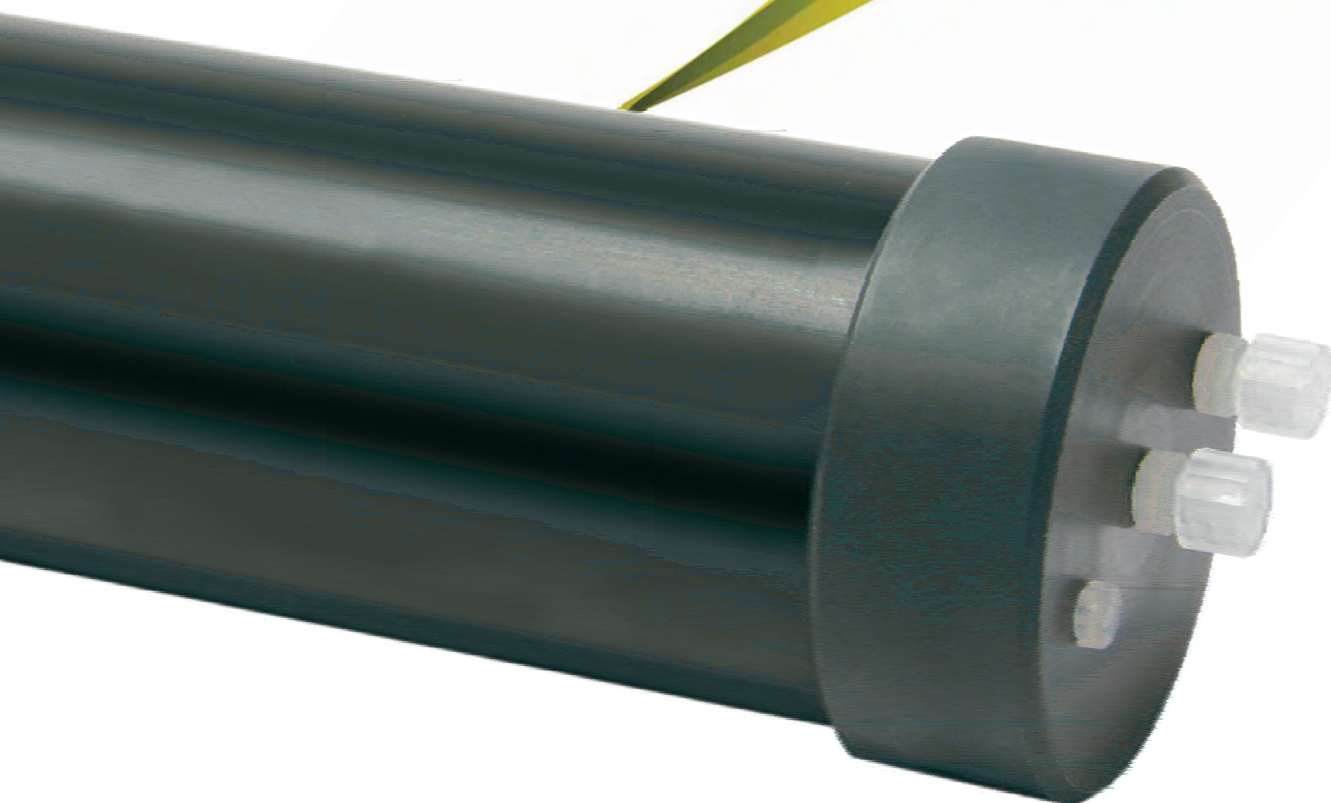




Instructions for Use

SeQuant[®] CARS[™]

Continuous Auto-Regeneration System
for SeQuant[®] SAMS[™] Suppressors



Instructions for Use

SeQuant® CARS™

Continuous Auto-Regeneration System

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General Information

The SeQuant® CARS™ system is designed to minimize the eluent background conductivity in anion chromatography and is used in combination with the SeQuant® SAMS™ membrane suppressor. The robust and flexible design of CARS™ ensures stable routine operation together with many different brands of ion chromatography systems and conductivity detectors.

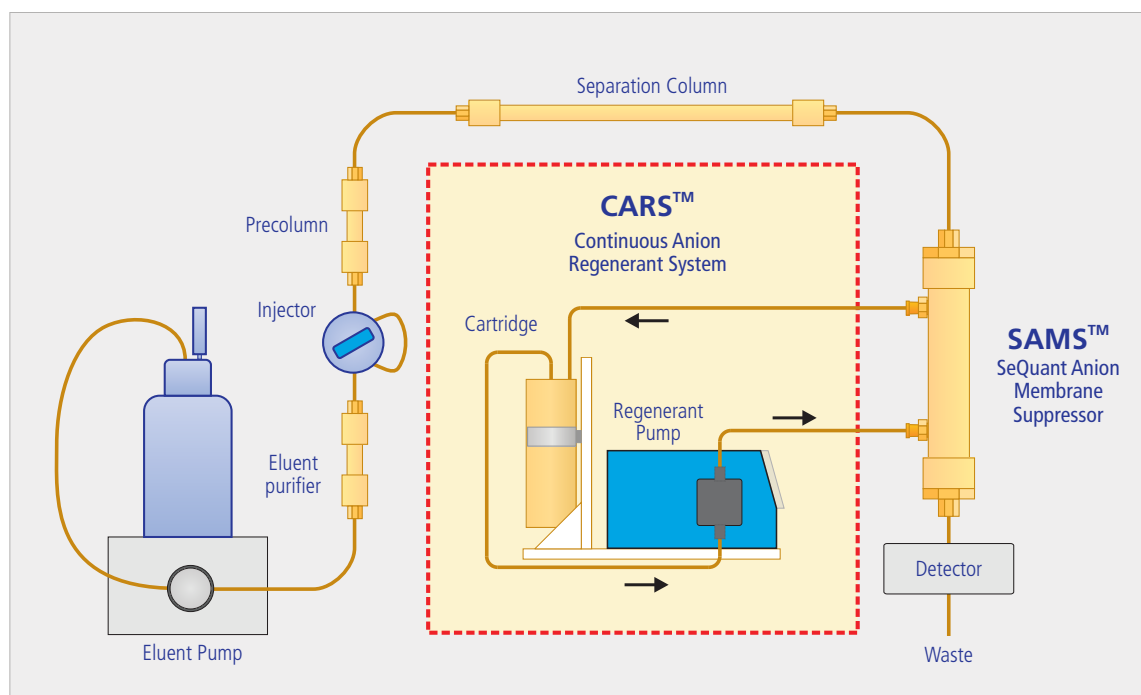


Figure 1: Schematic drawing of the system set-up when the SeQuant® CARS™ is used together with the SeQuant® SAMS™ for continuous chemical suppression in anion chromatography.

The CARS™ system acts by maintaining a constant acidic environment in the SAMS™ suppressor, where the ion chromatography eluent background conductivity is suppressed. Protons continuously supplied from the CARS™ cartridge to the SAMS™ suppressor are transported across the suppressor ion exchange membrane into the eluent. There protons replace the cationic counter ions in the eluent (often sodium or potassium), thereby neutralizing the eluent ions to their corresponding acids (often carbonic acid or water) which have very low conductivity. The replaced eluent cations are transported out from the SAMS™ suppressor and deposited on the CARS™ cartridge. Anions on the other hand, cannot cross the suppressor membrane due to ion exclusion. The SeQuant® ULB™-P regeneration solution circulating in the CARS™ system is an ultra-pure organic acid that act as a vehicle for transport of protons between the CARS™ cartridge and the SAMS™ suppressor.

The CARS™ system with SAMS™ suppressor is particularly well suited for applications requiring long, unattended routine operation, and exceptionally low and stable background conductivity. Gradient elution may also be carried out with minimal baseline drift, and the background level is unaffected if the user decide to change the mobile phase flow rate or ion strength to reduce the chromatographic run time. While convenient and cost-saving in laboratory applications, the SeQuant® CARS™ will really excel in applications such as environmental sampling in pristine areas, and for continuous industrial monitoring of high purity water.

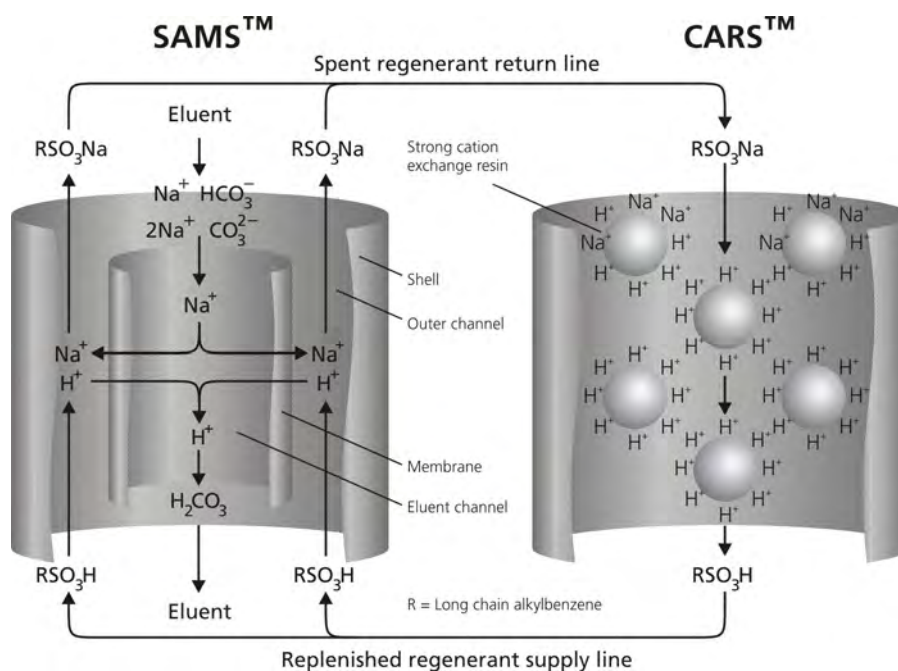


Figure 2: Ion exchange in a SeQuant® SAMS™ suppressor connected to SeQuant® CARSTM for continuous regeneration

Unpacking

The SeQuant® CARSTM system shipment contains the following parts:

- CARSTM Pump, mounted on stand designed to hold the cartridge (1 ea)
- Suppressor Installation Kit (1 ea)
Reorder number: 1.50619.0001
- CARSTM Cartridge Small, 0.5 L (1 ea)
Reorder number: 1.50613.0001
- ULB™-P Regeneration Solution (1 ea, 100 mL)
Reorder number: 1.50616.0100
- Spare Safety Check Valves 2 bar, 30 psi (2 ea)
- Instructions for Use (1 ea)

Please confirm the delivery against the list above.



Figure 3: SeQuant® CARSTM Cartridge (left) and SeQuant® SAMS™ Suppressor (right). SAMS™ is sold separately.

Installation

Diluting the ULB™-P Regeneration Solution



Wear protective glasses and gloves during handling of the ULB™-P Regeneration Solution.

The SeQuant® ULB™-P Regeneration Solution contains an ultra-pure, high-molecular weight, polymeric sulfonic acid, which may be corrosive and irritate skin and and spills should therefore be avoided. The use of eye protective glasses and gloves during handling is strongly recommended.

The ULB™-P is shipped as a concentrate and shall be diluted 1+4 with Reagent Grade Laboratory Water before use. Transfer all 100 mL of the supplied ULB™-P to a 500 mL flask. Add and dilute with 400 mL Reagent Grade Laboratory Water. Mix the solution properly. Diluted ULB™-P that is not used immediately should be stored in a plastic bottle in a cool place (ca 5-10 °C), but not below freezing.

Reagent Grade Laboratory Water is ultra-pure deionized water, free of organics, microorganisms and particulate, with a specific resistance of 18 Mohm cm⁻¹. Do not use water on bottle unless this is optimised for ion chromatography and do not contain high levels of ions. Contamination of the ULB™-P with ions will deteriorate the low background capability of the ULB™-P solution and decrease the performance of the CARSTM System.

Operating the Pump



To avoid damaging the CARSTM Pump, only change the flow rate when it is in operation.

There are two controls on the pump front:

- I. The top button mechanically adjusts the volume delivered per pump stroke and should only be used when the pump is operating. This button is used to alter the flow rate of ULB™-P and is normally set to a value of 80.
- II. The lower button is the power switch. Use this switch to turn the pump on and off.

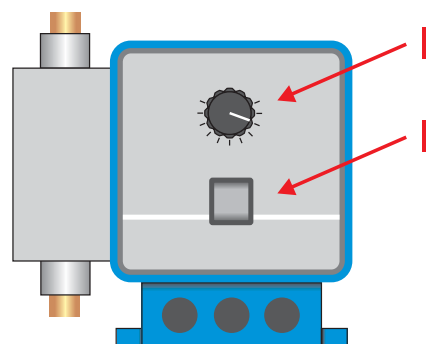


Figure 4: Control buttons on the CARSTM Pump.

Safety Check Valve

Install the Safety Check Valve (2 bar, 30 psi) at the top of the Pump outlet. This will protect the user against overpressure that could occur if the tubing in the system is accidentally blocked or squeezed. Connect the outlet of the Safety Check Valve to the Expansion Flask (EF), which should be able to hold all the ULB™-P in the system (~150 mL). A triggered Safety Check Valve is damaged and need to be replaced.

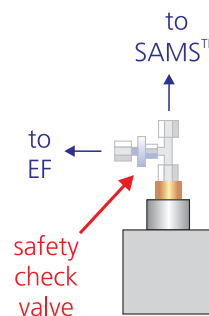


Figure 5: Install the Safety Check Valve and connect its outlet to the Expansion Flask (EF).

Cutting the Tubing

The tubing in the Suppressor Installation Kit should be cut with scissors into five pieces of suitable lengths. Two pieces should be long, about 1.5 m (5 ft) each, whereas the other three should be short, about 0.5 m (1.5 ft). Attach the six Luer Connectors to the two long tubing and one of the short. Use the two longer tubing to connect the suppressor and the other for connecting the Pump to the Cartridge. The remaining short pieces of tubing are used from the Safety Check Valve and the Cartridge Vent to the Expansion Flask or waste.

Installing and Filling the Cartridge

CARS™ Cartridges are delivered empty and must first be filled with diluted ULB™-P. The CARS™ Pump is used for this procedure and it involves some temporary plumbing, according to the steps listed below and as shown in Figure 6. Wear protective gloves and glasses when performing the filling procedure.

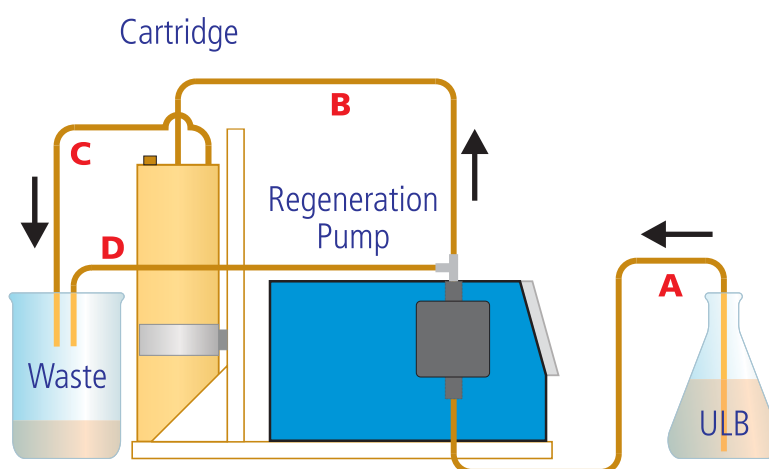


Figure 6: Tubing connections for filling the CARS™ Cartridge. Tubing D is connected from the exit of the Safety Check Valve.

1. Install the Cartridge in the holder at the rear of the Pump.
2. Remove the two Luer Plugs from the inlet and outlet of the Cartridge, but let the vent be plugged during the filling.
3. Connect a short tubing (A) to the Pump inlet (bottom) and place the other end of the tube in the flask containing the diluted ULB™-P.
4. Connect a long tubing (B) between the Pump outlet (top) and the Cartridge outlet (centre).
5. Connect a long tubing (C) to the inlet (edge) of the Cartridge and place the other end in a suitable waste bottle.
6. Connect a short tubing (D) from the exit of the Safety Check Valve to a waste bottle.
7. Start the Pump and let it operate until about 250 mL of the diluted ULB™-P has emerged to waste. Save the remaining approx 150 mL of diluted ULB™-P for future refilling needs. Store it in a plastic bottle cold, but not below freezing.
8. Stop the Pump.

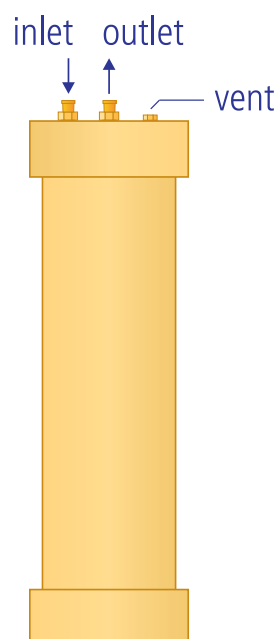


Figure 7: Connections on the CARS™ Cartridge.

Starting the CARSTM System with a SAMSTM Suppressor



Before you start the CARSTM Pump for normal operation, ensure that the connecting tubing are assembled correctly.

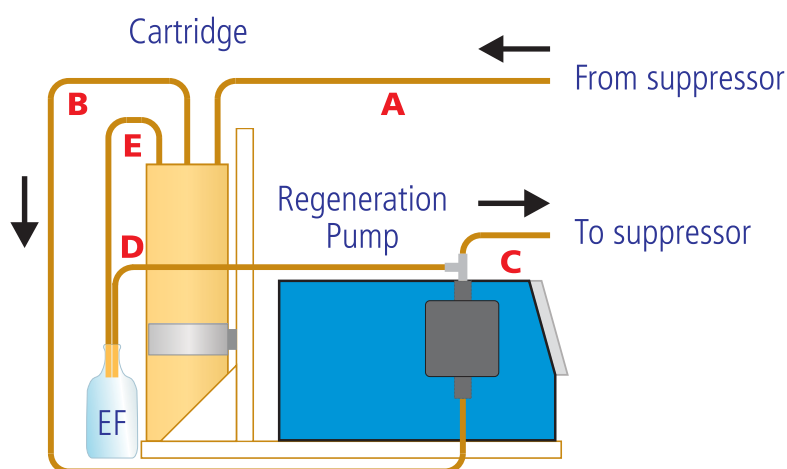


Figure 8: Tubing connections during normal operation the CARSTM System. Tubing D and E are connected to the Expansion Flask (EF) from the exit of the Safety Check Valve and from the Cartridge Vent, respectively.

1. Connect a long tubing (A) between the SAMSTM Suppressor outlet (top) and the Cartridge inlet (edge). This is the tubing leading to waste if you just performed the filling procedure.
2. Connect a short tubing (B) between the Cartridge outlet (centre) and the Pump inlet (bottom). This is the tubing placed in the ULB™-P Regeneration Solution flask if you just performed the filling procedure.
3. Connect a long tubing (C) between the Pump outlet (top) and the SAMSTM inlet (bottom). This is the tubing connected to the Cartridge outlet (centre) if you just performed the filling procedure.
4. Make sure the exit of the Safety Check Valve is connected to the Expansion Flask with a short tubing (D).
5. Disconnect the Cartridge vent plug and install the supplied fitting. Connect a short tubing (E) between the Cartridge Vent and the Expansion Flask.
6. Start the Pump and adjust the flow rate to a value of 80. This gives an expected flow rate of about 20 mL/min and a back-pressure in the regeneration channel below 1 bar (14 psi).
7. Flush your ion chromatography eluent pump system thoroughly with purified water if it has not recently been used for suppressed anion chromatography. Use fresh eluents and wash solutions free from organic solvents.

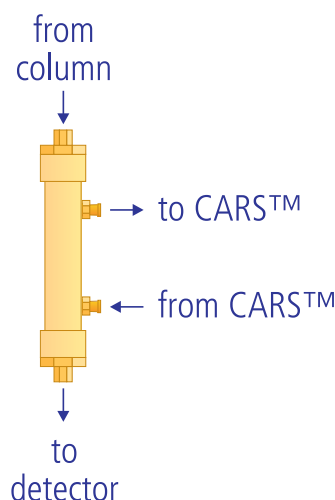


Figure 9: Connections on the SAMSTM Suppressor.

8. Connect the SAMSTM eluent inlet (top) to your column and the eluent outlet (bottom) to your detector. Note that it is recommended to install a Pressure Relief Valve (100 psi, sold separately) between your column and the SAMSTM to protect it against high detector back-pressures.
9. Start your eluent pump and let the system equilibrate for at least 30 minutes. Monitor the baseline of your chromatography system to determine when the suppression is stable.



Failure to install the Expansion Tubing and the Safety Check Valve constitutes a risk for leakage, damage to equipment and health hazard for laboratory staff.

Operation

The level and stability of the background conductivity will improve during the first operating hours of a new cartridge. This baseline is monitored through your conductivity detector and ion chromatography system.

Optimum Performance

To get the most stable background, the CARS™ System should be operated also when the eluent flow has been stopped, such as during nights. When eluent is not pumped through the suppressor, protons in the Cartridge and ULB™-P are not "consumed". The cartridge lifetime will therefore not be negatively affected by continuous recirculation.

The most optimal performance is obtained when the Cartridge is placed within the ion chromatography system compartment (column oven or similar), avoiding exposure to direct sunlight and other major temperature variations. The Cartridge should always be kept in an upright position during operation.

Cartridge Expansion Tubing

The SAMS™ is a membrane device, which is not entirely impermeable to water. Due to osmotic transfer of water between the ULB™-P and the eluent taking place over the long lifespan of the Cartridge, the volume of the ULB™-P may decrease, or more typically, increase. This means that some solution may leave the Cartridge through the waste tubing, but this has no effect on the performance of the system. Build-up of pressure in the CARS™ system will affect the performance and constitutes a risk for leakage and damage to equipment and health hazard for laboratory staff.

Air Bubbles

During operation of the CARS™ System, air bubbles may sometimes appear within the circulating ULB™-P. This does not affect the performance of the CARS™ unless air is accumulating in the SAMS™. To avoid this, the SAMS™ regeneration channel outlet should be positioned slightly higher than the inlet.

SAMS™ Suppressor



Always disconnect the SAMS™ if the separation column is being washed with solutions containing high concentrations of salt. The CARS™ Cartridge lifetime will otherwise be reduced and the SAMS™ Suppressor risks being poisoned by released contaminants.

For best results, the SAMS™ Suppressor should be installed close to the ion chromatography column. Extensive tubing between the column and suppressor or between the suppressor and detector will lead to band-broadening of the chromatographic peaks and loss of resolution. Optimum low level of background conductivity, noise and reproducibility are achieved when the SAMS™ is placed in a column oven or similar compartment with controlled temperature.

If your SAMS™ previously has been used with sulfuric acid or other low molecular-weight acids for regeneration, it must be flushed with minimum 50 mL of ultra-pure water to avoid contaminating the ULB™-P. A contaminated ULB™-P solution will result in a higher background level and more noise.

For further instruction regarding handling SAMS™, please consult its separate Instructions for Use.

Temporary Storage



Store diluted ULB™-P and filled CARSTM Cartridges plugged in a refrigerator at 5-10 °C.

Keep the CARSTM System in continuous operation during analysis even if the eluent flow is temporary stopped. However, if the ion chromatography system will not be used for a couple of days, it is recommended that the regeneration flow is stopped.

If the ion chromatography system will not be used for several weeks it is recommended that the Cartridge is removed and plugged and that the Pump flow path is flushed with deionized water for about 10 minutes. The Pump should finally be drained by pumping air for one minute. Prolonged operation without liquid in the Pump may lead to increased wear of the internal parts and is not recommended. Failure to flush the Pump when disconnected might result in precipitation of ULB™-P and clogging of the system. Prolonged storage of filled and plugged Cartridges, and diluted ULB™-P should be performed at cold temperatures (ca 5-10 °C), but not below freezing.

Expected Cartridge Lifetime

Eluent cations will break through the Cartridge before it is completely exhausted and a slight increase in background conductivity and noise indicates that a new Cartridge soon need to be installed. The practically useful capacity of the CARSTM Cartridge Small (0.5 L) is about 0.8 eq. Table 1 shows the expected practical Cartridge lifetime when used with some typical anion chromatography eluents.

Table 1: Expected practical lifetime of the CARSTM Cartridge Small (0.5 L) when used with some typical eluents for anion chromatography. Lifetimes at other eluent concentrations or flow rates may be extrapolated from the tabulated estimates.

Eluent Type and Concentration			Flow Rate	Estimated useful lifetime
NaOH <i>mM</i>	Na ₂ CO ₃ <i>mM</i>	NaHCO ₃ <i>mM</i>	<i>mL min⁻¹</i>	Full eight-hour working days <i>ea</i>
5.0	-	-	1.0	330
10.0	-	-	1.0	165
-	1.8	1.7	1.0	320
-	1.8	1.7	2.0	160

Disposal of CARSTM Cartridges

The Cartridge housing is made from polyvinyl chloride (PVC) and the interior filling is a sulfonated polystyrene cation exchange resin. Unless you are required to recycle different types of plastics separately, we recommend that the Cartridge is thoroughly washed with water and recycled as an all-plastic waste.

Disposal of ULB™-P Regeneration Solution

The chemical composition of the ULB™-P Regeneration Solution is quite similar to dishwashing detergents. This means that the solution can be safely disposed in the drain if flushed with plenty of water.

Disposal of SAMS™ Suppressors

The SAMS™ housing is made from polyvinylidene-fluoride (PVDF) and polyether-ether-ketone (PEEK). After being thoroughly flushed with water, SAMS™ can be recycled as all-plastic waste unless you are required to recycle different types of plastics separately.

Pump Maintenance

The Pump is very robust and can operate many months without significant maintenance. Parts that might need to be replaced are the inlet and outlet check valves and the mechanical membrane in the pump head. Both these operations are rather straightforward and can be performed in the laboratory. Please contact your local SeQuant® distributor for more information.

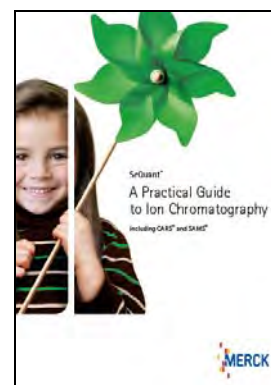
Reordering Information

Please contact your local SeQuant® distributor for placing your order.

Ord. No.	Description
1.50609.0001	SeQuant® SAMS™ Standard Suppressor
1.50610.0001	SeQuant® SAMS™ Gradient Suppressor
1.50611.0001	SeQuant® CARS™ Continuous Auto Regeneration System
1.50613.0001	SeQuant® CARS™ Cartridge Small (0.5 L, capacity 0.9 eq)
1.50614.0001	SeQuant® CARS™ Cartridge Large (0.75 L, capacity 1.3 eq)
1.50616.0100	SeQuant® ULB™-P Regeneration Solution (100 mL to be diluted 1+4)
1.50618.0001	SeQuant® Pressure Relief Valve (100 psi)
1.50619.0001	SeQuant® SAMS™ Installation Kit (5 m tubing and 6 ea fittings)
Contact dealer	Certipur® single or multi element NIST traceable IC standards

A Practical Guide to Ion Chromatography

To learn more about ion chromatography technology and how you can optimize your separation selectivity and detection sensitivity or troubleshoot your ion chromatography application, SeQuant® offers the free tutorial booklet *A Practical Guide to Ion Chromatography*. To ask for your free copy, please contact your local distributor or visit the website www.sequant.com.



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