "Enter" after choosing a setting.

1. Dionex ERS 500 Control Connections for the CD20/ED40 (Dionex DX-500 instruments):
   For these instruments, connect one end of the ERS control cable to slot 2, plug J3 behind the instrument front panel. Route the cable through the chase beneath the electronics to the back. Route the female ERS plug end to the chromatography module that you are using. Place the cable close to the ERS and attach.

2. Dionex ERS 500 Line Voltage for the CD20/ED40 (DX-500 instruments):
   These detectors have automatic switching power supplies to adjust to the line voltage. No user settings are required.

3. ERS Power Control for The CD20/ED40 (DX-500 instruments): The CD20 and ED40 are controlled from the instrument front panel on DX-500 instruments. Navigate to the SRS field and use the "Select" keys to scroll the current settings to "Off." Press "Enter."

CAUTION

As a general operating precaution, never apply current to the suppressor without eluent or water regenerant flowing through the suppressor at the same time. Always apply current whenever eluent is running through the suppressor.

B.1.1 Dionex ERS 500 Control for the Dionex DX-120

The Dionex ERS 500, Dionex ERS 500e and Dionex ERS 500 Carbonate are not compatible with the Thermo Scientific Dionex DX-120 instrument. Suppressor control for this instrument is only available via the use of a Dionex RFC-10 or Dionex RFC-30 suppressor controller.

NOTE

Dionex recommends the use of a Dionex RFC-10 or Dionex RFC-30 power supply for the Dionex DX-120 instrument.

B.1.2 ERS Control for the CDM-3/PED-2 (Dionex DX-300 Instruments)

The Dionex ERS 500, Dionex ERS 500e and Dionex ERS 500 Carbonate are not compatible with the Thermo Scientific Dionex DX-300 instrument. Suppressor control for this instrument is only available via the use of a Dionex RFC-10 or Dionex RFC-30 suppressor controller.

NOTE

Dionex recommends the use of a Dionex RFC-10 or Dionex RFC-30 power supply for the Dionex DX-300 instrument.

B.1.3 ERS Control for the Dionex DX-100 (Model DX 1-03)

The Dionex ERS 500, Dionex ERS 500e and Dionex ERS 500 Carbonate are not compatible with the Thermo Scientific Dionex DX-100 instrument. Suppressor control for this instrument is only available via the use of a Dionex RFC-10 or Dionex RFC-30 suppressor controller.

NOTE

Dionex recommends the use of a Dionex RFC-10 or Dionex RFC-30 power supply for the Dionex DX-100 instrument.

B.1.4 SRC Controller

NOTE

Thermo Scientific Dionex recommends the Dionex RFC-10 (Item # 060335) for standalone control of the Dionex ERS 500, Dionex ERS 500e or Dionex ERS 500 Carbonate in older systems. The Dionex RFC-10 provides current at 1 mA intervals for exact current control.

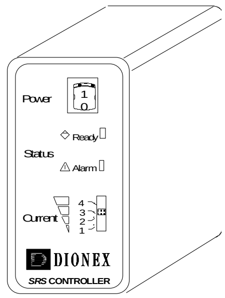
This unit is intended to provide power and control to one Dionex ERS 500 or Dionex ERS 500e when the associated detector does not have ERS control integrated into it.

The SRC-1 Power switch toggles On or Off AC line current to the SRC-1. Current is supplied to the Dionex ERS 500 only as long as the SRC-1 is powered on.

NOTE

The Dionex ERS 500 Carbonate is not compatible with the SRC Controller.

Figure B4 SRC-1 ERS Control



NOTE

There is no "ERS" setting on the Dionex SRC-1, use the SRS setting. The Dionex ERS 500 and Dionex ERS 500e are fully backwards compatible with all SRS power adapters and settings. For optimal performance a Dionex SCC-10 suppressor current controller should be used in conjunction with the Dionex SRC-1 controller to provide a current output of twelve settings.

The control and display panel of the Dionex SRC-1 is located on the front of that module's cabinet.

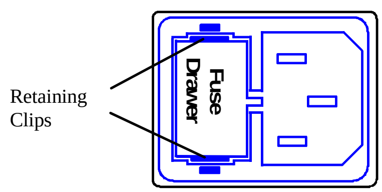
A. SRC-1 Controller Connections
For the Dionex SRC-1 Controller, connect the Dionex SRC-1 six-foot output cable directly to the Dionex ERS 500 current input connector.

B. SRC-1 Line Voltage
The 2-position rotary switch located on the back of the Dionex SRC-1 allows the selection of either 110 V or 220 V input line voltage. It can be adjusted with a large flat-bladed screwdriver or a small coin. The unit is not frequency sensitive and will work equally well on 50 or 60 Hz without adjustment. Each position accepts a wide range of input line voltages.

1. Use the 110 V position for all input line voltages between 85 V ac and 135 V ac.
2. Use the 220 V position for all input line voltages between 175 V ac and 265 V ac.

C. SRC-1 Power Control
The control and display panel on the Dionex SRC-1 is located on the front of that module's cabinet LED indicators inform the operator of the system's operational status.
The Dionex SRC-1 has its own AC Power On/Off switch to toggle the AC line current to the Dionex SRC-1 on and off (see Figure B4, "SRC-1 ERS Control"). This is the only way to turn the current output to the Dionex ERS 500 on and off on the Dionex SRC-1.
Two line input fuses are located in the fuse drawer on the socket of the AC input connector on the back panel of the Dionex SRC-1.

Figure B5 The SRC-1 Fuse Holder



To replace fuses, first remove the AC line cord, and then remove the fuse drawer by squeezing the retaining clips located at the right and left of the drawer. Pull the drawer outward to replace both fuses. Spare fuses are found in the shipping kit. The fuses are 5 X 20 mm, 0.315A/250V, low breaking capty FSF type (Item # 954747).

CAUTION

As a general operating precaution, never apply current to the suppressor without eluent or water regenerant flowing through the suppressor at the same time. Always apply current whenever eluent is running through the suppressor.

Appendix C – Alarm States for Older Instruments

C.1 Alarm States for the CD20/ED40 (Dionex DX-500 Instruments)

When using these detectors, the power setting will be shown on the screen when the suppressor is on. The suppressor cable must be connected to the controller and conductive liquid must be flowing to prevent an alarm state.

When the ERS Control unit is in shutdown mode after detecting a malfunction in the system, an alarm message "SRS Alarm" will flash on the screen. To determine the cause, press "Menu" proceed to the "Diagnostic Menu" and press "Analog Status." On the left side of the screen, two fields give the ERS status as shown below:

SRS CONNECTED: Y (or N)

This indicates that the suppressor is connected. If it shows "N" connect the ERS cable.

SRS OVER VOLT: N (or Y)

This indicates whether the suppressor has a voltage higher than it can support (7.5 to 8 V). Try lowering the power setting on the front panel. Also, see Section C.1.2, "The Alarm Red LED" for other causes.