

IC-Ag and IC-Ag Plus Devices

Introduction

Maxi-Clean™ and Extract-Clean™ IC Devices are solid-phase extraction devices used to eliminate matrix interferences from samples prior to analyses by ion chromatography. Each device consists of either 0.5mL or 1.5mL of polystyrene-based packing sandwiched between polyethylene frits within an injection-molded medical-grade polypropylene housing (Figure 1). Samples and wash solvents are passed through the packing using a luer hub syringe (for Maxi-Cleans™) or a vacuum manifold (for Extract-Cleans™). As sample comes in contact with the packing, specific chemical interactions take place which selectively retain certain components of the matrix in the device while the remaining components pass through the device outlet. The chemical characteristics of the packing dictate which sample components are retained. Seven chemistries are currently available.

Successful application of IC devices requires:

- 1) proper conditioning of the device prior to sample application,
- 2) application of the sample at a rate slow enough to allow the chemical interaction to take place while the sample is in the device, and
- 3) control of sample size to keep within the device's capacity.

The following information provides general recommendations for the use of IC-Ag devices. This procedure may be modified to accommodate samples with different characteristics.

General Information

Maxi-Clean™ and Extract-Clean™ IC-Ag provide a reliable method for the removal of halides prior to the analysis of anions by ion chromatography. IC-Ag devices contain either 0.5mL or 1.5mL of sulfonic acid cation exchange resin in the Ag⁺ form. The silver contained on the packing reacts with halides from the sample to form an insoluble salt (silver halide). In this process, cations from the sample are taken up by the resin to replace the silver consumed in the precipitation reaction. The net result is removal of halides (and an equivalent amount of sample cations) from the matrix. This process has little or no effect on sample anions that form soluble silver salts. Thus, the amounts of fluoride, nitrite, nitrate, phosphate and sulfate are not changed. Chloride, bromide, and iodide concentrations are reduced.

When large concentrations of halides are present in a sample, low levels of other anions may be lost during sample pretreatment with IC-Ag. This is probably due to the inclusion of the other ions in the precipitating silver halides. A study of the recovery of ions of interest in each sample matrix should be determined before quantitative results are obtained.

For more information on the use of Maxi-Clean™ IC cartridges and the recovery obtained with each please see:

R. Saari-Nordhaus, J.M. Anderson, Jr. and I.K. Anderson, Am. Lab., August (1990) 18.

I.K. Anderson, R. Saari-Nordhaus and J.M. Anderson, Jr., J. of Chromatography, 546 (1991) 61-71.

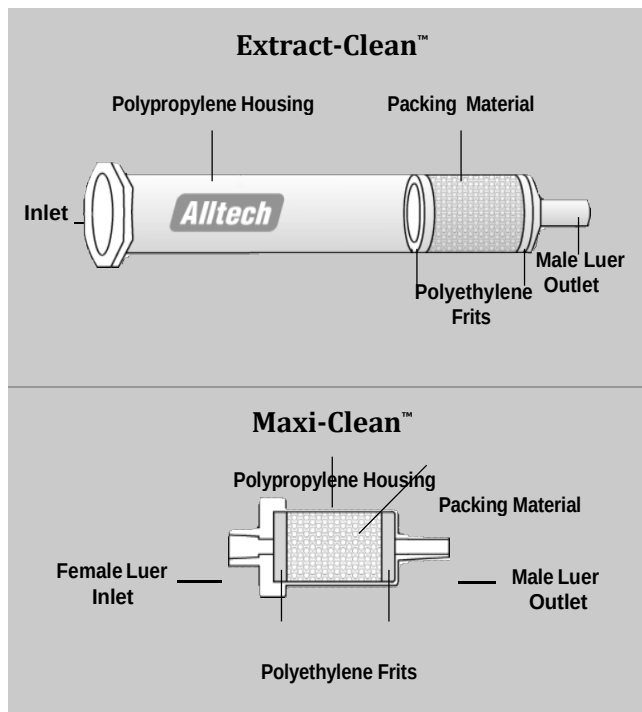


Figure 1

Flowrate

The devices have a number of flow-dependent parameters that may affect results. In general, high flowrates, particularly in the sample loading step, will decrease the performance while low flowrates will improve the extraction process. Low flowrates allow the sample to diffuse into the packing thus increasing capacity and improving the efficiency. The recommended flowrate for sample loading is 1mL/ minute or less.

Sample Mass

Each device contains either 0.8 or 2.0 milliequivalents of Ag⁺ (for the 0.5mL or 1.5mL device, respectively), which under ideal conditions will remove an equal amount of halide from the sample. In practice, this maximum capacity may not be realized. The nature of the sample (concentration, ionic strength, solvent) and the rate at which the sample is loaded into the device will affect the capacity. Where possible, adjust sample size to use 50% of less of the device's absolute capacity. Larger amounts of halide may be removed by using two or more Maxi-Clean™ cartridges in series. If the amount of halide in the sample is unknown, a test extraction should be performed to determine the correct sample size.

Sample Volume

The internal volumes of the different devices include the flow passages and interstitial packing volume. Although it is possible to recover all but 100µL (for the 0.5mL devices) or 150µL (for the 1.5mL devices) of sample with an air purge, best results are obtained when the sample volume greatly exceeds the internal volume of the cartridge.

Device	Bed Size	Internal Volume
Maxi-Clean™	0.5mL	300µL
Maxi-Clean™ Plus	1.5mL	650µL
Extract-Clean™	0.5mL	2.5mL
Extract-Clean™ Plus	1.5mL	1.5mL

Note: The used Maxi-Clean™ IC-Ag packing will darken when exposed to light.

General Procedure

- 1. Precondition the Device.** Pass 5 to 10mL of IC grade water through the device. This removes interstitial contaminants and wets the packed bed. For trace analysis work, repeat the rinsing procedure until the eluant is free from interferences.
- 2. Load the Sample.** Load the entire sample at 1mL/minute or less. The total amount of halide contained in the sample should not exceed the device capacity and preferably should be below 50% of total capacity. Discard the first 1mL of eluate. Collect the remaining eluate for analysis.

Other IC Devices

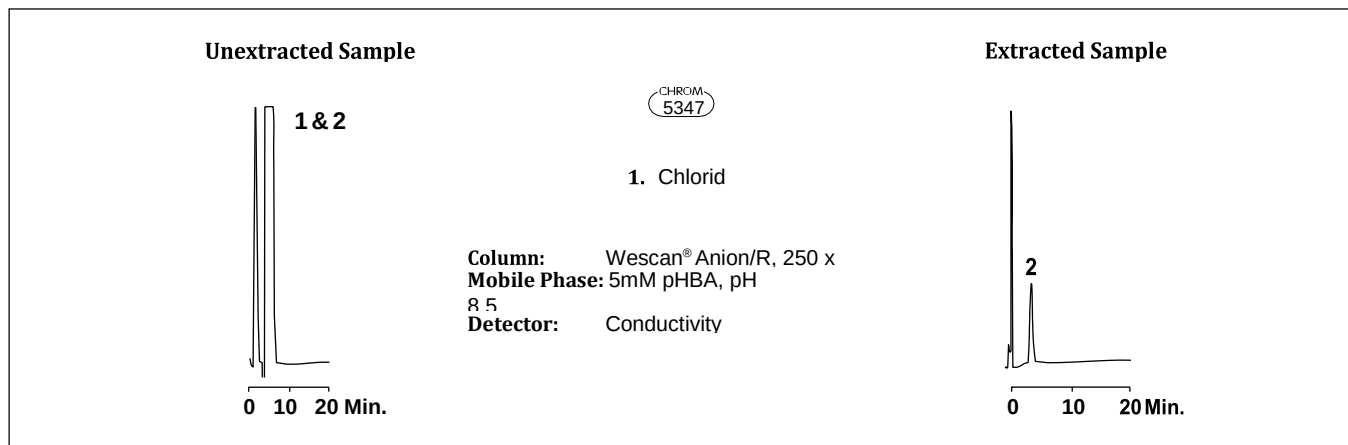
Device	Retains
IC-RP:	Hydrophobic Components
IC-OH:	Anions (pH increase)
IC-H:	Cations (pH reduction)
IC-Ag:	Chloride, Iodide, Bromide
IC-Ba:	Sulfate
IC-Na:	Cations (no pH change)
IC-Chelate:	Polyvalent Metal Ions
IC-Mixed Mode™ RP-OH:	Hydrophobic Components and Anions (pH increase)
IC-Mixed Mode™ RP-H:	Hydrophobic Components and Cations (pH reduction)

Example Nitrite in Brine Procedure:

1. Apply 4mL of sample to a preconditioned cartridge.
2. Discard first 1mL of eluate
3. Collect and analyze remaining mobile phase.

IC-Ag Devices

DESCRIPTION	VOLUME	QTY	PART No.
Maxi-Clean™ IC-Ag	0.5mL	50	5122577
Maxi-Clean™ IC-Ag Plus	1.5mL	25	5122569
Extract-Clean™ IC-Ag	0.5mL	50	5121733
Extract-Clean™ IC-Ag Plus	1.5mL	30	5122035



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IC-Ba and IC-Ba Plus Devices

Introduction

Maxi-Clean™ and Extract-Clean™ IC Devices are solid-phase extraction devices used to eliminate matrix interferences from samples prior to analyses by ion chromatography. Each device consists of either 0.5mL or 1.5mL of polystyrene-based packing sandwiched between polyethylene frits within an injection-molded medical-grade polypropylene housing (Figure 1). Samples and wash solvents are passed through the packing using a luer hub syringe (for Maxi-Clean™ devices) or a vacuum manifold (for Extract-Clean™ devices). As sample comes in contact with the packing, specific chemical interactions take place which selectively retain certain components of the matrix in the device while the remaining components pass through the device outlet. The chemical characteristics of the packing dictate which sample components are retained. Seven chemistries are currently available.

Successful application of IC devices requires:

- 1) proper conditioning of the device prior to sample application,
- 2) application of the sample at a rate slow enough to allow the chemical interaction to take place while the sample is in the device, and
- 3) control of sample size to keep within the device's capacity.

The following information provides general recommendations for the use of IC-Ba devices. This procedure may be modified to accommodate samples with different characteristics.

General Information

Maxi-Clean™ and Extract-Clean™ IC-Ba devices provide a reliable method for the removal of sulfate prior to the analysis of anions by ion chromatography. IC-Ba devices contain either 0.5mL or 1.5mL of sulfonic acid cation exchange resin in the Ba²⁺ form. The barium contained on the packing reacts with sulfate from the sample to form an insoluble salt (barium sulfate). In this process, cations from the sample are taken up by the resin to replace the barium consumed in the precipitation reaction. The net result is removal of sulfate (and an equivalent amount of sample cations) from the matrix. This process has little or no effect on sample anions that form soluble barium salts. Thus, the amounts of fluoride, chloride, bromide, nitrite, and nitrate are not changed. The recovery for phosphate may be reduced due to the formation of sparingly-soluble barium phosphate.

When a large concentration of sulfate is present in a sample, low levels of other anions may be lost during pretreatment with IC-Ba. This is probably due to the inclusion of the other ions in the precipitating barium sulfate. A study of the recovery of ions of interest in each sample matrix should be determined before quantitative results are obtained.

For more information on the use of Maxi-Clean™ IC cartridges and the recovery obtained with each please see:

R. Saari-Nordhaus, J.M. Anderson, Jr. and I.K. Anderson, *Am. Lab.*, August (1990) 18.

I.K. Anderson, R. Saari-Nordhaus and J.M. Anderson, Jr., *J. of Chromatography*, 546 (1991) 61-71.

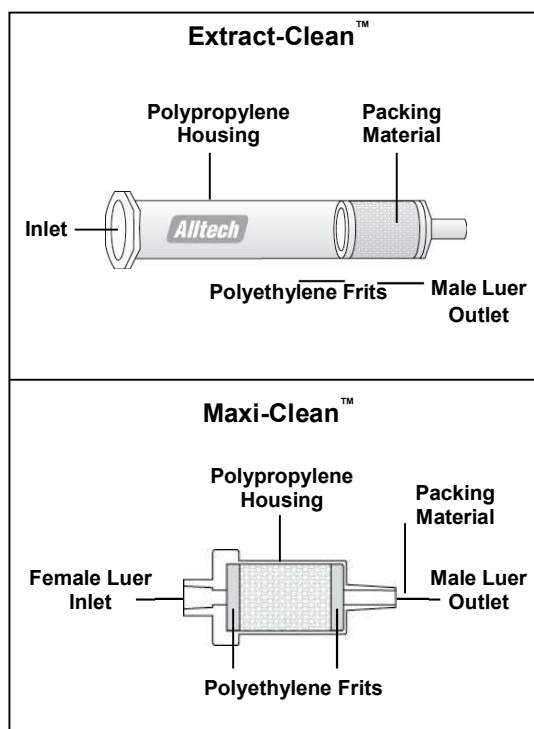


Figure 1

Flow Rate

The devices have a number of flow-dependent parameters that may affect results. In general, high flow rates, particularly in the sample loading step, will decrease the performance while low flow rates will improve the extraction process. Low flow rates allow the sample to diffuse into the packing thus increasing capacity and improving the efficiency. The recommended flow rate for sample loading is 1mL/minute or less.

Sample Mass

Each device contains either 0.8 or 2.0 milliequivalents of Ba²⁺ (for the 0.5mL or 1.5mL device, respectively), which under ideal conditions will remove an equal amount of sulfate from the sample. In practice, this maximum capacity may not be realized. The nature of the sample (concentration, ionic strength, solvent) and the rate at which the sample is loaded into the device will affect the capacity. Where possible, adjust sample size to use 50% or less of the device's absolute capacity. Larger amounts of sulfate may be removed by using two or more Maxi-Clean™ cartridges in series. If the amount of sulfate in the sample is unknown, a test extraction should be performed to determine the correct sample size.

Sample Volume

The internal volumes of the different devices include the flow passages and interstitial packing volume. Although it is possible to recover all but 100µL (for the 0.5mL devices) or 150µL (for the 1.5mL devices) of sample with an air purge, best results are obtained when the sample volume greatly exceeds the internal volume of the cartridge.

Device	Bed Size	Internal Volume
Maxi-Clean™	0.5mL	300µL
Maxi-Clean™ Plus	1.5mL	650µL
Extract-Clean™	0.5mL	2.5mL
Extract-Clean™ Plus	1.5mL	1.5mL

General Procedure

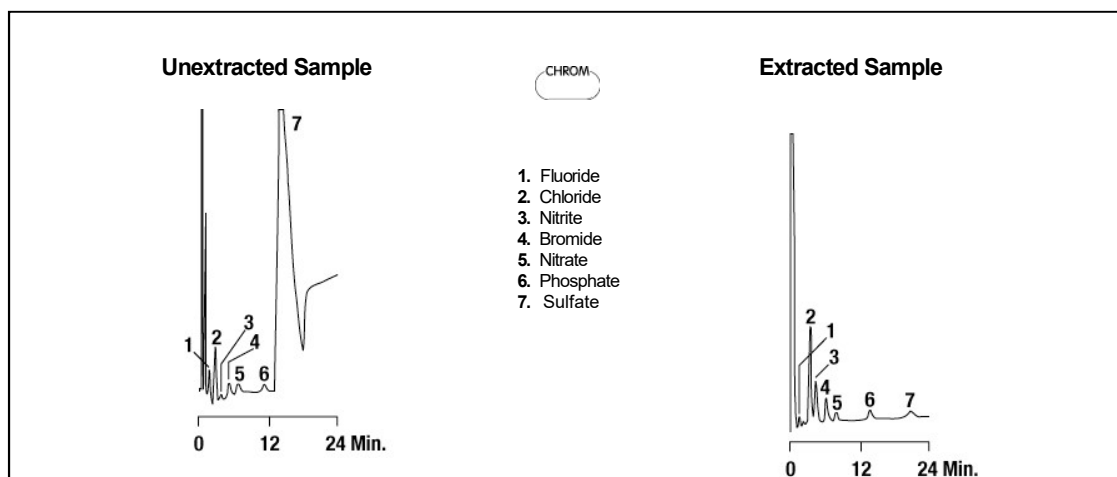
- 1. Precondition the Device.** Pass 5 to 10mL of IC grade water through the device. This removes interstitial contaminants and wets the packed bed. For trace analysis work, repeat the rinsing procedure until the eluant is free from interferences.
- 2. Load the Sample.** Load the entire sample at 1mL/minute or less. The total amount of sulfate contained in the sample should not exceed the device capacity and preferably should be below 50% of total capacity. Discard the first 1mL of eluate. Collect the remaining eluate for analysis.

Example

Trace Anions in Battery Acid

Procedure:

1. Dilute battery acid 400:1 with IC grade water.
2. Apply 4mL of sample to a preconditioned Cartridge.
3. Discard first 1mL of eluate.
4. Collect and analyze remaining eluate.



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Other IC Devices

Device	Retains
IC-RP:	Hydrophobic Components
IC-OH:	Anions (pH increase)
IC-H:	Cations (pH reduction)
IC-Ag:	Chloride, Iodide, Bromide
IC-Ba:	Sulfate
IC-Na:	Cations (no pH change)
IC-Chelate:	Polyvalent Metal Ions
IC-Mixed Mode RP-OH:	Hydrophobic Components and Anions (pH increase)
IC-Mixed Mode RP-H:	Hydrophobic Components and Cations (pH reduction)

IC-Ba Devices

Description	Volume	Qty	Part No.
Maxi-Clean™ IC-Ba	0.5mL	50	5122579
Maxi-Clean™ IC-Ba Plus	1.5mL	25	5122572
Extract-Clean™ IC-Ba	0.5mL	50	5122911

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IC-Chelate and IC-Chelate Plus Devices

Introduction

Maxi-Clean™ and Extract-Clean™ IC devices are solid-phase extraction devices used to eliminate matrix interferences from samples prior to analyses by ion chromatography. Each device consists of either 0.5mL or 1.5mL of polystyrene-based packing sandwiched between polyethylene frits within an injection-molded medical-grade polypropylene housing (**Figure 1**).

Samples and wash solvents are passed through the packing using a luer hub syringe (for Maxi-Clean™ devices) or a vacuum manifold (for Extract-Clean™ devices). As the sample comes in contact with the packing, specific chemical interactions take place that selectively retain certain components of the matrix in the device while the remaining components pass through the device outlet. The chemical characteristics of the packing dictate which sample components are retained. Seven chemistries are currently available.

Proper application of IC devices requires:

- 1) proper conditioning of the device prior to sample application,
- 2) application of the sample at a rate slow enough to allow the chemical interaction to take place while the sample is in the device, and
- 3) control of sample size to keep within the device's capacity.

The following information provides general recommendations for the use of IC-Chelate devices. Please note that the removal of polyvalent metal ions is a function of pH.

NOTICE

The Maxi-Clean™ and Extract-Clean™ IC-Chelate Devices must be stored in an air-tight container to prevent dehydration of the resin.

General Information

Maxi-Clean™ and Extract-Clean™ IC-Chelate devices provide a reliable method for the removal of polyvalent metal ions from samples prior to analysis by ion chromatography. They may also be useful for preconcentrating polyvalent metal ions from dilute samples. IC-Chelate devices contain either 0.5mL or 1.5mL of styrene divinylbenzene copolymer containing iminodiacetate ions, which act as chelating groups in binding polyvalent metal ions. Its selectivity is very high for divalent ions and transition metals. The quantity of metals absorbed onto the resin is function of pH; absorption is very low below pH2, it increases sharply from pH2 to pH4, and it reaches a maximum above pH4. The sodium contained on the packing will be displaced by the metals from the sample. The amount of metals removed is equivalent to the amount of sodium originally on the resin. Anions and nonmetallic ions that do not form a complex with the chelating resin may be retained through simple ion exchange mechanisms.

Flow Rate

The devices have a number of flow-dependent parameters that may affect results. In general, high flow rates, particularly in the sample loading step, will decrease the performance while low flow rates will improve the extraction process. Low flow rates allow the sample to diffuse into the packing, thus increasing capacity and improving the efficiency. The recommended flow rate for sample loading is 1mL/minute or less.

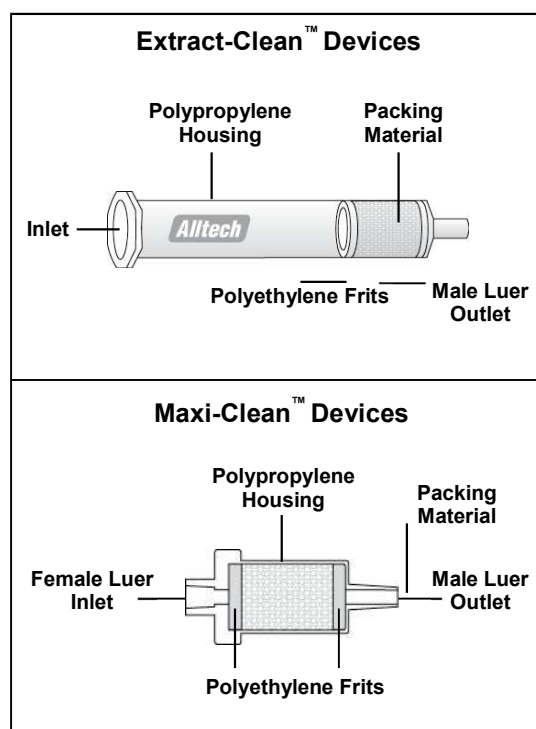


Figure 1

Sample Mass

Each device contains either 0.2 or 0.5 milliequivalents of sodium (for the 0.5mL or 1.5mL device, respectively), which under ideal conditions will remove an equal volume of polyvalent cations from the sample. In practice, this maximum capacity may not be realized. The nature of the sample (concentration, ionic strength, solvent) and the rate at which the sample is loaded into the device will affect the capacity. Where possible, adjust sample size to use 50% or less of the device's absolute capacity. Larger volumes of polyvalent cations may be removed by using two or more Maxi-Clean™ cartridges in series. If the volume of polyvalent cations in the sample is unknown, a test extraction should be performed to determine the correct sample size.

Sample Volume

The internal volumes of the different devices include the flow passages and interstitial packing volume. Although it is possible to recover all but 100µL (for the 0.5mL devices) or 150µL (for the 1.5mL devices) of sample with an air purge, best results are obtained when the sample volume greatly exceeds the internal volume of the cartridge.

Device	Bed Size	Internal Volume
Maxi-Clean™:	0.5mL	300µL
Maxi-Clean™ Plus:	1.5mL	650µL
Extract-Clean™:	0.5mL	2.5mL
Extract-Clean™ Plus:	1.5mL	1.5mL

General Procedure

- 1. Precondition the Device.** Pass 5 to 10mL of IC grade water through the device. This removes interstitial contaminants and wets the packed bed. For trace analysis work, repeat the rinsing procedure until the eluant is free from interferences.
- 2. Load the Sample.** Load the entire sample at 1mL/minute or less. The total amount of polyvalent cations contained in the sample should not exceed the device capacity and preferably should be below 50% of total capacity. Discard the first 1mL of eluate. Collect the remaining eluate for analysis.

Applications

Maxi-Clean™ and Extract-Clean™ IC-Chelate devices may be used to remove transition metals prior to organic acid analysis by ion exclusion chromatography. These transition metals may irreversibly retain on the strong cation exchanger of the packing, thus deactivating the ion exchange sites of the column.

Maxi-Clean™ and Extract-Clean™ IC-Chelate devices may also be used to preconcentrate transition metals from dilute samples. This is accomplished by passing a large volume of sample (with low transition metals concentration) through the device and eluting the retained ions in a smaller volume.

Maxi-Clean™ and Extract-Clean™ IC-Chelate devices may also be used for ultra purification of buffers for studying the effect of metals on biological systems.

Other IC Devices

Device	Retains
IC-RP:	Hydrophobic Components
IC-OH:	Anions (pH increase)
IC-H:	Cations (pH reduction)
IC-Ag:	Chloride, Iodide, Bromide
IC-Ba:	Sulfate
IC-Na:	Cations (no pH change)
IC-Chelate:	Polyvalent Metal Ions
IC-Mixed Mode RP-OH:	Hydrophobic Components and Anions (pH increase)
IC-Mixed Mode RP-H:	Hydrophobic Components and Cations (pH reduction)

IC-Chelate Devices

Description	Volume	Qty	Part No.
Maxi-Clean™ IC-Chelate	0.5mL	50	30250
Maxi-Clean™ IC-Chelate Plus	1.5mL	25	30265
Extract-Clean™ IC-Chelate	0.5mL	50	40250
Extract-Clean™ IC-Chelate Plus	1.5mL	30	140265

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IC-H and IC-H Plus Devices

Maxi-Clean™ and Extract-Clean™ IC devices are solid-phase extraction devices used to eliminate matrix interferences from samples prior to analyses by ion chromatography. Each device consists of either 0.5mL or 1.5mL of polystyrene-based packing sandwiched between polyethylene frits within an injection-molded medical-grade polypropylene housing (Figure 1). Samples and wash solvents are passed through the packing using a luer hub syringe (Maxi-Clean™ device) or a vacuum manifold (Extract-Clean™ device). As sample comes in contact with the packing, specific chemical interactions take place that selectively retain certain components of the matrix in the device while the remaining components pass through the device outlet. The chemical characteristics of the packing dictate which sample components are retained. Seven chemistries are currently available.

Successful application of IC devices requires:

- 1) proper conditioning of the device prior to sample application,
- 2) application of the sample at a rate slow enough to allow the chemical interaction to take place while the sample is in the device, and
- 3) control of sample size to keep within the device's capacity.

The following information provides general recommendations for the use of IC-H devices. This procedure may be modified to accommodate samples with different characteristics.

General Information

Maxi-Clean™ and Extract-Clean™ IC-H devices provide a reliable method for the adjustment of pH of basic samples prior to the analysis of anions by ion chromatography. They may also be useful for removing cations from samples prior to the analysis of anions. IC-H devices contain either 0.5mL or 1.5mL of sulfonic acid cation exchange resin in the H⁺ form. The hydronium contained on the packing reacts with hydroxide from the sample to form water thereby reducing pH. In this process, cations from the sample are taken up by the resin to replace the hydronium consumed in the neutralization reaction. The net result is removal of hydroxide (and an equivalent volume of sample cations) from the matrix.

Polyvalent cations will be preferentially retained over monovalent cations in acidic samples providing a mechanism for removal of polyvalent cations.

The recovery of weakly ionized anions such as nitrite and phosphate could be poor after sample pretreatment with IC-H. The loss of these anions may take place through a number of different mechanisms, including evolution of nitrous oxide, oxidation of nitrite to nitrate, adsorption in the resin or a combination of effects. A study of the recovery of ions of interest in each sample matrix should be determined before quantitative results are obtained.

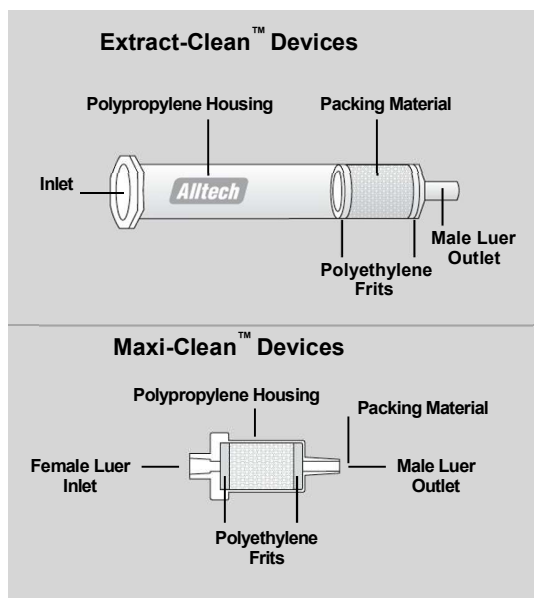


Figure 1

Flow Rate

The devices have a number of flow-dependent parameters that may affect results. In general, high flow rates, particularly in the sample loading step, will decrease the performance while low flow rates will improve the extraction process. Low flow rates allow the sample to diffuse into the packing thus increasing capacity and improving the efficiency. The recommended flow rate for sample loading is 1mL/minute or less.

Sample Mass

Each device contains either 0.8 or 2.0 milliequivalents of H⁺ (for the 0.5mL or 1.5mL device, respectively), which under ideal conditions will remove an equal amount of hydroxide or polyvalent cations from the sample. In practice, this maximum capacity may not be realized. The nature of the sample (concentration, ionic strength, solvent) and the rate at which the sample is loaded into the device will affect the capacity. Where possible, adjust sample size to use 50% or less of the device's absolute capacity. Larger volumes of hydroxide or polyvalent cations may be removed by using two or more Maxi-Clean™ cartridges in series. If the amount of hydroxide or polyvalent cations in the sample is unknown, a test extraction should be performed to determine the correct sample size.

For more information on the use of Maxi-Clean™ IC cartridges and the recovery obtained with each please see:

R. Saari-Nordhaus, J.M. Anderson, Jr. and I.K. Anderson, *Am. Lab.*, August (1990) 18.

I.K. Anderson, R. Saari-Nordhaus and J.M. Anderson, Jr., *J. of Chromatography*, 546 (1991) 61-71.

Sample Volume

The internal volumes of the different devices include the flow passages and interstitial packing volume. Although it is possible to recover all but 100µL (for the 0.5mL devices) or 150µL (for the 1.5mL devices) of sample with an air purge, best results are obtained when the sample volume greatly exceeds the internal volume of the cartridge.

Device	Bed Size	Internal Volume
® Maxi-Clean™ :	0.5mL	300µL
® Maxi-Clean™ Plus :	1.5mL	650µL
® Extract-Clean™ :	0.5mL	2.5mL
® Extract-Clean™ Plus :	1.5mL	1.5mL

Example

Trace Anions in Caustic

Procedure:

1. Apply 4mL of sample to a preconditioned Cartridge.
2. Discard the first 1mL of eluate.
3. Collect and analyze remaining eluate.

General Procedure

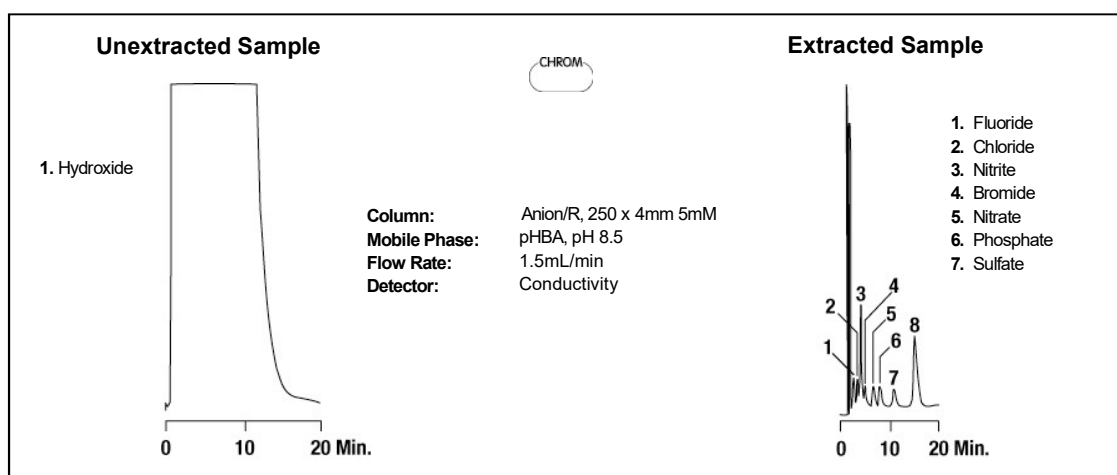
- 1. Precondition the Device.** Pass 5 to 10mL of IC grade water through the device. This removes interstitial contaminants and wets the packed bed. For trace analysis work, repeat the rinsing procedure until the eluant is free from interferences.
- 2. Load the Sample.** Load the entire sample at 1mL/minute or less. The total amount of hydroxide or polyvalent cations contained in the sample should not exceed the device capacity and preferably should be below 50% of total capacity. Discard the first 1mL of eluate. Collect the remaining eluate for analysis.

Other IC Devices

Device	Retains
IC-RP:	Hydrophobic Components
IC-OH:	Anions (pH increase)
IC-H:	Cations (pH reduction)
IC-Ag:	Chloride, Iodide, Bromide
IC-Ba:	Sulfate
IC-Na:	Cations (no pH change)
IC-Chelate:	Polyvalent Metal Ions
IC-Mixed Mode RP-OH:	Hydrophobic Components and Anions (pH increase)
IC-Mixed Mode RP-H:	Hydrophobic Components and Cations (pH reduction)

IC-H Devices

Description	Volume	Qty	Part No.
Maxi-Clean™ IC-H	0.5mL	50	5122575
Maxi-Clean™ IC-H Plus	1.5mL	25	5122568
Extract-Clean™ IC-H	0.5mL	50	5122910
Extract-Clean™ IC-H Plus	1.5mL	30	5122034



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IC-Na and IC-Na Plus Devices

Introduction

Maxi-Clean™ and Extract-Clean™ IC Devices are solid-phase extraction devices used to eliminate matrix interferences from samples prior to analyses by ion chromatography. Each device consists of either 0.5mL or 1.5mL of polystyrene-based packing sandwiched between polyethylene frits within an injection-molded medical-grade polypropylene housing (**Figure 1**).

Samples and wash solvents are passed through the packing using a luer hub syringe (for Maxi-Clean™ devices) or a vacuum manifold (for Extract-Clean™ devices). As sample comes in contact with the packing, specific chemical interactions take place which selectively retain certain components of the matrix in the device while the remaining components pass through the device outlet. The chemical characteristics of the packing dictate which sample components are retained. Seven chemistries are currently available.

Successful application of IC devices requires:

- 1) proper conditioning of the device prior to sample application,
- 2) application of the sample at a rate slow enough to allow the chemical interaction to take place while the sample is in the device, and
- 3) control of sample size to keep within the device's capacity.

The following information provides general recommendations for the use of IC-Na devices. This procedure may be modified to accommodate samples with different characteristics.

General Information

Maxi-Clean™ and Extract-Clean™ IC-Na devices provide a reliable method for the removal of cations from samples where the pH changes induced by solid-phase extraction resin in the hydrogen form are not appropriate. They may also be useful for pre-concentrating cations or removal of cations from matrix interferences, for example from samples that contain high concentrations of anions, prior to cation analysis on an anion column. IC-Na devices contain either 0.5mL or 1.5mL of sulfonic acid cation exchange resin in the Na⁺ form. The sodium contained on the packing will be displaced by the cations from the sample. The amount of cations removed is equivalent to the amount of sodium displaced from the resin. Anions from the sample will pass through the device unchanged.

Flow Rate

The devices have a number of flow-dependent parameters that may affect results. In general, high flow rates, particularly in the sample loading step, will decrease the performance while low flow rates will improve the extraction process. Low flow rates allow the sample to diffuse into the packing thus increasing capacity and improving the efficiency. The recommended flow rate for sample loading is 1mL/minute or less.

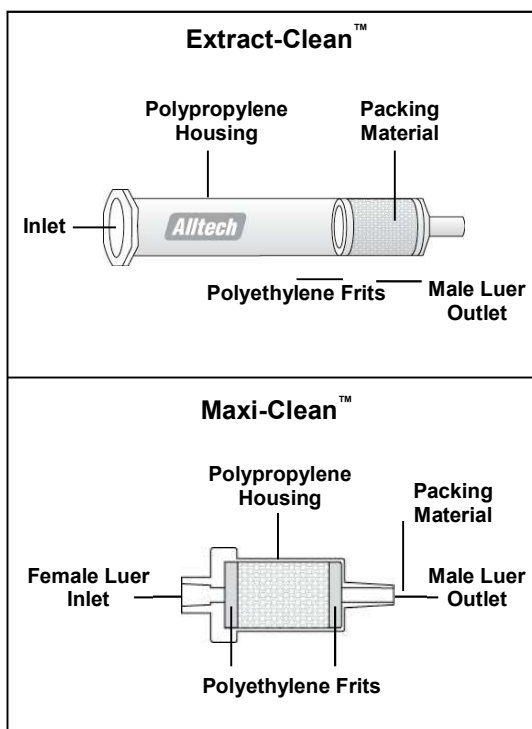


Figure 1

Sample Mass

The internal volumes of the different devices include the flow passages and interstitial packing volume. Although it is possible to recover all but 100µL (for the 0.5mL devices) or 150µL (for the 1.5mL devices) of sample with an air purge, best results are obtained when the sample volume greatly exceeds the internal volume of the cartridge.

Device	Bed Size	Internal Volume
Maxi-Clean™ :	0.5mL	300µL
Maxi-Clean™ Plus:	1.5mL	650µL
Extract-Clean™ :	0.5mL	2.5mL
Extract-Clean™ Plus:	1.5mL	1.5mL

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General Procedure

- 1. Precondition the Device.** Pass 5 to 10mL of IC grade water through the device. This removes interstitial contaminants and wets the packed bed. For trace analysis work, repeat the rinsing procedure until the eluant is free from interferences.
- 2 Load the Sample.** Load the entire sample at 1mL/minute or less. The total amount of cations contained in the sample should not exceed the device capacity and preferably should be below 50% of total capacity. Discard the first 1mL of eluate. Collect the remaining eluate for analysis.

Applications

Brier, R.A. and Ravichandran, R. K., The Pittsburgh Conference, Chicago, IL, March 4, 1991; Paper No. 232.

Other IC Devices

Device	Retains
IC-RP:	Hydrophobic Components
IC-OH:	Anions (pH increase)
IC-H:	Cations (pH reduction)
IC-Ag:	Chloride, Iodide, Bromide
IC-Ba:	Sulfate
IC-Na:	Cations (no pH change)
IC-Chelate:	Polyvalent Metal Ions
IC-Mixed Mode RP-OH:	Hydrophobic Components and Anions (pH increase)
IC-Mixed Mode RP-H:	Hydrophobic Components and Cations (pH reduction)

IC-Na Devices

Description	Volume	Qty	Part No.
Maxi-Clean™ IC-Na	0.5mL	50	5122580
Maxi-Clean™ IC-Na Plus	1.5mL	25	5122574
Extract-Clean™ IC-Na	0.5mL	50	5122912
Extract-Clean™ IC-Na Plus	1.5mL	30	5122037

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IC-OH and IC-OH Plus Devices

Introduction

Maxi-Clean™ and Extract-Clean™ IC Devices are solid-phase extraction devices used to eliminate matrix interferences from samples prior to analyses by ion chromatography. Each device consists of either 0.5mL or 1.5mL of polystyrene-based packing sandwiched between polyethylene frits within an injection-molded medical-grade polypropylene housing (Figure 1). Samples and wash solvents are passed through the packing using a luer hub syringe (for Maxi-Clean™) or a vacuum manifold (for Extract-Clean™). As sample comes in contact with the packing, specific chemical interactions take place which selectively retain certain components of the matrix in the device while the remaining components pass through the device outlet. The chemical characteristics of the packing dictate which sample components are retained. Seven chemistries are currently available.

Successful application of IC devices requires:

1. proper conditioning of the device prior to sample application,
2. application of the sample at a rate slow enough to allow the chemical interaction to take place while the sample is in the device, and
3. control of sample size to keep within the device's capacity.

The following information provides general recommendations for the use of IC-OH devices. This procedure may be modified to accommodate samples with different characteristics.

NOTE: The Maxi-Clean™ and Extract-Clean™ IC-OH devices are packed with polystyrene-divinylbenzene based anion exchanger in the quaternary amine functional group. The amine functional groups give this product the strong, unpleasant fishy smell. This smell is a normal part of the product and does not affect the performance of the devices.

General Information

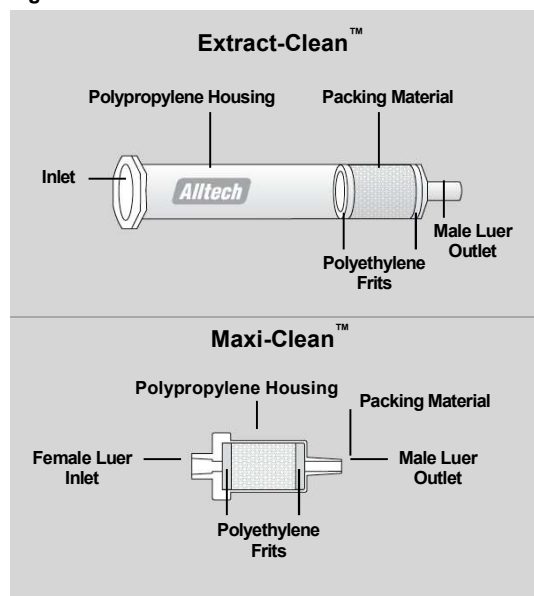
Maxi-Clean™ and Extract-Clean™ IC-OH provide a reliable method for the adjustment of pH of acidic samples prior to the analysis of cations by ion chromatography. They may also be useful for preconcentrating anions from dilute samples prior to the analysis of anions. IC-OH devices contain either 0.5mL or 1.5mL of quaternary ammonium anion exchange resin in the hydroxide form. The hydroxide contained on the packing reacts with hydronium from the sample to form water thereby increasing pH. In this process, anions from the sample are taken up by the resin to replace the hydroxide consumed in the neutralization reaction. The net result is removal of hydronium (and an equivalent amount of sample anions) from the matrix. Hydroxide is weakly retained by the resin and is readily displaced by most other anions. Sample preconcentration is accomplished by passing a large volume of sample (with low anion concentration) through the device and eluting the retained anions in a smaller volume.

For more information on the use of Maxi-Clean™ IC cartridges and the recovery obtained with each please see:

R. Saari-Nordhaus, J.M. Anderson, Jr. and I.K. Anderson, *Am. Lab.*, August (1990) 18.

I.K. Anderson, R. Saari-Nordhaus and J.M. Anderson, Jr., *J. of Chromatography*, 546 (1991) 61-71.

Figure 1



Flow Rate

The devices have a number of flow-dependent parameters that may affect results. In general, high flow rates, particularly in the sample loading step, will decrease the performance while low flow rates will improve the extraction process. Low flow rates allow the sample to diffuse into the packing thus increasing capacity and improving the efficiency. The recommended flow rate for sample loading is 1mL/minute or less.

Sample Mass

Each device contains either 0.6 or 1.5 milliequivalents of hydroxide (for the 0.5mL or 1.5mL device, respectively), which under ideal conditions will remove an equal amount of hydronium or other anions from the sample. In practice, this maximum capacity may not be realized. The nature of the sample (concentration, ionic strength, solvent) and the rate at which the sample is loaded into the device will affect the capacity. Where possible, adjust sample size to use 50% or less of the device's absolute capacity. Larger amounts of hydronium or other anions may be removed by using two or more Maxi-Clean™ cartridges in series. If the amount of hydronium or other anions in the sample is unknown, a test extraction should be performed to determine the correct sample size.

Sample Volume

The internal volumes of the different devices include the flow passages and interstitial packing volume. Although it is possible to recover all but 100µL (for the 0.5mL devices) or 150µL (for the 1.5mL devices) of sample with an air purge, best results are obtained when the sample volume greatly exceeds the internal volume of the cartridge.

Device	Bed Size	Internal Volume
Maxi-Clean™ :	0.5mL	300µL
Maxi-Clean™ Plus :	1.5mL	650µL
Extract-Clean™ :	0.5mL	2.5mL
Extract-Clean™ Plus :	1.5mL	1.5mL

General Procedure

- 1. Precondition the Device.** Pass 5 to 10mL of IC grade water through the device. This removes interstitial contaminants and wets the packed bed. For trace analysis work, repeat the rinsing procedure until the eluant is free from interferences.
- 2. Load the Sample.** Load the entire sample at 1mL/minute or less. The total amount of hydronium or other anions contained in the sample should not exceed the device capacity and preferably should be below 50% of total capacity. Discard the first 1mL of eluate. Collect the remaining eluate for analysis.
- 3. For pH Adjustment.** Discard the first 1mL of eluate. Collect the remaining eluate for analysis.

Other IC Devices

Device	Retains
IC-RP:	Hydrophobic Components
IC-OH:	Anions (pH increase)
IC-H:	Cations (pH reduction)
IC-Ag:	Chloride, Iodide, Bromide
IC-Ba:	Sulfate
IC-Na:	Cations (no pH change)
IC-Chelate:	Polyvalent Metal Ions
IC-Mixed Mode RP-OH:	Hydrophobic Components and Anions (pH increase)
IC-Mixed Mode RP-H:	Hydrophobic Components and Cations (pH reduction)

Example

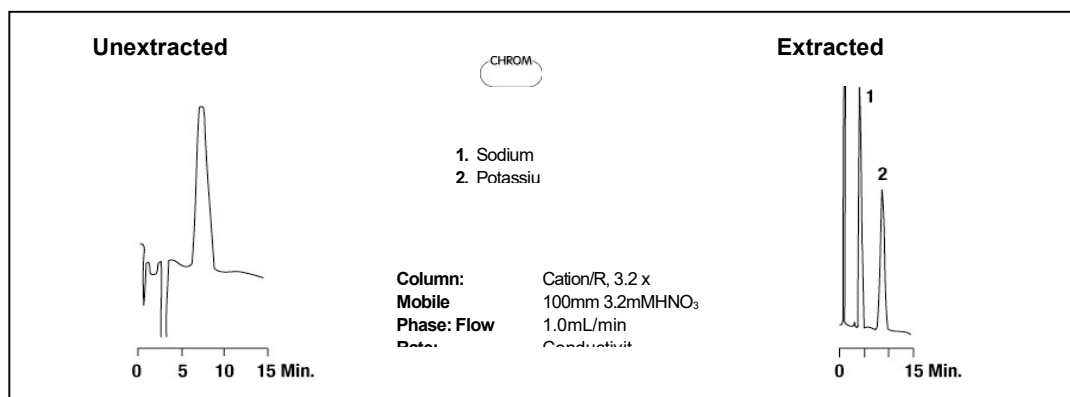
Cations in 1M Nitric Acid

Procedure:

1. Apply 2mL of sample to a preconditioned cartridge.
2. Discard first 1mL of eluate.
3. Collect and analyze remaining eluate.

IC-OH Devices

Description	Volume	Qty	Part No.
Maxi-Clean™ IC-OH	0.5mL	50	5122573
Maxi-Clean™ IC-OH Plus	1.5mL	25	5122567
Extract-Clean™ IC-OH	0.5mL	50	5122909
Extract-Clean™ IC-OH Plus	1.5mL	30	5122033



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Maxi-Clean™ IC-RP SPE Cartridges

Introduction

Maxi-Clean™ Ion Capture Devices are solid-phase extraction devices used to eliminate matrix interferences from samples prior to analyses by LC, IC, or GC. Each device consists of either 0.5mL or 1.5mL of polystyrene-based packing sandwiched between polyethylene frits within an injection-molded medical-grade polypropylene housing (**Figure 1**). Samples and wash solvents are passed through the packing using a luer hub syringe. As sample comes in contact with the packing, specific chemical interactions take place which selectively retain certain components of the matrix in the device while the remaining components pass through the device outlet.

Successful application of IC devices requires:

- 1) proper conditioning of the device prior to sample application,
- 2) application of the sample at a rate slow enough to allow the chemical interaction to take place while the sample is in the device, and
- 3) control of sample size to keep within the device's capacity.

The following information provides general recommendations for the use of IC-RP devices. This procedure may be modified to accommodate samples with different characteristics.

General Information

Maxi-Clean™ IC-RP devices provides a reliable method for the removal of hydrophobic components from aqueous samples prior to analysis by ion chromatography. IC-RP devices contain either 0.5mL or 1.5mL of hydrophobic porous polystyrene packing. Hydrophobic components of the sample are retained in the packing by reversed-phase mechanisms. Polar organics and inorganic anions and cations are not retained. The net result is removal of hydrophobic components from the matrix while polar components pass through the cartridge intact. This mechanism may be used to remove surfactants, organic acids, proteins and other organic substances.

Flow Rate

The devices have a number of flow-dependent parameters that may affect results. In general, high flow rates, particularly in the sample loading step, will decrease the performance while low flow rates will improve the extraction process. Low flow rates allow the sample to diffuse into the packing thus increasing capacity and improving the efficiency. The recommended flow rate for sample loading is 1mL/minute or less.

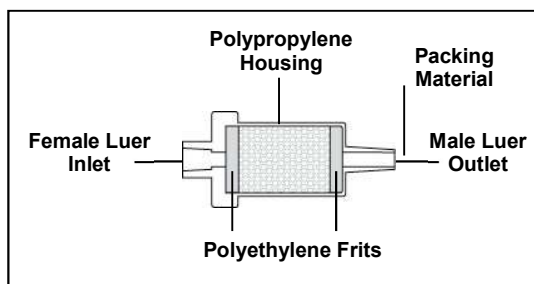


Figure 1

Sample Mass

Each device capacity is dependent on the nature of the sample components and on the matrix solvent. Sample components with the greatest degree of hydrophobicity and with net neutral charge will exhibit the highest capacity. In addition, capacity is enhanced when the matrix solvent is aqueous. Device capacity may be determined experimentally by passing a large volume of sample through the device and collecting the eluate in 1mL fractions. Assay each fraction for the contaminant. The device capacity is defined as the amount of sample that may be applied before the contaminant appears in the eluate. Best routine results are obtained when sample size is adjusted to use 50% or less of the device capacity.

Sample Volume

The internal volumes of the different devices include the flow passages and interstitial packing volume. Although it is possible to recover all but 100µL (for the 0.5mL devices) or 150µL (for the 1.5mL devices) of sample with an air purge, best results are obtained when the sample volume greatly exceeds the internal volume of the cartridge.

General Procedure

- 1. Precondition the Device.** Pass 5 to 10mL of HPLC grade methanol through the device. This removes interstitial contaminants and wets the packed bed. Follow this with 5 to 10mL of IC grade water. For trace analysis work, repeat this procedure until the water rinse is free from interferences.
- 2. Load the Sample.** Load the entire sample at 1mL/minute or less. The total amount of contaminant contained in the sample should not exceed the device capacity and preferably should be below 50% of total capacity. Discard the first 1mL of eluate. Collect the remaining eluate for analysis.

Other IC Devices

Device	Retains
IC-RP:	Hydrophobic Components
IC-OH:	Anions (pH increase)
IC-H:	Cations (pH reduction)
IC-Ag:	Chloride, Iodide, Bromide
IC-Ba:	Sulfate
IC-Na:	Cations (no pH change)
IC-Chelate:	Polyvalent Metal Ions
IC-Mixed Mode RP-OH:	Hydrophobic Components and Anions (pH increase)
IC-Mixed Mode RP-H:	Hydrophobic Components and Cations (pH reduction)

IC-RP Devices

Description	Volume	Qty	Part No.
Maxi-Clean™ IC-RP	0.5mL	50	5122571
Maxi-Clean™ IC-RP	1.5mL	25	5122566
Extract-Clean™ IC-RP	0.5mL	50	5122898

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