C197-E007

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Ion Chromatograph Selection Guide for Columns and Other Consumables

Contents

Chapter
1

Selection Guide for Columns and Other Consumables

Chapter
2

Supplementary Materials

Chapter

1

Selection Guide for Columns and Other Consumables

1-1. Introduction

Ion chromatographs separate ionic compounds using ion exchange columns designed for ion chromatography.
Various consumables are available that are required during analysis, such as for pretreating sample solutions. In addition, basic knowledge is also important during analysis and for selecting consumables.
This catalog provides a summary of consumables information necessary for ion chromatography. It is intended to assist the selection of ion chromatography consumables suitable for the given application.
The main items needed before starting ion chromatography are summarized in the table below.

Item	Remarks	Reference Page
Various pipettes	Rinse the pipettes with ultrapure water (pipetting) about 2 or 3 times before use. Check pipette tips for any residual water droplets before use.	-
Eluent storage bottles[1), 2), 3)]	1) Either borosilicate glass or polypropylene (PP) bottles may be used. 2) To prevent contamination from the container, store the bottles filled with ultrapure water when not in use. Before use, discard the ultrapure water that filled the bottles and rinse the bottles with fresh ultrapure water. 3) Detergent or other agents could cause contamination, so it is recommended that the bottle be rinsed several times with ultrapure water after use and designated for ion chromatography only.	-
PP eluent storage bottles[1), 2), 3)]		
PP volumetric flasks[2), 3)]		
Analytical columns	Used to separate ionic compounds in sample solutions.	4-7
Guard columns/guard filters	Analytical columns for ion chromatography are generally more expensive than typical HPLC columns. Guard columns or guard filters are recommended for protecting analytical columns from interfering substances contained in sample solutions.	
Eluents/carbon dioxide gas traps	· For carbonate-based eluents used in anion analysis, it is recommended to prepare stock solutions at roughly ten times the target concentration and dilute them before analysis. · Avoid using ultrasonic degassing when preparing carbonate-based eluents. The ultrasonic process can generate nitrite from atmospheric nitrogen.	8-12
Reagents for preparing standard solutions	Needed for preparing standard solutions.	
PP vials	Rinse PP vials and lids 2 or 3 times with ultrapure water before use. For high-sensitivity analysis, it is recommended to store the vials overnight filled with ultrapure water and then rinse them with ultrapure water before use.	13
Disposable pretreatment filters for filtering samples	Using disposable filters is recommended for ion chromatography. A filter pore size of 0.2 µm is recommended.	14
Solid-phase extraction cartridges	Solid phase extraction cartridges can be used for a variety of purposes, such as removing hydrophobic organic matter or removing high levels of chloride ions.	15

Notes:

- It is important to prevent contamination, especially from the environment, the working environment, and the tools used for sample preparation, because contamination can affect analytical results. Basically, it is recommended to prepare reagents, eluents, and other solutions in a fume hood and to avoid working with bare hands.
- Contamination can also be caused by substances attached to gloves. After putting on gloves, it is recommended that the gloves be rinsed with ultrapure water before conducting experiments.
- If contamination from the working environment is affecting analytical results, sometimes the problem can be resolved by working inside a fume hood that has been wiped down with ultrapure water.

1-2. Ion Chromatography Columns

1-2-1. Separating Ions in a Column

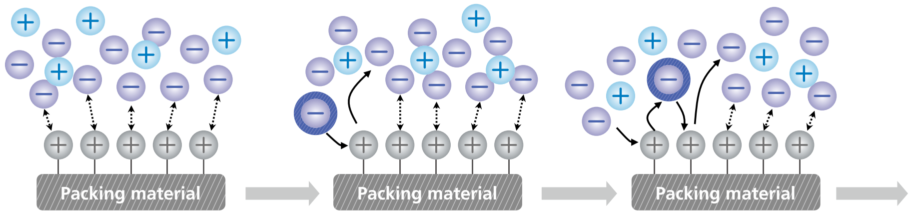
Either ion-exchange or ion-exclusion mechanisms are used to separate components in ion chromatography, where ion-exchange separation is typically used to separate inorganic ions. The following describes the ion-exchange mechanism for separating chloride ions (Cl^-) from a potassium chloride (KCl) sample solution using an aqueous sodium carbonate (Na_2CO_3) solution as the eluent.

Illustration of Using an Ion Exchange Column to Separate Cl^- Ions in a Sample Solution

Eluent: Aqueous Na_2CO_3 solution

Generation of Carbonate Ions (CO_3^{2-})
$Na_2CO_3 \rightarrow 2Na^+ + CO_3^{2-}$

⊖ Anions in the eluent (CO_3^{2-})
⊕ Cations in the eluent (Na^+)
⊕ Functional group in packing material (quaternary ammonium)
⊖ Anions in sample solution (Cl^-)



Equilibrium state is formed by electrostatic interaction between CO_3^{2-} ions and the functional groups on packing material surfaces.

Cl^- and CO_3^{2-} ions are exchanged.

Repeated ion-exchange interactions of Cl^- delay its elution from the column.

The Cl^- counterions become cations in the eluent.

An equilibrium state forms within the column due to electrostatic interaction between the anions (CO_3^{2-}) in the eluent and the anion exchange groups (quaternary ammonium) in the column. When anions in the sample solution (Cl^- in this case) flow into the column, they repeat electrostatic interactions with anion exchange groups as they move through the column. When the anions in the sample solution (Cl^-) elute from the column, the counterions (K^+ in this case) will have been exchanged with cations (Na^+ in this case) in the eluent. Though the counterions for the anions (Cl^-)in the sample solution that flows into the column are exchanged with cations (Na^+), the eluent will elute directly out of the column.

Change in Cl^- Counterions

$$K^+ + Cl^- \xrightarrow{\text{Inside the column}} Na^+ + Cl^-$$

The Cl^- counterions in the sample solution are exchanged with Na^+ ions in the eluent.

Change in Eluent Composition

$$2Na^+ + CO_3^{2-} \longrightarrow 2Na^+ + CO_3^{2-}$$

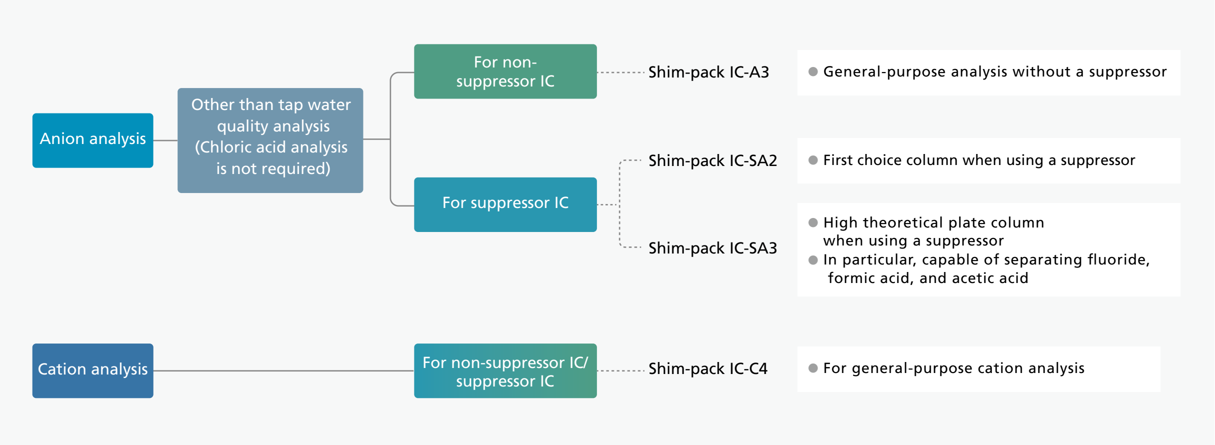
No change

When the anion concentration in the eluent increases, the decreased interaction between anions in the sample solution and anion exchange groups results in weaker retention and faster elution. Conversely, if the anion concentration in the eluent decreases, the increased interaction between anions in the sample solution and anion exchange groups results in stronger retention and slower elution.

If the eluate electrical conductivity is detected directly after it is eluted from the column, the constant detection of the abundant anions (CO_3^{2-}) and cations (Na^+) present in the eluent can cause baseline noise that interferes with detecting anions in the sample solution. Therefore, a suppressor is used to reduce such eluent effects.

1-2-2. Shim-pack IC Series Columns for Ion Chromatography

Refer to the flowchart below to select Shimadzu ion chromatography columns. To reduce adsorption-related contamination and deterioration of the analysis column caused by organic matter in the sample solution, use a guard column or guard filter.



Analytical Columns (General Purpose)

Product Name	P/N	Stationary Phase	Particle Size (μm)	Column Size	Remarks
Shim-pack IC-SA2	228-38983-91	Quaternary ammonium group	9	250 mm×4.0 mm I.D.	For anion suppressor IC
Shim-pack IC-SA3	228-41600-91	Quaternary ammonium group	5	250 mm×4.0 mm I.D.	For anion suppressor IC
Shim-pack IC-A3	228-31076-91	Quaternary ammonium group	5	150 mm×4.6 mm I.D.	For anion non-suppressor IC
Shim-pack IC-C4	228-41616-91	Carboxyl group	7	150 mm×4.6 mm I.D.	For cation non-suppressor IC/ suppressor IC

Guard Column (General Purpose)

Product Name	P/N	Column Size	Remarks
Shim-pack IC-SA2 (G) guard column	228-38983-92	10 mm×4.6 mm I.D.	Guard column for Shim-pack IC-SA2
Shim-pack IC-SA3 (G) guard column	228-41600-92	10 mm×4.6 mm I.D.	Guard column for Shim-pack IC-SA3
Shim-pack IC-GA3 guard column	228-31076-92	10 mm×4.6 mm I.D.	Guard column for Shim-pack IC-A3
Guard cartridge + holder set for Shim-pack IC-C4	228-59900-91	-	Set of guard cartridge and dedicated holder for Shim-pack IC-C4
Guard cartridge (for replacement) for Shim-pack IC-C4	228-59900-92	-	Guard cartridge for Shim-pack IC-C4 for replacement (contains 1 pc)

Examples of Various Guard Columns/Filters

Guard Column for Shim-pack IC-SA3

Guard Cartridge + Holder Set for Shim-pack IC-C4

Applications

More information about ion chromatograph-related applications is available at the following websites.

Search based on the
ion-chromatograph related applications

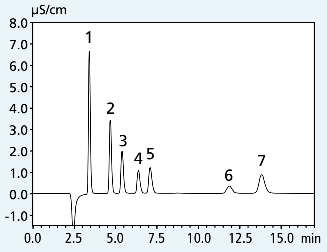
Search for applications based on the compound name

CoreFocus Library

1-2-3. Examples of Shim-pack IC Column Chromatograms —Standard Solutions—

For Anion Suppressor IC Analysis (Anion Analysis)

Shim-pack IC-SA2
Standard Solution with 7 Anionic Components



■ Conditions

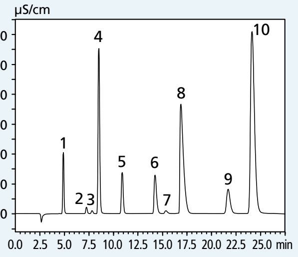
Column : Shim-pack IC-SA2
Mobile phase : 1.7 mmol/L sodium hydrogen carbonate/ 1.8 mmol/L sodium carbonate
Flow rate : 1.0 mL/min
Column temp. : 30 °C
Detection : Conductivity
Injection volume : 50 µL

■ Peaks

1. Fluoride : 1 mg/L
2. Chloride : 1 mg/L
3. Nitrite : 1 mg/L
4. Bromide : 1 mg/L
5. Nitrate : 1 mg/L
6. Phosphate : 1 mg/L
7. Sulfate : 1 mg/L

For Anion Suppressor IC Analysis (Anion Analysis)

Shim-pack IC-SA3
Standard Solution with 10 Anionic Components



■ Conditions

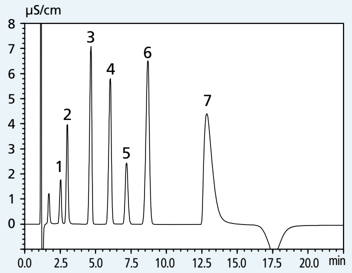
Column : Shim-pack IC-SA3
Mobile phase : 3.6 mmol/L sodium carbonate
Flow rate : 0.8 mL/min
Column temp. : 45 °C
Detection : Conductivity
Injection volume : 50 µL

■ Peaks

1. Fluoride : 1 mg/L
2. Chlorite : 1 mg/L
3. Bromate : 1 mg/L
4. Chloride : 1 mg/L
5. Nitrite : 5 mg/L
6. Bromide : 10 mg/L
7. Chlorate : 1 mg/L
8. Nitrate : 30 mg/L
9. Phosphate : 15 mg/L
10. Sulfate : 40 mg/L

For Anion Non-Suppressor IC Analysis (Anion Analysis)

Shim-pack IC-A3
Standard Solution with 7 Anionic Components



■ Conditions

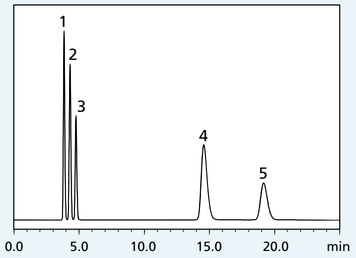
Column : Shim-pack IC-A3
Mobile phase : 8.0 mmol/L *p*-hydroxybenzoic acid/ 3.2 mmol/L Bis-tris. / 50 mmol/L Boric acid
Flow rate : 1.2 mL/min
Column temp. : 40 °C
Detection : Conductivity
Injection volume : 50 µL

■ Peaks

1. Phosphate : 30 mg/L
2. Fluoride : 5 mg/L
3. Chloride : 10 mg/L
4. Nitrite : 15 mg/L
5. Bromide : 10 mg/L
6. Nitrate : 30 mg/L
7. Sulfate : 40 mg/L

For Suppressor/Non-Suppressor IC Analysis (Cation Analysis)

Shim-pack IC-C4
Standard Solution with 5 Cationic Components



■ Conditions

Column : Shim-pack IC-C4
Mobile phase : 2.5 mmol/L methanesulfonic acid
Flow rate : 1.0 mL/min
Column temp. : 40 °C
Detection : Conductivity (with a suppressor)
Injection volume : 50 µL

■ Peaks

1. Sodium : 1 mg/L
2. Ammonium : 1 mg/L
3. Potassium : 1 mg/L
4. Magnesium : 1 mg/L
5. Calcium : 1 mg/L

1-3. Eluents and Standard Solutions

1-3-1. Water Used for Preparation

To protect the column, prevent ghost peaks, and avoid contamination of the flow path, the water used for ion chromatography must not contain ionic or organic compounds.
If using a commercial water filtration system, use a model with a name such as "ultrapure water system" that is capable of generating water with a specific resistance of 18.2 MΩ·cm and low TOC levels (<50 µg/L).

Notes:
· Using lower-grade water could cause pump malfunctions, unknown peaks due to autosampler contamination, elevated column pressure due to column contamination, premature degradation of peak shapes, or other problems.
· "Ultrapure water systems" are generally considered to be systems capable of generating ASTM D 1193-06 (2018) Type 1 or better water.

Reference Example: Extract from ASTM D 1193-06 (2018)

Parameter	Type 1	Type 2	Type 3	Type 4
Electrical conductivity (max.)	0.0555	1.0	0.25	5.0
Specific resistance (min.)	18	1.0	4.0	0.2
Total organic carbon (TOC) (max.)	50	50	200	-
Sodium (max.)	1	5	10	50
Chloride ions (max.)	1	5	10	50
Total silica (max.)	3	3	500	-

1-3-2. Eluents

Columns used for ion chromatography are often designed for specific applications or purposes, such as for analyzing regulated ions. Therefore, a column appropriate for the specific application or purpose of analysis must be selected. Even if using the same column, separation can be adjusted by changing the analytical conditions, including the eluent composition.

Reagents Used to Prepare Eluents

An example of reagents used for preparing eluents is shown below.
Impurities in reagents can cause unknown peaks.
If changes are made, use reagents of equivalent or higher quality than listed and verify performance before use.

Reagents for Preparing Eluents for Anion Analysis

For Suppressor IC

Reagent	Example of Manufacturer	Example of Product Code	Example of Volume	Example of Grade
Sodium carbonate	FUJIFILM Wako Pure Chemical	196-01595	500 g	Special grade
Sodium hydrogen carbonate	FUJIFILM Wako Pure Chemical	191-01305	500 g	Special grade

For Non-Suppressor IC

Reagent	Example of Manufacturer	Example of Product Code	Example of Volume	Example of Grade
p-hydroxybenzoic acid	Nacalai Tesque	18509-52	25 g	Nacalai standard Special grade GR
Bis-Tris	FUJIFILM Wako Pure Chemical	343-04742	25 g	(manufactured by Dojindo Laboratories)
Boric acid	FUJIFILM Wako Pure Chemical	029-02191	100 g	Special grade

Reagents for Preparing Eluents for Cation Analysis

For Suppressor IC

Reagent	Example of Manufacturer	Example of Product Code	Example of Volume	Example of Grade
2 mol/L methanesulfonic acid solution	FUJIFILM Wako Pure Chemical	131-12551	100 mL	For ion chromatography

For Non-Suppressor IC

Reagent	Example of Manufacturer	Example of Product Code	Example of Volume	Example of Grade
2 mol/L methanesulfonic acid solution	FUJIFILM Wako Pure Chemical	131-12551	100 mL	For ion chromatography
Oxalic acid dihydrate	FUJIFILM Wako Pure Chemical	155-00422	25 g	Special grade
18-crown-6	FUJIFILM Wako Pure Chemical	031-12542	25 g	Special grade

Eluent Compositions for Standard Analysis Using Shim-pack IC Series Columns

Standard analytical conditions are provided for each Shim-pack IC Series column to maximize column performance.
The following shows representative columns used and the composition and preparation method of standard eluents.

However, note that for some sample solutions with many interfering substances, it might not be possible to achieve adequate separation using standard analytical conditions.
In such cases, sometimes the separation can be improved by changing eluent composition, column temperature, or other factors. For more details, refer to the applications for ion chromatography.

Also, be sure to use clean equipment and eluent containers for preparing eluents. Preparing eluents using eluent containers or other supplies that have been left unused for an extended period could cause microbial growth, which could increase column pressures or cause column degradation.

Notes:
- Label the eluent container with the preparation date of the ten-fold concentrated stock solution and store it in a cool, dark place. The recommended storage period is two weeks to one month.
- Do not perform ultrasonic treatment or filtering during dilution. Doing so could generate trace ions or contaminate the eluent.

Shim-pack IC-SA2

Conditions	Eluent Composition	Flowrate (Normal)	Column Temp. (Normal)	Column Pressure Capacity	Remarks
Standard conditions 1	1.8 mmol/L sodium carbonate 1.7 mmol/L sodium hydrogen carbonate	1.0 mL/min	25 °C	12 MPa	Conditions for eluting carbonate ions between nitrate and phosphate ions
Standard conditions 2	0.6 mmol/L sodium carbonate 12.0 mmol/L sodium hydrogen carbonate	1.0 mL/min	30 °C		Conditions for eluting carbonate ions after sulfate ions
Conditions for fast analysis	1.8 mmol/L sodium carbonate 1.7 mmol/L sodium hydrogen carbonate	1.5 mL/min	40 °C		

- **Eluent Composition: 1.8 mmol/L sodium carbonate and 1.7 mmol/L sodium hydrogen carbonate**

  Prepare a ten-fold concentrated stock solution of the eluent used for analysis and then dilute it ten-fold with ultrapure water before use.
  Preparation of the ten-fold concentrated stock solution: Dissolve 1.91 g of sodium carbonate (Na_2CO_3 with MW 105.99) and 1.43 g of sodium hydrogen carbonate ($NaHCO_3$ with MW 84.01) in ultrapure water to a final volume of 1 L

- **Eluent Composition: 0.6 mmol/L sodium carbonate and 12.0 mmol/L sodium hydrogen carbonate**

  Prepare a ten-fold concentrated stock solution of the eluent used for analysis and then dilute it ten-fold with ultrapure water before use.
  Preparation of the ten-fold concentrated stock solution: Dissolve 0.636 g of sodium carbonate (Na_2CO_3 with MW 105.99) and 10.1 g of sodium hydrogen carbonate ($NaHCO_3$ with MW 84.01) in ultrapure water to a final volume of 1 L.

Shim-pack IC-SA3

Conditions	Eluent Composition	Flowrate (Normal)	Column Temp. (Normal)	Column Pressure Capacity	Remarks
Standard conditions	3.6 mmol/L sodium carbonate	0.8 mL/min	45 °C	15 MPa	

- **Eluent Composition: 3.6 mmol/L sodium carbonate**

  Prepare a ten-fold concentrated stock solution of the eluent used for analysis and then dilute it ten-fold with ultrapure water before use.
  Preparation of the ten-fold concentrated stock solution: Dissolve 3.82 g of sodium carbonate (Na_2CO_3 with MW 105.99) in ultrapure water to a final volume of 1 L.

Shim-pack IC-A3

Conditions	Eluent Composition	Flowrate (Normal)	Column Temp. (Normal)	Column Pressure Capacity	Remarks
Standard conditions	8 mmol/L *p*-hydroxybenzoic acid/ 3.2 mmol/L BisTris / 50 mmol/L Boric acid	1.2 mL/min	40 °C	12 MPa	

- **Eluent Composition: 8 mmol/L p-hydroxybenzoic acid, 3.2 mmol/L BisTris, and 50 mmol/L boric acid**

  Dissolve 1.105 g *p*-hydroxybenzoic acid, 0.670 g Bis-Tris, and 3.092 g boric acid in ultrapure water to a final volume of 1 L. Because these reagents have poor solubility, dissolve *p*-hydroxybenzoic acid in ultrapure water adjusted to basic conditions with Bis-Tris, and heat the mixture to approximately 30 °C with stirring, which further improves solubility.

Notes:
· A concentrated eluent stock solution cannot be prepared and stored. Because of their low solubility, the reagents cannot be stored under refrigerated conditions.
· The boric acid is added as a preservative.

Shim-pack IC-C4

Conditions	Eluent Composition	Flowrate (Normal)	Column Temp. (Normal)	Column Pressure Capacity	Remarks
Standard conditions	2.5 mmol/L methanesulfonic acid	1.0 mL/min	40 °C	6.5 MPa	
Conditions for high separation analysis	2.5 mmol/L methanesulfonic acid solution that contains 1 to 5 mmol/L 18-crown-6	1.0 mL/min	40 °C		These conditions are for improving separation of sodium and ammonium ions. These conditions delay the elution of potassium and ammonium ions. They are for non-suppressor IC.

- **Eluent Composition: 2.5 mmol/L methanesulfonic acid**

  Dissolve 1.25 mL of 2 mol/L methanesulfonic acid in ultrapure water to a final volume of 1 L.

- **Eluent Composition: 2.5 mmol/L methanesulfonic acid solution that contains 1 to 5 mmol/L 18-crown-6**

  For an eluent consisting of 2.5 mmol/L methanesulfonic acid with 1 mmol/L 18-crown-6 added, dissolve 1.25 mL of 2 mol/L methanesulfonic acid and 0.264 g of 18-crown-6 ($C_{12}H_{24}O_6$ with MW 264.318) in ultrapure water to a final volume of 1 L.

  Adding 18-crown-6 to the eluent delays the elution of potassium and ammonium ions.
  That delay effect can be increased by adding more 18-crown-6. Adjust the amount of 18-crown-6 to approximately 1 to 5 mmol/L.

1-3-3. Carbon Dioxide Gas Traps

When using a dilute alkaline eluent, even a small amount of dissolved carbon dioxide can change its composition and pH, affecting retention time and separation. When using such eluents, analysis stability can be improved by installing a carbon dioxide gas trap.

Product Name	P/N	Capacity
CO_2 Absorber	630-00999	500 mL
CO_2 absorber piping kit	228-74159-41	-

Notes:
- The CO_2 absorber and CO_2 absorber piping kit do not include an eluent bottle.
- For connection instructions, refer to the instruction manual included with the CO_2 absorber piping kit.

1-3-4. Reagents for Standard Solution Preparation

The type, grade, and sample concentration of reagents needed for ion chromatography vary depending on the analytical conditions and purpose of analysis. In particular, impurities in reagents used for ion chromatography can cause baseline fluctuations or the appearance of unknown peaks. For reference purposes, some single-component concentrated standard solutions for ion chromatography are listed below (some are JCSS certified). Using ion chromatography standard solutions available in your region is recommended.

Reference Manufacturer: FUJIFILM Wako Pure Chemical Corporation

Reagent	Example of Product Code	Example of Volume	Grade
Chloride ion standard solution (Cl- 1000)	038-16153	100 mL	For ion chromatography, JCSS-certified
Fluoride ion standard solution (F- 1000)	066-03401	50 mL	
Bromide ion standard solution (Br- 1000)	024-15331	50 mL	
Nitrite ion standard solution (NO2- 1000)	146-06453	100 mL	
Nitrite-nitrogen standard solution (NO2- (as N) 1000)	147-09901	100 mL	
Nitrate ion standard solution (NO3- 1000)	149-06443	100 mL	
Nitrate-nitrogen standard solution (NO3- (as N) 1000)	144-09891	100 mL	
Phosphate ion standard solution (PO43- 1000)	164-17463	100 mL	
Sulfate ion standard solution (SO42- 1000)	198-10823	100 mL	
Chlorate ion standard solution (ClO3- 1000)	031-24953	100 mL	
Chlorite ion standard solution (ClO2- 1000)	036-25581	100 mL	
Bromate ion standard solution (BrO3- 2000)	024-18913	50 mL	
Sodium ion standard solution (Na+: 1000 ppm)	193-09621	50 mL	
Potassium ion standard solution (K+: 1000 ppm)	163-13991	50 mL	
Magnesium ion standard solution (Mg^{2+}: 1000 ppm)	135-09761	50 mL	
Calcium ion standard solution (Ca^{2+}: 1000 ppm)	031-13321	50 mL	
Ammonium ion standard solution (NH4+: 1000 ppm)	019-15461	50 mL	
Lithium ion standard solution (Li+: 1000 ppm)	126-03391	50 mL	

1-4. Vials for Ion Chromatography

When performing ion chromatography, use vials designed for ion chromatography. Shimadzu provides two types of vials depending on capacity.

Product Name	P/N	Capacity	Vial Material	Cap Material	Septum Material	Slit	Quantity	Supports Nexera IC Automatic Dilution Function
Shim-vial S PP-U	228-59584-41	1.5 mL	Transparent polypropylene	Black polypropylene	White silicone Brown PTFE	No	100	○ Supported
1.5 mL PP vial for ion chromatography	GLC-IVS-100	1.5 mL	Transparent polypropylene	Blue polypropylene	White silicone Blue PTFE	Yes	100	× Not supported
4 mL PP vial for ion chromatography	228-31537-91	4 mL	Transparent polypropylene	White polypropylene	White silicone Brown PTFE	No	100	× Not supported

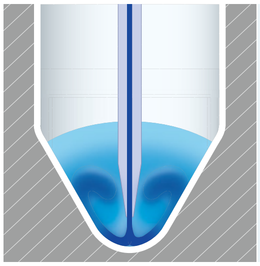
Shim-vial S PP-U

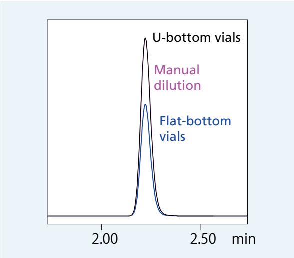
High-Quality Polypropylene Vials Compatible with Automatic Dilution

We use high-purity polypropylene, which is also used for pharmaceutical packaging, and thoroughly manage the traceability of raw materials.

The shape of the vial base is optimized for the automatic dilution process, and is designed to reduce uneven mixing, based on fluid dynamics and simulation. For example, when an autosampler’s automatic pretreatment function dispenses equal volumes of sample solution and diluent into a vial, typical flat-bottom vials may not allow the liquids to mix sufficiently. As a result, the analytical results may show decreased peak area values and greater variability compared with manual dilution.

In contrast, Shim-vial S PP-U vials feature a bottom shape that promotes natural mixing between the liquids based on fluid dynamics during dispensing. Consequently, the vials achieve more consistent analytical results using automatic pretreatment, due to area values comparable to manual mixing.





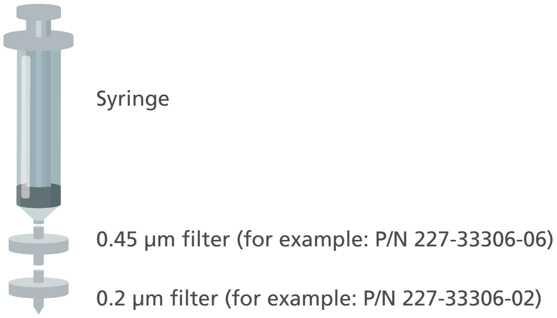
Notes:
- · If contamination of the vial is a concern, wash the vial and lid with ultrapure water two to three times before use.
  For information on contamination, refer to “Chapter 2 Supplementary Materials, Section 2-1.”
- · Mixing efficiency can vary depending on the viscosity of liquids to be mixed and sample solubility.

1-5. Membrane Filters

Normally, in HPLC and IC, membrane filters with pore sizes of 0.2 to 0.5 µm are used to filter sample solutions and prevent clogging of the flow path and column by foreign matter. Membrane filters are designed to attach to the tip of a plastic syringe, allowing filtration simply by pressing the syringe plunger. We recommend using membrane filters for IC, with low levels of inorganic ion contamination.

Two pore sizes are available: 0.45 µm and 0.2 µm. The 0.2 µm filter is recommended as the first choice.
Membrane filters with different pore sizes or diameters can also be connected and used depending on clogging conditions when processing sample solutions.

Example of use in combination: Syringe >>>> 0.45 µm filter (for example: P/N 227-33306-06) >>>> 0.2 µm filter (for example: P/N 227-33306-02)



Product Name	P/N	Effective Filtration Area (cm2)	Pore Size (μm)	Residual Liquid Volume (μL)	Quantity (No.)	Joints	Remarks
Syringe filter (for IC), 4 mm	227-33306-01	0.07	0.2	≤ 10	100	Inlet: Luer lock Outlet: Luer slip	Sample solvent: Aqueous
	227-33306-04		0.45				
Syringe filter (for IC), 13 mm	227-33306-02	0.8	0.2	≤ 30			
	227-33306-05		0.45				
Syringe filter (for IC), 25 mm	227-33306-03	4.0	0.2	≤ 100			
	227-33306-06		0.45				

Note: Product handled by Shimadzu GLC

Notes:
- Membrane filters are used to remove fine particulates and insoluble components from sample solutions, but there is a possibility that analyte ions will be removed along with them. It is necessary to check the membrane material and pore size in advance to ensure that the use of membrane filters will not affect the analysis results.
- Membrane filters are compatible with Luer lock-type syringes.
- If contamination from the storage environment is a concern, flush the filter with ultrapure water before use.

1-6. Solid-Phase Extraction Cartridges

Dilution with ultrapure water is typically used for ion chromatography pretreatment, but solid-phase cartridges are also used to remove components that could interfere with analysis (such as hydrophobic organic matter, concentrated strong acids, or metal ions) or to adjust the pH. Select the cartridges based on their function indicated in the table below.
A solid-phase cartridge must be selected that is suitable for the types and quantities of ions to be removed.

Maxi-Clean^{TM}*1 Cartridges

Product Name	Packing Volume 0.5 mL (Set of 50) P/N*2	Packing Volume 1.5 mL (Set of 25) P/N*2	Ion Exchange Capacity	Retention	Function	Remarks
Maxi-Clean IC-OH	30262	30254	1.0 meq/mL	Anions	Used to remove high concentrations of strong acids (such as hydrochloric acid, nitric acid, or sulfuric acid) such as when measuring alkali metal ions.	It exchanges anions with hydroxide ions. It is used to reduce anion concentrations in sample solutions, but it can also be used to concentrate anions. It can also be used to adjust the pH of acidic sample solutions closer to neutral.
Maxi-Clean IC-H	30264	30256	2.0 meq/mL	Cations	Used to remove high concentrations of alkali metal, alkaline earth metal, or other ions, such as when measuring inorganic anions in aqueous sodium hydroxide solutions.	It exchanges cations with H^+ ions. It is used to reduce cation concentrations in sample solutions, but it can also be used to concentrate cations. It can also be used to adjust the pH of basic sample solutions closer to neutral.
Maxi-Clean IC-Ag	30266	30258	2.0 meq/mL	Halogens (Cl^-, Br^-, and I^-)	Used to remove high concentrations of halide ions (Cl^-, Br^-, or I^-), such as when measuring nitric or nitrous acid ions in seawater or brackish water.	Can be used to remove excessive halides due to formation of silver halide precipitates. Though this cartridge can be used to reduce the concentration of chloride ions in sample solutions, it can simultaneously also remove bromide ions and other halogens.
Maxi-Clean IC-Ba	30268	30261	2.0 meq/mL	Sulfate ions	Used to remove high concentrations of sulfate ions by utilizing their tendency to form a precipitate with barium ions.	This can remove sulfate ions by forming barium sulfate ($BaSO_4$).
Maxi-Clean IC-Na	30270	30263	2.0 meq/mL	Cations	Exchanges cations with Na^+ ions	It exchanges cations with Na^+ ions. It can also be used to remove cations without changing the pH of sample solutions.
Maxi-Clean IC-Chelate	30250	30265	0.4 meq/mL	Multivalent metal ions	Used to remove transition metal ions, such as when measuring inorganic anions in plating solutions.	IIt exchanges transition metal and divalent cations with Na^+ ions. It can also be used to remove transition metal and divalent cations from sample solutions.
Maxi-Clean IC-RP	30260	30252	-	Hydrophobic compounds	Used to remove hydrophobic compounds, for example when measuring inorganic ions in wastewater samples with high dissolved carbon content.	It can be used to remove surfactants and other organic substances.

*1 Solid-phase extraction product manufactured by S*Pure Pte Ltd.
*2 In the case of products offered by Shimadzu GLC. For inquiries or purchases, please contact your local Shimadzu representative.

Notes:
- When using an IC-Ag cartridge, connect an IC-H cartridge in series at the IC-Ag outlet to prevent Ag from eluting from the solid-phase cartridge and entering the column.
- If Ag enters the column, a phenomenon occurs where the elution of specifically Cl^-, Br^-, and I^- ions are delayed.

Chapter

2

Supplementary Materials

2-1. Contamination in Ion Chromatography

Ion chromatography is an analytical method used widely in many regulated and other fields, but the types and concentrations of ions targeted can differ significantly depending on the purpose of analysis. In particular, analysis in regulated fields often involves separating and detecting ions with a large difference in concentration levels. Blank confirmation using ultrapure water analysis is also often mandated.

Clarifying the purpose for checking blanks helps determine whether any small peaks detected need to be taken into consideration. Blanks are typically checked by analyzing ultrapure water to determine the presence of peaks, but inorganic ions targeted by ion chromatography are easily introduced as contaminants from the environment or from personnel handling the samples. In particular, chloride ions are more likely to occur due to contamination from personnel. In addition, volatile acids such as nitric, sulfuric, formic, and acetic acids can readily become sources of contamination.

The important point here is that, although completely eliminating contamination is ideal, doing so requires careful control of equipment selection and handling, the water and reagents used, and the establishment of procedures and SOPs based on experience with contamination risks at each analytical step. There are limits to how much contamination can be reduced through SOPs alone. Needless to say, that requires analysts to understand the intent of SOPs and perform operations accordingly.

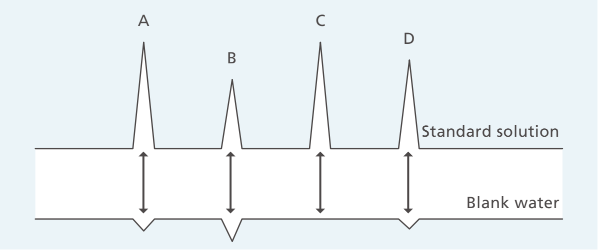
It is also essential to assess what level of blank contamination is acceptable to achieve the analytical objective.
Therefore, the following provides reference information on contamination considerations at each step of the analytical process.

2-1-1. Contamination during Eluent Preparation

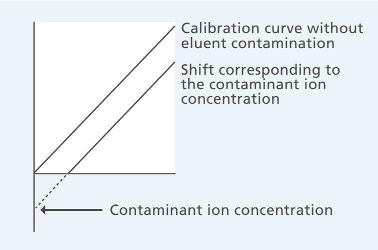
When eluents are prepared by dissolving reagents in ultrapure water, if the equipment used is contaminated, contaminants can leach into the eluent. This applies to all equipment used to prepare eluents, such as the graduated cylinders and volumetric flasks used for measuring and containers used to hold the eluent. Even the cleaning and storage methods can affect both the extent and the types of ionic contaminants introduced.

Phenomena that are Likely to Occur

When the eluent is contaminated with ions, those ions are continuously introduced into the column at a steady concentration and establish an equilibrium with the functional groups of the column packing material. If ultrapure water or any other substance is injected at that point for blank analysis, the temporary interruption in the ion supply from the eluent will cause the concentration to change. Such concentration fluctuations are typically detected as negative peaks, with the peak position corresponding to the column position where the contaminant ion was eluted. In the case of simultaneous contamination by multiple ions, multiple negative peaks are detected. The size of the negative peaks corresponds to the level of contamination by each ion. The presence of eluent contamination can be determined by blank analysis.



This phenomenon also occurs in standard solutions, causing the calibration curve to shift in the negative direction by an amount corresponding to the concentration of the contaminant ions.



How to Identify the Source of Contamination

If the phenomenon is resolved by preparing the eluent again using the same equipment, the equipment used in preparation is likely the contamination source.
If not resolved, a reagent used for eluent preparation, the suction filter, or something else might be contaminated.

How to Reduce Contamination

Equipment used for eluent preparation should be dedicated to ion chromatography, cleaned only with ultrapure water, and stored in a clean environment to ensure proper contamination control.

Target Contamination	Remarks
Water	Because ultrapure water can become contaminated once it is stored in a container, it is preferable to dispense the water directly into measuring equipment.
Reagents	Be careful to prevent contamination when eluent reagents are weighed. Though reagents may contain a residual level of ions that cannot be removed during manufacturing, due to the small quantities of reagent used per liter of water, the probability of it affecting analysis is often judged to be low. Nevertheless, as a precaution, the specifications sheet for reagents used to prepare eluents can be obtained to check residual ion levels.
Measuring equipment (volumetric flasks and graduated cylinders) PP volumetric flasks	Equipment used to measure ultrapure water should be used exclusively for ultrapure water. Also, unexpected contamination can be reduced by lightly rinsing the equipment with ultrapure water before use. If equipment is used for another purpose and then dried without being adequately cleaned, it can cause contamination from dried substances redissolving the next time ultrapure water is measured. In such cases as well, a habit of always rinsing equipment with ultrapure water before use can help prevent contamination.
Plastic containers	Plastic containers are used to temporarily hold small amounts. Using a micropipette in combination with measuring equipment for filling containers to volume can reduce the risk of contamination from such operations. Store such containers filled with ultrapure water and then discard the contents and rinse them with fresh ultrapure water before use.
Micropipette rinsing bottles	When using measuring equipment to fill containers to volume, using a micropipette instead of a rinse bottle can help avoid contamination. Filling a rinse bottle with ultrapure water for use is not recommended, because contamination from the tip end or substances leached from the plastic container are likely to contaminate the ultrapure water.
Eluent bottles	A GL-45 medium bottle that allows checking the condition of the eluent and that is easy to clean is recommended. Since eluents are aqueous solutions that contain only a few mmol/L of a salt or acid, simply rinsing eluent bottles several times with ultrapure water after use will provide ample cleaning effect. However, using a detergent intended specifically for glassware is not recommended because it could cause contamination. To minimize ionic contamination, eluent bottles should also be dedicated exclusively to ion chromatography.
Suction filters	Due to the large surface area of filters immersed in eluent bottles, they are among the most susceptible to contamination. When replacing the eluent with a newly prepared solution that differs in composition from the previous one, care should be taken to avoid contamination. This can be achieved by performing a single solution exchange with ultrapure water or a small portion of the new eluent before placing the filter into the new eluent bottle.

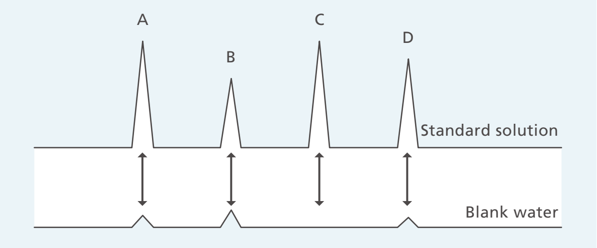
2-1-2. Contamination of Blank Water

Blank water is generally analyzed after the system is started up and the baseline has stabilized to check for the presence of peaks, caused by injection, that could interfere with analysis. It is used to determine whether or not the ion chromatograph system is operating normally.

If the water injected for blank water analysis is of the same quality as the water used to prepare the eluent, then no peaks other than the system peaks should appear if there is no contamination.
Blank water must be collected directly from the ultrapure water system in a manner that prevents contamination.

Phenomena that are Likely to Occur

Contaminant components in blank water are detected as positive peaks if they are ions that can be separated and detected with the column used for analysis.



How to Identify the Source of Contamination

Analyze a series of several blanks from the same vial. If there are no chromatogram changes, the contamination is likely to be in the blank water. If the peak sizes successively change with each of the several analyses, then consider the possibility of contamination from sources other than the blank water (such as autosampler injection actions).

How to Reduce Contamination

If the vial is identified as the contamination source, measures such as using tweezers or gloves to prevent contamination from handling and reviewing storage practices should be taken. It is also important to check whether the contamination can be avoided by rinsing with ultrapure water or pre-rinsing with the solution to be dispensed.

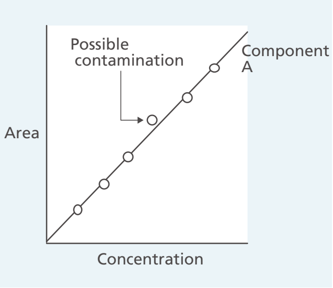
Water	Use water of the same quality as the water used to prepare the eluent. Using stored water or water generated by a different ultrapure water filtration equipment might result in detecting unknown peaks on the baseline.
Vials	Vials with a polypropylene body are typically used for ion chromatography, but glass vials are sometimes used, depending on the type of sample solution or the purpose of analysis. Checking the vials for contamination in advance, by analyzing water or eluent, is recommended. Depending on the vial storage state, contamination might occur during storage as well. Usage Precautions Due to the small capacity of vials (a few mL), vial or septum contamination might occur during storage or blank water might become contaminated during handling, which could result in detecting peaks on chromatograms. Vial contamination can be confirmed by placing ultrapure water in the vial and analyzing it in an ion chromatograph. If detected peaks affect the purpose of analysis, place fresh ultrapure water in the same vial and analyze it again to check for the presence of peaks.

2-1-3. Contamination during Standard Solution Preparation

Standard solutions are used to prepare calibration curves for quantitative analysis, so they must be prepared in a state with no contamination. Typically, standard solutions are prepared as a concentrated mixture, with stepped quantities of the standard mixture dispensed into multiple volumetric flasks, which are then filled to volume with ultrapure water.
Even if the multiple volumetric flasks have the same contamination level, the volumetric flasks used to prepare low-concentration standard solutions will have a larger effect on the prepared concentration

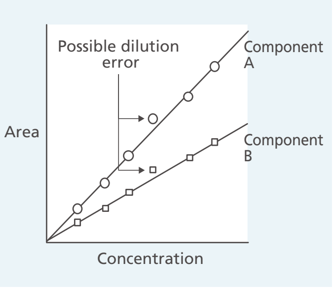
Phenomena that are Likely to Occur

The peaks in chromatograms corresponding to contaminated ions will become larger.



How to Identify the Source of Contamination

The type of contaminated ion and the process step where contamination occurred can be determined by creating a calibration curve and identifying distinct deviations in the plotted data.
If a data point plotted for respective ion concentrations is distinctly higher, rather than due to normal variability in area (height), then there is a high probability that contamination has occurred.



If multiple components show similarly increased peak sizes at the same concentration level, a dilution error is the more probable cause.

How to Reduce Contamination

Contamination from equipment used to prepare standard solutions must be eliminated.

Water	Use water of the same quality as the water used to prepare the eluent. Using stored water or water generated by a different ultrapure water filtration equipment might result in detecting unknown peaks on the baseline.
PP volumetric flasks	Screw-top polypropylene volumetric flasks are recommended. That configuration enables easy cleaning inside the cap. Stopper-type flasks closed by the same method as glass volumetric flasks require extra care to prevent contamination when cleaning the stopper area. Keeping the flasks filled with ultrapure water during storage is recommended. Discard the stored water and rinse the flask with fresh ultrapure water before use.
Plastic containers	Plastic containers are used to temporarily hold small amounts. Using a micropipette in combination with volumetric flasks for filling them to volume can eliminate contamination from such operations. Store such containers filled with ultrapure water and then discard the contents and rinse them with fresh ultrapure water before use.
Micropipettes	When using measuring equipment to fill containers to volume, using a micropipette instead of a rinse bottle can help avoid contamination.
Vials	Polypropylene vials are typically used for ion chromatography, but glass vials are sometimes used, depending on the type of sample solution or the purpose of analysis. Usage Precautions Due to the small capacity of vials (a few mL), vial contamination during storage could cause sample solution contamination that results in detecting peaks on chromatograms. Vial contamination can be confirmed by placing ultrapure water in the vial and analyzing it in an ion chromatograph. When dispensing standard solutions, you must use vials that either have been stored in a manner that produces no blank peaks at analytically significant levels, or have been cleaned with ultrapure water.

Notes:
· Water in rinse bottles might be contaminated and not recommended for volumetric flask measuring operations.
· Contamination can be reduced by using a micropipette for volumetric filling operations.

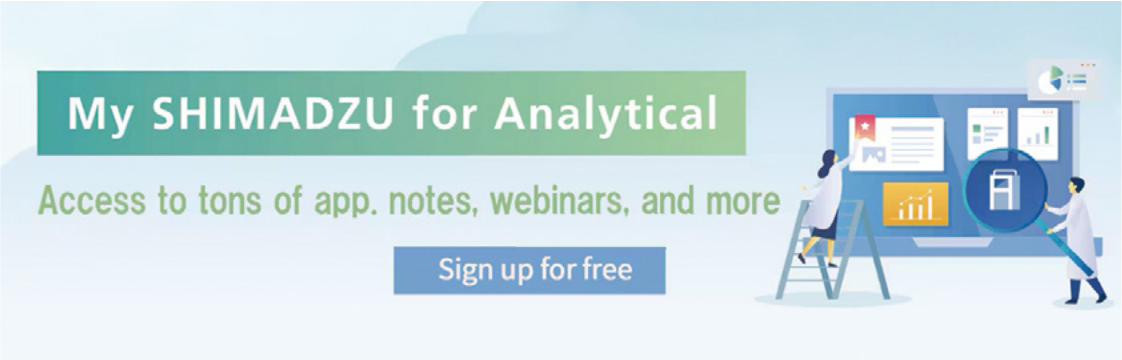
2-2. Other Information

The following provides some websites that provide a summary of information useful for ion chromatography.

2-2-1. What is My SHIMADZU ?

web

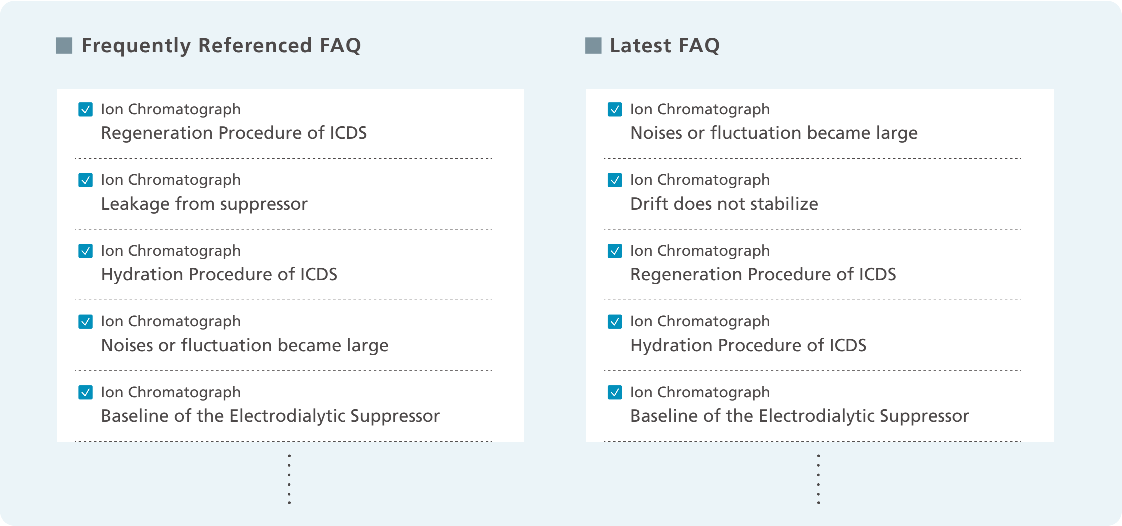
Information about ion chromatography-related applications and analytical considerations are shared through this web site.



2-2-2. Ion Chromatography FAQ

web

This website includes a summary of commonly asked questions about ion chromatography.



Frequently Referenced FAQ

- ☑ Ion Chromatograph
  Regeneration Procedure of ICDS
- ☑ Ion Chromatograph
  Leakage from suppressor
- ☑ Ion Chromatograph
  Hydration Procedure of ICDS
- ☑ Ion Chromatograph
  Noises or fluctuation became large
- ☑ Ion Chromatograph
  Baseline of the Electrodialytic Suppressor

⋮

Latest FAQ

- ☑ Ion Chromatograph
  Noises or fluctuation became large
- ☑ Ion Chromatograph
  Drift does not stabilize
- ☑ Ion Chromatograph
  Regeneration Procedure of ICDS
- ☑ Ion Chromatograph
  Hydration Procedure of ICDS
- ☑ Ion Chromatograph
  Baseline of the Electrodialytic Suppressor

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2-2-3. Maintenance Parts

For parts required to maintain instruments that are not included in this catalog, refer to the instruction manual or other documentation provided with your instrument.

Shimadzu Ion Chromatograph

Nexera IC

Make Every Analysis Count

Every day, laboratories around the world carry out regulatory-compliant analyses to safeguard the environment and protect human health. Ion chromatography plays a critical role in water quality testing, driving the need for intelligent analytical instruments that enable users of all experience levels to deliver accurate, reliable results with complete confidence. The Nexera IC ion chromatograph combines a compact footprint with uncompromising performance, enabling anyone to perform analysis effortlessly and efficiently.

Compact & Cost-Effective

Essential analytical functions are seamlessly integrated into a compact, space-efficient design, while thoughtful engineering and proprietary software minimize maintenance and reduce downtime. The result is faster, more efficient day-to-day operation and consistently reliable analytical results.

Effortless Efficiency

An innovative user interface makes operation effortless, allowing anyone to perform analysis with confidence. Complementary software streamlines daily workflows and ensures the instrument delivers stable, reliable performance every day.

Streamlined Automation

Advanced automation intelligently monitors system status and results to prevent errors, ensuring reliable data no matter the user's experience level. By streamlining tasks, it also reduces workload and boosts overall efficiency of the analytical workflow.

Streamlined Size, Expanded Analytical Capability

Standing under 50 cm, the Nexera IC allows easy eluent access, while its 52 cm-wide single-analysis system optimizes lab space. An optional IC-150D dual injection system enables simultaneous anion and cation analysis for enhanced versatility.

Single Analysis System

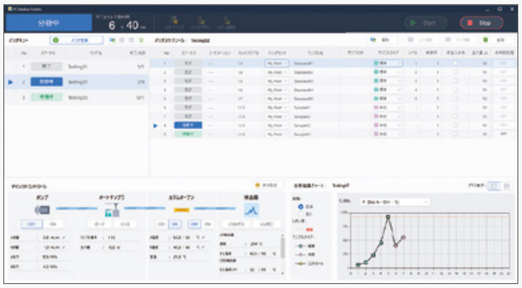
Dual Analysis System

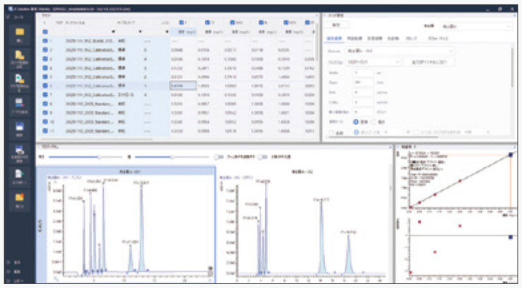
Single Analysis System
(Manual Injector)

All-in-One Software for Complete Data Management

IC Solution

IC Solution, the dedicated software for the ion chromatograph, combines routine and advanced analysis functions in a single, intuitive interface. Multiple quantitative results—including detection of outliers—can be reviewed at a glance, and comprehensive reports are easily generated from the analysis results.


IC Solution Data Acquisition Window


IC Solution Data Analysis Window

IC Support Software

The software supports daily operations, delivers comprehensive system management tools. It handles core ion analysis tasks like eluent monitoring and column tracking, records consumables usage, offers interactive troubleshooting, provides links to maintenance videos, and collects analysis data for easy validation support.


IC Support Software Home Screen

Product

Shimadzu Corporation
www.shimadzu.com/an/