Access to your success
SHIMADZU

C196-E039A

Enhanced Reliability of Ion Analysis

Shimadzu VP Series

Ion Chromatograph

High Performance Ion Chromatograph System

Enhanced Reliability of Ion Analysis

Discover Shimadzu's Ion Chromatograph, a breakthrough alternative to traditional suppressed systems.

The most important prerequisite in chromatographic ion analysis is, of course, the ability to acquire reliable data. To obtain trustworthy quantitative values, *repeatability*, *accuracy*, a *wide dynamic range* (extent of calibration curve linearity), and *adequate resolution* are fundamental. Truly exceptional analytical instrumentation, however, also strives for *high sensitivity*, *speed*, and *easy use* and *maintenance*. Where does one turn, then, for such excellence in an ion chromatograph system?

The answer lies in the progressive, nonsuppressed Shimadzu VP Series Ion Chromatograph. Merging innovative columns and mobile phases with high precision temperature control, pulse-free solvent delivery units and other exceptional hardware, our Ion Chromatograph offers convenient, dependable, sensitive ion analysis, at an affordable price.

High Repeatability and Wide Dynamic Range

The high repeatability and wide dynamic range of the VP Series Ion Chromatograph facilitate acquisition of far more reliable data than that gathered by the less advanced, suppressed instrumentation. Suppressed ion chromatographs perform the ion exchange reaction in the suppressor. The suppressor, however, adversely affects repeatability and is responsible for a loss of calibration curve linearity at low concentrations, introducing significant error at values below 1 ppm.

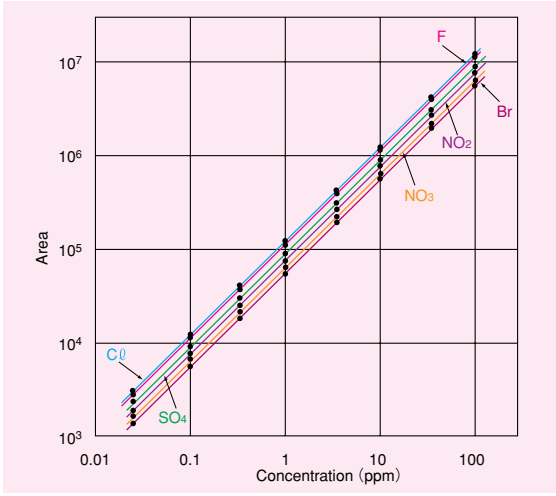
Example of Anion Analysis Repeatability (n=5)

	F	Cl	NO_2-N	NO_3-N	SO_4
ppm	1.00	1.00	0.30	0.25	1.00
RSD(%)	0.41	0.53	0.15	1.30	0.48
ppm	0.100	0.200	0.025	0.030	0.120
RSD(%)	0.42	0.76	0.44	1.03	3.95

Example of Cation Analysis Repeatability (n=5)

	Na	NH_4	K	Mg	Ca
ppm	1.0	1.0	1.0	1.0	1.0
RSD(%)	0.24	0.23	0.40	0.20	0.35
ppm	0.20	0.35	0.15	0.10	0.10
RSD(%)	0.50	1.63	2.07	0.57	0.99

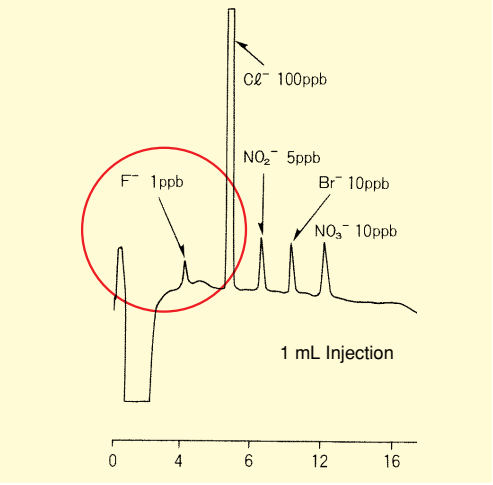
Example of a Calibration Curve



Linearity (45° at log-log) is consistent from low to high concentrations.

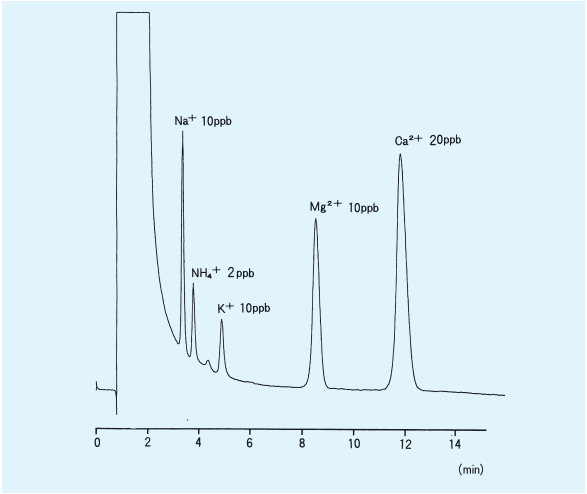
Enhanced Quantitative Precision, Even for F^-

Conventional ion chromatography tends to bury F^- in its solvent front, lowering expectations of quantitative accuracy and repeatability. However, the combination of the Shim-pack IC-A3 anion column and an optimized mobile phase selectively delays the elution of F^-. This deceleration enables precise quantification of 1 ppb F^-, as a peak on a flat baseline, without condensation. Similarly, the nonsuppressed ion chromatograph's highly flexible mobile phase can separate inorganic ions from organic acids.



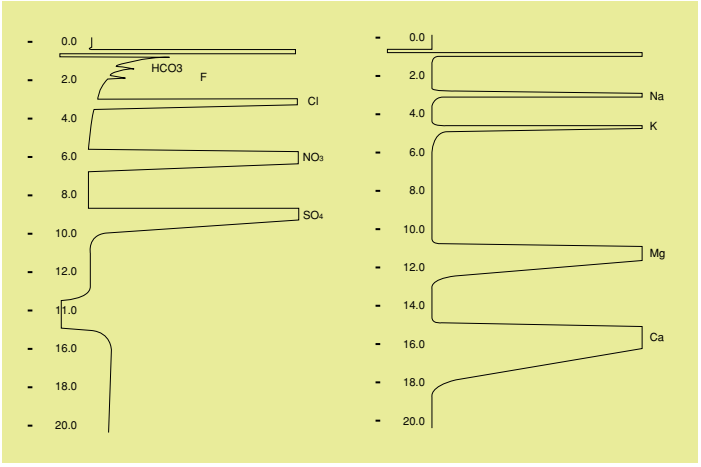
Improvement in Simultaneous Analysis of Monovalent and Divalent Cations

The VP Series High Performance Ion Chromatograph System can simultaneously analyze monovalent and divalent cations under isocratic conditions with the Shim-pack IC-C3 cation column. This newly developed column even allows extremely sensitive analysis of transition metal ions. Better still, one quick run concurrently quantifies neighboring peaks of varying concentration, such as 2 ppb NH_4^+ in 10 ppm Na^+ (1:1000), with high resolution.

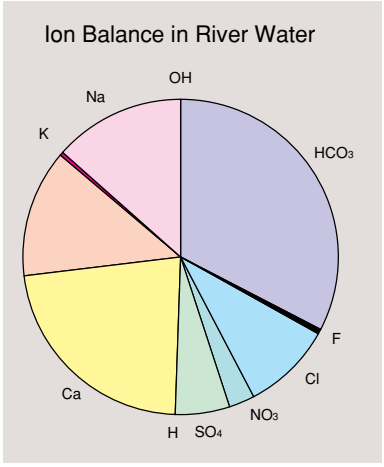


Precision Management Based on Measured Data

To ensure reliable data, Shimadzu's Ion Chromatograph verifies ion balance and proper conductivity from the data, a task termed *precision management*. First of all, the system confirms that anions and cations were exchanged equivalent for equivalent, a necessary condition for effective chromatograph function. It also assures that the conductivity measured corresponds with the calculated value. A suppressed ion chromatograph could never perform these checks because cannot assess bicarbonate ions separately. Of course, the VP Series Ion Chromatograph can reliably measure total carbonate ions, making precision management possible even in environmental water quality analysis.



Simultaneous Two-Channel Anion/Cation Analysis of River Water



As the VP Series Ion Chromatograph accurately measures bicarbonate ions, it can verify ion balance. This graph indicates accurate data because equal equivalents of anions and cations were exchanged.

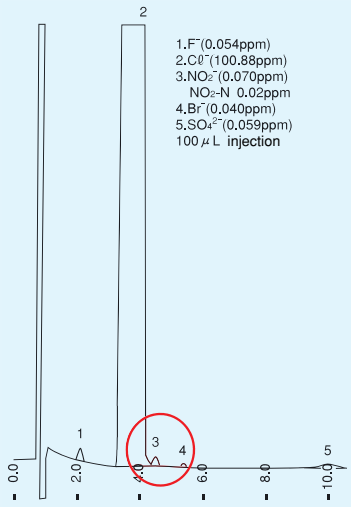
What is nonsuppressed ion chromatography?

Although a conductivity detector can be appropriate for studying inorganic anions, it cannot closely analyze highly conductive mobile phases. The current ion chromatographs enhance sensitivity through the use of specific mobile phases which lower, or suppress, the noise in the ion exchange reaction; these are referred to as suppressed ion chromatographs. However, the limited mobile phases that pertain to this method restrict the selectivity of component elution. Furthermore, problems with repeatability and calibration curve linearity accompany the suppressed reaction.

Without suppression, a new technology combining column and mobile phases has emerged to achieve more sensitive measurement. A suppressor would not work effectively in the mobile phases used by this new instrument, referred to as a nonsuppressed ion chromatograph. Instead, it takes advantage of a wide range of mobile phases, concentrations and pH to improve the quality of selective separation. Its enhanced selectivity enables the nonsuppressed ion chromatograph to separate and detect ions from solutions that may even include organic or weak acids.

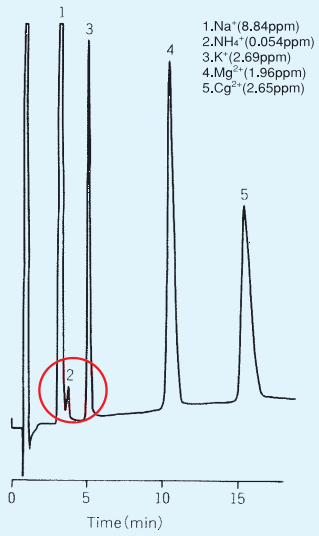
Always striving to incorporate new technology, Shimadzu bases the VP Series Ion Chromatograph on the nonsuppressed mobile phase design. We unite pulse-free solvent delivery, high precision temperature control and other cutting-edge hardware within a nonsuppressed ion chromatograph to help this technique live up to its fullest potential.

High Performance Applications



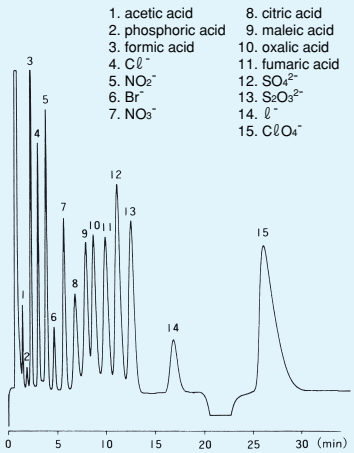
Analysis of test sample

In this example, trace amounts of F^-, NO_2^- (NO_2-N: 0.02 ppm) and Br^- ions are in solution with a large amount of Cl^-. The clean peak shapes and resolution given by the Shim-pack IC-C3 column enable ion enumeration, even for concentration differences of 10^3 or 10^4.



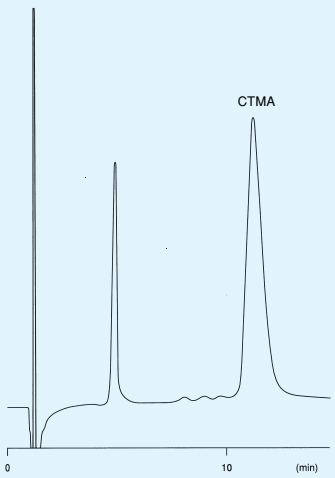
Analysis of Well Water (1/5 dilution)

The Shimadzu Ion Chromatograph clearly resolves both Na^+ and NH_4^+, despite a 10^3 difference in concentration.



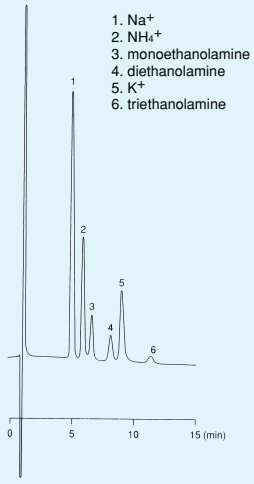
Simultaneous Separation of Inorganic and Organic Anions

The nonsuppression method delivers such a vast range of mobile phase selectivity that anions can be eluted from organic acids.



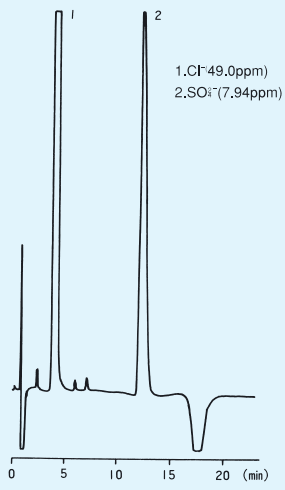
Analysis of Cetyltrimethyl-ammonium (CTMA) in a Commercial Rinse (1/20 dilution)

The Shim-pack IC-C3 can use a concentrated organic solvent for the mobile phase, enabling the Ion Chromatograph to analyze hydrophobic amines, while the existing suppressed methods have difficulty eluting them. Ions with multiple hydrophobic groups, such as triethyl and tetrabutyl ammonium, can also be studied.



Separation of Ethanolamines

The Shim-pack IC-C3 adeptly separates ethanolamines and monovalent inorganic cations.



Analysis of Acidic Substances (HCl, NOx, SOx) in Exhaust Fumes

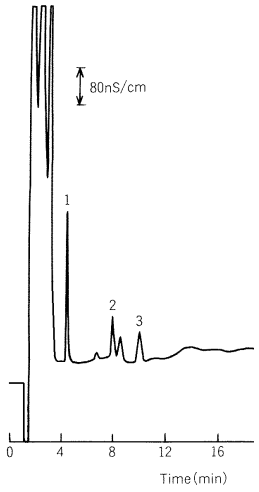
This chromatogram shows SOx found in a solution of SO_4^{-2} and H_2O_2. Alternatively, HCl can be dissolved and measured in 0.4% NaOH, or NO_3^- can be dissolved in a H_2O_2-sulfuric acid mixture and measured as NOx. Any of these can be measured with high sensitivity, but without complicated pretreatment.

For more details about the application data, please refer to the *Ion Chromatograph Application Data Book* (C190-E002).

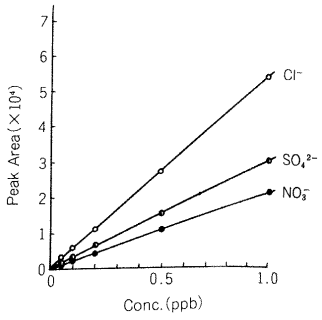
Automatic Concentration System

The Automatic Concentration System is used to assess samples with extremely low ion concentrations, such as purified water. In this system, the sample first passes through the concentration column connected to the high pressure flow changeover valve, and is then delivered to the analysis column. The Automatic Concentration System boasts such a high repeatability that when a sample has been concentrated to 40 mL, it accurately detects from the 10 ppt to subppb level with an RSD of 1-4%*.

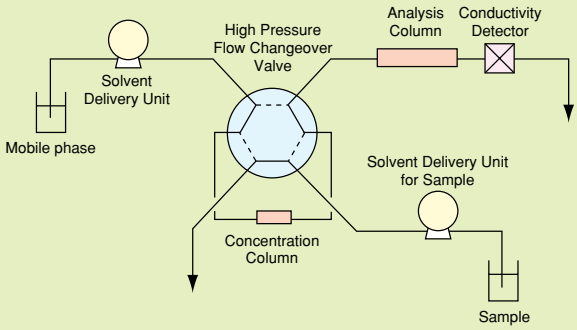
*Though difficult in some laboratory environments, all contamination must be prevented for accurate high sensitivity analysis.



Analysis of a Standard with the Automatic Concentration System



Calibration Curve (after blank correction) with the Automatic Concentration System

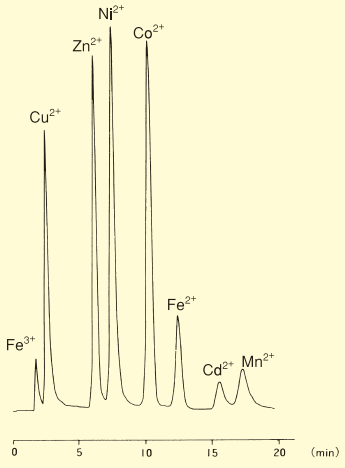


Flow Line of Automatic Concentration System

Widening Range of Reaction Detection Systems

The reaction detection system is easily upgraded with the VP Series Ion Chromatograph.

Transition Metal Analysis System

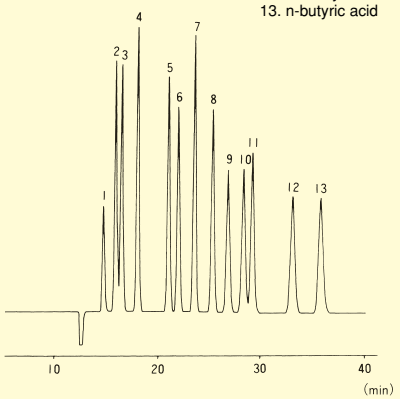


In the transition metal analysis system, PAR [4-(2-pyridylazo)-resorcinol], a reaction reagent in the postcolumn visible absorbance detector, promotes sensitive selective analysis of transition metals. Furthermore, after a system upgrade, the arsenazo III reagent can be used in the selective analysis of rare-earth metal ions.

The transition metal analysis system is used to measure free-existing Fe^{+2} and Fe^{+3}. An atomic absorption spectrophotometer (AA) or inductively coupled plasma spectrometer (ICP) is appropriate for total quantity analysis.
The water used in the mobile phase must not contain any oxidizing or reducing agents. Likewise, environmental contamination must be avoided in high sensitivity analysis.

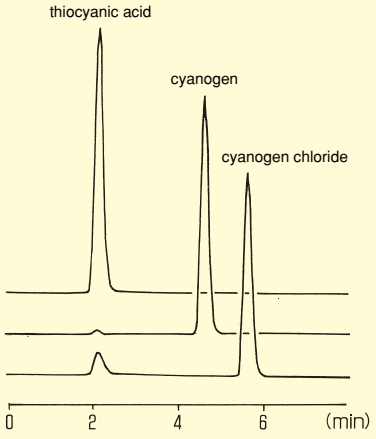
Organic Acid Analysis System

1. phosphoric acid
2. citric acid
3. pyruvic acid
4. malic acid
5. succinic acid
6. lactic acid
7. formic acid
8. acetic acid
9. levulinic acid
10. pyroglutamic acid
11. n-propionic acid
12. iso-butyric acid
13. n-butyric acid



The innovative Shimadzu postcolumn pH-buffered conductivity detector aids in high sensitivity, selective analysis of organic acids. Most samples, even those once demanding extensive pretreatment to eliminate matrix components, only require simple dilution or filtration for analysis. Furthermore, the organic acid analysis System can also study inorganic weak acids, including silicic, boric, cyanic, and carbonic acids.

Cyanogenic Compound Analysis System



This figure shows the selective results obtained with Shimadzu's unique separation and postcolumn methods, using 4-pyridinecarboxylic acid-pyrazolone. Matrix materials cause almost no interference. Analysis can be performed efficiently in 10-minute cycles; with a high performance column, it takes a mere seven minutes to study a specimen.

High Performance System Modules

The VP Series Ion Chromatograph System begins with various system modules, each engineered to exacting standards, and integrates them according to advanced nonsuppressor technology to provide unsurpassed performance and reliability.

<Anion/Cation Analysis System (Dual Flow Line Automated Analysis System)>

SCL-10A*SP*

The SCL-10A*SP* system controller provides integrated control of the entire VP Series HPLC system ana communication with CLASS-VP Chromatography Workstation.

CDD-10A*VP* Conductivity Detector

The innovative dual temperature control system and bipolar synchronous detection circuit provide high sensitivity and stability. Noise level: 0.004 μS/cm.

CTO-10AC*VP* Column Oven

Quick feedback and fan rotation-speed control mechanisms automatically maintain the column, detector and automatic switching valve at a constant temperature, even with ambient temperature fluctuations. Temperature control precision: ±0.1℃.

Reservoir Box

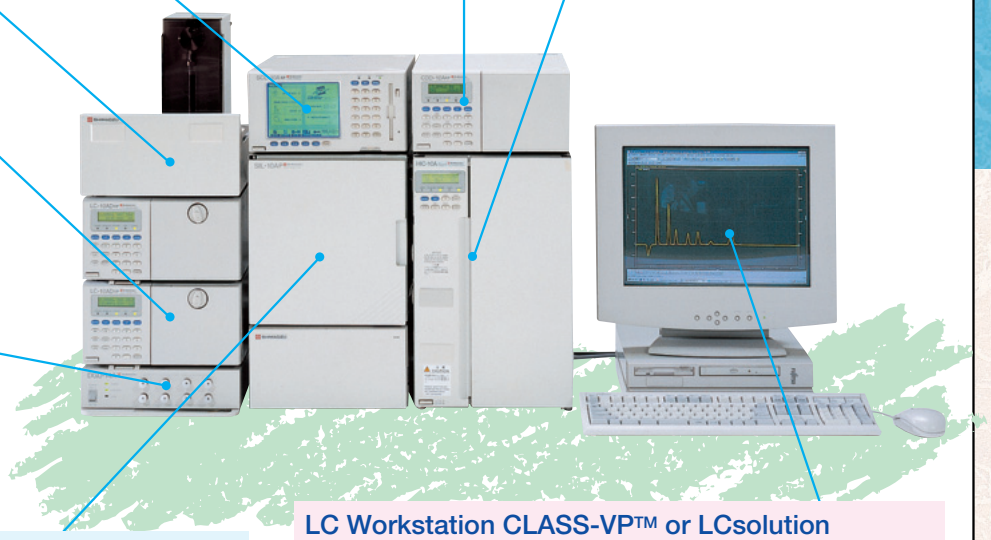
Conveniently accommodates up to seven 1-liter bottles.

LC-10AD*SP* Solvent Delivery Unit

Shimadzu's advanced micro-plunger technology offers pulse-free solvent delivery, optimizing detector performance. A high solvent delivery resolution of 6 nL/step ensures precise analysis.

DGU-14A Degasser Unit

Advanced degassing volume control enhances degassing stability to maintain high system precision. A reduced holding volume of 10 mL allows quick replacement of the mobile phase.



SIL-10AP Auto Sampler

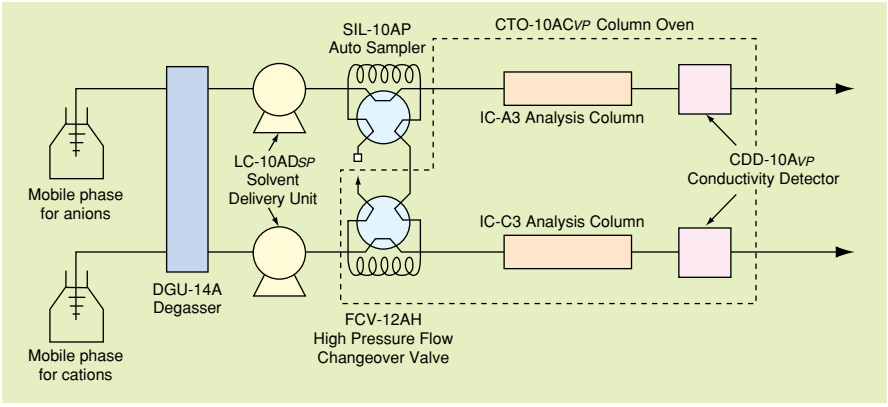
The ceramic flow changeover valve provides a durable, high-pressure seal, and the precision drive mechanism enables durable operation and long-term reliability. Injection volume range: 1-5000 μL; injection repeatability: RSD less than 1.0% (at 1mL); maximum number of samples: 100.

LC Workstation CLASS-VP™ or LCsolution

The LC workstation handles all LC control, data processing and report formatting. With the validation report for each module, automatic branch processing can perform various tasks, including system suitability tests, measurement and data searches using long file names. Furthermore, data can automatically be sent to network folders through automatic ASCII conversion or AIA Andi format.

Simultaneous Anion/Cation Analysis System

The analyst no longer needs to take time to prepare two samples; with one injection, the auto injector introduces one sample into both the main unit sample loop and the flow changeover valve sample loop.



SPD-M10A*VP*

Select the sensitivity detector that meets your requirements.

SPD-M10A*VP* This is an extremely sensitive 3-dimensional UV-Vis photodiode array detector. The absorption spectra of eluted components can be compared to those in a standard library to verify identification. This model is ideal for analyzing agricultural chemicals and organic contaminants.

SPD-10AV*VP* This high sensitivity UV-Vis detector is ideal for selectively detecting UV-absorbing ions, such as NO_3^- and Br^-, and cyanogen and transition metal ions.

C-R7A plus Data Processor

- Similar to a laptop, this data processor features a compact design with a sliding screen.
- The C-R7A plus incorporates four independent windows that allow it to perform independent 2-channel analysis asynchronously as though it were two units!
- It can run up to seven pretreatment programs in addition to the Chromatopac BASIC and event programming available in previous models. The Chromatopac exhibits superb programming capabilities because it is a chromatography-dedicated processor rather than a generalized personal computer.
- The System Check Program, one of the available supporting software packages, conveniently maintains the system modules according to the daily GLP/GMP/ISO requirements.
- The long-lasting thermal paper and complete HELP functions facilitate satisfaction of chromatographic analysis requirements.

For more details about the C-R7A plus, refer to Brochure No. C189-E016.

PIA-1000 Personal Ion Analyzer

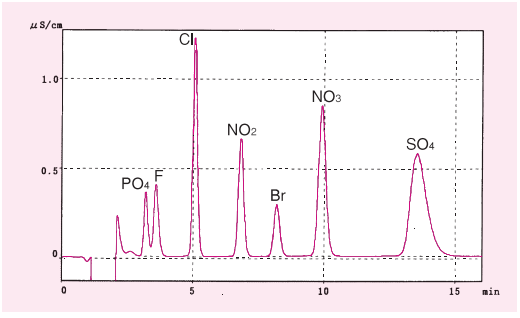
A portable and convenient ion chromatograph.

This instrument features interactive screen displays with an easy-to-use touch panel. From setting the measurement parameters to processing data, the analyst operates the PIA-1000 via on-screen keys.

The compact design incorporates both a data processor and floppy disk drive. Even better, with its 2 mm i.d. semi-micro column, this system consumes one-fifth of the solvent used by the 4.6 mm i.d. column.

Not only is the PIA-1000 compact for easy travel, but it offers a 3-way power supply- AC, special battery* and car battery* -so analysis can be performed right at the sampling site.
*optional accessories

The PIA-1000 starter kit includes the items necessary for a first run, including an analysis column, mobile phase, standard solution, and more. Order the starter kit which corresponds to your main unit. Kits are available for anion (see figure below) and cation analysis.



The PIA-1000 applies to anion analysis, as noted above, and monovalent/divalent cation analysis of environmental water.

- The PIA-1000 is more limited in terms of applications, appropriate samples, and sensitivity than the VP Series Ion Chromatograph.
- Data can be compressed on floppy disks for later analysis with CLASS-LC10.
- Linking the PIA-1000 to an SIL-10Ai Auto Injector enables automatic continuous analysis.

For more details on the PIA-1000, refer to Brochure No. C197-E000.

Configuration

Item	Part Number	Quantity	
		Single System	Dual System
SCL-10A*SP*	228-41250-xx	1	1
Option box VP	228-34708-xx	-	1
LC-10AD*SP*	228-36501-xx	1	2
DGU-12A	228-35358-xx	1	1
Reservoir box	228-34736-91	1	1
SIL-10AF	228-38599-xx	1	-
SIL-10AP	228-38598-xx	-	1
FCV-12AH	228-35323-xx	-	1
Piping kit for dual flow channels	228-41305-91	-	1
Piping kit for inert LC	228-33285-91	1	1
CTO-10AC*VP*	228-34611-xx	1	1
CDD-10A*VP*	228-41300-xx	1	1
Dual kit NS	228-41302-91	-	1
CLASS-VP Ver.6.12	223-05231-92	1	1

Columns

Item	Part Number	Column size	Quantity	
			Single System	Dual System
Shim-pack IC-A3	228-31076-91	150mm x 4.6mm i.d.	1	1
Shim-pack IC-SC1	228-36605-91	100mm x 4.6mm i.d.		1
Shim-pack IC-A3 (G)	228-31076-92	10mm x 4.6mm i.d.	(1)	(1)
Shim-pack IC-SC1 (G)	228-36605-92	10mm x 4.6mm i.d.		(1)

Specifications

Model Name	HIC-VP Super	PIA-1000
Type	Modular	Integrated
Solvent delivery system	Parallel double plunger	Serial double plunger
Flow rate setting range	0.001–9.999mL/min(0.001mL increments)	0.01–5mL/min(0.01mL increments)
Flow rate accuracy	Within ±2% or ±2μL	Within ±2% or ±2μL
Flow rate precision	Within ±0.3%	Within ±0.3%
Sample injection system	Variable injection volume	Manual Injection *1
Injection volume	0.1–50μL (0.1μL increments) *2	10μL
Oven control system	Forced air circulation	Block heater
Temperature setting range	4–80℃ (1℃ increments)	30–50℃ (1℃ increments)
Control temperature	(Room temperature −10) −80℃	(Room temperature +5) −50℃
Detector	Conductivity detector	Conductivity detector
Detection system	Non-suppressed	Non-suppressed
Cell volume	0.25μL	0.25μL
Range	0.01–51,200μS/cm	0.01–10000μS/cm
Data processing	External data processor	Internal functionality
External control	PC connection possible	Not available
Dimensions	W520×D420×H630(mm)	W260×D420×H300(mm)
Weight	72kg	15kg
Power	AC90–110V 955VA max	AC90–110V 100VA max
Ambient temperature	4–35℃	4–35℃

The specifications above pertain to a single flow basic configuration.
For modular type ion chromatographs, specifications may vary according to system configuration.
＊1: Autosampler (SIL-10Ai) can be connected for automatic continuous analysis.
＊2: Use of the optional 500μL loop allows a larger sample injection volume.

SHIMADZU

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